

**AFFILIATED INSTITUTIONS**

**REGULATIONS 2021**

**CHOICE BASED CREDIT SYSTEM**

**Common to all B. E. / B. Tech. Full-Time Programmes**

**(For the students admitted to B. E./B. Tech. Programme  
at various Non-Autonomous Affiliated Institutions)**

**DEGREE OF BACHELOR OF ENGINEERING / BACHELOR OF TECHNOLOGY**

This Regulation is applicable to the students admitted to B.E/B.Tech. Programmes at all Engineering Colleges affiliated to Anna University, Chennai (other than Autonomous Colleges) and to all the University Colleges of Engineering of Anna University, Chennai from the academic year 2021-2022 onwards.

**1. PRELIMINARY DEFINITIONS AND NOMENCLATURE**

In these Regulations, unless the context otherwise requires:

- I) **“Programme”** means Degree Programme, that is B.E./B.Tech. Degree Programme.
- II) **“Discipline”** means specialization or branch of B.E./B.Tech. Degree Programme, like Civil Engineering, Textile Technology, etc.
- III) **“Course”** means a theory or practical subject that is normally studied in a semester, like Mathematics, Physics, etc.
- IV) **“Director, Centre for Academic Courses”** means the authority of the University who is responsible for all academic activities of the Academic Programmes for implementation of relevant rules of this Regulations pertaining to the Academic Programmes.
- V) **“Chairperson”** means the Head of the Faculty.
- VI) **“Head of the Institution”** means the Principal of the College.
- VII) **“Head of the Department (HOD)”** means the Head of the Department concerned.
- VIII) **“Controller of Examinations (COE)”** means the authority of the University who is responsible for all activities of the University Examinations.
- IX) **“University”** means ANNA UNIVERSITY, CHENNAI.

## 2. ADMISSION

### 2.1 Candidates seeking admission to the first semester of the eight semesters B.E./ B.Tech. Degree Programme:

Should have passed the Higher Secondary Examinations of (10+2) Curriculum (Academic Stream) prescribed by the Government of Tamil Nadu with Mathematics, Physics and Chemistry as three of the four subjects of study under Part-III or any examination of any other University or authority accepted by the Syndicate of Anna University as equivalent thereto.

**(OR)**

Should have passed the Higher Secondary Examination of Vocational stream (Vocational groups in Engineering / Technology) as prescribed by the Government of Tamil Nadu.

### 2.2 Lateral entry admission

(i) The candidates who possess the Diploma in Engineering / Technology awarded by the State Board of Technical Education, Tamil Nadu or its equivalent are eligible to apply for Lateral entry admission to the third semester of B.E. / B.Tech., as per the rules fixed by Government of Tamil Nadu.

**(OR)**

(ii) The candidates who possess the Degree in Science (B.Sc.) (10+2+3 stream) with Mathematics as a subject at the B.Sc. Level are eligible to apply for Lateral entry admission to the third semester of B.E. / B.Tech.

Such candidates shall undergo two additional Engineering subject(s) in the **third and fourth semesters** as prescribed by the University.

## 3. PROGRAMMES OFFERED

B.E. / B.Tech. Programmes under the Faculty of Civil Engineering, Faculty of Mechanical Engineering, Faculty of Electrical Engineering, Faculty of Information and Communication Engineering and Faculty of Technology.

## 4. STRUCTURE OF PROGRAMMES

### 4.1 Categorization of Courses

Every B.E. / B. Tech. Programme will have a curriculum with syllabi consisting of theory and practical courses that shall be categorized as follows:

- i. **Humanities, Social Sciences and Management Courses (HSMC)** include Professional English, Communication skills etc.
- ii. **Basic Sciences Courses (BSC)** include Mathematics, Physics, Chemistry, Biology, Environmental Science etc.
- iii. **Engineering Sciences Courses (ESC)** include Engineering Practices, Engineering Graphics, Basics of Civil / Mechanical / Electrical / Electronics / Instrumentation, Computer Engineering, etc.
- iv. **Professional Core Courses (PCC)** include the core courses relevant to the chosen specialization/branch.

- v. **Professional Elective Courses (PEC)** include the elective courses relevant to the chosen specialization/ branch.
- vi. **Open Elective Courses (OEC)** include the courses offered by a branch to other branches, from the list specified in the respective curriculum of the B.E. / B. Tech. / B. Arch. Programmes.
- vii. **Employability Enhancement Courses (EEC)** include Project Work, Internship, Seminar, Professional Practices, Case Study and Industrial/Practical Training etc.
- viii. **Audit courses (AC)** include the courses such as Constitution of India, Sangam literature etc.

#### 4.2 **Personality and Character Development**

All students shall enroll, on admission, in any one of the personality and character development programmes NCC/NSS/NSO/YRC and undergo training / conduct activities for about 80 hours and attend a camp of about seven days. The training shall include classes on hygiene and health awareness and also training in first-aid. Alternately, activities of science, literature and arts also help for personality and character development. So, students shall conduct and participate actively in Science club/Literary Forum/Fine Arts activities for 80 hours and participate in at least ONE event.

**National Cadet Corps (NCC)** will have about 20 parades.

**National Service Scheme (NSS)** will have social service activities in and around the College / Institution.

**National Sports Organization (NSO)** will have Sports, Games, Drills and Physical exercises.

**Youth Red Cross (YRC)** will have activities related to social services in and around College/Institution.

While the training activities will normally be during weekends, the camp will normally be during vacation period.

**Science club** shall organise activities of popularisation of science and scientific temper through activities related to astronomy, works of great scientists from India and abroad, observing National Science Day, etc.

**Literary Club** like 'Tamil Ilakkiya Mandram' shall be formed, which shall organise colourful literary events to propagate good humanist values, morals and ethics reflected in the literature.

**Fine Arts Club** like music, painting and documentary films with social themes shall be encouraged.

Students who enroll and take active participation in anyone of the above activities for 80 hours and participate at least one event/programme will be given a certificate by the Head of the Institution and the copy of the same shall be forwarded to the Controller of Examinations for the purpose of record and scrutiny.

No fee shall be charged for all these activities.

#### 4.3 Number of courses per semester

Each semester curriculum shall normally have a blend of lecture courses not exceeding 7 Theory courses and Laboratory integrated theory courses and 4 Employability Enhancement Course(s) and Laboratory Courses. However, the total number of courses per semester shall not exceed 10. Each Course shall have credits assigned as per clause 4.4.

#### 4.4 Credit Assignment

Each course is assigned certain number of credits based on the following:

Contact period per week	CREDITS
1 Lecture Period	1
1 Tutorial Period	1
1 Laboratory Period (also for EEC courses like Seminar / Project Work /Case study / etc.)	0.5

#### 4.5. Industrial Training/ Internship

4.5.1 The students may undergo Industrial training for a period as specified in the Curriculum during the summer / winter vacation. In this case, the training has to be undergone continuously for a period of at least two weeks in an organization.

The students may undergo Internship at a Research organization / University/ Industry (after due approval from the Head of the Institution) for the period prescribed in the curriculum during the summer / winter vacation, in lieu of Industrial training. Attendance Certificate mentioning the period of Industrial Training / Internship and signed by the competent authority of the industry, as per the format provided by the Centre for Academic Courses shall be submitted to the Head of the Institution. The attendance certificate shall be forwarded to the COE, Anna University by the Head of the Institution for processing results.

4.5.2 If Industrial Training/ Internship is not prescribed in the curriculum, the student may undergo Industrial Training/ Internship optionally and the credits earned will be indicated in the Grade Sheet. If the student earns three credits in Industrial Training/ Internship, the student may drop one Professional Elective (only one professional elective can be dropped). In such cases, Industrial Training / Internship need to be undergone continuously from one organization or with a combination one two week and one four week from one/two organizations. However, if the number of credits earned is 1 or 2, then these credits shall not be considered for classification of the degree. Students shall get permission from the Head of the Institution for taking Industrial Training/Internship and the Certificate of completion of Industrial Training / Internship shall be forwarded to the COE.

DURATION OF TRAINING/INTERNSHIP	CREDITS
2 Weeks*	1
4 Weeks	2
6 Weeks	3

**\*1 Week = 40 Internship Hours**

#### 4.6 Industrial Visit

Every student is required to go for at least one Industrial Visit every semester starting from the second year of the Programme. The Heads of Departments shall ensure that necessary arrangements are made in this regard.

#### 4.7 Value Added Courses

The students may optionally undergo Value Added Courses (VAC) over and above the topics covered in the curriculum to obtain practical and industry specific knowledge. The credits earned through the Value Added Courses shall be over and above the total credit requirements prescribed in the curriculum for the award of the degree. **One / Two credit courses shall be offered by a Department of an institution with the prior approval from the Head of the Institution and the Centre for Academic courses without any additional fee charged from the students.** The details of the syllabus, time table and course coordinator may be sent to the Centre for Academic Courses at least one month before the course is offered for approval. **Students can take a maximum of two one credit courses / one two credit course** during the entire duration of the Programme.

#### 4.8 Online Courses

Students may be permitted to credit a maximum of two online courses, subject to a maximum of six credits, with the approval of the **Head of the Institution and the Centre for Academic Courses, in lieu of open elective / professional elective courses. The Head of the Institution shall form a three member committee with members as HOD and a faculty member from the Department of the student, HOD of any other branch of the Institution to ensure that the student has not studied such courses and would not repeat it again as Professional Core/Professional Elective/Open Elective courses.** Suitable online courses shall be chosen from the SWAYAM platform.

#### 4.9 Audit courses

The student may optionally study audit courses prescribed by the University and it will be mentioned in the Grade Sheet. However, it will not be considered for computation of CGPA.

#### 4.10 Advancement of Courses:-

The students who completed their final semester courses (except project work) in advance, shall be permitted to carry out their final semester Project Work for six months in an industry/research organization.

These students shall undergo the eighth semester courses other than the Project Work in the sixth and seventh semesters, provided they do not have current arrears and have a CGPA of 7.50 and above at the end of Semester IV. The Head of Department, in consultation with the faculty handling the said courses shall forward the proposal recommended by the Head of Institution to the Controller of Examinations through the Director, Centre for Academic Courses for approval at least 4 weeks before the commencement of the sixth semester of the programme for approval.

#### 4.11 Medium of Instruction

The medium of instruction is English for all courses, examinations, Seminar presentations and Project Work reports except for the programmes offered in Tamil Medium.

### 5. DURATION OF THE PROGRAMME

5.1 A student is ordinarily expected to complete the B.E. / B.Tech. Programme in 8 semesters (for HSC students) and six semesters (for Lateral Entry students) but in any case not more than 14 Semesters for HSC (or equivalent) students and not more than 12 semesters for Lateral Entry students.

5.1.1 A student is ordinarily expected to complete the B.E. Mechanical Engineering (Sandwich) Programme in 10 semesters (five academic years) but in any case not more than 18 Semesters for HSC (or equivalent) students.

5.2 Each semester shall normally consist of 75 working days or 540 periods of 50 minutes each. The Head of the Institution shall ensure that every teacher imparts instruction as per the number of periods specified in the syllabus and that the teacher teaches the full content of the specified syllabus for the course being taught.

5.3 The Head of the Institution may conduct additional classes for improvement, special coaching, conduct of model test etc., over and above the specified periods. But for the purpose of calculation of attendance requirement for writing the end semester examinations (as per clause 6) by the students, following method shall be used.

$$\text{Attendance} = \frac{\text{Percentage of Total no. of periods attended in all the courses per semester}}{(\text{No. of periods / week as prescribed in the curriculum}) \times 15} \times 100$$

The University Examination will normally follow immediately after the last working day of the semester as per the academic schedule prescribed from time to time.

5.4 The total period for completion of the programme reckoned from the commencement of the first semester to which the student was admitted shall not exceed the maximum period specified in clause 5.1 irrespective of the period of break of study (vide clause 18) in order that he/she may be eligible for the award of the degree (vide clause 16).

### 6. COURSE REGISTRATION

6.1 The institution is responsible for registering the courses that each student is proposing to undergo in the ensuing semester. Each student has to register for all courses to be undergone in the curriculum of a particular semester (with the facility to drop courses to a maximum of 6 credits (vide clause 6.2)). The courses dropped in earlier semesters can be registered in the subsequent semesters when offered.

The registration details of the student shall be approved by the Head of the Institution and forwarded to the Controller of Examinations. This registration is for undergoing the course as well as for writing the End Semester Examinations.

#### **The courses that a student registers in a particular semester may include**

- i. Courses of the current semester.
- ii. Courses dropped in the lower semesters and
- iii. Courses advanced to Semester VI and VII from Semester VIII (as per clause 4.10).

The maximum number of credits that can be registered in a semester is 36. However, this does not include the number of Re-appearance (RA) and Withdrawal (W) courses registered by the student for the appearance of Examination.

## 6.2 Flexibility to Drop courses

- 6.2.1 A student has to earn the total number of credits specified in the curriculum of the respective Programme of study in order to be eligible to obtain the degree.
- 6.2.2 From the second to final semesters, the student has the option of dropping existing courses in a semester during registration. Total number of credits of such courses shall not exceed 6 per semester. The student is permitted to drop the course(s) within 30 days of the commencement of the academic schedule.

## 7. ATTENDANCE REQUIREMENTS FOR COMPLETION OF THE SEMESTER

- 7.1 A student who has fulfilled the following conditions shall be deemed to have satisfied the requirements for completion of a semester.

Ideally every student is expected to attend all classes of all the courses and secure 100% attendance. However, in order to give provision for certain unavoidable reasons such as medical / participation in sports, the student is expected to attend at least 75% of the classes.

Therefore, he/she shall **secure not less than 75%** (after rounding off to the nearest integer) of overall attendance as calculated as per clause 5.3.

- 7.2 However, a student who secures overall attendance between 65% and 74% in the current semester due to medical reasons (prolonged hospitalization / accident / specific illness) / participation in sports events may be permitted to appear for the current semester examinations, subject to the condition that the student shall submit the medical certificate / sports participation certificate attested by the Head of the Institution. The same shall be forwarded to the Controller of Examinations for record purposes.
- 7.3 Students who **secure less than 65% overall attendance** shall not be permitted to write the University examination at the end of the semester and not permitted to move to the next semester. They are required to repeat the incomplete semester in the next academic year, as per the norms prescribed.

## 8. CLASS ADVISOR

There shall be a class advisor for each class. The class advisor will be one among the course-instructors of the class. He / She will be appointed by the HOD of the department concerned. The class advisor is the ex-officio member and the Convener of the class committee. The responsibilities for the class advisor shall be:

- To act as the channel of communication between the HOD and the students of the respective class.
- To collect and maintain various statistical details of students.
- To help the chairperson of the class committee in planning and conduct of the class committee meetings.

- To monitor the academic performance of the students including attendance and to inform the class committee.
- To attend to the students' welfare activities like awards, medals, scholarships and industrial visits.

## 9. CLASS COMMITTEE

9.1. Every class shall have a class committee consisting of teachers of the class concerned, student representatives and a chairperson, who is not teaching the class. It is like the 'Quality Circle' (more commonly used in industries) with the overall goal of improving the teaching-learning process. The functions of the class committee include:

- Solving problems experienced by students in the class room and in the laboratories.
- Clarifying the regulations of the degree programme and the details of rules therein particularly (clause 5 and 7).
- Informing the student representatives, the academic schedule including the dates of assessments and the syllabus coverage for each assessment.
- Informing the student representatives the details of Regulations regarding weightage used for each assessment. In the case of practical courses (laboratory / drawing / project work / seminar etc.) the breakup of marks for each experiment / exercise / module of work, should be clearly discussed in the class committee meeting and informed to the students.
- Analyzing the performance of the students of the class after each test and finding the ways and means of solving problems, if any.
- Identifying the slow-learners, if any, and requesting the teachers concerned to provide some additional help or guidance or coaching to such students.

9.2 The class committee for a class under a particular branch is normally constituted by the Head of the Department. However, if the students of different branches are mixed in a class (like the first semester which is generally common to all branches), the class committee is to be constituted by the Head of the Institution.

9.3 The class committee shall be constituted within the first week of each semester.

9.4 At least 4 student representatives (usually 2 boys and 2 girls) shall be included in the class committee, covering all the elective courses.

9.5 The chairperson of the class committee may invite the class adviser(s) and the Head of the Department to the class committee meeting.

9.6 The Head of the Institution may participate in any class committee meeting of the institution.

9.7 The chairperson is required to prepare the minutes of every meeting, submit the same to the Head of the Institution within two days of the meeting and arrange to circulate it among the students and teachers concerned. If there are some points in the minutes requiring action by the management, the same shall be brought to the notice of the Management by the Head of the Institution.

9.8 The first meeting of the class committee shall be held within one week from the date of commencement of the semester, in order to inform the students about the nature and weightage of assessments within the framework of the Regulations. Two or three subsequent meetings may be held in a semester at suitable intervals. **The Class**



**Committee Chairperson shall display the cumulative attendance particulars of each student on the Notice Board at the end of every such meeting to enable the students to know their attendance details to satisfy the clause 6 of this Regulation.** During these meetings the student members representing the entire class, shall meaningfully interact and express the opinions and suggestions of the other students of the class in order to improve the effectiveness of the teaching-learning process.

#### **10. COURSE COMMITTEE FOR COMMON COURSES**

Each common theory course offered to more than one discipline or group, shall have a "Course Committee" comprising all the teachers teaching the common course with one of them nominated as the course coordinator. The nomination of the course coordinator shall be made by the Head of the Department / Head of the Institution depending upon whether all the teachers teaching the common course belong to a single department or to several departments. The 'Course Committee' shall meet in order to arrive at a common scheme of evaluation for the test and shall ensure a uniform evaluation of the tests. Wherever feasible, the Course Committee may also prepare a common question paper for the internal assessment test(s).

#### **11. SYSTEM OF EXAMINATION**

- 11.1 Performance in each course of study shall be evaluated based on (i) continuous internal assessment throughout the semester and (ii) University examination at the end of the semester.
- 11.2 Each course, both theory and practical (including project work & viva voce examinations) shall be evaluated for a maximum of 100 marks.
  - 11.2.1 For all theory courses, the continuous internal assessment will carry **40 marks** while the End Semester University examination will carry **60 marks**.
  - 11.2.2 For all theory courses with laboratory component, the continuous internal assessment will carry **50 marks** while the End Semester University examination will carry **50 marks**.
  - 11.2.3 For all laboratory courses, the continuous internal assessment will carry **60 marks** while the End Semester University examination will carry **40 marks**.
  - 11.2.4 The continuous internal assessment for the project work will carry **40 marks** while the End Semester University examination will carry **60 marks**.
- 11.3 Industrial Training and Seminar shall carry 100 marks and shall be evaluated through internal assessment only.
- 11.4 The University examination (theory and practical) of 3 hours duration shall ordinarily be conducted between October and December during the odd semesters and between April and June during the even semesters.
- 11.5 The University examination for Project Work shall consist of evaluation of the final report submitted by the student or students of the project group (of not exceeding 4 students) by an external examiner and an internal examiner, followed by a viva-voce examination conducted separately for each student by a committee consisting of the external examiner, the supervisor of the project group and an internal examiner.

11.6 For the University examination of practical courses including Project Work, the internal and external examiners shall be appointed by the Controller of Examinations.

**12. PROCEDURE FOR AWARDING MARKS FOR INTERNAL ASSESSMENT**

For all theory, laboratory courses, theory courses with laboratory component and project work the continuous assessment shall be awarded as per the procedure given below:

**12.1 THEORY COURSES**

Two assessments each carrying 100 marks shall be conducted during the semester by the Department / College concerned. The total marks obtained in all assessments put together out of 200, shall be proportionately reduced for 40 marks and rounded to the nearest integer (This also implies equal weightage to the two assessments).

Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessment
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	
40	60	40	60	200*

\*The weighted average shall be converted into 40 marks for internal Assessment.

Two internal assessments will be conducted as a part of continuous assessment. Each internal assessment is to be conducted for 100 marks and will have to be distributed in two parts viz., Individual Assignment/Case study/Seminar/Mini project and Test with each having a weightage of 40% and 60% respectively. The tests shall be in written mode. The total internal assessment marks of 200 shall be converted into a maximum of 40 marks and rounded to the nearest integer.

**12.2 LABORATORY COURSES**

The maximum marks for Internal Assessment shall be 60 marks in case of practical courses. Every practical exercise / experiment shall be evaluated based on conduct of experiment / exercise and records to be maintained. There shall be at least one test. The criteria for arriving at the Internal Assessment marks of 60 is as follows: 75 marks shall be awarded for successful completion of all the prescribed experiments done in the Laboratory and 25 marks for the test. The total mark shall be converted into a maximum of 60 marks and rounded to the nearest integer.

Internal Assessment (100 Marks)*	
Evaluation of Laboratory Observation, Record	Test
75	25

\* Internal assessment marks shall be converted into 60 marks

### 12.3 THEORY COURSES WITH LABORATORY COMPONENT

If there is a theory course with laboratory component, there shall be two assessments: the first assessment (maximum mark is 100) will be similar to assessment of theory course and the second assessment (maximum mark is 100) will be similar to assessment of laboratory course respectively. The weightage of first assessment shall be 40 % and the second assessment be 60 %. **The weighted average of these two assessments shall be converted into 50 marks and rounded to the nearest integer.**

Assessment I (40% weightage) (Theory Component)		Assessment II (60% weightage) (Laboratory Component)		Total Internal Assessment
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Evaluation of Laboratory Observation, Record	Test	
40	60	75	25	200*

\*The weighted average shall be converted into 50 marks for internal Assessment.

### 12.4 PROJECT WORK

The student shall register for Project Work-I in pre-final semester and Project Work-II in final semester. Project work may be allotted to a single student or to a group of students not exceeding 4 per group. Project Work-II may/may not be a continuation of Project Work-I. If Project Work II is not a continuation of Project Work I, then the topic and constitution of the project team members need not be the same.

12.4.1 Project Work shall be carried out under the supervision of a “qualified teacher” in the Department concerned. In this context “qualified teacher” means the faculty member possessing (i) PG degree or (ii) Ph.D. degree.

12.4.2 The Project Work-II carried out in industry/academic/research institutions need not be a continuation of Project Work-I. In such cases, the Project Work-II shall be jointly supervised by a supervisor of the department and an expert as a joint supervisor from the organization and the student shall be instructed to meet the supervisor periodically and to attend the review committee meetings for evaluating the progress. The review meetings, if necessary, may also be arranged in online mode with prior approval from the Head of the Institution and suitable record of the meetings shall be maintained.

12.4.3 The Head of the Institutions shall constitute a review committee for Project Work for each programme. The review committee consists of supervisor, an expert from the Department and a project coordinator from the Department. If the project coordinator/expert member happens to be the supervisor, then an alternate member shall be nominated. In the case of Industrial Project, the review committee shall have the supervisor, the coordinator from industry and the project coordinator from the Department.

There shall be three reviews during the semesters VII and VIII by the review committee. The student shall make presentation on the progress made by him / her before the committee. The total marks obtained in the three reviews shall be **reduced for 40 marks** and rounded to the nearest integer (as per the scheme given in 12.4.4).

12.4.4 The project report shall carry a maximum of 20 marks. The project report shall be submitted as per the approved guidelines as given by the Director, Centre for Academic Courses. Same marks shall be awarded to every student within the project group for the project report. The viva-voce examination shall carry 40 marks. Marks are awarded to each student of the project group is based on the individual performance in the viva-voce examination.

Review I	Review II	Review III	End Semester Examinations				
			Project Report		Viva-Voce Examination		
10	15	15	Internal	External	Internal	External	Supervisor
			10	10	10	20	10

12.4.5 The last date for submission of the project report is on the last working day of the semester. If a student fails to submit the project report on or before the specified deadline or the student has submitted the project report but did not appear for the viva-voce examination, it will be considered as fail in the Project Work and the student shall re-register for the same in the subsequent semester.

## 12.5 OTHER EMPLOYABILITY ENHANCEMENT COURSES

- (a) The Seminar / Case Study / Mini Project course is to be considered as purely INTERNAL (with 100% internal marks only). Every student is expected to present a minimum of 2 seminars per semester before the evaluation committee and for each seminar, marks can be equally apportioned. The three member committee appointed by the Head of the Institution, consisting of the course coordinator and two experts from the Department, will evaluate the seminar and at the end of the semester, the marks shall be consolidated and taken as the final mark. The evaluation shall be based on the seminar paper (40%), presentation (40%) and response to the questions asked during presentation (20%).
- (b) The Industrial / Practical Training, Summer Project, Internship, shall carry 100 marks and shall be evaluated through internal assessment only. At the end of Industrial / Practical Training / Internship / Summer Project, the student shall submit an attendance certificate from the organization where he / she has undergone training and a brief report. The evaluation will be made based on this report and a viva-voce Examination, conducted internally by a three member Departmental Committee constituted by the Head of the Institution consisting of the course coordinator and two experts from the Department. The certificates (issued by the organization) submitted by the students shall be attached to the mark list sent by the Head of the Institution to the Controller of Examinations.
- (c) For all the courses under Employability Enhancement Courses Category, except the Project Work, the evaluation shall be done with 100% internal marks and as per the procedure described in clause 12.5 (a) / (b).

## 12.6 ASSESSMENT FOR VALUE ADDED COURSES

The one / two credit course shall carry 100 marks and shall be evaluated through **continuous assessments only**. Two Assessments as per the clause 12.1 or 12.2 shall be conducted by the Department concerned. The total marks obtained in the assessments shall be reduced to 100 marks and rounded to the nearest integer. A committee consisting of the Head of the Department, staff handling the course and a senior faculty member nominated by the Head of the Institution shall do the evaluation process. The list of students along with the marks and the grades earned shall be forwarded to the Controller of Examinations for appropriate action at least one month before the commencement of End Semester Examinations. The grades earned by the students for Value Added Courses will be recorded in the Grade Sheet, however the same shall not be considered for the computation of CGPA.

## 12.7 ASSESSMENT FOR ONLINE COURSES

Students may be permitted to credit two online courses (which are provided with certificate), subject to a maximum of six credits. **The online course of 3 credits can be considered instead of one elective course**. These online courses shall be chosen from the SWAYAM platform, provided the offering organisation conducts regular examination and provides marks. The credits earned shall be transferred and the marks earned shall be converted into grades and transferred, provided the student has passed in the examination as per the norms of the offering organisation. The details regarding online courses taken up by the student and marks/credits earned and the approval for the course from Centre for Academic Courses shall be sent to the Controller of Examinations, Anna University in the subsequent semester(s) along with the details of the elective(s) to be dropped.

**12.8. Internal marks approved by the Head of the Institution shall be displayed by the respective HODs within 5 days from the last working day.**

## 12.9 Attendance Record

Every teacher is required to maintain an 'ATTENDANCE AND ASSESSMENT RECORD', which consists of attendance marked in each lecture or practical or project work class, the test marks and the record of class work (topic covered), separately for each course. This should be submitted to the Head of the Department periodically (at least three times in a semester) for checking the syllabus coverage and the records of test marks and attendance. The Head of the Department will put his/her signature and date after due verification. At the end of the semester, the record should be verified by the Head of the Institution who will keep this document in safe custody (for five years). The University or any inspection team appointed by the University may verify the records of attendance and assessment of both current and previous semesters.

## 12.10 Conduct of Academic Audit by every Institution

Every educational institution shall strive for a better performance of the students by conducting the internal assessments as mentioned in Clause 12.

In order to ensure the above, Academic Audit is to be done for every course taught during the semester. For the internal assessments conducted for each course as per details provided in Clause 12, the academic records shall be maintained in the form of documentation for the individual assignments / case study report / report of mini project submitted by each student and assessment test question paper and answer script. Report of industrial training / internship shall also be maintained, if applicable. For laboratory courses students' record shall be maintained. Further, the attendance of all students shall be maintained as a record.

The Head of the Institution shall arrange to conduct the Academic Audit for every course in a semester by forming the respective committees with an external course expert as one of the members drawn from a Technical institution of repute near the institute.

The University or any inspection team appointed by the University may verify the records of Academic Audit report of the courses of both current and previous semesters, as and when required.

### **13. REQUIREMENTS FOR APPEARING FOR UNIVERSITY EXAMINATIONS**

A student shall normally be permitted to appear for the University Examinations for all the courses registered in the current semester (vide clause 6) if he/she has satisfied the semester completion requirements (as per clause 7).

Further, examination registration by a student is mandatory for all the courses in the current semester and all arrear(s) course(s) for the University examinations failing which, the student will not be permitted to move to the higher semester.

A student who has already appeared for any course in a semester and passed the examination is not entitled to reappear in the same subject for improvement of grades.

### **14. PASSING REQUIREMENTS**

- 14.1 A student who secures not less than 50% of total marks prescribed for the course [Internal Assessment + End semester University Examinations] with a minimum of 45% of the marks prescribed for the end-semester University Examination, shall be declared to have passed the course and acquired the relevant number of credits. This is applicable for both theory and laboratory courses (including project work).
- 14.2 If a student fails to secure a pass in a theory course / laboratory course (except electives), the student shall register and appear only for the end semester examination in the subsequent semester. In such case, the internal assessment marks obtained by the student in the first appearance shall be retained and considered valid for all subsequent attempts till the student secures a pass. However, from the third attempt onwards if a student fails to obtain pass marks (IA + End Semester Examination) as per clause 14.1, then the student shall be declared to have passed the examination if he/she secures a minimum of 50% marks prescribed for the University end semester examinations alone.
- 14.3 If the course, in which the student has failed, is a Professional Elective or an Open Elective course, the student may be permitted to complete the same course. In such case, the internal assessment marks obtained by the student in the first appearance shall be retained and considered valid for all subsequent attempts till the candidate secures a pass. However, from the third attempt onwards if a candidate fails to obtain pass marks (IA + End Semester Examination) as per clause 14.1, then the candidate shall be declared to have passed the examination if he/she secures a minimum of 50% marks prescribed for the University end semester examinations alone.

If any other Professional Elective or Open Elective course is opted by the student, the previous registration is cancelled and henceforth it is to be considered as a new Professional Elective or Open Elective course. The student has to register and attend the classes, earn the continuous assessment marks, fulfil the attendance requirements as per clause 7 and appear for the end semester examination.

- 14.4 If a student is absent during the viva - voce examination, it would be considered as fail. If a student fails to secure a pass in Project Work-I, **the student shall register** for the course again in the subsequent semester and can do Project Work-I and II together.
- 14.5 The passing requirement for the courses which are assessed only through purely internal assessments (EEC courses except Project Work and laboratory), is 50% of the internal assessment (continuous assessment) marks only.
- 14.6 A student can apply for revaluation of the student's semester examination answer paper in a theory course, as per the guidelines of the COE on payment of a prescribed fee along with prescribed application to the COE through the Head of the Institution. The COE will arrange for the revaluation and the results will be intimated to the student concerned through the Head of the Institution. Revaluation is not permitted for laboratory course and EEC courses.

## 15. AWARD OF LETTER GRADES

- 15.1 The award of letter grades will be decided using relative grading principle. The performance of a student will be reported using letter grades, each carrying certain points as detailed below:

Letter Grade	Grade Points*
O (Outstanding)	10
A + (Excellent)	9
A (Very Good)	8
B + (Good)	7
B (Average)	6
C (Satisfactory)	5
RA (Re-appearance)	0
SA (Shortage of Attendance)	0
W (Withdrawal)	0

A student is deemed to have passed and acquired the corresponding credits in a particular course if he/she obtains any one of the following grades: "O", "A+", "A", "B+", "B", "C".

'SA' denotes shortage of attendance (as per clause 7.3) and hence prevented from writing the end semester examinations. 'SA' will appear only in the result sheet.

“**RA**” denotes that the student has failed to pass in that course. “**W**” denotes **withdrawal** from the exam for the particular course. The grades RA and W will figure both in the Grade Sheet as well as in the Result Sheet. In both cases, the student has to appear for the End Semester Examinations as per the Regulations.

If the grade RA is given to **Theory Courses/ Laboratory Courses** it is **not required to satisfy the** attendance requirements (vide clause 7), but has to appear for the end semester examination and fulfil the norms specified in clause 14 to earn a pass in the respective courses.

If the grade RA is given to **EEC course (except Project Work), which are evaluated only through internal assessment**, the student shall register for the course again in the subsequent semester, fulfil the norms as specified in clause 14 to earn pass in the course. However, attendance requirement need not be satisfied.

- 15.2 For the Co-curricular activities such as National Cadet Corps (NCC)/ National Service Scheme (NSS) / NSO / YRC / Science club / Literary Club/ Fine Arts Club, a ‘completed’ remark will appear in the Grade Sheet on successful completion of the same. Every student shall put in a minimum of 75% attendance in the training and attend the camp or events of the clubs compulsorily. The training and camp or club events shall be completed during the first year of the programme. However, for valid reasons, the Head of the Institution may permit a student to complete this requirement in the subsequent years. **Successful completion of any one of the above co-curricular activities is compulsory for the award of degree.**
- 15.3 The grades O, A+, A, B+, B, C obtained for the one/two credit course (not the part of curriculum) shall figure in the Grade Sheet under the title ‘**Value Added Courses/Internship/Industrial training**’. The courses for which the grades obtained are RA, SA **will not figure in the Grade Sheet.**
- 15.4 For the students who complete the Audit Course satisfying attendance requirement, the title of the Audit Course will be mentioned in the Grade Sheet. If the attendance requirement is not satisfied, it will not be shown in the **Grade Sheet.**
- 15.5 **GRADE SHEET**

After results are declared, Grade Sheets will be issued to each student which will contain the following details:

- The college in which the student has studied
- The list of courses registered during the semester and the grade scored.
- The Grade Point Average (GPA) for the semester and
- The Cumulative Grade Point Average (CGPA) of all courses enrolled from first semester onwards.

GPA for a semester is the ratio of the sum of the products of the number of credits acquired for courses and the corresponding points to the sum of the number of credits acquired for the courses in the semester. CGPA will be calculated in a similar manner, considering all the courses registered from first semester. RA grades will be excluded for calculating GPA and CGPA.



$$\text{GPA / CGPA} = \frac{\sum_{i=1}^n C_i \text{ GP}_i}{\sum_{i=1}^n C_i}$$

where  $C_i$  is the number of Credits assigned to the course

$\text{GP}_i$  is the point corresponding to the grade obtained for each course

$n$  is number of all courses successfully cleared during the particular semester in the case of GPA and during all the semesters in the case of CGPA.

## 16 ELIGIBILITY FOR THE AWARD OF THE DEGREE

16.1 A student shall be declared to be eligible for the award of the B.E. / B.Tech. Degree provided the student has

- i. Successfully gained the required number of total credits as specified in the curriculum corresponding to the student's programme within the stipulated time.
- ii. Successfully completed the course requirements, appeared for the End - Semester examinations and passed all the subjects within the period as prescribed in clause 5.1 and 5.1.1.
- iii. Successfully passed any additional courses prescribed by the Director, Centre for Academic Courses whenever the student is readmitted under Regulations R-2021 from the earlier Regulations.
- iv. Successfully completed the NCC / NSS / NSO / YRC / Science Club / Literature Club / Fine Arts Club requirements.
- v. No disciplinary action pending against the student.
- vi. The award of Degree must have been approved by the Syndicate of the University.

## 16.2 CLASSIFICATION OF THE DEGREE AWARDED

### 16.2.1 FIRST CLASS WITH DISTINCTION

A student who satisfies the following conditions shall be declared to have passed the examination in **First class with Distinction**:

- Should have passed the examination in all the courses of all the eight semesters (10 Semesters in case of Mechanical (Sandwich) and 6 semesters in the case of Lateral Entry) in the student's First Appearance within **five** years (Six years in the case of Mechanical (Sandwich) and Four years in the case of Lateral Entry). Withdrawal from examination (vide Clause 17) will not be considered as an appearance.
- Should have secured a CGPA of not less than **8.50**.
- One year authorized break of study (if availed of) is included in the five years (Six years in the case of Mechanical (Sandwich) and four years in the case of lateral entry) for award of First class with Distinction.
- Should NOT have been prevented from writing end semester examination due to lack of attendance in any semester.

### 16.2.2 **FIRST CLASS:-**

A student who satisfies the following conditions shall be declared to have passed the examination in **First class**:

- Should have passed the examination in all the courses of all eight semesters (10 Semesters in case of Mechanical (Sandwich) and 6 semesters in the case of Lateral Entry) **within five years**. (Six years in case of Mechanical (Sandwich) and Four years in the case of Lateral Entry).
- One year authorized break of study (if availed of) or prevention from writing the End Semester examination due to lack of attendance (if applicable) is included in the duration of five years (Six years in case of Mechanical (Sandwich) and four years in the case of lateral entry) for award of First class.
- Should have secured a CGPA of not less than **6.50**.

### 16.2.3 **SECOND CLASS:-**

All other students (not covered in clauses 16.2.1 and 16.2.2) who qualify for the award of the degree (vide Clause 16.1) shall be declared to have passed the examination in **Second Class**.

**16.3** A student who is absent in end semester examination in a course / project work after having registered for the same shall be considered to have appeared in that examination for the purpose of classification. (subject to clause 17).

### **16.4 Photocopy / Revaluation**

A student can apply for photocopy of his/her semester examination answer paper in a theory course, as per the guidelines of the COE, on payment of a prescribed fee through proper application to the Controller of Examinations through the Head of the Institutions. The answer script is to be valued and justified by a faculty member, who has handled the subject and recommend for revaluation with the breakup of marks for each question. Based on the recommendation, the student can register for the revaluation through proper application to the Controller of Examinations. The Controller of Examinations will arrange for the revaluation and the results will be intimated to the student concerned through the Head of the Institutions. Revaluation is not permitted for practical courses and EEC courses.

A student can apply for revaluation of answer scripts for not exceeding 5 subjects at a time.

### **16.5 Review**

Students not satisfied with Revaluation can apply for Review of his/ her examination answer paper in a theory course, within the prescribed date on payment of a prescribed fee through proper application to the Controller of Examinations through the Head of the Institution.

Students applying for Revaluation only are eligible to apply for Review.

## **17. PROVISION FOR WITHDRAWAL FROM END-SEMESTER EXAMINATION**

- 17.1 A student may, for valid reasons, (medically unfit / unexpected family situations / sports approved by the Chairman, Sports Board and the HOD) be granted permission to withdraw from appearing for the end semester examination in any course or courses in **ANY ONE** of the semester examinations during the entire duration of the degree programme. The application shall be sent to the COE through the Head of the Institutions with required documents.
- 17.2 Withdrawal application is valid if the student is otherwise eligible to write the examination (Clause 7) and if it is made within TEN days after the date of the examination(s) in that course or courses and recommended by the Head of the Institution and approved by the Controller of Examinations. For a student to withdraw from a course / courses, he/she should have registered for the course, fulfilled the attendance requirements (vide clause 7) and earned continuous assessment marks.
- 17.2.1 Notwithstanding the requirement of mandatory 10 days, applications for withdrawal for special cases under extraordinary conditions will be considered on the merit of the case.
- 17.3 In case of withdrawal from a course / courses, the courses will figure both in the Grade Sheet as well as in the Result Sheet. However, withdrawal shall not be considered as an appearance for the eligibility of a student for First Class with Distinction.
- 17.4 If a student withdraws from writing end semester examinations for a course or courses, he/she shall register for the same in the subsequent semester and write the end semester examination(s).
- 17.5 If a student applies for withdrawal from Project Work, he/she will be permitted for the withdrawal only after the submission of project report before the deadline. However, the student may appear for the viva voce examination within 30/60 days after the declaration of results for Project Work I and II respectively and the same shall not be considered as reappearance.
- 17.6 Withdrawal is permitted for the end semester examinations in the final semester, as per clause 16.2.1.

## **18. PROVISION FOR AUTHORISED BREAK OF STUDY**

- 18.1 A student is permitted to go on authorised break of study for a maximum period of one year as a single spell.
- 18.2 Break of Study shall be granted only once for valid reasons for a maximum of one year during the entire period of study of the degree programme. However, in extraordinary situation the student may apply for additional break of study not exceeding another one year. If a student intends to temporarily discontinue the programme in the middle of the semester for valid reasons, and to re-join the programme in a subsequent year, permission may be granted based on the merits of the case provided he / she applies to the Director, Student Affairs in advance, but not later than the last date for registering for the end semester examination of the semester in question, through the Head of the Institution stating the reasons therefore and the probable date of re-joining the programme.

- 18.3 The student permitted to re-join the programme after break of study / prevention due to lack of attendance, shall be governed by the Curriculum and Regulations in force at the time of re-joining. The students re-joining in new Regulations shall register for additional courses, if any, as notified by the Centre for Academic Courses under change of Regulations. These courses may be from any of the semesters of the curriculum in force, so as to bridge the curriculum in force and the old curriculum. In such cases, the total number of credits to be earned by the student may be more than or equal to the total number of credits prescribed in the curriculum in force.
- 18.4 The authorized break of study is included in the duration specified for passing all the courses for the purpose of classification (vide Clause 16.2).
- 18.5 The total period for completion of the Programme reckoned from, the commencement of the first semester to which the candidate was admitted shall not exceed the maximum period specified in clause 5.1 irrespective of the period of break of study in order that he/she may be eligible for the award of the degree.
- 18.6 If any student is prevented for want of required attendance, the period of prevention shall not be considered as authorized 'Break of Study' (Clause 18.1).
- 18.7 If a student in Full Time mode wants to take up a job / start-up / entrepreneurship during the period of study he/she shall apply for authorised break of study for one year. The student shall join the job / start-up / entrepreneurship only after getting approval of the same by the Director, Centre for Academic Courses with due proof to that effect.
- 18.8 No fee is applicable to students during the Break of Study period.

## **19. DISCIPLINE**

- 19.1 Every student is required to observe disciplined and decorous behaviour both inside and outside the college and not to indulge in any activity which will tend to bring down the prestige of the University / College. The Head of the Institution shall constitute a disciplinary committee consisting of the Head of the Institution, Two Heads of Department of which one should be from the faculty of the student, to enquire into acts of indiscipline and notify the University about the disciplinary action recommended for approval. In case of any serious disciplinary action which leads to suspension or dismissal, then a committee shall be constituted including one representative from Anna University, Chennai. In this regard, the member will be nominated by the University on getting information from the Head of the Institution.
- 19.2 If a student indulges in malpractice in any of the University / internal examination he / she shall be liable for punitive action as prescribed by the University from time to time.

## **20. REVISION OF REGULATIONS, CURRICULUM AND SYLLABI**

The University may from time to time revise, amend or change the Regulations, curriculum, syllabus and scheme of examinations through the Academic Council with the approval of the Syndicate.

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**ANNA UNIVERSITY, CHENNAI**  
**NON - AUTONOMOUS AFFILIATED COLLEGES**  
**REGULATIONS 2021**  
**CHOICE BASED CREDIT SYSTEM**

**B.E. COMPUTER SCIENCE AND ENGINEERING**

**I. PROGRAM EDUCATIONAL OBJECTIVES (PEOs)**

**Graduates can**

- Apply their technical competence in computer science to solve real world problems, with technical and people leadership.
- Conduct cutting edge research and develop solutions on problems of social relevance.
- Work in a business environment, exhibiting team skills, work ethics, adaptability and lifelong learning.

**II. PROGRAM OUTCOMES (POs)**

- 1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- 2 **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- 4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- 5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- 6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- 7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- 8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- 9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 10 **Communication:** Communicate effectively on complex engineering activities with the

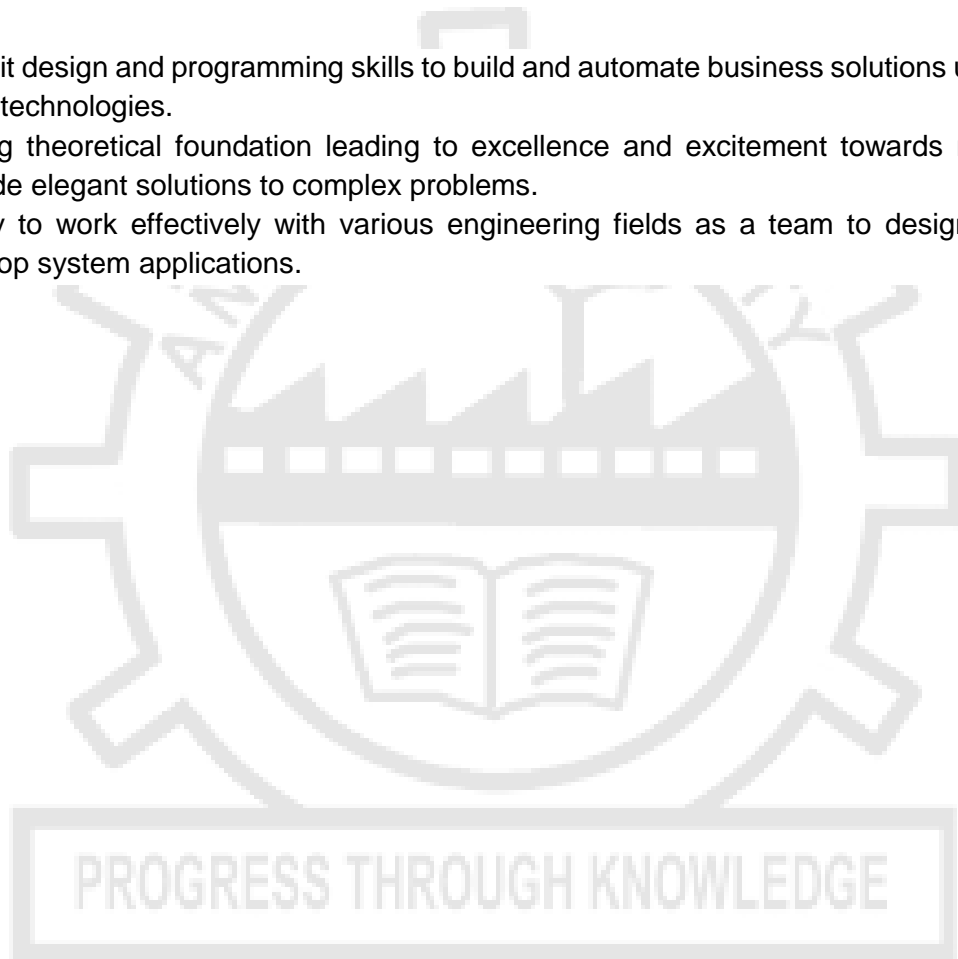
engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

- 11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- 12 **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

### III. PROGRAM SPECIFIC OUTCOMES (PSOs)

The Students will be able to

- Exhibit design and programming skills to build and automate business solutions using cutting edge technologies.
- Strong theoretical foundation leading to excellence and excitement towards research, to provide elegant solutions to complex problems.
- Ability to work effectively with various engineering fields as a team to design, build and develop system applications.



Mapping of Course Outcome and Programme Outcome																			
Year	Sem	Course name	PO												PSO				
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3		
I	I	Induction Programme																	
		Professional English - I	1.6	2.2	1.8	2.2	1.5	3	3	3	1.6	3	3	3	-	-	-		
		Matrices and Calculus	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-		
		Engineering Physics	3	3	1.6	1.2	1.8	1	-	-	-	-	-	1	-	-	-		
		Engineering Chemistry	2.8	1.3	1.6	1	-	1.5	1.8	-	-	-	-	1.5	-	-	-		
		Problem Solving and Python Programming	2	3	3	3	2	-	-	-	-	-	-	2	2	3	3		
		தமிழர் மரபு /Heritage of Tamils																	
		Problem Solving and Python Programming Laboratory	2	3	3	3	2	-	-	-	-	-	-	2	2	3	3	-	
		Physics and Chemistry Laboratory	3	2.4	2.6	1	1												
		2.6	1.3	1.6	1	1	1.4	1.8	-	-	-	-	1.3	-	-	-			
	English Laboratory §	3	3	3	3	1	3	3	3	3	3	3	3	3	-	-	-		
	II	Professional English - II	3	3	3	3	2.75	3	3	3	2.2	3	3	3	-	-	-		
		Statistics and Numerical Methods	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-		
		Physics for Information Science	3	1.3	2	1.3	2.3	1	1.3	-	-	-	-	2	-	-	-		
	Basic Electrical and Electronics Engineering	2	1.8	1	-	-	-	-	1	-	-	-	2	-	-	1			
	Engineering Graphics	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-			
	Programming in C	2	2	2	1	2	1	1	1	2	-	3	2	2	2	-			
	தமிழரும் தொழில்நுட்பமும் /Tamils and Technology																		
	Engineering Practices Laboratory	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1			
	Programming in C Laboratory	2	2	3	2	1	2	-	-	2	1	2	2	2	2				
	Communication Laboratory / Foreign Language §	2.4	2.8	3	3	1.8	3	3	3	3	3	3	3	-	-	-			
II	III	Discrete Mathematics	1	3	2	1	-	-	-	-	-	1	-	-	-	-	-		
	Digital Principles and Computer Organization	3	3	3	3	1.8	1.6	1	1	1	1	1.6	2.6	1.4	2.6	1.6			
	Foundations of Data Science	2	2	1	2	2	1	1	-	1	1	1	2	2	2	2			
	Data Structures	2	2	1	2	2	1	1	-	1	1	1	2	2	2	2			

		Object Oriented Programming	2	1	2	2	2	-	-	-	2	2	1	2	3	2	2
		Data Structures Laboratory	2	2	2	1	2	-	-	-	2	2	2	2	2	2	3
		Object Oriented Programming Laboratory	2	2	2	2	2	-	-	-	2	2	2	2	2	2	2
		Data Science Laboratory	2	2	2	2	1	-	-	-	2	2	2	2	2	3	2
		Professional Development <sup>§</sup>															
	<b>IV</b>	Theory of Computation	2	2	2	2	1	-	-	-	1	2	2	2	2	2	2
		Artificial Intelligence and Machine Learning	2	1	2	2	1	-	-	-	2	2	2	3	2	2	2
		Database Management Systems	2	2	3	2	1	-	-	-	2	2	2	2	2	2	3
		Algorithms	2.67	1.8	3	1				1.33				1		1	1
		Introduction to Operating Systems	2	2	2	2	1	-	-	-	2	2	2	2	1	2	2
		Environmental Sciences and Sustainability	2.8	1.8	1	1	-	2.2	2.4	-	-	-	-	1.8	-	-	-
		Operating Systems Laboratory	2	2	2	2	2	-	-	-	2	2	2	2	2	2	2
		Database Management Systems Laboratory	2	3	2	2	1	-	-	-	2	1	3	2	2	2	2
<b>III</b>	<b>V</b>	Computer Networks	-	1	-	-	1	-	-	-	-	1	-	-	-	1	1
		Compiler Design	3.00	2.80	2.60	2.20	2.00	-	-	-	2.60	2.00	1.60	2.40	1.80	1.80	2.00
		Cryptography and Cyber Security	3	2.6	2.6	2.6	2.8	-	-	-	2	-	-	1.2	2.8	2.8	3
		Distributed Computing	1.8	2.4	1.8	2.4	2	-	-	-	2.6	2.2	2.2	1.6	2	1.8	1.6
	<b>VI</b>	Object Oriented Software Engineering	2	2	1	2	2	-	-	-	-	1	1	2	2	2	1
		Embedded Systems and IoT	2.6	2	3	2.4	1.5	-	-	-	1	2.2	2.2	2.4	2.2	1.6	2.6
<b>IV</b>	<b>VII</b>	Human Values and Ethics															
		Summer internship															
	<b>VIII</b>	Project Work Internship															

1 - low, 2 - medium, 3 - high, '-' - no correlation



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**REGULATIONS 2021**  
**B. E. COMPUTER SCIENCE AND ENGINEERING**  
**CHOICE BASED CREDIT SYSTEM**  
**CURRICULUM AND SYLLABI FOR SEMESTERS I TO VIII**  
**SEMESTER I**

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IP3151	Induction Programme	-	-	-	-	-	0
<b>THEORY</b>								
2.	HS3152	Professional English - I	HSMC	3	0	0	3	3
3.	MA3151	Matrices and Calculus	BSC	3	1	0	4	4
4.	PH3151	Engineering Physics	BSC	3	0	0	3	3
5.	CY3151	Engineering Chemistry	BSC	3	0	0	3	3
6.	GE3151	Problem Solving and Python Programming	ESC	3	0	0	3	3
7.	GE3152	தமிழர் மரபு /Heritage of Tamils	HSMC	1	0	0	1	1
<b>PRACTICALS</b>								
8.	GE3171	Problem Solving and Python Programming Laboratory	ESC	0	0	4	4	2
9.	BS3171	Physics and Chemistry Laboratory	BSC	0	0	4	4	2
10.	GE3172	English Laboratory §	EEC	0	0	2	2	1
<b>TOTAL</b>				<b>16</b>	<b>1</b>	<b>10</b>	<b>27</b>	<b>22</b>

§ Skill Based Course

**SEMESTER II**

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	HS3252	Professional English - II	HSMC	2	0	0	2	2
2.	MA3251	Statistics and Numerical Methods	BSC	3	1	0	4	4
3.	PH3256	Physics for Information Science	BSC	3	0	0	3	3
4.	BE3251	Basic Electrical and Electronics Engineering	ESC	3	0	0	3	3
5.	GE3251	Engineering Graphics	ESC	2	0	4	6	4
6.	CS3251	Programming in C	PCC	3	0	0	3	3
7.	GE3252	தமிழரும் தொழில்நுட்பமும் /Tamils and Technology	HSMC	1	0	0	1	1
8.		NCC Credit Course Level 1#	-	2	0	0	2	2#
<b>PRACTICALS</b>								
9.	GE3271	Engineering Practices Laboratory	ESC	0	0	4	4	2
10.	CS3271	Programming in C Laboratory	PCC	0	0	4	4	2
11.	GE3272	Communication Laboratory / Foreign Language §	EEC	0	0	4	4	2
<b>TOTAL</b>				<b>17</b>	<b>1</b>	<b>16</b>	<b>34</b>	<b>26</b>

# NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

§ Skill Based Course

**SEMESTER III**

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	MA3354	Discrete Mathematics	BSC	3	1	0	4	4
2.	CS3351	Digital Principles and Computer Organization	ESC	3	0	2	5	4
3.	CS3352	Foundations of Data Science	PCC	3	0	0	3	3
4.	CS3301	Data Structures	PCC	3	0	0	3	3
5.	CS3391	Object Oriented Programming	PCC	3	0	0	3	3
<b>PRACTICALS</b>								
6.	CS3311	Data Structures Laboratory	PCC	0	0	3	3	1.5
7.	CS3381	Object Oriented Programming Laboratory	PCC	0	0	3	3	1.5
8.	CS3361	Data Science Laboratory	PCC	0	0	4	4	2
9.	GE3361	Professional Development <sup>§</sup>	EEC	0	0	2	2	1
<b>TOTAL</b>				<b>15</b>	<b>1</b>	<b>14</b>	<b>30</b>	<b>23</b>

<sup>§</sup> Skill Based Course

**SEMESTER IV**

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	CS3452	Theory of Computation	PCC	3	0	0	3	3
2.	CS3491	Artificial Intelligence and Machine Learning	PCC	3	0	2	5	4
3.	CS3492	Database Management Systems	PCC	3	0	0	3	3
4.	CS3401	Algorithms	PCC	3	0	2	5	4
5.	CS3451	Introduction to Operating Systems	PCC	3	0	0	3	3
6.	GE3451	Environmental Sciences and Sustainability	BSC	2	0	0	2	2
7.		NCC Credit Course Level 2 <sup>#</sup>		3	0	0	3	3 <sup>#</sup>
<b>PRACTICALS</b>								
8.	CS3461	Operating Systems Laboratory	PCC	0	0	3	3	1.5
9.	CS3481	Database Management Systems Laboratory	PCC	0	0	3	3	1.5
<b>TOTAL</b>				<b>20</b>	<b>0</b>	<b>10</b>	<b>30</b>	<b>22</b>

<sup>#</sup> NCC Credit Course level 2 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

**SEMESTER V**

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	CS3591	Computer Networks	PCC	3	0	2	5	4
2.	CS3501	Compiler Design	PCC	3	0	2	5	4
3.	CB3491	Cryptography and Cyber Security	PCC	3	0	0	3	3
4.	CS3551	Distributed Computing	PCC	3	0	0	3	3
5.		Professional Elective I	PEC	-	-	-	-	3
6.		Professional Elective II	PEC	-	-	-	-	3
7.		Mandatory Course-I <sup>&amp;</sup>	MC	3	0	0	3	0
<b>TOTAL</b>				-	-	-	-	<b>20</b>

<sup>&</sup> Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under Mandatory Course-I)

**SEMESTER VI**

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	CCS356	Object Oriented Software Engineering	PCC	3	0	2	5	4
2.	CS3691	Embedded Systems and IoT	PCC	3	0	2	5	4
3.		Open Elective – I <sup>*</sup>	OEC	3	0	0	3	3
4.		Professional Elective III	PEC	-	-	-	-	3
5.		Professional Elective IV	PEC	-	-	-	-	3
6.		Professional Elective V	PEC	-	-	-	-	3
7.		Professional Elective VI	PEC	-	-	-	-	3
8.		Mandatory Course-II <sup>&amp;</sup>	MC	3	0	0	3	0
9.		NCC Credit Course Level 3 <sup>#</sup>		3	0	0	3	3 <sup>#</sup>
<b>TOTAL</b>				-	-	-	-	<b>23</b>

<sup>\*</sup>Open Elective – I Shall be chosen from the list of open electives offered by other Programmes

<sup>&</sup> Mandatory Course-II is a Non-credit Course (Student shall select one course from the list given under Mandatory Course-II)

<sup>#</sup> NCC Credit Course level 3 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA

**SEMESTER VII / VIII\***

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	GE3791	Human Values and Ethics	HSMC	2	0	0	2	2
2.		Elective - Management <sup>#</sup>	HSMC	3	0	0	3	3
3.		Open Elective – II**	OEC	3	0	0	3	3
4.		Open Elective – III**	OEC	3	0	0	3	3
5.		Open Elective – IV**	OEC	3	0	0	3	3
<b>PRACTICALS</b>								
6.	CS3711	Summer internship	EEC	0	0	0	0	2
<b>TOTAL</b>				<b>14</b>	<b>0</b>	<b>0</b>	<b>14</b>	<b>16</b>

\*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

\*\* Open Elective II - IV (Shall be chosen from the list of open electives offered by other Programmes).

<sup>#</sup> Elective - Management shall be chosen from the Elective Management courses.

**SEMESTER VIII /VII\***

S. NO	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>PRACTICALS</b>								
1.	CS3811	Project Work/Internship	EEC	0	0	20	20	10
<b>TOTAL</b>				<b>0</b>	<b>0</b>	<b>20</b>	<b>20</b>	<b>10</b>

\*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

**TOTAL CREDITS: 162**

**ELECTIVE – MANAGEMENT COURSES**

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	GE3751	Principles of Management	HSMC	3	0	0	3	3
2.	GE3752	Total Quality Management	HSMC	3	0	0	3	3
3.	GE3753	Engineering Economics and Financial Accounting	HSMC	3	0	0	3	3
4.	GE3754	Human Resource Management	HSMC	3	0	0	3	3
5.	GE3755	Knowledge Management	HSMC	3	0	0	3	3
6.	GE3792	Industrial Management	HSMC	3	0	0	3	3

### MANDATORY COURSES I

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3081	Introduction to Women and Gender Studies	MC	3	0	0	3	0
2.	MX3082	Elements of Literature	MC	3	0	0	3	0
3.	MX3083	Film Appreciation	MC	3	0	0	3	0
4.	MX3084	Disaster Risk Reduction and Management	MC	3	0	0	3	0

### MANDATORY COURSES II

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3085	Well Being with Traditional Practices - Yoga, Ayurveda and Siddha	MC	3	0	0	3	0
2.	MX3086	History of Science and Technology in India	MC	3	0	0	3	0
3.	MX3087	Political and Economic Thought for a Humane Society	MC	3	0	0	3	0
4.	MX3088	State, Nation Building and Politics in India	MC	3	0	0	3	0
5.	MX3089	Industrial Safety	MC	3	0	0	3	0

PROGRESS THROUGH KNOWLEDGE

## PROFESSIONAL ELECTIVE COURSES: VERTICALS

Vertical I Data Science	Vertical II Full Stack Development	Vertical III Cloud Computing and Data Center Technologies	Vertical IV Cyber Security and Data Privacy	Vertical V Creative Media	Vertical VI Emerging Technologies	Vertical VII Artificial Intelligence and Machine Learning
Exploratory Data Analysis	Web Technologies	Cloud Computing	Ethical Hacking	Augmented Reality/Virtual Reality	Augmented Reality/Virtual Reality	Knowledge Engineering
Recommender Systems	App Development	Virtualization	Digital and Mobile Forensics	Multimedia and Animation	Robotic Process Automation	Soft Computing
Neural Networks and Deep Learning	Cloud Services Management	Cloud Services Management	Social Network Security	Video Creation and Editing	Neural Networks and Deep Learning	Neural Networks and Deep Learning
Text and Speech Analysis	UI and UX Design	Data Warehousing	Modern Cryptography	UI and UX Design	Cyber security	Text and Speech Analysis
Business Analytics	Software Testing and Automation	Storage Technologies	Engineering Secure Software Systems	Digital marketing	Quantum Computing	Optimization Techniques
Image and Video Analytics	Web Application Security	Software Defined Networks	Cryptocurrency and Blockchain Technologies	Visual Effects	Cryptocurrency and Blockchain Technologies	Game Theory
Computer Vision	DevOps	Stream Processing	Network Security	Game Development	Game Development	Cognitive Science
Big Data Analytics	Principles of Programming Languages	Security and Privacy in Cloud	Security and Privacy in Cloud	Multimedia Data Compression and Storage	3D Printing and Design	Ethics And AI

### **Registration of Professional Elective Courses from Verticals:**

Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E./B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to the Regulations 2021, Clause 4.10 (Amendments).

## PROFESSIONAL ELECTIVE COURSES: VERTICALS

### VERTICAL 1: DATA SCIENCE

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CCS346	Exploratory Data Analysis	PEC	2	0	2	4	3
2.	CCS360	Recommender Systems	PEC	2	0	2	4	3
3.	CCS355	Neural Networks and Deep Learning	PEC	2	0	2	4	3
4.	CCS369	Text and Speech Analysis	PEC	2	0	2	4	3
5.	CCW331	Business Analytics	PEC	2	0	2	4	3
6.	CCS349	Image and Video Analytics	PEC	2	0	2	4	3
7.	CCS338	Computer Vision	PEC	2	0	2	4	3
8.	CCS334	Big Data Analytics	PEC	2	0	2	4	3

### VERTICAL 2: FULL STACK DEVELOPMENT

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CCS375	Web Technologies	PEC	2	0	2	4	3
2.	CCS332	App Development	PEC	2	0	2	4	3
3.	CCS336	Cloud Services Management	PEC	2	0	2	4	3
4.	CCS370	UI and UX Design	PEC	2	0	2	4	3
5.	CCS366	Software Testing and Automation	PEC	2	0	2	4	3
6.	CCS374	Web Application Security	PEC	2	0	2	4	3
7.	CCS342	DevOps	PEC	2	0	2	4	3
8.	CCS358	Principles of Programming Languages	PEC	3	0	0	3	3

### VERTICAL 3: CLOUD COMPUTING AND DATA CENTER TECHNOLOGIES

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CCS335	Cloud Computing	PEC	2	0	2	4	3
2.	CCS372	Virtualization	PEC	2	0	2	4	3
3.	CCS336	Cloud Services Management	PEC	2	0	2	4	3
4.	CCS341	Data Warehousing	PEC	2	0	2	4	3
5.	CCS367	Storage Technologies	PEC	3	0	0	3	3
6.	CCS365	Software Defined Networks	PEC	2	0	2	4	3
7.	CCS368	Stream Processing	PEC	2	0	2	4	3
8.	CCS362	Security and Privacy in Cloud	PEC	2	0	2	4	3

### VERTICAL 4: CYBER SECURITY AND DATA PRIVACY

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CCS344	Ethical Hacking	PEC	2	0	2	4	3
2.	CCS343	Digital and Mobile Forensics	PEC	2	0	2	4	3
3.	CCS363	Social Network Security	PEC	2	0	2	4	3
4.	CCS351	Modern Cryptography	PEC	2	0	2	4	3
5.	CB3591	Engineering Secure Software Systems	PEC	2	0	2	4	3
6.	CCS339	Cryptocurrency and Blockchain Technologies	PEC	2	0	2	4	3
7.	CCS354	Network Security	PEC	2	0	2	4	3
8.	CCS362	Security and Privacy in Cloud	PEC	2	0	2	4	3



### VERTICAL 5: CREATIVE MEDIA

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CCS333	Augmented Reality/Virtual Reality	PEC	2	0	2	4	3
2.	CCS352	Multimedia and Animation	PEC	2	0	2	4	3
3.	CCS371	Video Creation and Editing	PEC	2	0	2	4	3
4.	CCS370	UI and UX Design	PEC	2	0	2	4	3
5.	CCW332	Digital marketing	PEC	2	0	2	4	3
6.	CCS373	Visual Effects	PEC	2	0	2	4	3
7.	CCS347	Game Development	PEC	2	0	2	4	3
8.	CCS353	Multimedia Data Compression and Storage	PEC	2	0	2	4	3

### VERTICAL 6: EMERGING TECHNOLOGIES

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CCS333	Augmented Reality/Virtual Reality	PEC	2	0	2	4	3
2.	CCS361	Robotic Process Automation	PEC	2	0	2	4	3
3.	CCS355	Neural Networks and Deep Learning	PEC	2	0	2	4	3
4.	CCS340	Cyber security	PEC	2	0	2	4	3
5.	CCS359	Quantum Computing	PEC	2	0	2	4	3
6.	CCS339	Cryptocurrency and Blockchain Technologies	PEC	2	0	2	4	3
7.	CCS347	Game Development	PEC	2	0	2	4	3
8.	CCS331	3D Printing and Design	PEC	2	0	2	4	3

**VERTICAL 7: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CCS350	Knowledge Engineering	PEC	2	0	2	4	3
2.	CCS364	Soft Computing	PEC	2	0	2	4	3
3.	CCS355	Neural Networks and Deep Learning	PEC	2	0	2	4	3
4.	CCS369	Text and Speech Analysis	PEC	2	0	2	4	3
5.	CCS357	Optimization Techniques	PEC	2	0	2	4	3
6.	CCS348	Game Theory	PEC	2	0	2	4	3
7.	CCS337	Cognitive Science	PEC	2	0	2	4	3
8.	CCS345	Ethics And AI	PEC	2	0	2	4	3

**OPEN ELECTIVES**

(Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories).

**OPEN ELECTIVES – I**

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OAS351	Space Science	OEC	3	0	0	3	3
2.	OIE351	Introduction to Industrial Engineering	OEC	3	0	0	3	3
3.	OBT351	Food, Nutrition and Health	OEC	3	0	0	3	3
4.	OCE351	Environment and Social Impact Assessment	OEC	3	0	0	3	3
5.	OEE351	Renewable Energy System	OEC	3	0	0	3	3
6.	OEI351	Introduction to Industrial Instrumentation and Control	OEC	3	0	0	3	3
7.	OMA351	Graph Theory	OEC	3	0	0	3	3

### OPEN ELECTIVES – II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OIE352	Resource Management Techniques	OEC	3	0	0	3	3
2.	OMG351	Fintech Regulation	OEC	3	0	0	3	3
3.	OFD351	Holistic Nutrition	OEC	3	0	0	3	3
4.	AI3021	IT in Agricultural System	OEC	3	0	0	3	3
5.	OEI352	Introduction to Control Engineering	OEC	3	0	0	3	3
6.	OPY351	Pharmaceutical Nanotechnology	OEC	3	0	0	3	3
7.	OAE351	Aviation Management	OEC	3	0	0	3	3

### OPEN ELECTIVES – III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS351	English for Competitive Examinations	OEC	3	0	0	3	3
2.	OMG352	NGOs and Sustainable Development	OEC	3	0	0	3	3
3.	OMG353	Democracy and Good Governance	OEC	3	0	0	3	3
4.	CME365	Renewable Energy Technologies	OEC	3	0	0	3	3
5.	OME354	Applied Design Thinking	OEC	3	0	0	3	3
6.	MF3003	Reverse Engineering	OEC	3	0	0	3	3
7.	OPR351	Sustainable Manufacturing	OEC	3	0	0	3	3
8.	AU3791	Electric and Hybrid Vehicles	OEC	3	0	0	3	3
9.	OAS352	Space Engineering	OEC	3	0	0	3	3
10.	OIM351	Industrial Management	OEC	3	0	0	3	3
11.	OIE354	Quality Engineering	OEC	3	0	0	3	3
12.	OSF351	Fire Safety Engineering	OEC	3	0	0	3	3
13.	OML351	Introduction to Non-destructive Testing	OEC	3	0	0	3	3
14.	OMR351	Mechatronics	OEC	3	0	0	3	3
15.	ORA351	Foundation of Robotics	OEC	3	0	0	3	3
16.	OAE352	Fundamentals of Aeronautical Engineering	OEC	3	0	0	3	3
17.	OGI351	Remote Sensing Concepts	OEC	3	0	0	3	3

18.	OAI351	Urban Agriculture	OEC	3	0	0	3	3
19.	OEN351	Drinking Water Supply and Treatment	OEC	3	0	0	3	3
20.	OEE352	Electric Vehicle Technology	OEC	3	0	0	3	3
21.	OEI353	Introduction to PLC Programming	OEC	3	0	0	3	3
22.	OCH351	Nano Technology	OEC	3	0	0	3	3
23.	OCH352	Functional Materials	OEC	3	0	0	3	3
24.	OFD352	Traditional Indian Foods	OEC	3	0	0	3	3
25.	OFD353	Introduction to food processing	OEC	3	0	0	3	3
26.	OPY352	IPR for Pharma Industry	OEC	3	0	0	3	3
27.	OTT351	Basics of Textile Finishing	OEC	3	0	0	3	3
28.	OTT352	Industrial Engineering for Garment Industry	OEC	3	0	0	3	3
29.	OTT353	Basics of Textile Manufacture	OEC	3	0	0	3	3
30.	OPE351	Introduction to Petroleum Refining and Petrochemicals	OEC	3	0	0	3	3
31.	CPE334	Energy Conservation and Management	OEC	3	0	0	3	3
32.	OPT351	Basics of Plastics Processing	OEC	3	0	0	3	3
33.	OEC351	Signals and Systems	OEC	3	0	0	3	3
34.	OEC352	Fundamentals of Electronic Devices and Circuits	OEC	3	0	0	3	3
35.	CBM348	Foundation Skills in Integrated Product Development	OEC	3	0	0	3	3
36.	CBM333	Assistive Technology	OEC	3	0	0	3	3
37.	OMA352	Operations Research	OEC	3	0	0	3	3
38.	OMA353	Algebra and Number Theory	OEC	3	0	0	3	3
39.	OMA354	Linear Algebra	OEC	3	0	0	3	3
40.	OCE353	Lean Concepts, Tools and Practices	OEC	3	0	0	3	3
41.	OBT352	Basics of Microbial Technology	OEC	3	0	0	3	3
42.	OBT353	Basics of Biomolecules	OEC	3	0	0	3	3
43.	OBT354	Fundamentals of Cell and Molecular Biology	OEC	3	0	0	3	3

**OPEN ELECTIVES – IV**

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS352	Project Report Writing	OEC	3	0	0	3	3
2.	OMA355	Advanced Numerical Methods	OEC	3	0	0	3	3
3.	OMA356	Random Processes	OEC	3	0	0	3	3
4.	OMA357	Queuing and Reliability Modelling	OEC	3	0	0	3	3
5.	OMG354	Production and Operations Management for Entrepreneurs	OEC	3	0	0	3	3
6.	OMG355	Multivariate Data Analysis	OEC	3	0	0	3	3
7.	OME352	Additive Manufacturing	OEC	3	0	0	3	3
8.	CME343	New Product Development	OEC	3	0	0	3	3
9.	OME355	Industrial Design & Rapid Prototyping Techniques	OEC	3	0	0	3	3
10.	MF3010	Micro and Precision Engineering	OEC	3	0	0	3	3
11.	OMF354	Cost Management of Engineering Projects	OEC	3	0	0	3	3
12.	AU3002	Batteries and Management system	OEC	3	0	0	3	3
13.	AU3008	Sensors and Actuators	OEC	3	0	0	3	3
14.	OAS353	Space Vehicles	OEC	3	0	0	3	3
15.	OIM352	Management Science	OEC	3	0	0	3	3
16.	OIM353	Production Planning and Control	OEC	3	0	0	3	3
17.	OIE353	Operations Management	OEC	3	0	0	3	3
18.	OSF352	Industrial Hygiene	OEC	3	0	0	3	3
19.	OSF353	Chemical Process Safety	OEC	3	0	0	3	3
20.	OML352	Electrical, Electronic and Magnetic materials	OEC	3	0	0	3	3
21.	OML353	Nanomaterials and Applications	OEC	3	0	0	3	3
22.	OMR352	Hydraulics and Pneumatics	OEC	3	0	0	3	3
23.	OMR353	Sensors	OEC	3	0	0	3	3
24.	ORA352	Concepts in Mobile Robots	OEC	3	0	0	3	3
25.	MV3501	Marine Propulsion	OEC	3	0	0	3	3
26.	OMV351	Marine Merchant Vessels	OEC	3	0	0	3	3
27.	OMV352	Elements of Marine Engineering	OEC	3	0	0	3	3
28.	CRA332	Drone Technologies	OEC	3	0	0	3	3

29.	OGI352	Geographical Information System	OEC	3	0	0	3	3
30.	OAI352	Agriculture Entrepreneurship Development	OEC	3	0	0	3	3
31.	OEN352	Biodiversity Conservation	OEC	3	0	0	3	3
32.	OEE353	Introduction to control systems	OEC	3	0	0	3	3
33.	OEI354	Introduction to Industrial Automation Systems	OEC	3	0	0	3	3
34.	OCH353	Energy Technology	OEC	3	0	0	3	3
35.	OCH354	Surface Science	OEC	3	0	0	3	3
36.	OFD354	Fundamentals of Food Engineering	OEC	3	0	0	3	3
37.	OFD355	Food safety and Quality Regulations	OEC	3	0	0	3	3
38.	OPY353	Nutraceuticals	OEC	3	0	0	3	3
39.	OTT354	Basics of Dyeing and Printing	OEC	3	0	0	3	3
40.	FT3201	Fibre Science	OEC	3	0	0	3	3
41.	OTT355	Garment Manufacturing Technology	OEC	3	0	0	3	3
42.	OPE353	Industrial safety	OEC	3	0	0	3	3
43.	OPE354	Unit Operations in Petro Chemical Industries	OEC	3	0	0	3	3
44.	OPT352	Plastic Materials for Engineers	OEC	3	0	0	3	3
45.	OPT353	Properties and Testing of Plastics	OEC	3	0	0	3	3
46.	OEC353	VLSI Design	OEC	3	0	0	3	3
47.	CBM370	Wearable Devices	OEC	3	0	0	3	3
48.	CBM356	Medical Informatics	OEC	3	0	0	3	3
49.	OCE354	Basics of Integrated Water Resources Management	OEC	3	0	0	3	3
50.	OBT355	Biotechnology for Waste Management	OEC	3	0	0	3	3
51.	OBT356	Lifestyle Diseases	OEC	3	0	0	3	3
52.	OBT357	Biotechnology in Health Care	OEC	3	0	0	3	3

## SUMMARY

Name of the Programme: B.E. Computer Science and Engineering										
S.No	Subject Area	Credits per Semester								Total Credits
		I	II	III	IV	V	VI	VII/VIII	VIII/VII	
1	HSMC	4	3					5		12
2	BSC	12	7	4	2					25
3	ESC	5	9	4						18
4	PCC		5	14	20	14	8			61
5	PEC					6	12			18
6	OEC						3	9		12
7	EEC	1	2	1				2	10	16
8	Non-Credit /(Mandatory)					√	√			
<b>Total</b>		<b>22</b>	<b>26</b>	<b>23</b>	<b>22</b>	<b>20</b>	<b>23</b>	<b>16</b>	<b>10</b>	<b>162</b>

### ENROLLMENT FOR B.E. / B. TECH. (HONOURS) / MINOR DEGREE (OPTIONAL)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor Degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes, Moreover, for minor degree the student can register for courses from any one of the following verticals also.

Complete details are available in clause 4.10 (Amendments) of Regulations 2021.

**VERTICALS FOR MINOR DEGREE**  
**(In addition to all the verticals of other programmes)**

<b>Vertical I Fintech and Block Chain</b>	<b>Vertical II Entrepreneurship</b>	<b>Vertical III Public Administration</b>	<b>Vertical IV Business Data Analytics</b>	<b>Vertical V Environment and Sustainability</b>
Financial Management	Foundations of Entrepreneurship	Principles of Public Administration	Statistics for Management	Sustainable infrastructure Development
Fundamentals of Investment	Team Building & Leadership Management for Business	Constitution of India	Datamining for Business Intelligence	Sustainable Agriculture and Environmental Management
Banking, Financial Services and Insurance	Creativity & Innovation in Entrepreneurship	Public Personnel Administration	Human Resource Analytics	Sustainable Bio Materials
Introduction to Blockchain and its Applications	Principles of Marketing Management for Business	Administrative Theories	Marketing and Social Media Web Analytics	Materials for Energy Sustainability
Fintech Personal Finance and Payments	Human Resource Management for Entrepreneurs	Indian Administrative System	Operation and Supply Chain Analytics	Green Technology
Introduction to Fintech	Financing New Business Ventures	Public Policy Administration	Financial Analytics	Environmental Quality Monitoring and Analysis
-	-	-	-	Integrated Energy Planning for Sustainable Development
-	-	-	-	Energy Efficiency for Sustainable Development



(choice of courses for Minor degree is to be made from any one vertical of other programmes or from anyone of the following verticals)

**VERTICAL 1: FINTECH AND BLOCK CHAIN**

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG331	Financial Management	PEC	3	0	0	3	3
2.	CMG332	Fundamentals of Investment	PEC	3	0	0	3	3
3.	CMG333	Banking, Financial Services and Insurance	PEC	3	0	0	3	3
4.	CMG334	Introduction to Blockchain and its Applications	PEC	3	0	0	3	3
5.	CMG335	Fintech Personal Finance and Payments	PEC	3	0	0	3	3
6.	CMG336	Introduction to Fintech	PEC	3	0	0	3	3

**VERTICAL 2: ENTREPRENEURSHIP**

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG337	Foundations of Entrepreneurship	PEC	3	0	0	3	3
2.	CMG338	Team Building & Leadership Management for Business	PEC	3	0	0	3	3
3.	CMG339	Creativity & Innovation in Entrepreneurship	PEC	3	0	0	3	3
4.	CMG340	Principles of Marketing Management For Business	PEC	3	0	0	3	3
5.	CMG341	Human Resource Management for Entrepreneurs	PEC	3	0	0	3	3
6.	CMG342	Financing New Business Ventures	PEC	3	0	0	3	3

**VERTICAL 3: PUBLIC ADMINISTRATION**

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG343	Principles of Public Administration	PEC	3	0	0	3	3
2.	CMG344	Constitution of India	PEC	3	0	0	3	3
3.	CMG345	Public Personnel Administration	PEC	3	0	0	3	3
4.	CMG346	Administrative Theories	PEC	3	0	0	3	3
5.	CMG347	Indian Administrative System	PEC	3	0	0	3	3
6.	CMG348	Public Policy Administration	PEC	3	0	0	3	3

**VERTICAL 4: BUSINESS DATA ANALYTICS**

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG349	Statistics for Management	PEC	3	0	0	3	3
2.	CMG350	Datamining For Business Intelligence	PEC	3	0	0	3	3
3.	CMG351	Human Resource Analytics	PEC	3	0	0	3	3
4.	CMG352	Marketing and Social Media Web Analytics	PEC	3	0	0	3	3
5.	CMG353	Operation and Supply Chain Analytics	PEC	3	0	0	3	3
6.	CMG354	Financial Analytics	PEC	3	0	0	3	3

PROGRESS THROUGH KNOWLEDGE

**VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY**

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CES331	Sustainable infrastructure Development	PEC	3	0	0	3	3
2.	CES332	Sustainable Agriculture and Environmental Management	PEC	3	0	0	3	3
3.	CES333	Sustainable Bio Materials	PEC	3	0	0	3	3
4.	CES334	Materials for Energy Sustainability	PEC	3	0	0	3	3
5.	CES335	Green Technology	PEC	3	0	0	3	3
6.	CES336	Environmental Quality Monitoring and Analysis	PEC	3	0	0	3	3
7.	CES337	Integrated Energy Planning for Sustainable Development	PEC	3	0	0	3	3
8.	CES338	Energy Efficiency for Sustainable Development	PEC	3	0	0	3	3



This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

“Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have a broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed.”

“One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character.”

Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

(i) Physical Activity

This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

(ii) Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

(iii) Universal Human Values

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, make decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and don'ts, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing.

Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

(iv) Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

(v) Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

(vi) Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

(vii) Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the underprivileged.

(viii) Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix) Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering / Technology / Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

**Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.**

References:

Guide to Induction program from AICTE

**COURSE OBJECTIVES:**

- To improve the communicative competence of learners
- To learn to use basic grammatic structures in suitable contexts
- To acquire lexical competence and use them appropriately in a sentence and understand their meaning in a text
- To help learners use language effectively in professional contexts
- To develop learners' ability to read and write complex texts, summaries, articles, blogs, definitions, essays and user manuals.

**UNIT I INTRODUCTION TO EFFECTIVE COMMUNICATION 1**

What is effective communication? (Explain using activities) Why is communication critical for excellence during study, research and work? What are the seven C's of effective communication? What are key language skills? What is effective listening? What does it involve? What is effective speaking? What does it mean to be an excellent reader? What should you be able to do? What is effective writing? How does one develop language and communication skills? What does the course focus on? How are communication and language skills going to be enhanced during this course? What do you as a learner need to do to enhance your English language and communication skills to get the best out of this course?

**INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 8**

Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails. Writing - Writing emails / letters introducing oneself. Grammar - Present Tense (simple and progressive); Question types: Wh/ Yes or No/ and Tags. Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).

**UNIT II NARRATION AND SUMMATION 9**

Reading - Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel & technical blogs. Writing - Guided writing-- Paragraph writing Short Report on an event (field trip etc.) Grammar –Past tense (simple); Subject-Verb Agreement; and Prepositions. Vocabulary - Word forms (prefixes& suffixes); Synonyms and Antonyms. Phrasal verbs.

**UNIT III DESCRIPTION OF A PROCESS / PRODUCT 9**

Reading – Reading advertisements, gadget reviews; user manuals. Writing - Writing definitions; instructions; and Product /Process description. Grammar - Imperatives; Adjectives; Degrees of comparison; Present & Past Perfect Tenses. Vocabulary - Compound Nouns, Homonyms; and Homophones, discourse markers (connectives & sequence words).

**UNIT IV CLASSIFICATION AND RECOMMENDATIONS 9**

Reading – Newspaper articles; Journal reports –and Non Verbal Communication ( tables, pie charts etc,. ). Writing – Note-making / Note-taking (\*Study skills to be taught, not tested); Writing recommendations; Transferring information from non verbal ( chart , graph etc, to verbal mode) Grammar – Articles; Pronouns - Possessive & Relative pronouns. Vocabulary - Collocations; Fixed / Semi fixed expressions.

**UNIT V EXPRESSION 9**

Reading – Reading editorials; and Opinion Blogs; Writing – Essay Writing (Descriptive or narrative). Grammar – Future Tenses, Punctuation; Negation (Statements & Questions); and Simple,

Compound & Complex Sentences. Vocabulary - Cause & Effect Expressions – Content vs Function words.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES :**

At the end of the course, learners will be able

**CO1:**To use appropriate words in a professional context

**CO2:**To gain understanding of basic grammatic structures and use them in right context.

**CO3:**To read and infer the denotative and connotative meanings of technical texts

**CO4:**To write definitions, descriptions, narrations and essays on various topics

**TEXT BOOKS :**

1. English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition)
2. English for Science & Technology Cambridge University Press, 2021.  
Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

**REFERENCES:**

1. Technical Communication – Principles And Practices By Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2. A Course Book On Technical English By Lakshminarayanan, Scitech Publications (India) Pvt. Ltd.
3. English For Technical Communication (With CD) By Aysha Viswamohan, Mcgraw Hill Education, ISBN : 0070264244.
4. Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.
5. Learning to Communicate – Dr. V. Chellammal, Allied Publishing House, New Delhi,2003.

**ASSESSMENT PATTERN**

Two internal assessments and an end semester examination to test students’ reading and writing skills along with their grammatical and lexical competence.

**CO’s-PO’s & PSO’s MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1	1	1	1	3	3	3	1	3	-	3	-	-	-
2	1	1	1	1	1	3	3	3	1	3	-	3	-	-	-
3	2	3	2	3	2	3	3	3	2	3	3	3	-	-	-
4	2	3	2	3	2	3	3	3	2	3	3	3	-	-	-
5	2	3	3	3	-	3	3	3	2	3	-	3	-	-	-
<b>AVg.</b>	<b>1.6</b>	<b>2.2</b>	<b>1.8</b>	<b>2.2</b>	<b>1.5</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>1.6</b>	<b>3</b>	<b>3</b>	<b>3</b>	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES:**

- To develop the use of matrix algebra techniques that are needed by engineers for practical applications.
- To familiarize the students with differential calculus.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To make the students understand various techniques of integration.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

**UNIT I MATRICES****9 + 3**

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley - Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms – Applications: Stretching of an elastic membrane.

**UNIT II DIFFERENTIAL CALCULUS****9 + 3**

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum, product, quotient, chain rules) - Implicit differentiation - Logarithmic differentiation - Applications: Maxima and Minima of functions of one variable.

**UNIT III FUNCTIONS OF SEVERAL VARIABLES****9 + 3**

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Applications: Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.

**UNIT IV INTEGRAL CALCULUS****9 + 3**

Definite and Indefinite integrals - Substitution rule - Techniques of Integration: Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals - Applications: Hydrostatic force and pressure, moments and centres of mass.

**UNIT V MULTIPLE INTEGRALS****9 + 3**

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals – Applications: Moments and centres of mass, moment of inertia.

**TOTAL: 60 PERIODS****COURSE OUTCOMES:**

At the end of the course the students will be able to

**CO1:** Use the matrix algebra methods for solving practical problems.

**CO2:** Apply differential calculus tools in solving various application problems.

**CO3:** Able to use differential calculus ideas on several variable functions.

**CO4:** Apply different methods of integration in solving practical problems.

**CO5:** Apply multiple integral ideas in solving areas, volumes and other practical problems.



**TEXT BOOKS :**

1. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10<sup>th</sup> Edition, New Delhi, 2016.
2. Grewal.B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44<sup>th</sup> Edition , 2018.
3. James Stewart, " Calculus: Early Transcendentals", Cengage Learning, 8<sup>th</sup> Edition, New Delhi, 2015. [For Units II & IV - Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8 ].

**REFERENCES:**

1. Anton. H, Bivens. I and Davis. S, "Calculus", Wiley, 10<sup>th</sup> Edition, 2016
2. Bali. N., Goyal. M. and Watkins. C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.), New Delhi, 7<sup>th</sup> Edition, 2009.
3. Jain . R.K. and Iyengar. S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 5<sup>th</sup> Edition, 2016.
4. Narayanan. S. and Manicavachagom Pillai. T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6. Srimantha Pal and Bhunia. S.C, "Engineering Mathematics" Oxford University Press, 2015.
7. Thomas. G. B., Hass. J, and Weir. M.D, "Thomas Calculus", 14<sup>th</sup> Edition, Pearson India, 2018.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO2	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO3	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO4	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO5	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
Avg	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

PH3151

ENGINEERING PHYSICS

L T P C

3 0 0 3

**COURSE OBJECTIVES:**

- To make the students effectively achieve an understanding of mechanics.
- To enable the students to gain knowledge of electromagnetic waves and its applications.
- To introduce the basics of oscillations, optics and lasers.
- Equipping the students to successfully understand the importance of quantum physics.
- To motivate the students towards the applications of quantum mechanics.

**UNIT I MECHANICS****9**

Multi-particle dynamics: Center of mass (CM) – CM of continuous bodies – motion of the CM – kinetic energy of the system of particles. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy and moment of inertia - theorems of M.I –moment of inertia of continuous bodies –

M.I of a diatomic molecule - torque – rotational dynamics of rigid bodies – conservation of angular momentum – rotational energy state of a rigid diatomic molecule - gyroscope - torsional pendulum – double pendulum –Introduction to nonlinear oscillations.

**UNIT II ELECTROMAGNETIC WAVES 9**

The Maxwell's equations - wave equation; Plane electromagnetic waves in vacuum, Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

**UNIT III OSCILLATIONS, OPTICS AND LASERS 9**

Simple harmonic motion - resonance –analogy between electrical and mechanical oscillating systems - waves on a string - standing waves - traveling waves - Energy transfer of a wave - sound waves - Doppler effect. Reflection and refraction of light waves - total internal reflection - interference –Michelson interferometer –Theory of air wedge and experiment. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients - population inversion - Nd-YAG laser, CO<sub>2</sub> laser, semiconductor laser –Basic applications of lasers in industry.

**UNIT IV BASIC QUANTUM MECHANICS 9**

Photons and light waves - Electrons and matter waves –Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization –Free particle - particle in a infinite potential well: 1D,2D and 3D Boxes- Normalization, probabilities and the correspondence principle.

**UNIT V APPLIED QUANTUM MECHANICS 9**

The harmonic oscillator(qualitative)- Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope - Resonant diode - Finite potential wells (qualitative)- Bloch's theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the students should be able to

**CO1:** Understand the importance of mechanics.

**CO2:** Express their knowledge in electromagnetic waves.

**CO3:** Demonstrate a strong foundational knowledge in oscillations, optics and lasers.

**CO4:** Understand the importance of quantum physics.

**CO5:** Comprehend and apply quantum mechanical principles towards the formation of energy bands.

**TEXT BOOKS:**

1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017.
2. E.M.Purcell and D.J.Morin, Electricity and Magnetism, Cambridge Univ.Press, 2013.
3. Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGraw-Hill (Indian Edition), 2017.

**REFERENCES:**

1. R.Wolfson. Essential University Physics. Volume 1 & 2. Pearson Education (Indian Edition), 2009.

- Paul A. Tipler, Physic – Volume 1 & 2, CBS, (Indian Edition), 2004.
- K.Thyagarajan and A.Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications, (Indian Edition), 2019.
- D.Halliday, R.Resnick and J.Walker. Principles of Physics, Wiley (Indian Edition), 2015.
- N.Garcia, A.Damask and S.Schwarz. Physics for Computer Science Students. Springer-Verlag, 2012.

#### CO's-PO's & PSO's MAPPING

CO	PO	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	1	1	1	-	-	-	-	-	-	-	-	-
2	3	3	2	1	2	1	-	-	-	-	-	-	-	-	-
3	3	3	2	2	2	1	-	-	-	-	-	1	-	-	-
4	3	3	1	1	2	1	-	-	-	-	-	-	-	-	-
5	3	3	1	1	2	1	-	-	-	-	-	-	-	-	-
AV	3	3	1.6	1.2	1.8	1	-	-	-	-	-	1	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

CY3151

ENGINEERING CHEMISTRY

L T P C  
3 0 0 3

#### COURSE OBJECTIVES:

- To inculcate sound understanding of water quality parameters and water treatment techniques.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To introduce the basic concepts and applications of phase rule and composites.
- To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
- To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

#### UNIT I WATER AND ITS TREATMENT

9

Water: Sources and impurities, Water quality parameters: Definition and significance of-color, odour, turbidity, pH, hardness, alkalinity, TDS, COD and BOD, fluoride and arsenic. Municipal water treatment: primary treatment and disinfection (UV, Ozonation, break-point chlorination). Desalination of brackish water: Reverse Osmosis. Boiler troubles: Scale and sludge, Boiler corrosion, Caustic embrittlement, Priming & foaming. Treatment of boiler feed water: Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralization and zeolite process.

#### UNIT II NANO CHEMISTRY

9

Basics: Distinction between molecules, nanomaterials and bulk materials; Size-dependent properties (optical, electrical, mechanical and magnetic); Types of nanomaterials: Definition, properties and uses of – nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro spinning. Applications of nanomaterials in medicine, agriculture, energy, electronics and catalysis.

#### UNIT III PHASE RULE AND COMPOSITES

9

Phase rule: Introduction, definition of terms with examples. One component system - water system; Reduced phase rule; Construction of a simple eutectic phase diagram - Thermal analysis; Two

component system: lead-silver system - Pattinson process.

Composites: Introduction: Definition & Need for composites; Constitution: Matrix materials (Polymer matrix, metal matrix and ceramic matrix) and Reinforcement (fiber, particulates, flakes and whiskers). Properties and applications of: Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. Hybrid composites - definition and examples.

#### **UNIT IV FUELS AND COMBUSTION**

**9**

Fuels: Introduction: Classification of fuels; Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; Power alcohol and biodiesel.

Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; Ignition temperature: spontaneous ignition temperature, Explosive range; Flue gas analysis - ORSAT Method. CO<sub>2</sub> emission and carbon footprint.

#### **UNIT V ENERGY SOURCES AND STORAGE DEVICES**

**9**

Stability of nucleus: mass defect (problems), binding energy; Nuclear energy: light water nuclear power plant, breeder reactor. Solar energy conversion: Principle, working and applications of solar cells; Recent developments in solar cell materials. Wind energy; Geothermal energy; Batteries: Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion-battery; Electric vehicles - working principles; Fuel cells: H<sub>2</sub>-O<sub>2</sub> fuel cell, microbial fuel cell; Supercapacitors: Storage principle, types and examples.

**TOTAL: 45 PERIODS**

#### **COURSE OUTCOMES:**

At the end of the course, the students will be able:

**CO1:**To infer the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.

**CO2:**To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.

**CO3:**To apply the knowledge of phase rule and composites for material selection requirements.

**CO4:**To recommend suitable fuels for engineering processes and applications.

**CO5:**To recognize different forms of energy resources and apply them for suitable applications in energy sectors.

#### **TEXT BOOKS:**

1. P. C. Jain and Monica Jain, "Engineering Chemistry", 17<sup>th</sup> Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2018.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3. S.S. Dara, "A Text book of Engineering Chemistry", S. Chand Publishing, 12<sup>th</sup> Edition, 2018

#### **REFERENCES:**

1. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, "Text book of nanoscience and nanotechnology", Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2. O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2<sup>nd</sup> Edition, 2017.

3. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.
4. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, Second Edition, 2019.
5. O.V. Roussak and H.D. Gesser, Applied Chemistry-A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013.

#### CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	1	-	1	1	-	-	-	-	1	-	-	-
2	2	-	-	1	-	2	2	-	-	-	-	-	-	-	-
3	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
4	3	1	1	-	-	1	2	-	-	-	-	-	-	-	-
5	3	1	2	1	-	2	2	-	-	-	-	2	-	-	-
<b>CO</b>	<b>2.8</b>	<b>1.3</b>	<b>1.6</b>	<b>1</b>	<b>-</b>	<b>1.5</b>	<b>1.8</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1.5</b>	<b>-</b>	<b>-</b>	<b>-</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation

GE3151

PROBLEM SOLVING AND PYTHON PROGRAMMING

L T P C  
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#### COURSE OBJECTIVES:

- To understand the basics of algorithmic problem solving.
- To learn to solve problems using Python conditionals and loops.
- To define Python functions and use function calls to solve problems.
- To use Python data structures - lists, tuples, dictionaries to represent complex data.
- To do input/output with files in Python.

#### UNIT I COMPUTATIONAL THINKING AND PROBLEM SOLVING

9

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

#### UNIT II DATA TYPES, EXPRESSIONS, STATEMENTS

9

Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

#### UNIT III CONTROL FLOW, FUNCTIONS, STRINGS

9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

**UNIT IV LISTS, TUPLES, DICTIONARIES****9**

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

**UNIT V FILES, MODULES, PACKAGES****9**

Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

**TOTAL : 45 PERIODS****COURSE OUTCOMES:**

**Upon completion of the course, students will be able to**

- CO1:** Develop algorithmic solutions to simple computational problems.
- CO2:** Develop and execute simple Python programs.
- CO3:** Write simple Python programs using conditionals and loops for solving problems.
- CO4:** Decompose a Python program into functions.
- CO5:** Represent compound data using Python lists, tuples, dictionaries etc.
- CO6:** Read and write data from/to files in Python programs.

**TEXT BOOKS:**

1. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.

**REFERENCES:**

1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1<sup>st</sup> Edition, 2021.
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1<sup>st</sup> Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press, 2021
4. Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2<sup>nd</sup> Edition, No Starch Press, 2019.
5. <https://www.python.org/>
6. Martin C. Brown, "Python: The Complete Reference", 4<sup>th</sup> Edition, Mc-Graw Hill, 2018.

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<b>1</b>	3	3	3	3	2	-	-	-	-	-	2	2	3	3	-
<b>2</b>	3	3	3	3	2	-	-	-	-	-	2	2	3	-	-
<b>3</b>	3	3	3	3	2	-	-	-	-	-	2	-	3	-	-
<b>4</b>	2	2	-	2	2	-	-	-	-	-	1	-	3	-	-
<b>5</b>	1	2	-	-	1	-	-	-	-	-	1	-	2	-	-
<b>6</b>	2	2	-	-	2	-	-	-	-	-	1	-	2	-	-
<b>AVg.</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	-	-	-	-	-	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

**UNIT I LANGUAGE AND LITERATURE****3**

Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

**UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE****3**

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

**UNIT III FOLK AND MARTIAL ARTS****3**

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

**UNIT IV THINAI CONCEPT OF TAMILS****3**

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

**UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE****3**

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

**TOTAL : 15 PERIODS****TEXT-CUM-REFERENCE BOOKS**

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சந்திரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies).
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation,

- Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
  11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
  12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

GE3152

தமிழர் மரபு

L T P C  
1 0 0 1

**அலகு I மொழி மற்றும் இலக்கியம்: 3**  
இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

**அலகு II மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை: 3**  
நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள் – பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளூர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

**அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்: 3**  
தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஓயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

**அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள்: 3**  
தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.



**அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு:**

**3**

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிக்கல்கள் - தமிழ்ப் புத்தகங்களின் அச்ச வரலாறு.

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருளை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
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10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

PROGRESS THROUGH KNOWLEDGE

**GE3171**

**PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY L T P C**

**0 0 4 2**

**COURSE OBJECTIVES:**

- To understand the problem solving approaches.
- To learn the basic programming constructs in Python.
- To practice various computing strategies for Python-based solutions to real world problems.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

## EXPERIMENTS:

**Note: The examples suggested in each experiment are only indicative. The lab instructor is expected to design other problems on similar lines. The Examination shall not be restricted to the sample experiments listed here.**

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).
3. Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6. Implementing programs using Functions. (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings. (reverse, palindrome, character count, replacing characters)
8. Implementing programs using written modules and Python Standard Libraries (pandas, numpy. Matplotlib, scipy)
9. Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word)
10. Implementing real-time/technical applications using Exception handling. (divide by zero error, voter's age validity, student mark range validation)
11. Exploring Pygame tool.
12. Developing a game activity using Pygame like bouncing ball, car race etc.

**TOTAL: 60 PERIODS**

## COURSE OUTCOMES:

On completion of the course, students will be able to:

**CO1:** Develop algorithmic solutions to simple computational problems

**CO2:** Develop and execute simple Python programs.

**CO3:** Implement programs in Python using conditionals and loops for solving problems.

**CO4:** Deploy functions to decompose a Python program.

**CO5:** Process compound data using Python data structures.

**CO6:** Utilize Python packages in developing software applications.

## TEXT BOOKS:

1. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.

## REFERENCES:

1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1<sup>st</sup> Edition, 2021.
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1<sup>st</sup> Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press, 2021.
4. Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2<sup>nd</sup> Edition, No Starch Press, 2019.
5. <https://www.python.org/>
6. Martin C. Brown, "Python: The Complete Reference", 4<sup>th</sup> Edition, Mc-Graw Hill, 2018.

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2	3	3	3	3	2	-	-	-	-	-	2	2	3	-	-
3	3	3	3	3	2	-	-	-	-	-	2	-	3	-	-
4	2	2	-	2	2	-	-	-	-	-	1	-	3	-	-
5	1	2	-	-	1	-	-	-	-	-	1	-	2	-	-
6	2	2	-	-	2	-	-	-	-	-	1	-	2	-	-
AVg.	2	3	3	3	2	-	-	-	-	-	2	2	3	3	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

BS3171

PHYSICS AND CHEMISTRY LABORATORY

L T P C  
0 0 4 2

### PHYSICS LABORATORY : (Any Seven Experiments)

#### COURSE OBJECTIVES:

- To learn the proper use of various kinds of physics laboratory equipment.
  - To learn how data can be collected, presented and interpreted in a clear and concise manner.
  - To learn problem solving skills related to physics principles and interpretation of experimental data.
  - To determine error in experimental measurements and techniques used to minimize such error.
  - To make the student an active participant in each part of all lab exercises.
1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular and irregular objects.
  2. Simple harmonic oscillations of cantilever.
  3. Non-uniform bending - Determination of Young's modulus
  4. Uniform bending – Determination of Young's modulus
  5. Laser- Determination of the wavelength of the laser using grating
  6. Air wedge - Determination of thickness of a thin sheet/wire
  7. a) Optical fibre -Determination of Numerical Aperture and acceptance angle  
b) Compact disc- Determination of width of the groove using laser.

8. Acoustic grating- Determination of velocity of ultrasonic waves in liquids.
9. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids
10. Post office box -Determination of Band gap of a semiconductor.
11. Photoelectric effect
12. Michelson Interferometer.
13. Melde's string experiment
14. Experiment with lattice dynamics kit.

**TOTAL: 30 PERIODS**

### COURSE OUTCOMES:

Upon completion of the course, the students should be able to

**CO1:** Understand the functioning of various physics laboratory equipment.

**CO2:** Use graphical models to analyze laboratory data.

**CO3:** Use mathematical models as a medium for quantitative reasoning and describing physical reality.

**CO4:** Access, process and analyze scientific information.

**CO5:** Solve problems individually and collaboratively.

### CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-
2	3	3	2	1	1	-	-	-	-	-	-	-	-	-	-
3	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-
4	3	3	2	1	1	-	-	-	-	-	-	-	-	-	-
5	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-
<b>AVG</b>	3	2.4	2.6	1	1	-	-	-	-	-	-	-	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

### CHEMISTRY LABORATORY: (Any seven experiments to be conducted)

#### COURSE OBJECTIVES:

- To inculcate experimental skills to test basic understanding of water quality parameters, such as, acidity, alkalinity, hardness, DO, chloride and copper.
  - To induce the students to familiarize with electroanalytical techniques such as, pH metry, potentiometry and conductometry in the determination of impurities in aqueous solutions.
  - To demonstrate the analysis of metals and alloys.
  - To demonstrate the synthesis of nanoparticles
1. Preparation of  $\text{Na}_2\text{CO}_3$  as a primary standard and estimation of acidity of a water sample using the primary standard
  2. Determination of types and amount of alkalinity in a water sample.
    - Split the first experiment into two
  3. Determination of total, temporary & permanent hardness of water by EDTA method.
  4. Determination of DO content of water sample by Winkler's method.
  5. Determination of chloride content of water sample by Argentometric method.
  6. Estimation of copper content of the given solution by Iodometry.
  7. Estimation of TDS of a water sample by gravimetry.
  8. Determination of strength of given hydrochloric acid using pH meter.

9. Determination of strength of acids in a mixture of acids using conductivity meter.
10. Conductometric titration of barium chloride against sodium sulphate (precipitation titration)
11. Estimation of iron content of the given solution using potentiometer.
12. Estimation of sodium /potassium present in water using a flame photometer.
13. Preparation of nanoparticles (TiO<sub>2</sub>/ZnO/CuO) by Sol-Gel method.
14. Estimation of Nickel in steel
15. Proximate analysis of Coal

**TOTAL : 30 PERIODS**

**COURSE OUTCOMES:**

**CO1:**To analyse the quality of water samples with respect to their acidity, alkalinity, hardness and DO.

**CO2:**To determine the amount of metal ions through volumetric and spectroscopic techniques

**CO3:**To analyse and determine the composition of alloys.

**CO4:**To learn simple method of synthesis of nanoparticles

**CO5:**To quantitatively analyse the impurities in solution by electroanalytical techniques

**TEXT BOOKS :**

1. J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas and B. Sivasankar, Vogel's Textbook of Quantitative Chemical Analysis (2009).

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	1	-	-	2	2	-	-	-	-	2	-	-	-
2	3	1	2	-	-	1	2	-	-	-	-	1	-	-	-
3	3	2	1	1	-	-	1	-	-	-	-	-	-	-	-
4	2	1	2	-	-	2	2	-	-	-	-	-	-	-	-
5	2	1	2	-	1	2	2	-	-	-	-	1	-	-	-
<b>Avg.</b>	<b>2.6</b>	<b>1.3</b>	<b>1.6</b>	<b>1</b>	<b>1</b>	<b>1.4</b>	<b>1.8</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1.3</b>	<b>-</b>	<b>-</b>	<b>-</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation

**GE3172**

**ENGLISH LABORATORY**

**L T P C**  
**0 0 2 1**

**COURSE OBJECTIVES:**

- To improve the communicative competence of learners
- To help learners use language effectively in academic /work contexts
- To develop various listening strategies to comprehend various types of audio materials like lectures, discussions, videos etc.
- To build on students' English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
- To use language efficiently in expressing their opinions via various media.

**UNIT I INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION**

**6**

Listening for general information-specific details- conversation: Introduction to classmates - Audio / video (formal & informal); Telephone conversation; Listening to voicemail & messages; Listening and filling a form. Speaking - making telephone calls-Self Introduction; Introducing a friend; -

politeness strategies- making polite requests, making polite offers, replying to polite requests and offers- understanding basic instructions( filling out a bank application for example).

**UNIT II NARRATION AND SUMMATION 6**

Listening - Listening to podcasts, anecdotes / stories / event narration; documentaries and interviews with celebrities. Speaking - Narrating personal experiences / events-Talking about current and temporary situations & permanent and regular situations\* - describing experiences and feelings-engaging in small talk- describing requirements and abilities.

**UNIT III DESCRIPTION OF A PROCESS / PRODUCT 6**

Listening - Listen to product and process descriptions; a classroom lecture; and advertisements about products. Speaking – Picture description- describing locations in workplaces- Giving instruction to use the product- explaining uses and purposes- Presenting a product- describing shapes and sizes and weights- talking about quantities(large & small)-talking about precautions.

**UNIT IV CLASSIFICATION AND RECOMMENDATIONS 6**

Listening – Listening to TED Talks; Listening to lectures - and educational videos. Speaking – Small Talk; discussing and making plans-talking about tasks-talking about progress- talking about positions and directions of movement-talking about travel preparations- talking about transportation-

**UNIT V EXPRESSION 6**

Listening – Listening to debates/ discussions; different viewpoints on an issue; and panel discussions. Speaking –making predictions- talking about a given topic-giving opinions-understanding a website-describing processes

**TOTAL : 30 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, learners will be able

**CO1:**To listen to and comprehend general as well as complex academic information

**CO2:**To listen to and understand different points of view in a discussion

**CO3:**To speak fluently and accurately in formal and informal communicative contexts

**CO4:**To describe products and processes and explain their uses and purposes clearly and accurately

**CO5:**To express their opinions effectively in both formal and informal discussions

**CO's-PO's & PSO's MAPPING**

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
2	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
3	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
4	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
5	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
<b>AVg.</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>-</b>	<b>-</b>	<b>-</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation

**Note:** The average value of this course to be used for program articulation matrix.

## ASSESSMENT PATTERN

- One online / app based assessment to test listening /speaking
- End Semester **ONLY** listening and speaking will be conducted online.
- Proficiency certification is given on successful completion of listening and speaking internal test and end semester exam.

HS3252

PROFESSIONAL ENGLISH - II

L T P C  
2 0 0 2

## COURSE OBJECTIVES :

- To engage learners in meaningful language activities to improve their reading and writing skills
- To learn various reading strategies and apply in comprehending documents in professional context.
- To help learners understand the purpose, audience, contexts of different types of writing
- To develop analytical thinking skills for problem solving in communicative contexts
- To demonstrate an understanding of job applications and interviews for internship and placements

### UNIT I MAKING COMPARISONS

6

Reading - Reading advertisements, user manuals, brochures; Writing – Professional emails, Email etiquette - Compare and Contrast Essay; Grammar – Mixed Tenses, Prepositional phrases

### UNIT II EXPRESSING CAUSAL RELATIONS IN SPEAKING AND WRITING

6

Reading - Reading longer technical texts– Cause and Effect Essays, and Letters / emails of complaint, Writing - Writing responses to complaints. Grammar - Active Passive Voice transformations, Infinitive and Gerunds

### UNIT III PROBLEM SOLVING

6

Reading - Case Studies, excerpts from literary texts, news reports etc. Writing – Letter to the Editor, Checklists, Problem solution essay / Argumentative Essay. Grammar – Error correction; If conditional sentences

### UNIT IV REPORTING OF EVENTS AND RESEARCH

6

Reading –Newspaper articles; Writing – Recommendations, Transcoding, Accident Report, Survey Report Grammar – Reported Speech, Modals Vocabulary – Conjunctions- use of prepositions

### UNIT V THE ABILITY TO PUT IDEAS OR INFORMATION COGENTLY

6

Reading – Company profiles, Statement of Purpose, (SOP), an excerpt of interview with professionals; Writing – Job / Internship application – Cover letter & Resume; Grammar – Numerical adjectives, Relative Clauses.

**TOTAL : 30 PERIODS**

## COURSE OUTCOMES:

At the end of the course, learners will be able

**CO1:**To compare and contrast products and ideas in technical texts.

**CO2:**To identify and report cause and effects in events, industrial processes through technical texts

**CO3:**To analyse problems in order to arrive at feasible solutions and communicate them in the written format.

**CO4:**To present their ideas and opinions in a planned and logical manner

**CO5:**To draft effective resumes in the context of job search.

**TEXT BOOKS :**

1. English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.
2. English for Science & Technology Cambridge University Press 2021.
3. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

**REFERENCES:**

1. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.
2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, NewDelhi.
3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.

**ASSESSMENT PATTERN**

Two internal assessments and an end semester examination to test students’ reading and writing skills along with their grammatical and lexical competence.

**CO’s-PO’s & PSO’s MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	3	3	3	3	2	3	3	3	-	-	-
2	3	3	3	3	3	3	3	3	2	3	3	3	-	-	-
3	3	3	3	3	3	3	3	3	2	3	3	3	-	-	-
4	3	3	3	3	2	3	3	3	2	3	3	3	-	-	-
5	-	-	-	-	-	-	-	-	3	3	3	3	-	-	-
AVg.	3	3	3	3	2.75	3	3	3	2.2	3	3	3	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

**Note:** The average value of this course to be used for program articulation matrix.

**MA3251**

**STATISTICS AND NUMERICAL METHODS**

**L T P C**

**3 1 0 4**

**COURSE OBJECTIVES:**

- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of solving algebraic and transcendental equations.



- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

#### **UNIT I TESTING OF HYPOTHESIS**

**9 + 3**

Sampling distributions - Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.

#### **UNIT II DESIGN OF EXPERIMENTS**

**9 + 3**

One way and two way classifications - Completely randomized design – Randomized block design – Latin square design -  $2^2$  factorial design.

#### **UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS**

**9 + 3**

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.

#### **UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION**

**9 + 3**

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

#### **UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**

**9 + 3**

Single step methods: Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first order differential equations - Multi step methods: Milne's and Adams - Bash forth predictor corrector methods for solving first order differential equations.

**TOTAL: 60 PERIODS**

#### **COURSE OUTCOMES:**

Upon successful completion of the course, students will be able to:

**CO1:**Apply the concept of testing of hypothesis for small and large samples in real life problems.

**CO2:**Apply the basic concepts of classifications of design of experiments in the field of agriculture.

**CO3:**Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.

**CO4:**Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.

**CO5:**Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

#### **TEXT BOOKS:**

1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10<sup>th</sup> Edition, New Delhi, 2015.
2. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8<sup>th</sup> Edition, 2015.

## REFERENCES:

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9<sup>th</sup> Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8<sup>th</sup> Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7<sup>th</sup> Edition, 2007.
4. Gupta S.C. and Kapoor V. K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 12<sup>th</sup> Edition, 2020.
5. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics ", Tata McGraw Hill Edition, 4<sup>th</sup> Edition, 2012.
6. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", 9<sup>th</sup> Edition, Pearson Education, Asia, 2010.

## CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO2	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO3	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO4	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO5	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
Avg	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

PH3256

PHYSICS FOR INFORMATION SCIENCE

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## COURSE OBJECTIVES:

- To make the students understand the importance in studying electrical properties of materials.
- To enable the students to gain knowledge in semiconductor physics
- To instill knowledge on magnetic properties of materials.
- To establish a sound grasp of knowledge on different optical properties of materials, optical displays and applications
- To inculcate an idea of significance of nano structures, quantum confinement, ensuing nano device applications and quantum computing.

## UNIT I ELECTRICAL PROPERTIES OF MATERIALS

9

Classical free electron theory - Expression for electrical conductivity – Thermal conductivity, expression - Wiedemann-Franz law – Success and failures - electrons in metals – Particle in a three dimensional box – degenerate states – Fermi- Dirac statistics – Density of energy states – Electron in periodic potential – Energy bands in solids – tight binding approximation - Electron effective mass – concept of hole.

## UNIT II SEMICONDUCTOR PHYSICS

9

Intrinsic Semiconductors – Energy band diagram – direct and indirect band gap semiconductors – Carrier concentration in intrinsic semiconductors – extrinsic semiconductors - Carrier concentration in N-type & P-type semiconductors – Variation of carrier concentration with temperature – variation of Fermi level with temperature and impurity concentration – Carrier transport in Semiconductor:

random motion, drift, mobility and diffusion – Hall effect and devices – Ohmic contacts – Schottky diode.

**UNIT III MAGNETIC PROPERTIES OF MATERIALS 9**

Magnetic dipole moment – atomic magnetic moments- magnetic permeability and susceptibility - Magnetic material classification: diamagnetism – paramagnetism – ferromagnetism – antiferromagnetism – ferrimagnetism – Ferromagnetism: origin and exchange interaction- saturation magnetization and Curie temperature – Domain Theory- M versus H behaviour – Hard and soft magnetic materials – examples and uses— Magnetic principle in computer data storage – Magnetic hard disc (GMR sensor).

**UNIT IV OPTICAL PROPERTIES OF MATERIALS 9**

Classification of optical materials – carrier generation and recombination processes - Absorption emission and scattering of light in metals, insulators and semiconductors (concepts only) - photo current in a P-N diode – solar cell - LED – Organic LED – Laser diodes – Optical data storage techniques.

**UNIT V NANODEVICES AND QUANTUM COMPUTING 9**

Introduction - quantum confinement – quantum structures: quantum wells, wires and dots — band gap of nanomaterials. Tunneling – Single electron phenomena: Coulomb blockade - resonant-tunneling diode – single electron transistor – quantum cellular automata - Quantum system for information processing - quantum states – classical bits – quantum bits or qubits –CNOT gate - multiple qubits – Bloch sphere – quantum gates – advantage of quantum computing over classical computing.

**TOTAL :45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the students should be able to

**CO1:**gain knowledge on classical and quantum electron theories, and energy band structures

**CO2:**acquire knowledge on basics of semiconductor physics and its applications in various devices

**CO3:**get knowledge on magnetic properties of materials and their applications in data storage,

**CO4:**have the necessary understanding on the functioning of optical materials for optoelectronics

**CO5:**understand the basics of quantum structures and their applications and basics of quantum computing

**TEXT BOOKS:**

1. Jasprit Singh, “Semiconductor Devices: Basic Principles”, Wiley (Indian Edition), 2007.
2. S.O. Kasap. Principles of Electronic Materials and Devices, McGraw-Hill Education (Indian Edition), 2020.
3. Parag K. Lala, Quantum Computing: A Beginner's Introduction, McGraw-Hill Education (Indian Edition), 2020.

**REFERENCES:**

1. Charles Kittel, Introduction to Solid State Physics, Wiley India Edition, 2019.
2. Y.B.Band and Y.Avishai, Quantum Mechanics with Applications to Nanotechnology and
3. Information Science, Academic Press, 2013.
4. V.V.Mitin, V.A. Kochelap and M.A.Stroschio, Introduction to Nanoelectronics, Cambridge Univ.Press, 2008.
5. G.W. Hanson, Fundamentals of Nanoelectronics, Pearson Education (Indian Edition) 2009.

6. B.Rogers, J.Adams and S.Pennathur, Nanotechnology: Understanding Small Systems, CRC Press, 2014.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	3	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
3	3	-	-	1	2	1	1	-	-	-	-	-	-	-	-	-
4	3	-	2	1	3	-	1	-	-	-	-	-	-	-	-	-
5	3	2	2	2	2	1	2	-	-	-	-	2	-	-	-	-
<b>AVG</b>	3	1.3	2	1.3	2.3	1	1.3	-	-	-	-	2	-	-	-	-

1-Low,2-Medium,3-High,”-“no correlation

Note: the average value of this course to be used for program articulation matrix.

**BE3251 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce the basics of electric circuits and analysis
- To impart knowledge in the basics of working principles and application of electrical machines
- To introduce analog devices and their characteristics
- To educate on the fundamental concepts of digital electronics
- To introduce the functional elements and working of measuring instruments

**UNIT I ELECTRICAL CIRCUITS 9**

DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm’s Law - Kirchhoff’s Laws –Independent and Dependent Sources – Simple problems- Nodal Analysis, Mesh analysis with Independent sources only (Steady state)

Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor – Steady state analysis of RLC circuits (Simple problems only)

**UNIT II ELECTRICAL MACHINES 9**

Construction and Working principle- DC Separately and Self excited Generators, EMF equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Construction, Working principle and Applications of Transformer, Three phase Alternator, Synchronous motor and Three Phase Induction Motor.

**UNIT III ANALOG ELECTRONICS 9**

Resistor, Inductor and Capacitor in Electronic Circuits- Semiconductor Materials: Silicon &Germanium – PN Junction Diodes, Zener Diode –Characteristics Applications – Bipolar Junction Transistor-Biasing, JFET, SCR, MOSFET,IGBT – Types, I-V Characteristics and Applications, Rectifier and Inverters

**UNIT IV DIGITAL ELECTRONICS****9**

Review of number systems, binary codes, error detection and correction codes, Combinational logic - representation of logic functions-SOP and POS forms, K-map representations - minimization using K maps (Simple Problems only).

**UNIT V MEASUREMENTS AND INSTRUMENTATION****9**

Functional elements of an instrument, Standards and calibration, Operating Principle, types -Moving Coil and Moving Iron meters, Measurement of three phase power, Energy Meter, Instrument Transformers-CT and PT, DSO- Block diagram- Data acquisition.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

After completing this course, the students will be able to

**CO1:** Compute the electric circuit parameters for simple problems

**CO2:** Explain the working principle and applications of electrical machines

**CO3:** Analyze the characteristics of analog electronic devices

**CO4:** Explain the basic concepts of digital electronics

**CO5:** Explain the operating principles of measuring instruments

**TEXT BOOKS:**

1. Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", Second Edition, McGraw Hill Education, 2020
2. S.K.Bhattacharya "Basic Electrical and Electronics Engineering", Pearson Education, Second Edition, 2017.
3. Sedha R.S., "A textbook book of Applied Electronics", S. Chand & Co., 2008
4. James A .Svoboda, Richard C. Dorf, "Dorf's Introduction to Electric Circuits", Wiley, 2018.
5. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2015.

**REFERENCES:**

1. Kothari DP and I.J Nagrath, "Basic Electrical Engineering", Fourth Edition, McGraw Hill Education, 2019.
2. Thomas L. Floyd, 'Digital Fundamentals', 11th Edition, Pearson Education, 2017.
3. 4. Albert Malvino, David Bates, 'Electronic Principles, McGraw Hill Education; 7th edition, 2017.
5. Mahmood Nahvi and Joseph A. Edminister, "Electric Circuits", Schaum' Outline Series, McGraw Hill, 2002.
6. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	1	-	-	-	-	1	-	-	-	2	-	-	1
2	2	2	1	-	-	-	-	1	-	-	-	2	-	-	1
3	2	1	1	-	-	-	-	1	-	-	-	2	-	-	1
4	2	2	1	-	-	-	-	1	-	-	-	2	-	-	1
5	2	2	1	-	-	-	-	1	-	-	-	2	-	-	1
<b>CO</b>	2	1.8	1	-	-	-	-	1	-	-	-	2	-	-	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Drawing engineering curves.
- Drawing a freehand sketch of simple objects.
- Drawing orthographic projection of solids and section of solids.
- Drawing development of solids
- Drawing isometric and perspective projections of simple solids.

**CONCEPTS AND CONVENTIONS (Not for Examination)**

Importance of graphics in engineering applications — Use of drafting instruments — BIS conventions and specifications — Size, layout and folding of drawing sheets — Lettering and dimensioning.

**UNIT I PLANE CURVES****6+12**

Basic Geometrical constructions, Curves used in engineering practices: Conics — Construction of ellipse, parabola and hyperbola by eccentricity method — Construction of cycloid — construction of involutes of square and circle — Drawing of tangents and normal to the above curves.

**UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE****6+12**

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

**UNIT III PROJECTION OF SOLIDS AND FREEHAND SKETCHING****6+12**

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method. Visualization concepts and Free Hand sketching: Visualization principles —Representation of Three Dimensional objects — Layout of views- Freehand sketching of multiple views from pictorial views of objects.

Practicing three dimensional modeling of simple objects by CAD Software (Not for examination)

**UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES****6 +12**

Sectioning of above solids in simple vertical position when the cutting plane is inclined to one of the principal planes and perpendicular to the other — obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids — Prisms, pyramids cylinders and cones.

Practicing three dimensional modeling of simple objects by CAD Software (Not for examination)

**UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS****6+12**

Principles of isometric projection — isometric scale — isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids - Prisms, pyramids and cylinders by visual ray method.

Practicing three dimensional modeling of isometric projection of simple objects by CAD Software  
(Not for examination)

**TOTAL: (L=30+P=60) 90 PERIODS**

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1:**Use BIS conventions and specifications for engineering drawing.

**CO2:**Construct the conic curves, involutes and cycloid.

**CO3:**Solve practical problems involving projection of lines.

**CO4:**Draw the orthographic, isometric and perspective projections of simple solids.

**CO5:**Draw the development of simple solids.

**TEXT BOOK:**

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 53rd Edition, 2019.
2. Natarajan K.V., "A Text Book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2018.
3. Parthasarathy, N. S. and Vela Murali, "Engineering Drawing", Oxford University Press, 2015

**REFERENCES:**

1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill, 2nd Edition, 2019.
2. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Publications, Bangalore, 27th Edition, 2017.
3. Luzzader, Warren.J. and Duff, John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4. Parthasarathy N. S. and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.
5. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson Education India, 2nd Edition, 2009.
6. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.

Publication of Bureau of Indian Standards:

1. IS 10711 — 2001: Technical products Documentation — Size and layout of drawing sheets.
2. IS 9609 (Parts 0 & 1) — 2001: Technical products Documentation — Lettering.
3. IS 10714 (Part 20) — 2001 & SP 46 — 2003: Lines for technical drawings.
4. IS 11669 — 1986 & SP 46 —2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) — 2001: Technical drawings — Projection Methods.

Special points applicable to University Examinations on Engineering Graphics:

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit a solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

### CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
2	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
3	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
4	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
5	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
<b>CO</b>	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

CS3251

PROGRAMMING IN C

L T P C  
3 0 0 3

#### COURSE OBJECTIVES:

- To understand the constructs of C Language.
- To develop C Programs using basic programming constructs
- To develop C programs using arrays and strings
- To develop modular applications in C using functions
- To develop applications in C using pointers and structures
- To do input/output and file handling in C

#### UNIT I BASICS OF C PROGRAMMING

9

Introduction to programming paradigms – Applications of C Language - Structure of C program - C programming: Data Types - Constants – Enumeration Constants - Keywords – Operators: Precedence and Associativity - Expressions - Input/Output statements, Assignment statements – Decision making statements - Switch statement - Looping statements – Preprocessor directives - Compilation process

#### UNIT II ARRAYS AND STRINGS

9

Introduction to Arrays: Declaration, Initialization – One dimensional array –Two dimensional arrays - String operations: length, compare, concatenate, copy – Selection sort, linear and binary search.

#### UNIT III FUNCTIONS AND POINTERS

9

Modular programming - Function prototype, function definition, function call, Built-in functions (string functions, math functions) – Recursion, Binary Search using recursive functions –Pointers – Pointer operators – Pointer arithmetic – Arrays and pointers – Array of pointers – Parameter passing: Pass by value, Pass by reference.

#### UNIT IV STRUCTURES AND UNION

9

Structure - Nested structures – Pointer and Structures – Array of structures – Self referential structures – Dynamic memory allocation - Singly linked list – typedef – Union - Storage classes and Visibility.

#### UNIT V FILE PROCESSING

9

Files – Types of file processing: Sequential access, Random access – Sequential access file - Random access file - Command line arguments.



## COURSE OUTCOMES:

Upon completion of the course, the students will be able to

**CO1:** Demonstrate knowledge on C Programming constructs

**CO2:** Develop simple applications in C using basic constructs

**CO3:** Design and implement applications using arrays and strings

**CO4:** Develop and implement modular applications in C using functions.

**CO5:** Develop applications in C using structures and pointers.

**CO6:** Design applications using sequential and random access file processing.

**TOTAL : 45 PERIODS**

## TEXT BOOKS:

1. ReemaThareja, "Programming in C", Oxford University Press, Second Edition, 2016.
2. Kernighan, B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2015.

## REFERENCES:

1. Paul Deitel and Harvey Deitel, "C How to Program with an Introduction to C++", Eighth edition, Pearson Education, 2018.
2. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.
3. Byron S. Gottfried, "Schaum's Outline of Theory and Problems of Programming with C", McGraw-Hill Education, 1996.
4. Pradip Dey, Manas Ghosh, "Computer Fundamentals and Programming in C", Second Edition, Oxford University Press, 2013.
5. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", 1st Edition, Pearson Education, 2013.

## CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	2	1	2	1	1	1	2	-	3	2	1	2	-
2	2	2	2	1	2	1	1	1	2	-	3	3	2	2	-
3	2	3	2	1	2	1	1	1	2	-	3	2	2	2	-
4	3	2	2	1	3	1	1	1	2	-	3	3	2	2	-
5	2	3	3	1	2	1	2	1	2	-	3	2	2	3	-
6	2	2	3	2	1	2	-	-	2	1	2	2	2	2	-
CO	2	2	2	1	2	1	1	1	2	-	3	2	2	2	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

**UNIT I WEAVING AND CERAMIC TECHNOLOGY 3**

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

**UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3**

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

**UNIT III MANUFACTURING TECHNOLOGY 3**

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold-Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

**UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3**

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

**UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3**

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

**TOTAL : 15 PERIODS****TEXT-CUM-REFERENCE BOOKS**

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநறை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International

Institute of Tamil Studies.)

9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

GE3252

தமிழரும் தொழில்நுட்பமும்

L T P C

1 0 0 1

**அலகு I நெசவு மற்றும் பாணைத் தொழில்நுட்பம்:**

3

சங்க காலத்தில் நெசவுத் தொழில் – பாணைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

**அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்:**

3

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

**அலகு III உற்பத்தித் தொழில் நுட்பம்:**

3

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

**அலகு IV வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்:**

3

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குழுவித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

**அலகு V அறிவியல் தமிழ் மற்றும் கணித்தமிழ்:**

**3**

அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருறை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)  
Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

PROGRESS THROUGH KNOWLEDGE

**NX3251**

**NCC Credit Course Level 1\*  
(ARMY WING)**

NCC Credit Course Level - I

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>

**NCC GENERAL**

**6**

NCC 1 Aims, Objectives & Organization of NCC

1

NCC 2 Incentives

2

NCC 3 Duties of NCC Cadet

1

NCC 4 NCC Camps: Types & Conduct

2

**NATIONAL INTEGRATION AND AWARENESS**

**4**

NI 1 National Integration: Importance & Necessity

1

NI 2 Factors Affecting National Integration

1

NI 3 Unity in Diversity & Role of NCC in Nation Building

1

NI 4 Threats to National Security

1

**PERSONALITY DEVELOPMENT**

**7**

PD 1 Self-Awareness, Empathy, Critical & Creative Thinking,  
Decision Making and Problem Solving

2

PD 2 Communication Skills

3

PD 3 Group Discussion: Stress & Emotions

2

**LEADERSHIP**

**5**

L 1 Leadership Capsule: Traits, Indicators, Motivation, Moral  
Values, Honour Code

3

L 2 Case Studies: Shivaji, Jhasi Ki Rani

2

**SOCIAL SERVICE AND COMMUNITY DEVELOPMENT**

**8**

SS 1 Basics, Rural Development Programmes, NGOs, Contribution  
of Youth

3

SS 4 Protection of Children and Women Safety

1

SS 5 Road / Rail Travel Safety

1

SS 6 New Initiatives

2

SS 7 Cyber and Mobile Security Awareness

1

**TOTAL: 30 PERIODS**

**NX3252**

**NCC Credit Course Level 1\*  
(NAVAL WING)**

NCC Credit Course Level - I

L	T	P	C
2	0	0	2

**NCC GENERAL**

NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2

**NATIONAL INTEGRATION AND AWARENESS**

NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1

**PERSONALITY DEVELOPMENT**

PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2

**LEADERSHIP**

L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2

**SOCIAL SERVICE AND COMMUNITY DEVELOPMENT**

SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

**TOTAL : 30 PERIODS**

**NX3253**

**NCC Credit Course Level 1\*  
(AIR FORCE WING)**

NCC Credit Course Level - I

L	T	P	C
2	0	0	2

**NCC GENERAL**

NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2

**NATIONAL INTEGRATION AND AWARENESS**

NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1

**PERSONALITY DEVELOPMENT**

PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2

**LEADERSHIP**

L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2

**SOCIAL SERVICE AND COMMUNITY DEVELOPMENT**

SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

**TOTAL : 30 PERIODS**

**COURSE OBJECTIVES:**

The main learning objective of this course is to provide hands on training to the students in:

1. Drawing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planing; making joints in wood materials used in commonhousehold wood work.
2. Wiring various electrical joints in common household electrical wire work.
3. Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts; Assembling simple mechanical assembly of common household equipments; Making a tray out of metal sheet using sheet metal work.
4. Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.

**GROUP – A (CIVIL & ELECTRICAL)****PART I****CIVIL ENGINEERING PRACTICES****15****PLUMBING WORK:**

- a) Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
- b) Preparing plumbing line sketches.
- c) Laying pipe connection to the suction side of a pump
- d) Laying pipe connection to the delivery side of a pump.
- e) Connecting pipes of different materials: Metal, plastic and flexible pipes used inhousehold appliances.

**WOOD WORK:**

- a) Sawing,
- b) Planing and
- c) Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.

## Wood Work Study:

- a) Studying joints in door panels and wooden furniture
- b) Studying common industrial trusses using models.



**PART II****ELECTRICAL ENGINEERING PRACTICES****15**

- a) Introduction to switches, fuses, indicators and lamps - Basic switch board wiring with lamp, fan and three pin socket
- b) Staircase wiring
- c) Fluorescent Lamp wiring with introduction to CFL and LED types.
- d) Energy meter wiring and related calculations/ calibration
- e) Study of Iron Box wiring and assembly
- f) Study of Fan Regulator (Resistor type and Electronic type using Diac/Triac/quadrac)
- g) Study of emergency lamp wiring/Water heater

**GROUP – B (MECHANICAL AND ELECTRONICS)****PART III****MECHANICAL ENGINEERING PRACTICES****15****WELDING WORK:**

- a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
- b) Practicing gas welding.

**BASIC MACHINING WORK:**

- a) (simple)Turning.
- b) (simple)Drilling.
- c) (simple)Tapping.

**ASSEMBLY WORK:**

- a) Assembling a centrifugal pump.
- b) Assembling a household mixer.
- c) Assembling an airconditioner.

**SHEET METAL WORK:**

- a) Making of a square tray

**FOUNDRY WORK:**

- a) Demonstrating basic foundry operations.

**PART IV****ELECTRONIC ENGINEERING PRACTICES****15****SOLDERING WORK:**

- a) Soldering simple electronic circuits and checking continuity.

**ELECTRONIC ASSEMBLY AND TESTING WORK:**

- a) Assembling and testing electronic components on a small PCB.

## ELECTRONIC EQUIPMENT STUDY:

- a) Study an elements of smart phone..
- b) Assembly and dismantle of LED TV.
- c) Assembly and dismantle of computer/ laptop

**TOTAL : 60 PERIODS**

### COURSE OUTCOMES:

**Upon completion of this course, the students will be able to:**

**CO1:** Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.

**CO2:** Wire various electrical joints in common household electrical wire work.

**CO3:** Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical assembly of common household equipments; Make a tray out of metal sheet using sheet metal work.

**CO4:** Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

### CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1
2	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1
3	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1
CO	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CS3271**

**PROGRAMMING IN C LABORATORY**

**L T P C**  
**0 0 4 2**

### COURSE OBJECTIVES:

- To familiarise with C programming constructs.
- To develop programs in C using basic constructs.
- To develop programs in C using arrays.
- To develop applications in C using strings, pointers, functions.
- To develop applications in C using structures.
- To develop applications in C using file processing.

### LIST OF EXPERIMENTS:

**Note:** The lab instructor is expected to design problems based on the topics listed. The Examination shall not be restricted to the sample experiments designed.

1. I/O statements, operators, expressions
2. decision-making constructs: if-else, goto, switch-case, break-continue
3. Loops: for, while, do-while
4. Arrays: 1D and 2D, Multi-dimensional arrays, traversal
5. Strings: operations
6. Functions: call, return, passing parameters by (value, reference), passing arrays to function.
7. Recursion

8. Pointers: Pointers to functions, Arrays, Strings, Pointers to Pointers, Array of Pointers
9. Structures: Nested Structures, Pointers to Structures, Arrays of Structures and Unions.
10. Files: reading and writing, File pointers, file operations, random access, processor directives.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

**Upon completion of the course, the students will be able to**

- CO1:** Demonstrate knowledge on C programming constructs.
- CO2:** Develop programs in C using basic constructs.
- CO3:** Develop programs in C using arrays.
- CO4:** Develop applications in C using strings, pointers, functions.
- CO5:** Develop applications in C using structures.
- CO6:** Develop applications in C using file processing.

**TEXT BOOKS:**

1. ReemaThareja, "Programming in C", Oxford University Press, Second Edition, 2016.
2. Kernighan, B.W and Ritchie, D.M, "The C Programming language", Second Edition, Pearson Education, 2015.

**REFERENCES:**

1. Paul Deitel and Harvey Deitel, "C How to Program with an Introduction to C++", Eighth edition, Pearson Education, 2018.
2. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.
3. Byron S. Gottfried, "Schaum's Outline of Theory and Problems of Programming with C", McGraw-Hill Education, 1996.
4. Pradip Dey, Manas Ghosh, "Computer Fundamentals and Programming in C", Second Edition, Oxford University Press, 2013.
5. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", 1st Edition, Pearson Education, 2013.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	3	3	1	1	1	-	-	2	1	2	2	2	2	
2	2	3	3	2	1	1	-	-	2	1	2	2	2	3	
3	2	2	2	1	1	2	-	-	2	-	2	2	2	2	
4	2	2	2	2	1	2	-	-	3	-	3	3	3	2	
5	2	2	3	2	3	2	-	-	3	-	3	3	3	3	
6	2	2	3	2	1	2	-	-	2	1	2	2	2	2	
<b>Avg</b>	2	2	3	2	1	2	-	-	2	1	2	2	2	2	

1 - low, 2 - medium, 3 - high, '-' - no correlation

**GE3272**

**COMMUNICATION LABORATORY**

**L T P C**

**0 0 4 2**

**COURSE OBJECTIVES**

- To identify varied group discussion skills and apply them to take part in effective discussions in a professional context.
- To analyse concepts and problems and make effective presentations explaining them clearly and precisely.
- To be able to communicate effectively through formal and informal writing.

- To be able to use appropriate language structures to write emails, reports and essays
- To give instructions and recommendations that are clear and relevant to the context

**UNIT I** **12**

Speaking-Role Play Exercises Based on Workplace Contexts, - talking about competition-discussing progress toward goals-talking about experiences- talking about events in life- discussing past events-Writing: writing emails ( formal & semi-formal).

**UNIT II** **12**

Speaking: discussing news stories-talking about frequency-talking about travel problems-discussing travel procedures- talking about travel problems- making arrangements-describing arrangements-discussing plans and decisions- discussing purposes and reasons- understanding common technology terms-Writing: - writing different types of emails.

**UNIT III** **12**

Speaking: discussing predictions-describing the climate-discussing forecasts and scenarios- talking about purchasing-discussing advantages and disadvantages- making comparisons- discussing likes and dislikes- discussing feelings about experiences-discussing imaginary scenarios Writing: short essays and reports-formal/semi-formal letters.

**UNIT IV** **12**

Speaking: discussing the natural environment-describing systems-describing position and movement- explaining rules-( example- discussing rental arrangements)- understanding technical instructions-Writing: writing instructions-writing a short article.

**UNIT V** **12**

Speaking: describing things relatively-describing clothing-discussing safety issues (making recommendations) talking about electrical devices-describing controlling actions- Writing: job application( Cover letter + Curriculum vitae)-writing recommendations.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES**

**CO1:**Speak effectively in group discussions held in a formal/semi formal contexts.

**CO2:**Discuss, analyse and present concepts and problems from various perspectives to arrive at suitable solutions

**CO3:**Write emails, letters and effective job applications.

**CO4:**Write critical reports to convey data and information with clarity and precision

**CO5:**Give appropriate instructions and recommendations for safe execution of tasks

**Assessment Pattern**

- One online / app based assessment to test speaking and writing skills
- Proficiency certification is given on successful completion of speaking and writing.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	3	3	1	3	3	3	3	3	3	3	-	-	-
2	2	3	3	3	1	3	3	3	3	3	3	3	-	-	-
3	2	2	3	3	1	3	3	3	3	3	3	3	-	-	-
4	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
5	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
<b>AVg.</b>	<b>2.4</b>	<b>2.8</b>	<b>3</b>	<b>3</b>	<b>1.8</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

**Note:** The average value of this course to be used for program articulation matrix.

**COURSE OBJECTIVES:**

- To extend student's logical and mathematical maturity and ability to deal with abstraction.
- To introduce most of the basic terminologies used in computer science courses and application of ideas to solve practical problems.
- To understand the basic concepts of combinatorics and graph theory.
- To familiarize the applications of algebraic structures.
- To understand the concepts and significance of lattices and boolean algebra which are widely used in computer science and engineering.

**UNIT I LOGIC AND PROOFS****9+3**

Propositional logic – Propositional equivalences - Predicates and quantifiers – Nested quantifiers – Rules of inference - Introduction to proofs – Proof methods and strategy.

**UNIT II COMBINATORICS****9+3**

Mathematical induction – Strong induction and well ordering – The basics of counting – The pigeonhole principle – Permutations and combinations – Recurrence relations – Solving linear recurrence relations – Generating functions – Inclusion and exclusion principle and its applications.

**UNIT III GRAPHS****9+3**

Graphs and graph models – Graph terminology and special types of graphs – Matrix representation of graphs and graph isomorphism – Connectivity – Euler and Hamilton paths.

**UNIT IV ALGEBRAIC STRUCTURES****9+3**

Algebraic systems – Semi groups and monoids - Groups – Subgroups – Homomorphism's – Normal subgroup and cosets – Lagrange's theorem – Definitions and examples of Rings and Fields.

**UNIT V LATTICES AND BOOLEAN ALGEBRA****9+3**

Partial ordering – Posets – Lattices as posets – Properties of lattices - Lattices as algebraic systems – Sub lattices – Direct product and homomorphism – Some special lattices – Boolean algebra – Sub Boolean Algebra – Boolean Homomorphism.

**TOTAL: 60 PERIODS****COURSE OUTCOMES:**

At the end of the course, students would :

**CO1:**Have knowledge of the concepts needed to test the logic of a program.

**CO2:**Have an understanding in identifying structures on many levels.

**CO3:**Be aware of a class of functions which transform a finite set into another finite set which relates to input and output functions in computer science.

**CO4:**Be aware of the counting principles.

**CO5:**Be exposed to concepts and properties of algebraic structures such as groups, rings and fields.

**TEXT BOOKS:**

1. Rosen. K.H., "Discrete Mathematics and its Applications", 7<sup>th</sup> Edition, Tata McGraw Hill Pub. Co. Ltd., New Delhi, Special Indian Edition, 2017.
2. Tremblay. J.P. and Manohar. R, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw Hill Pub. Co. Ltd, New Delhi, 30<sup>th</sup> Reprint, 2011.

## REFERENCES:

1. Grimaldi. R.P. "Discrete and Combinatorial Mathematics: An Applied Introduction", 5<sup>th</sup> Edition, Pearson Education Asia, Delhi, 2013.
2. Koshy. T. "Discrete Mathematics with Applications", Elsevier Publications, 2006.
3. Lipschutz. S. and Mark Lipson., "Discrete Mathematics", Schaum's Outlines, Tata McGraw Hill Pub. Co. Ltd., New Delhi, 3<sup>rd</sup> Edition, 2010.

### CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	-	-	-	-	-	-	-	-	2	-	-	-
2	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	3	2	-	-	2	-	-	-	3	-	-	-	-	-
4	-	2	2	2	-	-	-	-	-	-	-	-	-	-	-
5	-	2	2	2	-	-	-	-	-	2	-	-	-	-	-
AVg.	1	3	2	1	-	-	-	-	-	1	-	-	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

CS3351

DIGITAL PRINCIPLES AND COMPUTER ORGANIZATION

L T P C

3 0 2 4

### COURSE OBJECTIVES:

- To analyze and design combinational circuits.
- To analyze and design sequential circuits
- To understand the basic structure and operation of a digital computer.
- To study the design of data path unit, control unit for processor and to familiarize with the hazards.
- To understand the concept of various memories and I/O interfacing.

#### UNIT I COMBINATIONAL LOGIC

9

Combinational Circuits – Karnaugh Map - Analysis and Design Procedures – Binary Adder – Subtractor – Decimal Adder - Magnitude Comparator – Decoder – Encoder – Multiplexers - Demultiplexers

#### UNIT II SYNCHRONOUS SEQUENTIAL LOGIC

9

Introduction to Sequential Circuits – Flip-Flops – operation and excitation tables, Triggering of FF, Analysis and design of clocked sequential circuits – Design – Moore/Mealy models, state minimization, state assignment, circuit implementation - Registers – Counters.

#### UNIT III COMPUTER FUNDAMENTALS

9

Functional Units of a Digital Computer: Von Neumann Architecture – Operation and Operands of Computer Hardware Instruction – Instruction Set Architecture (ISA): Memory Location, Address and Operation – Instruction and Instruction Sequencing – Addressing Modes, Encoding of Machine Instruction – Interaction between Assembly and High Level Language.

#### UNIT IV PROCESSOR

9

Instruction Execution – Building a Data Path – Designing a Control Unit – Hardwired Control, Microprogrammed Control – Pipelining – Data Hazard – Control Hazards.

**UNIT V MEMORY AND I/O****9**

Memory Concepts and Hierarchy – Memory Management – Cache Memories: Mapping and Replacement Techniques – Virtual Memory – DMA – I/O – Accessing I/O: Parallel and Serial Interface – Interrupt I/O – Interconnection Standards: USB, SATA

**45 PERIODS****PRACTICAL EXERCISES:****30 PERIODS**

1. Verification of Boolean theorems using logic gates.
2. Design and implementation of combinational circuits using gates for arbitrary functions.
3. Implementation of 4-bit binary adder/subtractor circuits.
4. Implementation of code converters.
5. Implementation of BCD adder, encoder and decoder circuits
6. Implementation of functions using Multiplexers.
7. Implementation of the synchronous counters
8. Implementation of a Universal Shift register.
9. Simulator based study of Computer Architecture

**COURSE OUTCOMES:**

**At the end of this course, the students will be able to:**

**CO1 :** Design various combinational digital circuits using logic gates

**CO2 :** Design sequential circuits and analyze the design procedures

**CO3 :** State the fundamentals of computer systems and analyze the execution of an instruction

**CO4 :** Analyze different types of control design and identify hazards

**CO5 :** Identify the characteristics of various memory systems and I/O communication

**TOTAL: 75 PERIODS****TEXT BOOKS:**

1. M. Morris Mano, Michael D. Ciletti, "Digital Design : With an Introduction to the Verilog HDL, VHDL, and System Verilog", Sixth Edition, Pearson Education, 2018.
2. David A. Patterson, John L. Hennessy, "Computer Organization and Design, The Hardware/Software Interface", Sixth Edition, Morgan Kaufmann/Elsevier, 2020.

**REFERENCES:**

1. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian, "Computer Organization and Embedded Systems", Sixth Edition, Tata McGraw-Hill, 2012.
2. William Stallings, "Computer Organization and Architecture – Designing for Performance", Tenth Edition, Pearson Education, 2016.
3. M. Morris Mano, "Digital Logic and Computer Design", Pearson Education, 2016.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3	2	1	1	1	1	2	3	2	3	3
2	3	3	3	3	2	1	1	1	1	1	2	3	1	2	2
3	3	3	3	3	2	2	1	1	1	1	2	3	2	3	1
4	3	3	3	3	1	1	1	1	1	1	1	2	1	3	1
5	3	3	3	3	1	2	1	1	1	1	1	2	1	2	1
AVg.	3	3	3	3	1.8	1.6	1	1	1	1	1.6	2.6	1.4	2.6	1.6

1 - low, 2 - medium, 3 - high, '-'- no correlation

**COURSE OBJECTIVES:**

- To understand the data science fundamentals and process.
- To learn to describe the data for the data science process.
- To learn to describe the relationship between data.
- To utilize the Python libraries for Data Wrangling.
- To present and interpret data using visualization libraries in Python

**UNIT I INTRODUCTION****9**

Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – Data preparation - Exploratory Data analysis – build the model–presenting findings and building applications - Data Mining - Data Warehousing – Basic Statistical descriptions of Data

**UNIT II DESCRIBING DATA****9**

Types of Data - Types of Variables -Describing Data with Tables and Graphs –Describing Data with Averages - Describing Variability - Normal Distributions and Standard (z) Scores

**UNIT III DESCRIBING RELATIONSHIPS****9**

Correlation –Scatter plots –correlation coefficient for quantitative data –computational formula for correlation coefficient – Regression –regression line –least squares regression line – Standard error of estimate – interpretation of  $r^2$  –multiple regression equations –regression towards the mean

**UNIT IV PYTHON LIBRARIES FOR DATA WRANGLING****9**

Basics of Numpy arrays –aggregations –computations on arrays –comparisons, masks, boolean logic – fancy indexing – structured arrays – Data manipulation with Pandas – data indexing and selection – operating on data – missing data – Hierarchical indexing – combining datasets – aggregation and grouping – pivot tables

**UNIT V DATA VISUALIZATION****9**

Importing Matplotlib – Line plots – Scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn.

**COURSE OUTCOMES:**

**At the end of this course, the students will be able to:**

**CO1:** Define the data science process

**CO2:** Understand different types of data description for data science process

**CO3:** Gain knowledge on relationships between data

**CO4:** Use the Python Libraries for Data Wrangling

**CO5:** Apply visualization Libraries in Python to interpret and explore data

**TOTAL:45 PERIODS****TEXT BOOKS**

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications, 2016. (Unit I)
2. Robert S. Witte and John S. Witte, "Statistics", Eleventh Edition, Wiley Publications, 2017. (Units II and III)



3. Jake VanderPlas, "Python Data Science Handbook", O'Reilly, 2016. (Units IV and V)

**REFERENCES:**

1. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press, 2014.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	1	2	2	-	-	-	1	1	1	2	2	2	2
2	2	1	-	1	1	-	-	-	2	1	1	2	2	3	1
3	2	2	1	2	2	1	1	-	1	2	1	3	2	2	3
4	3	2	2	1	2	-	-	-	1	1	2	2	3	3	2
5	2	2	1	2	2	-	-	-	1	1	1	2	2	2	2
<b>AVg.</b>	2	2	1	2	2	1	1	-	1	1	1	2	2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CS3301**

**DATA STRUCTURES**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the concepts of ADTs.
- To Learn linear data structures – lists, stacks, and queues.
- To understand non-linear data structures – trees and graphs.
- To understand sorting, searching and hashing algorithms.
- To apply Tree and Graph structures.

**UNIT I        LISTS**

**9**

Abstract Data Types (ADTs) – List ADT – Array-based implementation – Linked list implementation – Singly linked lists – Circularly linked lists – Doubly-linked lists – Applications of lists – Polynomial ADT – Radix Sort – Multilists.

**UNIT II        STACKS AND QUEUES**

**9**

Stack ADT – Operations – Applications – Balancing Symbols – Evaluating arithmetic expressions- Infix to Postfix conversion – Function Calls – Queue ADT – Operations – Circular Queue – DeQueue – Applications of Queues.

**UNIT III        TREES**

**9**

Tree ADT – Tree Traversals - Binary Tree ADT – Expression trees – Binary Search Tree ADT – AVL Trees – Priority Queue (Heaps) – Binary Heap.

**UNIT IV        MULTIWAY SEARCH TREES AND GRAPHS**

**9**

B-Tree – B+ Tree – Graph Definition – Representation of Graphs – Types of Graph - Breadth-first traversal – Depth-first traversal — Bi-connectivity – Euler circuits – Topological Sort – Dijkstra's algorithm – Minimum Spanning Tree – Prim's algorithm – Kruskal's algorithm

**UNIT V          SEARCHING, SORTING AND HASHING TECHNIQUES****9**

Searching – Linear Search – Binary Search. Sorting – Bubble sort – Selection sort – Insertion sort – Shell sort – Merge Sort – Hashing – Hash Functions – Separate Chaining – Open Addressing – Rehashing – Extendible Hashing.

**COURSE OUTCOMES:**

At the end of this course, the students will be able to:

**CO1:** Define linear and non-linear data structures.

**CO2:** Implement linear and non-linear data structure operations.

**CO3:** Use appropriate linear/non-linear data structure operations for solving a given problem.

**CO4:** Apply appropriate graph algorithms for graph applications.

**CO5:** Analyze the various searching and sorting algorithms.

**TOTAL:45 PERIODS****TEXT BOOKS**

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd Edition, Pearson Education, 2005.
2. Kamthane, Introduction to Data Structures in C, 1st Edition, Pearson Education, 2007

**REFERENCES**

1. Langsam, Augenstein and Tanenbaum, Data Structures Using C and C++, 2nd Edition, Pearson Education, 2015.
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms", Fourth Edition, Mcgraw Hill/ MIT Press, 2022.
3. Alfred V. Aho, Jeffrey D. Ullman, John E. Hopcroft, Data Structures and Algorithms, 1st edition, Pearson, 2002.
4. Kruse, Data Structures and Program Design in C, 2nd Edition, Pearson Education, 2006.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	1	2	2	1	1	-	1	2	1	3	2	1	3
2	1	2	1	2	2	-	-	-	1	1	1	2	2	2	2
3	2	3	1	2	3	-	-	-	1	1	1	2	2	1	2
4	2	1	-	1	1	-	-	-	2	1	1	2	2	3	1
5	1	2	1	2	2	1	1	-	1	2	1	3	2	2	3
<b>AVg.</b>	2	2	1	2	2	1	1	-	1	1	1	2	2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CS3391****OBJECT ORIENTED PROGRAMMING**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand Object Oriented Programming concepts and basics of Java programming language
- To know the principles of packages, inheritance and interfaces
- To develop a java application with threads and generics classes
- To define exceptions and use I/O streams
- To design and build Graphical User Interface Application using JAVA FX

**UNIT I INTRODUCTION TO OOP AND JAVA 9**

Overview of OOP – Object oriented programming paradigms – Features of Object Oriented Programming – Java Buzzwords – Overview of Java – Data Types, Variables and Arrays – Operators – Control Statements – Programming Structures in Java – Defining classes in Java – Constructors-Methods -Access specifiers - Static members- Java Doc comments

**UNIT II INHERITANCE, PACKAGES AND INTERFACES 9**

Overloading Methods – Objects as Parameters – Returning Objects –Static, Nested and Inner Classes. Inheritance: Basics– Types of Inheritance -Super keyword -Method Overriding – Dynamic Method Dispatch –Abstract Classes – final with Inheritance. Packages and Interfaces: Packages – Packages and Member Access –Importing Packages – Interfaces.

**UNIT III EXCEPTION HANDLING AND MULTITHREADING 9**

Exception Handling basics – Multiple catch Clauses – Nested try Statements – Java’s Built-in Exceptions – User defined Exception. Multithreaded Programming: Java Thread Model–Creating a Thread and Multiple Threads – Priorities – Synchronization – Inter Thread Communication- Suspending –Resuming, and Stopping Threads –Multithreading. Wrappers – Auto boxing.

**UNIT IV I/O, GENERICS, STRING HANDLING 9**

I/O Basics – Reading and Writing Console I/O – Reading and Writing Files. Generics: Generic Programming – Generic classes – Generic Methods – Bounded Types – Restrictions and Limitations. Strings: Basic String class, methods and String Buffer Class.

**UNIT V JAVAFX EVENT HANDLING, CONTROLS AND COMPONENTS 9**

JAVAFX Events and Controls: Event Basics – Handling Key and Mouse Events. Controls: Checkbox, ToggleButton – RadioButtons – ListView – ComboBox – ChoiceBox – Text Controls – ScrollPane. Layouts – FlowPane – HBox and VBox – BorderPane – StackPane – GridPane. Menus – Basics – Menu – Menu bars – MenuItem.

**COURSE OUTCOMES:**

On completion of this course, the students will be able to

**CO1:**Apply the concepts of classes and objects to solve simple problems

**CO2:**Develop programs using inheritance, packages and interfaces

**CO3:**Make use of exception handling mechanisms and multithreaded model to solve real world problems

**CO4:**Build Java applications with I/O packages, string classes, Collections and generics concepts

**CO5:**Integrate the concepts of event handling and JavaFX components and controls for developing GUI based applications

**TOTAL:45 PERIODS**

**TEXT BOOKS:**

1. Herbert Schildt, “Java: The Complete Reference”, 11<sup>th</sup> Edition, McGraw Hill Education, New Delhi, 2019
2. Herbert Schildt, “Introducing JavaFX 8 Programming”, 1<sup>st</sup> Edition, McGraw Hill Education, New Delhi, 2015

**REFERENCE:**

1. Cay S. Horstmann, “Core Java Fundamentals”, Volume 1, 11<sup>th</sup> Edition, Prentice Hall, 2018.

## CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	3	1	3	-	-	-	3	2	2	2	3	1	2
2	2	1	3	2	1	-	-	-	2	1	1	3	3	3	2
3	3	3	1	2	2	-	-	-	3	2	1	2	3	1	3
4	3	1	2	2	2	-	-	-	1	2	1	3	3	1	1
5	1	1	2	3	2	-	-	-	3	2	1	2	3	3	3
<b>AVg.</b>	2	1	2	2	2	-	-	-	2	2	1	2	3	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

CS3311

DATA STRUCTURES LABORATORY

L T P C  
0 0 3 1.5

### COURSE OBJECTIVES:

- To demonstrate array implementation of linear data structure algorithms.
- To implement the applications using Stack.
- To implement the applications using Linked list
- To implement Binary search tree and AVL tree algorithms.
- To implement the Heap algorithm.
- To implement Dijkstra's algorithm.
- To implement Prim's algorithm
- To implement Sorting, Searching and Hashing algorithms.

### LIST OF EXERCISES:

1. Array implementation of Stack, Queue and Circular Queue ADTs
2. Implementation of Singly Linked List
3. Linked list implementation of Stack and Linear Queue ADTs
4. Implementation of Polynomial Manipulation using Linked list
5. Implementation of Evaluating Postfix Expressions, Infix to Postfix conversion
6. Implementation of Binary Search Trees
7. Implementation of AVL Trees
8. Implementation of Heaps using Priority Queues
9. Implementation of Dijkstra's Algorithm
10. Implementation of Prim's Algorithm
11. Implementation of Linear Search and Binary Search
12. Implementation of Insertion Sort and Selection Sort
13. Implementation of Merge Sort
14. Implementation of Open Addressing (Linear Probing and Quadratic Probing)

**TOTAL:45 PERIODS**

### COURSE OUTCOMES:

At the end of this course, the students will be able to:

- CO1:** Implement Linear data structure algorithms.
- CO2:** Implement applications using Stacks and Linked lists
- CO3:** Implement Binary Search tree and AVL tree operations.
- CO4:** Implement graph algorithms.
- CO5:** Analyze the various searching and sorting algorithms.

## CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	2	2	1	-	-	-	-	2	1	2	2	2	2	3
2	3	3	1	1	-	-	-	-	1	1	1	3	1	2	2
3	2	1	3	1	-	-	-	-	1	1	2	3	3	3	3
4	3	1	3	3	-	-	-	-	1	2	3	3	2	1	2
5	3	2	1	1	2	-	-	-	3	3	3	1	3	1	3
<b>AVg.</b>	2	2	2	1	2	-	-	-	2	2	2	2	2	2	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

CS3381

OBJECT ORIENTED PROGRAMMING LABORATORY

L T P C

0 0 3 1.5

### COURSE OBJECTIVES:

- To build software development skills using java programming for real-world applications.
- To understand and apply the concepts of classes, packages, interfaces, inheritance, exception handling and file processing.
- To develop applications using generic programming and event handling

### LIST OF EXPERIMENTS:

1. Solve problems by using sequential search, binary search, and quadratic sorting algorithms (selection, insertion)
2. Develop stack and queue data structures using classes and objects.
3. Develop a java application with an Employee class with Emp\_name, Emp\_id, Address, Mail\_id, Mobile\_no as members. Inherit the classes, Programmer, Assistant Professor, Associate Professor and Professor from employee class. Add Basic Pay (BP) as the member of all the inherited classes with 97% of BP as DA, 10 % of BP as HRA, 12% of BP as PF, 0.1% of BP for staff club funds. Generate pay slips for the employees with their gross and net salary.
4. Write a Java Program to create an abstract class named Shape that contains two integers and an empty method named printArea(). Provide three classes named Rectangle, Triangle and Circle such that each one of the classes extends the class Shape. Each one of the classes contains only the method printArea( ) that prints the area of the given shape.
5. Solve the above problem using an interface.
6. Implement exception handling and creation of user defined exceptions.
7. Write a java program that implements a multi-threaded application that has three threads. First thread generates a random integer every 1 second and if the value is even, the second thread computes the square of the number and prints. If the value is odd, the third thread will print the value of the cube of the number.
8. Write a program to perform file operations.
9. Develop applications to demonstrate the features of generics classes.
10. Develop applications using JavaFX controls, layouts and menus.
11. Develop a mini project for any application using Java concepts.

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:

On completion of this course, the students will be able to

**CO1** : Design and develop java programs using object oriented programming concepts

**CO2** : Develop simple applications using object oriented concepts such as package, exceptions

**CO3:** Implement multithreading, and generics concepts

**CO4 :** Create GUIs and event driven programming applications for real world problems

**CO5:** Implement and deploy web applications using Java

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	2	1	-	-	-	-	1	2	2	2	1	2	3
2	2	1	3	1	-	-	-	-	2	3	3	2	1	3	1
3	2	2	1	2	1	-	-	-	1	2	1	3	2	3	2
4	2	2	1	3	-	-	-	-	3	1	1	1	2	1	2
5	1	3	3	1	3	-	-	-	1	1	1	1	2	1	2
<b>AVg.</b>	2	2	2	2	2	-	-	-	2	2	2	2	2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CS3361**

**DATA SCIENCE LABORATORY**

**L T P C**  
**0 0 4 2**

**COURSE OBJECTIVES:**

- To understand the python libraries for data science
- To understand the basic Statistical and Probability measures for data science.
- To learn descriptive analytics on the benchmark data sets.
- To apply correlation and regression analytics on standard data sets.
- To present and interpret data using visualization packages in Python.

**LIST OF EXPERIMENTS:**

1. Download, install and explore the features of NumPy, SciPy, Jupyter, Statsmodels and Pandas packages.
2. Working with Numpy arrays
3. Working with Pandas data frames
4. Reading data from text files, Excel and the web and exploring various commands for doing descriptive analytics on the Iris data set.
5. Use the diabetes data set from UCI and Pima Indians Diabetes data set for performing the following:
  - a. Univariate analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis.
  - b. Bivariate analysis: Linear and logistic regression modeling
  - c. Multiple Regression analysis
  - d. Also compare the results of the above analysis for the two data sets.
6. Apply and explore various plotting functions on UCI data sets.
  - a. Normal curves
  - b. Density and contour plots
  - c. Correlation and scatter plots
  - d. Histograms
  - e. Three dimensional plotting
7. Visualizing Geographic Data with Basemap

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:****At the end of this course, the students will be able to:****CO1:** Make use of the python libraries for data science**CO2:** Make use of the basic Statistical and Probability measures for data science.**CO3:** Perform descriptive analytics on the benchmark data sets.**CO4:** Perform correlation and regression analytics on standard data sets**CO5:** Present and interpret data using visualization packages in Python.**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	-	-	-	-	1	3	3	3	1	3	2
2	3	2	2	3	1	-	-	-	3	1	3	2	1	3	3
3	3	2	1	3	1	-	-	-	2	1	1	1	3	2	3
4	2	3	1	3	-	-	-	-	2	3	2	3	3	3	1
5	1	2	3	1	1	-	-	-	2	1	3	1	1	3	3
AVg.	2	2	2	2	1	-	-	-	2	2	2	2	2	3	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**GE3361****PROFESSIONAL DEVELOPMENT****L T P C****0 0 2 1****COURSE OBJECTIVES:**

To be proficient in important Microsoft Office tools: MS WORD, EXCEL, POWERPOINT.

- To be proficient in using MS WORD to create quality technical documents, by using standard templates, widely acceptable styles and formats, variety of features to enhance the presentability and overall utility value of content.
- To be proficient in using MS EXCEL for all data manipulation tasks including the common statistical, logical, mathematical etc., operations, conversion, analytics, search and explore, visualize, interlink, and utilizing many more critical features offered
- To be able to create and share quality presentations by using the features of MS PowerPoint, including: organization of content, presentability, aesthetics, using media elements and enhance the overall quality of presentations.

**MS WORD:****10 Hours**

Create and format a document

Working with tables

Working with Bullets and Lists

Working with styles, shapes, smart art, charts

Inserting objects, charts and importing objects from other office tools

Creating and Using document templates

Inserting equations, symbols and special characters

Working with Table of contents and References, citations

Insert and review comments

Create bookmarks, hyperlinks, endnotes footnote

Viewing document in different modes

Working with document protection and security

Inspect document for accessibility

**MS EXCEL:**

**10 Hours**

Create worksheets, insert and format data

Work with different types of data: text, currency, date, numeric etc.

Split, validate, consolidate, Convert data

Sort and filter data

Perform calculations and use functions: (Statistical, Logical, Mathematical, date, Time etc.)

Work with Lookup and reference formulae

Create and Work with different types of charts

Use pivot tables to summarize and analyse data

Perform data analysis using own formulae and functions

Combine data from multiple worksheets using own formulae and built-in functions to generate results

Export data and sheets to other file formats

Working with macros

Protecting data and Securing the workbook

**MS POWERPOINT:**

**10 Hours**

Select slide templates, layout and themes

Formatting slide content and using bullets and numbering

Insert and format images, smart art, tables, charts

Using Slide master, notes and handout master

Working with animation and transitions

Organize and Group slides

Import or create and use media objects: audio, video, animation

Perform slideshow recording and Record narration and create presentable videos

**TOTAL: 30 PERIODS**



## COURSE OUTCOMES:

On successful completion the students will be able to

**CO1:**Use MS Word to create quality documents, by structuring and organizing content for their day to day technical and academic requirements

**CO2:**Use MS EXCEL to perform data operations and analytics, record, retrieve data as per requirements and visualize data for ease of understanding

**CO3:**Use MS PowerPoint to create high quality academic presentations by including common tables, charts, graphs, interlinking other elements, and using media objects.

**CS3452**

## THEORY OF COMPUTATION

**L T P C**

**3 0 0 3**

### COURSE OBJECTIVES:

- To understand foundations of computation including automata theory
- To construct models of regular expressions and languages.
- To design context free grammar and push down automata
- To understand Turing machines and their capability
- To understand Undecidability and NP class problems

### **UNIT I AUTOMATA AND REGULAR EXPRESSIONS 9**

Need for automata theory - Introduction to formal proof – Finite Automata (FA) – Deterministic Finite Automata (DFA) – Non-deterministic Finite Automata (NFA) – Equivalence between NFA and DFA – Finite Automata with Epsilon transitions – Equivalence of NFA and DFA- Equivalence of NFAs with and without  $\epsilon$ -moves- Conversion of NFA into DFA – Minimization of DFAs.

### **UNIT II REGULAR EXPRESSIONS AND LANGUAGES 9**

Regular expression – Regular Languages- Equivalence of Finite Automata and regular expressions – Proving languages to be not regular (Pumping Lemma) – Closure properties of regular languages.

### **UNIT III CONTEXT FREE GRAMMAR AND PUSH DOWN AUTOMATA 9**

Types of Grammar - Chomsky's hierarchy of languages -Context-Free Grammar (CFG) and Languages – Derivations and Parse trees – Ambiguity in grammars and languages – Push Down Automata (PDA): Definition – Moves - Instantaneous descriptions -Languages of pushdown automata – Equivalence of pushdown automata and CFG-CFG to PDA-PDA to CFG – Deterministic Pushdown Automata.

### **UNIT IV NORMAL FORMS AND TURING MACHINES 9**

Normal forms for CFG – Simplification of CFG- Chomsky Normal Form (CNF) and Greibach Normal Form (GNF) – Pumping lemma for CFL – Closure properties of Context Free Languages –Turing Machine : Basic model – definition and representation – Instantaneous Description – Language acceptance by TM – TM as Computer of Integer functions – Programming techniques for Turing machines (subroutines).

### **UNIT V UNDECIDABILITY 9**

Unsolvable Problems and Computable Functions –PCP-MPCP- Recursive and recursively enumerable languages – Properties - Universal Turing machine -Tractable and Intractable problems

- P and NP completeness – Kruskal’s algorithm – Travelling Salesman Problem- 3-CNF SAT problems.

**COURSE OUTCOMES:**

At the end of this course, the students will be able to:

- CO1:** Construct automata theory using Finite Automata
- CO2:** Write regular expressions for any pattern
- CO3:** Design context free grammar and Pushdown Automata
- CO4:** Design Turing machine for computational functions
- CO5:** Differentiate between decidable and undecidable problems

**TOTAL:45 PERIODS**

**TEXT BOOKS:**

1. Hopcroft J.E., Motwani R. & Ullman J.D., "Introduction to Automata Theory, Languages and Computations", 3rd Edition, Pearson Education, 2008.
2. John C Martin , "Introduction to Languages and the Theory of Computation", 4th Edition, Tata McGraw Hill, 2011.

**REFERENCES:**

1. Harry R Lewis and Christos H Papadimitriou , "Elements of the Theory of Computation", 2nd Edition, Prentice Hall of India, 2015.
2. Peter Linz, "An Introduction to Formal Language and Automata", 6th Edition, Jones & Bartlett, 2016.
3. K.L.P.Mishra and N.Chandrasekaran, "Theory of Computer Science: Automata Languages and Computation", 3<sup>rd</sup> Edition, Prentice Hall of India, 2006.

**CO’s-PO’s & PSO’s MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	3	2	3	-	-	-	-	1	1	2	3	1	3	2
2	2	2	3	2	1	-	-	-	3	3	2	3	3	1	2
3	2	2	3	2	1	-	-	-	1	3	1	2	1	2	2
4	2	2	2	1	-	-	-	-	1	3	3	2	1	3	2
5	2	2	2	1	1	-	-	-	1	1	3	2	3	1	3
AVg.	2	2	2	2	1	-	-	-	1	2	2	2	2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CS3491**

**ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING**

**L T P C  
3 0 2 4**

**COURSE OBJECTIVES:**

The main objectives of this course are to:

- Study about uninformed and Heuristic search techniques.
- Learn techniques for reasoning under uncertainty
- Introduce Machine Learning and supervised learning algorithms
- Study about ensembling and unsupervised learning algorithms
- Learn the basics of deep learning using neural networks

<b>UNIT I</b>	<b>PROBLEM SOLVING</b>	<b>9</b>
Introduction to AI - AI Applications - Problem solving agents – search algorithms – uninformed search strategies – Heuristic search strategies – Local search and optimization problems – adversarial search – constraint satisfaction problems (CSP)		
<b>UNIT II</b>	<b>PROBABILISTIC REASONING</b>	<b>9</b>
Acting under uncertainty – Bayesian inference – naïve Bayes models. Probabilistic reasoning – Bayesian networks – exact inference in BN – approximate inference in BN – causal networks.		
<b>UNIT III</b>	<b>SUPERVISED LEARNING</b>	<b>9</b>
Introduction to machine learning – Linear Regression Models: Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function – Probabilistic discriminative model - Logistic regression, Probabilistic generative model – Naive Bayes, Maximum margin classifier – Support vector machine, Decision Tree, Random forests		
<b>UNIT IV</b>	<b>ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING</b>	<b>9</b>
Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization		
<b>UNIT V</b>	<b>NEURAL NETWORKS</b>	<b>9</b>
Perceptron - Multilayer perceptron, activation functions, network training – gradient descent optimization – stochastic gradient descent, error backpropagation, from shallow networks to deep networks – Unit saturation (aka the vanishing gradient problem) – ReLU, hyperparameter tuning, batch normalization, regularization, dropout.		
		<b>45 PERIODS</b>
<b>PRACTICAL EXERCISES:</b>		<b>30 PERIODS</b>
<ol style="list-style-type: none"><li>1. Implementation of Uninformed search algorithms (BFS, DFS)</li><li>2. Implementation of Informed search algorithms (<math>A^*</math>, memory-bounded <math>A^*</math>)</li><li>3. Implement naïve Bayes models</li><li>4. Implement Bayesian Networks</li><li>5. Build Regression models</li><li>6. Build decision trees and random forests</li><li>7. Build SVM models</li><li>8. Implement ensembling techniques</li><li>9. Implement clustering algorithms</li><li>10. Implement EM for Bayesian networks</li><li>11. Build simple NN models</li><li>12. Build deep learning NN models</li></ol>		
<b>COURSE OUTCOMES:</b>		
At the end of this course, the students will be able to:		
<b>CO1:</b> Use appropriate search algorithms for problem solving		
<b>CO2:</b> Apply reasoning under uncertainty		
<b>CO3:</b> Build supervised learning models		
<b>CO4:</b> Build ensembling and unsupervised models		
<b>CO5:</b> Build deep learning neural network models		
		<b>TOTAL:75 PERIODS</b>

**TEXT BOOKS:**

1. Stuart Russell and Peter Norvig, "Artificial Intelligence – A Modern Approach", Fourth Edition, Pearson Education, 2021.
2. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Fourth Edition, 2020.

**REFERENCES:**

1. Dan W. Patterson, "Introduction to Artificial Intelligence and Expert Systems", Pearson Education, 2007
2. Kevin Night, Elaine Rich, and Nair B., "Artificial Intelligence", McGraw Hill, 2008
3. Patrick H. Winston, "Artificial Intelligence", Third Edition, Pearson Education, 2006
4. Deepak Khemani, "Artificial Intelligence", Tata McGraw Hill Education, 2013 (<http://nptel.ac.in/>)
5. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
6. Tom Mitchell, "Machine Learning", McGraw Hill, 3rd Edition, 1997.
7. Charu C. Aggarwal, "Data Classification Algorithms and Applications", CRC Press, 2014
8. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, "Foundations of Machine Learning", MIT Press, 2012.
9. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	3	-	-	-	-	1	3	3	3	1	2	2
2	1	1	1	3	1	-	-	-	1	2	1	3	2	3	2
3	2	1	2	1	1	-	-	-	2	1	1	3	1	1	1
4	3	1	3	1	-	-	-	-	2	1	2	1	2	2	2
5	3	1	1	2	2	-	-	-	3	1	2	3	2	1	2
AVg.	2	1	2	2	1	-	-	-	2	2	2	3	2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CS3492****DATABASE MANAGEMENT SYSTEMS**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

- To learn the fundamentals of data models, relational algebra and SQL
- To represent a database system using ER diagrams and to learn normalization techniques
- To understand the fundamental concepts of transaction, concurrency and recovery processing
- To understand the internal storage structures using different file and indexing techniques which will help in physical DB design
- To have an introductory knowledge about the Distributed databases, NOSQL and database security

**UNIT I RELATIONAL DATABASES****10**

Purpose of Database System – Views of data – Data Models – Database System Architecture – Introduction to relational databases – Relational Model – Keys – Relational Algebra – SQL fundamentals – Advanced SQL features – Embedded SQL– Dynamic SQL

**UNIT II DATABASE DESIGN 8**

Entity-Relationship model – E-R Diagrams – Enhanced-ER Model – ER-to-Relational Mapping – Functional Dependencies – Non-loss Decomposition – First, Second, Third Normal Forms, Dependency Preservation – Boyce/Codd Normal Form – Multi-valued Dependencies and Fourth Normal Form – Join Dependencies and Fifth Normal Form

**UNIT III TRANSACTIONS 9**

Transaction Concepts – ACID Properties – Schedules – Serializability – Transaction support in SQL – Need for Concurrency – Concurrency control – Two Phase Locking- Timestamp – Multiversion – Validation and Snapshot isolation– Multiple Granularity locking – Deadlock Handling – Recovery Concepts – Recovery based on deferred and immediate update – Shadow paging – ARIES Algorithm

**UNIT IV IMPLEMENTATION TECHNIQUES 9**

RAID – File Organization – Organization of Records in Files – Data dictionary Storage – Column Oriented Storage– Indexing and Hashing –Ordered Indices – B+ tree Index Files – B tree Index Files – Static Hashing – Dynamic Hashing – Query Processing Overview – Algorithms for Selection, Sorting and join operations – Query optimization using Heuristics - Cost Estimation.

**UNIT V ADVANCED TOPICS 9**

Distributed Databases: Architecture, Data Storage, Transaction Processing, Query processing and optimization – NOSQL Databases: Introduction – CAP Theorem – Document Based systems – Key value Stores – Column Based Systems – Graph Databases. Database Security: Security issues – Access control based on privileges – Role Based access control – SQL Injection – Statistical Database security – Flow control – Encryption and Public Key infrastructures – Challenges

**COURSE OUTCOMES:**

**Upon completion of this course, the students will be able to**

- CO1:** Construct SQL Queries using relational algebra
- CO2:** Design database using ER model and normalize the database
- CO3:** Construct queries to handle transaction processing and maintain consistency of the database
- CO4:** Compare and contrast various indexing strategies and apply the knowledge to tune the performance of the database
- CO5:** Appraise how advanced databases differ from Relational Databases and find a suitable database for the given requirement.

**TOTAL:45 PERIODS**

**TEXT BOOKS:**

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, "Database System Concepts", Seventh Edition, McGraw Hill, 2020.
2. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", Seventh Edition, Pearson Education, 2017

**REFERENCES:**

1. C.J.Date, A.Kannan, S.Swamynathan, "An Introduction to Database Systems", Eighth Edition, Pearson Education, 2006.

## CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	3	2	1	-	-	-	2	1	1	1	2	1	3
2	3	1	1	1	1	-	-	-	2	3	3	3	3	1	2
3	3	2	3	2	1	-	-	-	2	1	1	2	2	3	3
4	1	2	3	2	-	-	-	-	3	2	3	3	1	2	3
5	1	1	3	3	2	-	-	-	1	3	3	1	2	2	2
AVg.	2	2	3	2	1	-	-	-	2	2	2	2	2	2	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

CS3401

ALGORITHMS

L T P C

3 0 2 4

### COURSE OBJECTIVES:

- To understand and apply the algorithm analysis techniques on searching and sorting algorithms
- To critically analyze the efficiency of graph algorithms
- To understand different algorithm design techniques
- To solve programming problems using state space tree
- To understand the concepts behind NP Completeness, Approximation algorithms and randomized algorithms.

### UNIT I

#### INTRODUCTION

9

**Algorithm analysis:** Time and space complexity - Asymptotic Notations and its properties Best case, Worst case and average case analysis – Recurrence relation: substitution method - Lower bounds – **searching:** linear search, binary search and Interpolation Search, **Pattern search:** The naïve string-matching algorithm - Rabin-Karp algorithm - Knuth-Morris-Pratt algorithm. **Sorting:** Insertion sort – heap sort

### UNIT II

#### GRAPH ALGORITHMS

9

Graph algorithms: Representations of graphs - Graph traversal: DFS – BFS - applications - Connectivity, strong connectivity, bi-connectivity - Minimum spanning tree: Kruskal's and Prim's algorithm- Shortest path: Bellman-Ford algorithm - Dijkstra's algorithm - Floyd-Warshall algorithm Network flow: Flow networks - Ford-Fulkerson method – Matching: Maximum bipartite matching

### UNIT III

#### ALGORITHM DESIGN TECHNIQUES

9

**Divide and Conquer methodology:** Finding maximum and minimum - Merge sort - Quick sort **Dynamic programming:** Elements of dynamic programming — Matrix-chain multiplication - Multi stage graph — Optimal Binary Search Trees. **Greedy Technique:** Elements of the greedy strategy - Activity-selection problem — Optimal Merge pattern — Huffman Trees.

### UNIT IV

#### STATE SPACE SEARCH ALGORITHMS

9

**Backtracking:** n-Queens problem - Hamiltonian Circuit Problem - Subset Sum Problem – Graph colouring problem **Branch and Bound:** Solving 15-Puzzle problem - Assignment problem - Knapsack Problem - Travelling Salesman Problem

**UNIT V****NP-COMPLETE AND APPROXIMATION ALGORITHM****9**

Tractable and intractable problems: Polynomial time algorithms – Venn diagram representation - NP-algorithms - NP-hardness and NP-completeness – Bin Packing problem - Problem reduction: TSP – 3-CNF problem. **Approximation Algorithms:** TSP - **Randomized Algorithms:** concept and application - primality testing - randomized quick sort - Finding  $k^{\text{th}}$  smallest number

**45 PERIODS****PRACTICAL EXERCISES:****30 PERIODS****Searching and Sorting Algorithms**

1. Implement Linear Search. Determine the time required to search for an element. Repeat the experiment for different values of  $n$ , the number of elements in the list to be searched and plot a graph of the time taken versus  $n$ .
2. Implement recursive Binary Search. Determine the time required to search an element. Repeat the experiment for different values of  $n$ , the number of elements in the list to be searched and plot a graph of the time taken versus  $n$ .
3. Given a text  $\text{txt}[0\dots n-1]$  and a pattern  $\text{pat}[0\dots m-1]$ , write a function  $\text{search}(\text{char pat}[], \text{char txt}[])$  that prints all occurrences of  $\text{pat}[]$  in  $\text{txt}[]$ . You may assume that  $n > m$ .
4. Sort a given set of elements using the Insertion sort and Heap sort methods and determine the time required to sort the elements. Repeat the experiment for different values of  $n$ , the number of elements in the list to be sorted and plot a graph of the time taken versus  $n$ .

**Graph Algorithms**

1. Develop a program to implement graph traversal using Breadth First Search
2. Develop a program to implement graph traversal using Depth First Search
3. From a given vertex in a weighted connected graph, develop a program to find the shortest paths to other vertices using Dijkstra's algorithm.
4. Find the minimum cost spanning tree of a given undirected graph using Prim's algorithm.
5. Implement Floyd's algorithm for the All-Pairs- Shortest-Paths problem.
6. Compute the transitive closure of a given directed graph using Warshall's algorithm.

**Algorithm Design Techniques**

1. Develop a program to find out the maximum and minimum numbers in a given list of  $n$  numbers using the divide and conquer technique.
2. Implement Merge sort and Quick sort methods to sort an array of elements and determine the time required to sort. Repeat the experiment for different values of  $n$ , the number of elements in the list to be sorted and plot a graph of the time taken versus  $n$ .

**State Space Search Algorithms**

1. Implement N Queens problem using Backtracking.

**Approximation Algorithms Randomized Algorithms**

1. Implement any scheme to find the optimal solution for the Traveling Salesperson problem and then solve the same problem instance using any approximation algorithm and determine the error in the approximation.
2. Implement randomized algorithms for finding the  $k^{\text{th}}$  smallest number.  
The programs can be implemented in C/C++/JAVA/ Python.

**TOTAL:75 PERIODS****COURSE OUTCOMES:**

At the end of this course, the students will be able to:

**CO1:** Analyze the efficiency of algorithms using various frameworks

**CO2:** Apply graph algorithms to solve problems and analyze their efficiency.

**CO3:** Make use of algorithm design techniques like divide and conquer, dynamic programming and greedy techniques to solve problems

**CO4:** Use the state space tree method for solving problems.

**CO5:** Solve problems using approximation algorithms and randomized algorithms

**TEXT BOOKS:**

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", 3rd Edition, Prentice Hall of India, 2009.
2. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran "Computer Algorithms/C++" Orient Blackswan, 2<sup>nd</sup> Edition, 2019.

**REFERENCES:**

1. Anany Levitin, "Introduction to the Design and Analysis of Algorithms", 3rd Edition, Pearson Education, 2012.
2. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, "Data Structures and Algorithms", Reprint Edition, Pearson Education, 2006.
3. S. Sridhar, "Design and Analysis of Algorithms", Oxford university press, 2014.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	-	-	-	-	1	-	-	-	-	1	-	1	-
2	2	3	-	-	-	-	1	-	-	-	-	1	-	1	-
3	1	2	3	1	-	-	2	-	-	-	-	-	-	1	1
4	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
5	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>AVg.</b>	2.67	1.8	3	1	-	-	1.33	-	-	-	-	1	-	1	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CS3451**

**INTRODUCTION TO OPERATING SYSTEMS**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the basics and functions of operating systems.
- To understand processes and threads
- To analyze scheduling algorithms and process synchronization.
- To understand the concept of deadlocks.
- To analyze various memory management schemes.
- To be familiar with I/O management and file systems.
- To be familiar with the basics of virtual machines and Mobile OS like iOS and Android.

**UNIT I INTRODUCTION**

**7**

Computer System - Elements and organization; Operating System Overview - Objectives and Functions - Evolution of Operating System; Operating System Structures – Operating System Services - User Operating System Interface - System Calls – System Programs - Design and Implementation - Structuring methods.



<b>UNIT II</b>	<b>PROCESS MANAGEMENT</b>	<b>11</b>
Processes - Process Concept - Process Scheduling - Operations on Processes - Inter-process Communication; CPU Scheduling - Scheduling criteria - Scheduling algorithms: Threads - Multithread Models – Threading issues; Process Synchronization - The Critical-Section problem - Synchronization hardware – Semaphores – Mutex - Classical problems of synchronization - Monitors; Deadlock - Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from deadlock.		
<b>UNIT III</b>	<b>MEMORY MANAGEMENT</b>	<b>10</b>
Main Memory - Swapping - Contiguous Memory Allocation – Paging - Structure of the Page Table - Segmentation, Segmentation with paging; Virtual Memory - Demand Paging – Copy on Write - Page Replacement - Allocation of Frames –Thrashing.		
<b>UNIT IV</b>	<b>STORAGE MANAGEMENT</b>	<b>10</b>
Mass Storage system – Disk Structure - Disk Scheduling and Management; File-System Interface - File concept - Access methods - Directory Structure - Directory organization - File system mounting - File Sharing and Protection; File System Implementation - File System Structure - Directory implementation - Allocation Methods - Free Space Management; I/O Systems – I/O Hardware, Application I/O interface, Kernel I/O subsystem.		
<b>UNIT V</b>	<b>VIRTUAL MACHINES AND MOBILE OS</b>	<b>7</b>
Virtual Machines – History, Benefits and Features, Building Blocks, Types of Virtual Machines and their Implementations, Virtualization and Operating-System Components; Mobile OS - iOS and Android.		
		<b>TOTAL:45 PERIODS</b>
<b>COURSE OUTCOMES:</b>		
<b>At the end of this course, the students will be able to:</b>		
<b>CO1</b> : Analyze various scheduling algorithms and process synchronization.		
<b>CO2</b> : Explain deadlock prevention and avoidance algorithms.		
<b>CO3</b> : Compare and contrast various memory management schemes.		
<b>CO4</b> : Explain the functionality of file systems, I/O systems, and Virtualization		
<b>CO5</b> : Compare iOS and Android Operating Systems.		
<b>TEXT BOOKS:</b>		
1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, “Operating System Concepts”II, 10 <sup>th</sup> Edition, John Wiley and Sons Inc., 2018.		
2. Andrew S Tanenbaum, "Modern Operating Systems", Pearson, 5 <sup>th</sup> Edition, 2022 New Delhi.		
<b>REFERENCES:</b>		
1. Ramaz Elmasri, A. Gil Carrick, David Levine, “ Operating Systems – A Spiral Approach”, Tata McGraw Hill Edition, 2010.		
2. William Stallings, "Operating Systems: Internals and Design Principles", 7 <sup>th</sup> Edition, Prentice Hall, 2018.		
3. Achyut S.Godbole, Atul Kahate, “Operating Systems”, McGraw Hill Education, 2016.		

## CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	2	2	-	-	-	-	3	2	3	1	1	2	2
2	2	2	3	1	1	-	-	-	2	1	1	2	2	1	2
3	1	3	2	2	1	-	-	-	2	2	1	1	1	2	2
4	1	3	3	3	-	-	-	-	1	2	1	2	1	3	2
5	3	1	2	1	1	-	-	-	3	2	3	2	2	2	1
<b>AVg.</b>	2	2	2	2	1	-	-	-	2	2	2	2	1	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

GE3451

ENVIRONMENTAL SCIENCES AND SUSTAINABILITY

L T P C

2 0 0 2

### COURSE OBJECTIVES:

- To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation.
- To impart knowledge on the causes, effects and control or prevention measures of environmental pollution and natural disasters.
- To facilitate the understanding of global and Indian scenario of renewable and nonrenewable resources, causes of their degradation and measures to preserve them.
- To familiarize the concept of sustainable development goals and appreciate the interdependence of economic and social aspects of sustainability, recognize and analyze climate changes, concept of carbon credit and the challenges of environmental management.
- To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles and analyze the role of sustainable urbanization.

### UNIT I ENVIRONMENT AND BIODIVERSITY

6

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

### UNIT II ENVIRONMENTAL POLLUTION

9

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts .

### UNIT III RENEWABLE SOURCES OF ENERGY

6

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

### UNIT IV SUSTAINABILITY AND MANAGEMENT

6

Development , GDP ,Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols-

Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

## **UNIT V SUSTAINABILITY PRACTICES**

**6**

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economical and technological change.

**TOTAL: 30 PERIODS**

### **COURSE OUTCOMES:**

**CO1:**To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.

**CO2:**To identify the causes, effects of environmental pollution and natural disasters and contribute to the preventive measures in the society.

**CO3:**To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.

**CO4:**To recognize the different goals of sustainable development and apply them for suitable technological advancement and societal development.

**CO5:**To demonstrate the knowledge of sustainability practices and identify green materials, energy cycles and the role of sustainable urbanization.

### **TEXT BOOKS:**

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

### **REFERENCES :**

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 . edition 2010.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, Third Edition, 2015.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

### CO's-PO's & PSO's MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	-	-	-	2	3	-	-	-	-	2	-	-	-
2	3	2	-	-	-	3	3	-	-	-	-	2	-	-	-
3	3	-	1	-	-	2	2	-	-	-	-	2	-	-	-
4	3	2	1	1	-	2	2	-	-	-	-	2	-	-	-
5	3	2	1	-	-	2	2	-	-	-	-	1	-	-	-
<b>Avg.</b>	<b>2.8</b>	<b>1.8</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>2.2</b>	<b>2.4</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1.8</b>	<b>-</b>	<b>-</b>	<b>-</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation

CS3461

OPERATING SYSTEMS LABORATORY

L T P C  
0 0 3 1.5

#### COURSE OBJECTIVES:

- To install windows operating systems.
- To understand the basics of Unix command and shell programming.
- To implement various CPU scheduling algorithms.
- To implement Deadlock Avoidance and Deadlock Detection Algorithms
- To implement Page Replacement Algorithms
- To implement various memory allocation methods.
- To be familiar with File Organization and File Allocation Strategies.

#### LIST OF EXPERIMENTS:

1. Installation of windows operating system
2. Illustrate UNIX commands and Shell Programming
3. Process Management using System Calls : Fork, Exit, Getpid, Wait, Close
4. Write C programs to implement the various CPU Scheduling Algorithms
5. Illustrate the inter process communication strategy
6. Implement mutual exclusion by Semaphore
7. Write C programs to avoid Deadlock using Banker's Algorithm
8. Write a C program to Implement Deadlock Detection Algorithm
9. Write C program to implement Threading
10. Implement the paging Technique using C program
11. Write C programs to implement the following Memory Allocation Methods
  - a. First Fit
  - b. Worst Fit
  - c. Best Fit
12. Write C programs to implement the various Page Replacement Algorithms
13. Write C programs to Implement the various File Organization Techniques
14. Implement the following File Allocation Strategies using C programs
  - a. Sequential
  - b. Indexed
  - c. Linked
15. Write C programs for the implementation of various disk scheduling algorithms

16. Install any guest operating system like Linux using VMware.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

**At th end of this course, the students will be able to:**

- CO1 :** Define and implement UNIX Commands.
- CO2 :** Compare the performance of various CPU Scheduling Algorithms.
- CO3 :** Compare and contrast various Memory Allocation Methods.
- CO4 :** Define File Organization and File Allocation Strategies.
- CO5 :** Implement various Disk Scheduling Algorithms.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	3	1	1	-	-	-	1	3	3	3	2	1	3
2	3	1	1	2	2	-	-	-	3	2	1	1	3	1	2
3	3	3	2	1	2	-	-	-	3	3	1	2	2	2	2
4	1	2	2	3	2	-	-	-	3	1	3	1	1	2	1
5	2	2	1	1	3	-	-	-	1	2	2	3	1	3	3
<b>AVg.</b>	2	2	2	2	2	-	-	-	2	2	2	2	2	2	2

1 - low, 2 - medium, 3 - high, "-" - no correlation

**CS3481**

**DATABASE MANAGEMENT SYSTEMS LABORATORY**

**L T P C**  
**0 0 3 1.5**

**COURSE OBJECTIVES:**

- To learn and implement important commands in SQL.
- To learn the usage of nested and joint queries.
- To understand functions, procedures and procedural extensions of databases.
- To understand design and implementation of typical database applications.
- To be familiar with the use of a front end tool for GUI based application development.

**LIST OF EXPERIMENTS:**

1. Create a database table, add constraints (primary key, unique, check, Not null), insert rows, update and delete rows using SQL DDL and DML commands.
2. Create a set of tables, add foreign key constraints and incorporate referential integrity.
3. Query the database tables using different 'where' clause conditions and also implement aggregate functions.
4. Query the database tables and explore sub queries and simple join operations.
5. Query the database tables and explore natural, equi and outer joins.
6. Write user defined functions and stored procedures in SQL.
7. Execute complex transactions and realize DCL and TCL commands.
8. Write SQL Triggers for insert, delete, and update operations in a database table.
9. Create View and index for database tables with a large number of records.
10. Create an XML database and validate it using XML schema.
11. Create Document, column and graph based data using NOSQL database tools.
12. Develop a simple GUI based database application and incorporate all the above-mentioned features
13. Case Study using any of the real life database applications from the following list

- a) Inventory Management for a EMart Grocery Shop
- b) Society Financial Management
- c) Cop Friendly App – Eseva
- d) Property Management – eMall
- e) Star Small and Medium Banking and Finance
  - Build Entity Model diagram. The diagram should align with the business and functional goals stated in the application.
  - Apply Normalization rules in designing the tables in scope.
  - Prepared applicable views, triggers (for auditing purposes), functions for enabling enterprise grade features.
  - Build PL SQL / Stored Procedures for Complex Functionalities, ex EOD Batch Processing for calculating the EMI for Gold Loan for each eligible Customer.
- Ability to showcase ACID Properties with sample queries with appropriate settings

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**At the end of this course, the students will be able to:**

**CO1:** Create databases with different types of key constraints.

**CO2:** Construct simple and complex SQL queries using DML and DCL commands.

**CO3:** Use advanced features such as stored procedures and triggers and incorporate in GUI based application development.

**CO4:** Create an XML database and validate with meta-data (XML schema).

**CO5:** Create and manipulate data using NOSQL database.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	-	-	-	-	3	1	3	2	2	3	2
2	2	2	3	2	2	-	-	-	1	2	3	3	2	1	2
3	3	3	2	1	1	-	-	-	1	1	1	3	2	3	3
4	1	3	3	3	1	-	-	-	1	1	3	2	3	1	3
5	3	2	1	1	1	-	-	-	2	2	3	1	3	1	2
AVg.	2	3	2	2	1	-	-	-	2	1	3	2	2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

CS3591

**COMPUTER NETWORKS**

**L T P C**  
**3 0 2 4**

**COURSE OBJECTIVES:**

- To understand the concept of layering in networks.
- To know the functions of protocols of each layer of TCP/IP protocol suite.
- To visualize the end-to-end flow of information.
- To learn the functions of network layer and the various routing protocols
- To familiarize the functions and protocols of the Transport layer

**UNIT I INTRODUCTION AND APPLICATION LAYER 10**

Data Communication - Networks – Network Types – Protocol Layering – TCP/IP Protocol suite – OSI Model – Introduction to Sockets - Application Layer protocols: HTTP – FTP – Email protocols (SMTP - POP3 - IMAP - MIME) – DNS – SNMP

**UNIT II TRANSPORT LAYER 9**

Introduction - Transport-Layer Protocols: UDP – TCP: Connection Management – Flow control - Congestion Control - Congestion avoidance (DECbit, RED) – SCTP – Quality of Service

**UNIT III NETWORK LAYER 7**

Switching : Packet Switching - Internet protocol - IPV4 – IP Addressing – Subnetting - IPV6, ARP, RARP, ICMP, DHCP

**UNIT IV ROUTING 7**

Routing and protocols: Unicast routing - Distance Vector Routing - RIP - Link State Routing – OSPF – Path-vector routing - BGP - Multicast Routing: DVMRP – PIM.

**UNIT V DATA LINK AND PHYSICAL LAYERS 12**

Data Link Layer – Framing – Flow control – Error control – Data-Link Layer Protocols – HDLC – PPP - Media Access Control – Ethernet Basics – CSMA/CD – Virtual LAN – Wireless LAN (802.11) - Physical Layer: Data and Signals - Performance – Transmission media- Switching – Circuit Switching.

**45 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

1. Learn to use commands like tcpdump, netstat, ifconfig, nslookup and traceroute. Capture ping and trace route PDUs using a network protocol analyzer and examine.
2. Write a HTTP web client program to download a web page using TCP sockets.
3. Applications using TCP sockets like: a) Echo client and echo server b) Chat
4. Simulation of DNS using UDP sockets.
5. Use a tool like Wireshark to capture packets and examine the packets
6. Write a code simulating ARP /RARP protocols.
7. Study of Network simulator (NS) and Simulation of Congestion Control Algorithms using NS.
8. Study of TCP/UDP performance using Simulation tool.
9. Simulation of Distance Vector/ Link State Routing algorithm.
10. Simulation of an error correction code (like CRC)

**COURSE OUTCOMES:**

**At the end of this course, the students will be able to:**

**CO 1:** Explain the basic layers and its functions in computer networks.

**CO 2:** Understand the basics of how data flows from one node to another.

**CO 3:** Analyze routing algorithms.

**CO 4:** Describe protocols for various functions in the network.

**CO 5:** Analyze the working of various application layer protocols.

**TOTAL:75 PERIODS**

**TEXT BOOKS**

1. James F. Kurose, Keith W. Ross, Computer Networking, A Top-Down Approach Featuring the Internet, Eighth Edition, Pearson Education, 2021.
2. Behrouz A. Forouzan, Data Communications and Networking with TCP/IP Protocol Suite, Sixth Edition TMH, 2022

## REFERENCES

1. Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach, Fifth Edition, Morgan Kaufmann Publishers Inc., 2012.
2. William Stallings, Data and Computer Communications, Tenth Edition, Pearson Education, 2013.
3. Nader F. Mir, Computer and Communication Networks, Second Edition, Prentice Hall, 2014.
4. Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, "Computer Networks: An Open Source Approach", McGraw Hill, 2012.

## CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	-	2	-	-		-	-	-	-	-	-	-	3	-	-
2	-	1	-	-	2	-	-	-	-	-	-	2	-	2	-
3	-	2	-	-	3	-	-	-	-	-	-	-	-	3	-
4	-		-	1	2	-	-	-	-	3	-	-	-	-	-
5	-	3	2	-	-	-	-	-	-	-	-	-	-	-	3
AVg.	-	1	-	-	1	-	-	-	-	1	-	-	-	1	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

CS3501

COMPILER DESIGN

L T P C  
3 0 2 4

### COURSE OBJECTIVES:

- To learn the various phases of compiler.
- To learn the various parsing techniques.
- To understand intermediate code generation and run-time environment.
- To learn to implement the front-end of the compiler.
- To learn to implement code generator.
- To learn to implement code optimization.

### UNIT I INTRODUCTION TO COMPILERS & LEXICAL ANALYSIS

8

Introduction- Translators- Compilation and Interpretation- Language processors -The Phases of Compiler – Lexical Analysis – Role of Lexical Analyzer – Input Buffering – Specification of Tokens – Recognition of Tokens – Finite Automata – Regular Expressions to Automata NFA, DFA – Minimizing DFA - Language for Specifying Lexical Analyzers – Lex tool.

### UNIT II SYNTAX ANALYSIS

11

Role of Parser – Grammars – Context-free grammars – Writing a grammar Top Down Parsing - General Strategies - Recursive Descent Parser Predictive Parser-LL(1) - Parser-Shift Reduce Parser-LR Parser- LR (0)Item Construction of SLR Parsing Table - Introduction to LALR Parser - Error Handling and Recovery in Syntax Analyzer-YACC tool - Design of a syntax Analyzer for a Sample Language



### **UNIT III SYNTAX DIRECTED TRANSLATION & INTERMEDIATE CODE GENERATION 9**

Syntax directed Definitions-Construction of Syntax Tree-Bottom-up Evaluation of S-Attribute Definitions- Design of predictive translator - Type Systems-Specification of a simple type Checker-Equivalence of Type Expressions-Type Conversions. Intermediate Languages: Syntax Tree, Three Address Code, Types and Declarations, Translation of Expressions, Type Checking, Back patching.

### **UNIT IV RUN-TIME ENVIRONMENT AND CODE GENERATION 9**

Runtime Environments – source language issues – Storage organization – Storage Allocation Strategies: Static, Stack and Heap allocation - Parameter Passing-Symbol Tables - Dynamic Storage Allocation - Issues in the Design of a code generator – Basic Blocks and Flow graphs - Design of a simple Code Generator - Optimal Code Generation for Expressions– Dynamic Programming Code Generation.

### **UNIT V CODE OPTIMIZATION 8**

Principal Sources of Optimization – Peep-hole optimization - DAG- Optimization of Basic Blocks - Global Data Flow Analysis - Efficient Data Flow Algorithm – Recent trends in Compiler Design.

**45 PERIODS**

#### **LIST OF EXPERIMENTS:**

1. Using the LEX tool, Develop a lexical analyzer to recognize a few patterns in C. (Ex. identifiers, constants, comments, operators etc.). Create a symbol table, while recognizing identifiers.
2. Implement a Lexical Analyzer using LEX Tool
3. Generate YACC specification for a few syntactic categories.
  - a. Program to recognize a valid arithmetic expression that uses operator +, -, \* and /.
  - b. Program to recognize a valid variable which starts with a letter followed by any number of letters or digits.
  - c. Program to recognize a valid control structures syntax of C language (For loop, while loop, if-else, if-else-if, switch-case, etc.).
  - d. Implementation of calculator using LEX and YACC
4. Generate three address code for a simple program using LEX and YACC.
5. Implement type checking using Lex and Yacc.
6. Implement simple code optimization techniques (Constant folding, Strength reduction and Algebraic transformation)
7. Implement back-end of the compiler for which the three address code is given as input and the 8086 assembly language code is produced as output.

**30 PERIODS**

**TOTAL: 75 PERIODS**

#### **COURSE OUTCOMES:**

On Completion of the course, the students should be able to:

**CO1:** Understand the techniques in different phases of a compiler.

**CO2:** Design a lexical analyser for a sample language and learn to use the LEX tool.

**CO3:** Apply different parsing algorithms to develop a parser and learn to use YACC tool

**CO4:** Understand semantics rules (SDT), intermediate code generation and run-time environment.

**CO5:**Implement code generation and apply code optimization techniques.

**TEXT BOOK:**

1. Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, "Compilers: Principles, Techniques and Tools", Second Edition, Pearson Education, 2009.

**REFERENCES**

1. Randy Allen, Ken Kennedy, Optimizing Compilers for Modern Architectures: A Dependence based Approach, Morgan Kaufmann Publishers, 2002.
2. Steven S. Muchnick, Advanced Compiler Design and ImplementationII, Morgan Kaufmann Publishers - Elsevier Science, India, Indian Reprint 2003.
3. Keith D Cooper and Linda Torczon, Engineering a CompilerI, Morgan Kaufmann Publishers Elsevier Science, 2004.
4. V. Raghavan, Principles of Compiler DesignII, Tata McGraw Hill Education Publishers, 2010.
5. Allen I. Holub, Compiler Design in CII, Prentice-Hall Software Series, 1993.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	-	-	-	-	3	3	1	3	2	3	2
2	3	3	3	3	3	-	-	-	3	2	3	2	2	1	2
3	3	3	2	2	3	-	-	-	3	1	1	1	2	2	3
4	3	2	2	1	1	-	-	-	2	3	2	3	1	2	1
5	3	3	3	2	1	-	-	-	2	1	1	3	2	1	2
<b>AVg.</b>	<b>3.00</b>	<b>2.80</b>	<b>2.60</b>	<b>2.20</b>	<b>2.00</b>	-	-	-	<b>2.60</b>	<b>2.00</b>	<b>1.60</b>	<b>2.40</b>	<b>1.80</b>	<b>1.80</b>	<b>2.00</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CB3491**

**CRYPTOGRAPHY AND CYBER SECURITY**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- Learn to analyze the security of in-built cryptosystems.
- Know the fundamental mathematical concepts related to security.
- Develop cryptographic algorithms for information security.
- Comprehend the various types of data integrity and authentication schemes
- Understand cyber crimes and cyber security.

**UNIT I INTRODUCTION TO SECURITY**

**9**

Computer Security Concepts – The OSI Security Architecture – Security Attacks – Security Services and Mechanisms – A Model for Network Security – Classical encryption techniques: Substitution techniques, Transposition techniques, Steganography – Foundations of modern cryptography: Perfect security – Information Theory – Product Cryptosystem – Cryptanalysis.

**UNIT II SYMMETRIC CIPHERS**

**9**

Number theory – Algebraic Structures – Modular Arithmetic - Euclid's algorithm – Congruence and matrices – Group, Rings, Fields, Finite Fields

SYMMETRIC KEY CIPHERS: SDES – Block Ciphers – DES, Strength of DES – Differential and linear cryptanalysis – Block cipher design principles – Block cipher mode of operation – Evaluation criteria for AES – Pseudorandom Number Generators – RC4 – Key distribution.

**UNIT III ASYMMETRIC CRYPTOGRAPHY 9**

MATHEMATICS OF ASYMMETRIC KEY CRYPTOGRAPHY: Primes – Primality Testing – Factorization – Euler's totient function, Fermat's and Euler's Theorem – Chinese Remainder Theorem – Exponentiation and logarithm

ASYMMETRIC KEY CIPHERS: RSA cryptosystem – Key distribution – Key management – Diffie Hellman key exchange – Elliptic curve arithmetic – Elliptic curve cryptography.

**UNIT IV INTEGRITY AND AUTHENTICATION ALGORITHMS 9**

Authentication requirement – Authentication function – MAC – Hash function – Security of hash function: HMAC, CMAC – SHA – Digital signature and authentication protocols – DSS – Schnorr Digital Signature Scheme – ElGamal cryptosystem – Entity Authentication: Biometrics, Passwords, Challenge Response protocols – Authentication applications – Kerberos

MUTUAL TRUST: Key management and distribution – Symmetric key distribution using symmetric and asymmetric encryption – Distribution of public keys – X.509 Certificates.

**UNIT V CYBER CRIMES AND CYBER SECURITY 9**

Cyber Crime and Information Security – classifications of Cyber Crimes – Tools and Methods – Password Cracking, Keyloggers, Spywares, SQL Injection – Network Access Control – Cloud Security – Web Security – Wireless Security

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

**CO1:** Understand the fundamentals of networks security, security architecture, threats and vulnerabilities

**CO2:** Apply the different cryptographic operations of symmetric cryptographic algorithms

**CO3:** Apply the different cryptographic operations of public key cryptography

**CO4:** Apply the various Authentication schemes to simulate different applications.

**CO5:** Understand various cyber crimes and cyber security.

**TEXT BOOKS**

1. William Stallings, "Cryptography and Network Security - Principles and Practice", Seventh Edition, Pearson Education, 2017.
2. Nina Godbole, Sunit Belapure, "Cyber Security: Understanding Cyber crimes, Computer Forensics and Legal Perspectives", First Edition, Wiley India, 2011.

**REFERENCES**

1. Behrouz A. Ferouzan, Debdeep Mukhopadhyay, "Cryptography and Network Security", 3rd Edition, Tata Mc Graw Hill, 2015.
2. Charles Pfleeger, Shari Pfleeger, Jonathan Margulies, "Security in Computing", Fifth Edition, Prentice Hall, New Delhi, 2015.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	2	2	-	-	-	1	-	-	1	2	3	3
2	3	3	3	3	3	-	-	-	2	-	-	1	3	3	3
3	3	3	3	3	3	-	-	-	2	-	-	1	3	3	3
4	3	3	3	3	3	-	-	-	2	-	-	1	3	3	3
5	3	2	3	2	3	-	-	-	3	-	-	2	3	2	3
AVg.	3	2.6	2.6	2.6	2.8	-	-	-	2	-	-	1.2	2.8	2.8	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CS3551**

**DISTRIBUTED COMPUTING**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce the computation and communication models of distributed systems
- To illustrate the issues of synchronization and collection of information in distributed systems
- To describe distributed mutual exclusion and distributed deadlock detection techniques
- To elucidate agreement protocols and fault tolerance mechanisms in distributed systems
- To explain the cloud computing models and the underlying concepts

**UNIT I INTRODUCTION**

**8**

Introduction: Definition-Relation to Computer System Components – Motivation – Message -Passing Systems versus Shared Memory Systems – Primitives for Distributed Communication – Synchronous versus Asynchronous Executions – Design Issues and Challenges; A Model of Distributed Computations: A Distributed Program – A Model of Distributed Executions – Models of Communication Networks – Global State of a Distributed System.

**UNIT II LOGICAL TIME AND GLOBAL STATE**

**10**

Logical Time: Physical Clock Synchronization: NTP – A Framework for a System of Logical Clocks – Scalar Time – Vector Time; Message Ordering and Group Communication: Message Ordering Paradigms – Asynchronous Execution with Synchronous Communication – Synchronous Program Order on Asynchronous System – Group Communication – Causal Order – Total Order; Global State and Snapshot Recording Algorithms: Introduction – System Model and Definitions – Snapshot Algorithms for FIFO Channels.

**UNIT III DISTRIBUTED MUTEX AND DEADLOCK**

**10**

Distributed Mutual exclusion Algorithms: Introduction – Preliminaries – Lamport's algorithm – Ricart-Agrawala's Algorithm – Token-Based Algorithms – Suzuki-Kasami's Broadcast Algorithm; Deadlock Detection in Distributed Systems: Introduction – System Model – Preliminaries – Models of Deadlocks – Chandy-Misra-Haas Algorithm for the AND model and OR Model.

**UNIT IV CONSENSUS AND RECOVERY**

**10**

Consensus and Agreement Algorithms: Problem Definition – Overview of Results – Agreement in a Failure-Free System(Synchronous and Asynchronous) – Agreement in Synchronous Systems with Failures; Checkpointing and Rollback Recovery: Introduction – Background and Definitions – Issues in Failure Recovery – Checkpoint-based Recovery – Coordinated Checkpointing Algorithm - - Algorithm for Asynchronous Checkpointing and Recovery

**UNIT V CLOUD COMPUTING****7**

Definition of Cloud Computing – Characteristics of Cloud – Cloud Deployment Models – Cloud Service Models – Driving Factors and Challenges of Cloud – Virtualization – Load Balancing – Scalability and Elasticity – Replication – Monitoring – Cloud Services and Platforms: Compute Services – Storage Services – Application Services

**COURSE OUTCOMES:**

**Upon the completion of this course, the student will be able to**

**CO1:** Explain the foundations of distributed systems (K2)

**CO2:** Solve synchronization and state consistency problems (K3)

**CO3:** Use resource sharing techniques in distributed systems (K3)

**CO4:** Apply working model of consensus and reliability of distributed systems (K3)

**CO5:** Explain the fundamentals of cloud computing (K2)

**TOTAL:45 PERIODS****TEXT BOOKS**

1. Kshemkalyani Ajay D, Mukesh Singhal, "Distributed Computing: Principles, Algorithms and Systems", Cambridge Press, 2011.
2. Mukesh Singhal, Niranjan G Shivaratri, "Advanced Concepts in Operating systems", McGraw Hill Publishers, 1994.

**REFERENCES**

1. George Coulouris, Jean Dollimore, Time Kindberg, "Distributed Systems Concepts and Design", Fifth Edition, Pearson Education, 2012.
2. Pradeep L Sinha, "Distributed Operating Systems: Concepts and Design", Prentice Hall of India, 2007.
3. Tanenbaum A S, Van Steen M, "Distributed Systems: Principles and Paradigms", Pearson Education, 2007.
4. Liu M L, "Distributed Computing: Principles and Applications", Pearson Education, 2004.
5. Nancy A Lynch, "Distributed Algorithms", Morgan Kaufman Publishers, 2003.
6. Arshdeep Bagga, Vijay Madiseti, " Cloud Computing: A Hands-On Approach", Universities Press, 2014.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	3	3	1	-	-	-	2	1	3	3	2	1	1
2	1	3	2	1	2	-	-	-	2	2	2	2	1	3	2
3	2	2	1	3	3	-	-	-	3	2	1	1	1	2	1
4	1	2	2	3	1	-	-	-	3	3	2	1	3	1	1
5	3	3	1	2	3	-	-	-	3	3	3	1	3	2	3
<b>Avg.</b>	1.8	2.4	1.8	2.4	2	-	-	-	2.6	2.2	2.2	1.6	2	1.8	1.6

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES:**

- To understand Software Engineering Lifecycle Models
- To Perform software requirements analysis
- To gain knowledge of the System Analysis and Design concepts using UML.
- To understand software testing and maintenance approaches
- To work on project management scheduling using DevOps

**UNIT I SOFTWARE PROCESS AND AGILE DEVELOPMENT 9**

Introduction to Software Engineering, Software Process, Perspective and Specialized Process Models –Introduction to Agility-Agile process-Extreme programming-XP Process-Case Study.

**UNIT II REQUIREMENTS ANALYSIS AND SPECIFICATION 9**

Requirement analysis and specification – Requirements gathering and analysis – Software Requirement Specification – Formal system specification – Finite State Machines – Petrinets – Object modelling using UML – Use case Model – Class diagrams – Interaction diagrams – Activity diagrams – State chart diagrams – Functional modelling – Data Flow Diagram- CASE TOOLS.

**UNIT III SOFTWARE DESIGN 9**

Software design – Design process – Design concepts – Coupling – Cohesion – Functional independence – Design patterns – Model-view-controller – Publish-subscribe – Adapter – Command – Strategy – Observer – Proxy – Facade – Architectural styles – Layered - Client Server - Tiered - Pipe and filter- User interface design-Case Study.

**UNIT IV SOFTWARE TESTING AND MAINTENANCE 9**

Testing – Unit testing – Black box testing– White box testing – Integration and System testing– Regression testing – Debugging - Program analysis – Symbolic execution – Model Checking-Case Study

**UNIT V PROJECT MANAGEMENT 9**

Software Project Management- Software Configuration Management - Project Scheduling- DevOps: Motivation-Cloud as a platform-Operations- Deployment Pipeline:Overall Architecture Building and Testing-Deployment- Tools- Case Study

**COURSE OUTCOMES:**

**CO1:** Compare various Software Development Lifecycle Models

**CO2:** Evaluate project management approaches as well as cost and schedule estimation strategies.

**CO3:** Perform formal analysis on specifications.

**CO4:** Use UML diagrams for analysis and design.

**CO5:** Architect and design using architectural styles and design patterns, and test the system

**45 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

**LIST OF EXPERIMENTS:**

1. Identify a software system that needs to be developed.
2. Document the Software Requirements Specification (SRS) for the identified system.
3. Identify use cases and develop the Use Case model.

4. Identify the conceptual classes and develop a Domain Model and also derive a Class Diagram from that.
5. Using the identified scenarios, find the interaction between objects and represent them using UML Sequence and Collaboration Diagrams
6. Draw relevant State Chart and Activity Diagrams for the same system.
7. Implement the system as per the detailed design
8. Test the software system for all the scenarios identified as per the usecase diagram
9. Improve the reusability and maintainability of the software system by applying appropriate design patterns.
10. Implement the modified system and test it for various scenarios.

#### **SUGGESTED DOMAINS FOR MINI-PROJECT:**

1. Passport automation system.
2. Book bank
3. Exam registration
4. Stock maintenance system.
5. Online course reservation system
6. Airline/Railway reservation system
7. Software personnel management system
8. Credit card processing
9. e-book management system
10. Recruitment system
11. Foreign trading system
12. Conference management system
13. BPO management system
14. Library management system
15. Student information system

**TOTAL:75 PERIODS**

#### **TEXT BOOKS**

1. Bernd Bruegge and Allen H. Dutoit, "Object-Oriented Software Engineering: Using UML, Patterns and Java", Third Edition, Pearson Education, 2009.
2. Roger S. Pressman, Object-Oriented Software Engineering: An Agile Unified Methodology, First Edition, Mc Graw-Hill International Edition, 2014.

#### **REFERENCES**

1. Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli, Fundamentals of Software Engineering, 2nd edition, PHI Learning Pvt. Ltd., 2010.
2. Craig Larman, Applying UML and Patterns, 3rd ed, Pearson Education, 2005.
3. Len Bass, Ingo Weber and Liming Zhu, "DevOps: A Software Architect's Perspective", Pearson Education, 2016
4. Rajib Mall, Fundamentals of Software Engineering, 3rd edition, PHI Learning Pvt. Ltd., 2009.
5. Stephen Schach, Object-Oriented and Classical Software Engineering, 8th ed, McGraw-Hill, 2010.

### CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	1	2	2	-	-	-	-	1	1	2	2	2	1
2	2	3	2	3	2	-	-	-	2	2	3	2	3	2	1
3	2	3	2	1	1	-	-	-	2	2	3	2	2	3	1
4	2	3	2	2	3	-	-	-	2	2	3	2	2	3	1
5	2	3	1	2	2	-	-	-	-	-	-	1	3	2	2
AVg.	2	2	1	2	2	-	-	-	-	1	1	2	2	2	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

CS3691

EMBEDDED SYSTEMS AND IOT

L T P C

3 0 2 4

#### COURSE OBJECTIVES:

- To learn the internal architecture and programming of an embedded processor.
- To introduce interfacing I/O devices to the processor.
- To introduce the evolution of the Internet of Things (IoT).
- To build a small low-cost embedded and IoT system using Arduino/Raspberry Pi/ open platform.
- To apply the concept of Internet of Things in real world scenario.

#### UNIT I 8-BIT EMBEDDED PROCESSOR 9

8-Bit Microcontroller – Architecture – Instruction Set and Programming – Programming Parallel Ports – Timers and Serial Port – Interrupt Handling.

#### UNIT II EMBEDDED C PROGRAMMING 9

Memory And I/O Devices Interfacing – Programming Embedded Systems in C – Need For RTOS – Multiple Tasks and Processes – Context Switching – Priority Based Scheduling Policies.

#### UNIT III IOT AND ARDUINO PROGRAMMING 9

Introduction to the Concept of IoT Devices – IoT Devices Versus Computers – IoT Configurations – Basic Components – Introduction to Arduino – Types of Arduino – Arduino Toolchain – Arduino Programming Structure – Sketches – Pins – Input/Output From Pins Using Sketches – Introduction to Arduino Shields – Integration of Sensors and Actuators with Arduino.

#### UNIT IV IOT COMMUNICATION AND OPEN PLATFORMS 9

IoT Communication Models and APIs – IoT Communication Protocols – Bluetooth – WiFi – ZigBee – GPS – GSM modules – Open Platform (like Raspberry Pi) – Architecture – Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud.

#### UNIT V APPLICATIONS DEVELOPMENT 9

Complete Design of Embedded Systems – Development of IoT Applications – Home Automation – Smart Agriculture – Smart Cities – Smart Healthcare.

45 PERIODS



**PRACTICAL EXERCISES:****30 PERIODS**

1. Write 8051 Assembly Language experiments using simulator.
2. Test data transfer between registers and memory.
3. Perform ALU operations.
4. Write Basic and arithmetic Programs Using Embedded C.
5. Introduction to Arduino platform and programming
6. Explore different communication methods with IoT devices (Zigbee, GSM, Bluetooth)
7. Introduction to Raspberry PI platform and python programming
8. Interfacing sensors with Raspberry PI
9. Communicate between Arduino and Raspberry PI using any wireless medium
10. Setup a cloud platform to log the data
11. Log Data using Raspberry PI and upload to the cloud platform
12. Design an IOT based system

**COURSE OUTCOMES:****CO1:** Explain the architecture of embedded processors.**CO2:** Write embedded C programs.**CO3:** Design simple embedded applications.**CO4:** Compare the communication models in IOT**CO5:** Design IoT applications using Arduino/Raspberry Pi /open platform.**TOTAL :75 PERIODS****TEXTBOOKS**

1. Muhammed Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems", Pearson Education, Second Edition, 2014
2. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017.

**REFERENCES**

1. Michael J. Pont, "Embedded C", Pearson Education, 2007.
2. Wayne Wolf, "Computers as Components: Principles of Embedded Computer System Design", Elsevier, 2006.
3. Andrew N Sloss, D. Symes, C. Wright, "Arm System Developer's Guide", Morgan Kauffman/ Elsevier, 2006.
4. Arshdeep Bahga, Vijay Madiseti, "Internet of Things – A hands-on approach", Universities Press, 2015

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
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1	3	3	3	3	-	-	-	-	1	2	3	3	2	1	3
2	2	1	3	2	2	-	-	-	1	2	2	3	3	1	3
3	3	1	3	3	1	-	-	-	1	2	1	1	1	3	3
4	3	2	3	2	1	-	-	-	1	2	2	3	2	2	1
5	2	3	3	2	2	-	-	-	1	3	3	2	3	1	3
<b>AVg.</b>	2.6	2	3	2.4	1.5	-	-	-	1	2.2	2.2	2.4	2.2	1.6	2.6

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES:****To enable the students to**

- Get connected with reputed industry/ laboratory/academia / research institute
- Get practical knowledge on Product Development / Services and operations / Software Design and Development / Testing / Analytics/ research/ startups/ professionalism / business processes and insights / domain knowledge/ Industry Practices/ and other related aspects and develop skills to solve related problems
- Develop technical, soft, team skills to cater to the needs of the industry / academia / businesses / research / organizations in the core aspects of Automation, Digitalization

The students individually undergo training in reputed firms/ research institutes / laboratories for the specified duration. After the completion of training, a detailed report should be submitted within ten days from the commencement of next semester. The students will be evaluated as per the Regulations.

**No. of Weeks: 04**

**COURSE OUTCOMES:****On completion of the course, the student will know about**

CO1: Industry Practices, Processes, Techniques, technology, automation and other core aspects of software industry

CO2: Analyze, Design solutions to complex business problems

CO3: Build and deploy solutions for target platform

CO4: Preparation of Technical reports and presentation.

**COURSE OBJECTIVES:****To train the students**

- For gaining domain knowledge, and technical skills to solve potential business / research problems
- Gather requirements and Design suitable software solutions and evaluate alternatives
- To work in small teams and understand the processes and practices in the 'industry.
- Implement, Test and deploy solutions for target platforms
- Preparing project reports and presentation

The students shall individually / or as group work on business/research domains and related problems approved by the Department / organization that offered the internship / project.

The student can select any topic which is relevant to his/her specialization of the programme. The student should continue the work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review

committee, a detailed report which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work, results and discussion, conclusion and references should be prepared as per the format prescribed by the University and submitted to the Head of the department. The students will be evaluated based on the report and viva-voce examination by a panel of examiners as per the Regulations.

**TOTAL: 300 PERIODS**

**COURSE OUTCOMES:**

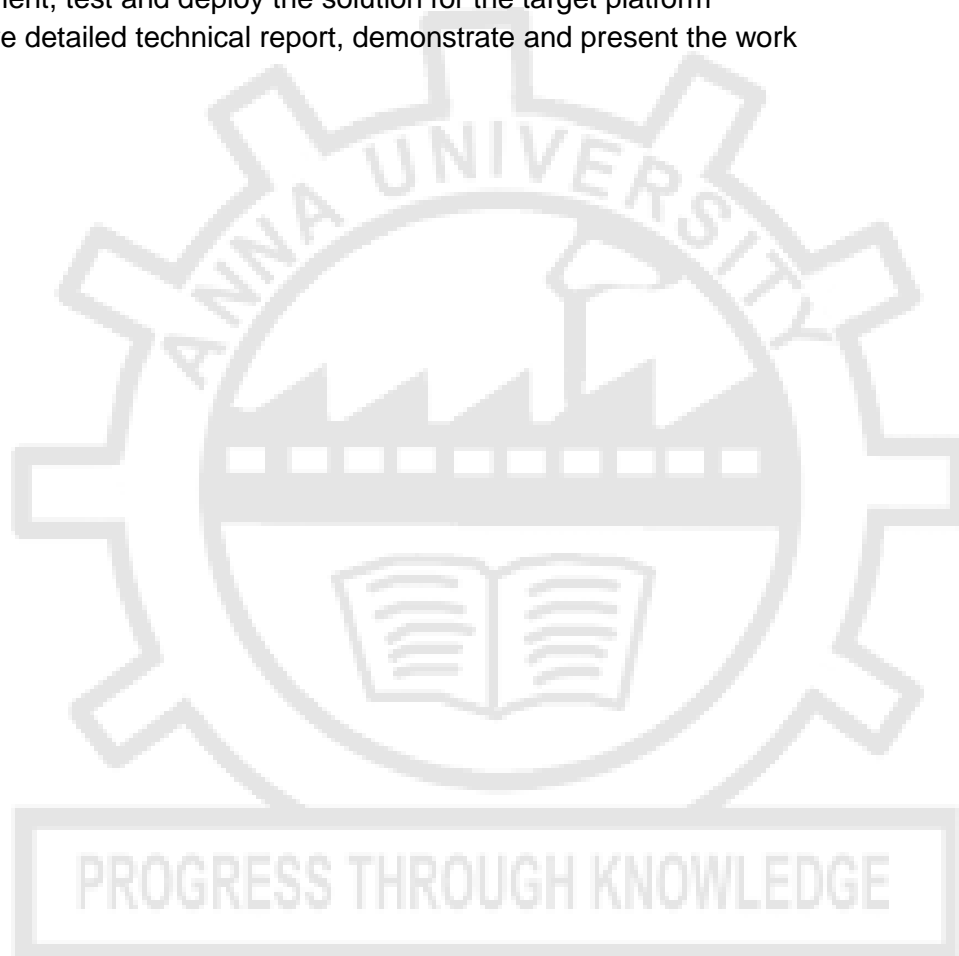
**At the end of the project, the student will be able to**

CO1: Gain Domain knowledge and technical skill set required for solving industry / research problems

CO2: Provide solution architecture, module level designs, algorithms

CO3: Implement, test and deploy the solution for the target platform

CO4: Prepare detailed technical report, demonstrate and present the work



## VERTICALS

CCS346

**EXPLORATORY DATA ANALYSIS**

**L T P C**  
**2 0 2 3**

### **COURSE OBJECTIVES:**

- To outline an overview of exploratory data analysis.
- To implement data visualization using Matplotlib.
- To perform univariate data exploration and analysis.
- To apply bivariate data exploration and analysis.
- To use Data exploration and visualization techniques for multivariate and time series data.

### **UNIT I                    EXPLORATORY DATA ANALYSIS                    6**

EDA fundamentals – Understanding data science – Significance of EDA – Making sense of data – Comparing EDA with classical and Bayesian analysis – Software tools for EDA - Visual Aids for EDA- Data transformation techniques-merging database, reshaping and pivoting, Transformation techniques.

### **UNIT II                    EDA USING PYTHON                    6**

Data Manipulation using Pandas – Pandas Objects – Data Indexing and Selection – Operating on Data – Handling Missing Data – Hierarchical Indexing – Combining datasets – Concat, Append, Merge and Join – Aggregation and grouping – Pivot Tables – Vectorized String Operations.

### **UNIT III                    UNIVARIATE ANALYSIS                    6**

Introduction to Single variable: Distribution Variables - Numerical Summaries of Level and Spread - Scaling and Standardizing – Inequality.

### **UNIT IV                    BIVARIATE ANALYSIS                    6**

Relationships between Two Variables - Percentage Tables - Analysing Contingency Tables - Handling Several Batches - Scatterplots and Resistant Lines.

### **UNIT V                    MULTIVARIATE AND TIME SERIES ANALYSIS                    6**

Introducing a Third Variable - Causal Explanations - Three-Variable Contingency Tables and Beyond – Fundamentals of TSA – Characteristics of time series data – Data Cleaning – Time-based indexing – Visualizing – Grouping – Resampling.

**30 PERIODS**

### **PRACTICAL EXERCISES:**

**30 PERIODS**

1. Install the data Analysis and Visualization tool: R/ Python /Tableau Public/ Power BI.
2. Perform exploratory data analysis (EDA) with datasets like email data set. Export all your emails as a dataset, import them inside a pandas data frame, visualize them and get different insights from the data.
3. Working with Numpy arrays, Pandas data frames , Basic plots using Matplotlib.
4. Explore various variable and row filters in R for cleaning data. Apply various plot features in R on sample data sets and visualize.
5. Perform Time Series Analysis and apply the various visualization techniques.
6. Perform Data Analysis and representation on a Map using various Map data sets with Mouse Rollover effect, user interaction, etc..

- Build cartographic visualization for multiple datasets involving various countries of the world; states and districts in India etc.
- Perform EDA on Wine Quality Data Set.
- Use a case study on a data set and apply the various EDA and visualization techniques and present an analysis report.

### COURSE OUTCOMES:

**At the end of this course, the students will be able to:**

**CO1:** Understand the fundamentals of exploratory data analysis.

**CO2:** Implement the data visualization using Matplotlib.

**CO3:** Perform univariate data exploration and analysis.

**CO4:** Apply bivariate data exploration and analysis.

**CO5:** Use Data exploration and visualization techniques for multivariate and time series data.

**TOTAL: 60 PERIODS**

### TEXT BOOKS:

- Suresh Kumar Mukhiya, Usman Ahmed, "Hands-On Exploratory Data Analysis with Python", Packt Publishing, 2020. (Unit 1)
- Jake Vander Plas, "Python Data Science Handbook: Essential Tools for Working with Data", First Edition, O Reilly, 2017. (Unit 2)
- Catherine Marsh, Jane Elliott, "Exploring Data: An Introduction to Data Analysis for Social Scientists", Wiley Publications, 2nd Edition, 2008. (Unit 3,4,5)

### REFERENCES:

- Eric Pimpler, Data Visualization and Exploration with R, GeoSpatial Training service, 2017.
- Claus O. Wilke, "Fundamentals of Data Visualization", O'reilly publications, 2019.
- Matthew O. Ward, Georges Grinstein, Daniel Keim, "Interactive Data Visualization: Foundations, Techniques, and Applications", 2nd Edition, CRC press, 2015.

### CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	3	3	-	-	-	2	2	3	2	3	3	2
2	2	2	2	3	3	-	-	-	3	2	2	2	1	2	3
3	2	3	2	2	3	-	-	-	2	2	2	1	2	3	1
4	2	2	2	2	3	-	-	-	3	2	2	1	2	2	2
5	2	2	3	2	1	-	-	-	1	2	2	1	2	2	3
<b>AVg.</b>	2.2	2.2	2.4	2.4	2.6	-	-	-	2.2	2	2.2	1.4	2	2.4	2.2

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS360

RECOMMENDER SYSTEMS

L T P C

2 0 2 3

### COURSE OBJECTIVES:

- To understand the foundations of the recommender system.
- To learn the significance of machine learning and data mining algorithms for Recommender systems
- To learn about collaborative filtering
- To make students design and implement a recommender system.

- To learn collaborative filtering.

## **UNIT I INTRODUCTION**

**6**

Introduction and basic taxonomy of recommender systems - Traditional and non-personalized Recommender Systems - Overview of data mining methods for recommender systems- similarity measures- Dimensionality reduction – Singular Value Decomposition (SVD)

### **Suggested Activities:**

- Practical learning – Implement Data similarity measures.
- External Learning – Singular Value Decomposition (SVD) applications

### **Suggested Evaluation Methods:**

- Quiz on Recommender systems.
- Quiz of python tools available for implementing Recommender systems

## **UNIT II CONTENT-BASED RECOMMENDATION SYSTEMS**

**6**

High-level architecture of content-based systems - Item profiles, Representing item profiles, Methods for learning user profiles, Similarity-based retrieval, and Classification algorithms.

### **Suggested Activities:**

- Assignment on content-based recommendation systems
- Assignment of learning user profiles

### **Suggested Evaluation Methods:**

- Quiz on similarity-based retrieval.
- Quiz of content-based filtering

## **UNIT III COLLABORATIVE FILTERING**

**6**

A systematic approach, Nearest-neighbor collaborative filtering (CF), user-based and item-based CF, components of neighborhood methods (rating normalization, similarity weight computation, and neighborhood selection)

### **Suggested Activities:**

- Practical learning – Implement collaborative filtering concepts
- Assignment of security aspects of recommender systems

### **Suggested Evaluation Methods:**

- Quiz on collaborative filtering
- Seminar on security measures of recommender systems

## **UNIT IV ATTACK-RESISTANT RECOMMENDER SYSTEMS**

**6**

Introduction – Types of Attacks – Detecting attacks on recommender systems – Individual attack – Group attack – Strategies for robust recommender design - Robust recommendation algorithms.

### **Suggested Activities:**

- Group Discussion on attacks and their mitigation
- Study of the impact of group attacks

- External Learning – Use of CAPTCHAs

**Suggested Evaluation Methods:**

- Quiz on attacks on recommender systems
- Seminar on preventing attacks using the CAPTCHAs

**UNIT V EVALUATING RECOMMENDER SYSTEMS**

**6**

Evaluating Paradigms – User Studies – Online and Offline evaluation – Goals of evaluation design – Design Issues – Accuracy metrics – Limitations of Evaluation measures

**Suggested Activities:**

- Group Discussion on goals of evaluation design
- Study of accuracy metrics

**Suggested Evaluation Methods:**

- Quiz on evaluation design
- Problems on accuracy measures

**30 PERIODS**

**PRACTICAL EXERCISES**

**30 PERIODS**

1. Implement Data similarity measures using Python
2. Implement dimension reduction techniques for recommender systems
3. Implement user profile learning
4. Implement content-based recommendation systems
5. Implement collaborative filter techniques
6. Create an attack for tampering with recommender systems
7. Implement accuracy metrics like Receiver Operated Characteristic curves

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

**On completion of the course, the students will be able to:**

**CO1:**Understand the basic concepts of recommender systems.

**CO2:**Implement machine-learning and data-mining algorithms in recommender systems data sets.

**CO3:**Implementation of Collaborative Filtering in carrying out performance evaluation of recommender systems based on various metrics.

**CO4:**Design and implement a simple recommender system.

**CO5:**Learn about advanced topics of recommender systems.

**CO6:**Learn about advanced topics of recommender systems applications

**TEXTBOOKS:**

1. Charu C. Aggarwal, Recommender Systems: The Textbook, Springer, 2016.
2. Dietmar Jannach , Markus Zanker , Alexander Felfernig and Gerhard Friedrich , Recommender Systems: An Introduction, Cambridge University Press (2011), 1st ed.
3. Francesco Ricci , Lior Rokach , Bracha Shapira , Recommender Sytems Handbook, 1st ed, Springer (2011),
4. Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, Mining of massive datasets, 3<sup>rd</sup> edition, Cambridge University Press, 2020.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	1	2	1	-	-	-	1	-	-	1	-	-	-
2	1	2	-	-	1	-	-	-	-	-	-	1	-	-	-
3	2	3	1	-	1	-	-	-	2	-	-	-	-	-	-
4	3	2	2	2	1	-	-	-	2	-	-	2	-	-	-
5	1	1	-	2	1	-	-	-	-	-	-	1	-	-	-
6	2	2	1	1	1	-	-	-	-	-	-	1	-	-	-
AVg	1.83	2	0.83	1.16	1	-	-	-	0.83	-	-	1	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CCS355**

**NEURAL NETWORKS AND DEEP LEARNING**

**L T P C**  
**2 0 2 3**

**COURSE OBJECTIVES:**

- To understand the basics in deep neural networks
- To understand the basics of associative memory and unsupervised learning networks
- To apply CNN architectures of deep neural networks
- To analyze the key computations underlying deep learning, then use them to build and train deep neural networks for various tasks.
- To apply autoencoders and generative models for suitable applications.

**UNIT I INTRODUCTION**

**6**

Neural Networks-Application Scope of Neural Networks-Artificial Neural Network: An Introduction-Evolution of Neural Networks-Basic Models of Artificial Neural Network- Important Terminologies of ANNs-Supervised Learning Network.

**UNIT II ASSOCIATIVE MEMORY AND UNSUPERVISED LEARNING NETWORKS**

**6**

Training Algorithms for Pattern Association-Autoassociative Memory Network-Heteroassociative Memory Network-Bidirectional Associative Memory (BAM)-Hopfield Networks-Iterative Autoassociative Memory Networks-Temporal Associative Memory Network-Fixed Weight Competitive Nets-Kohonen Self-Organizing Feature Maps-Learning Vector Quantization-Counter propagation Networks-Adaptive Resonance Theory Network.

**UNIT III THIRD-GENERATION NEURAL NETWORKS**

**6**

Spiking Neural Networks-Convolutional Neural Networks-Deep Learning Neural Networks-Extreme Learning Machine Model-Convolutional Neural Networks: The Convolution Operation – Motivation – Pooling – Variants of the basic Convolution Function – Structured Outputs – Data Types – Efficient Convolution Algorithms – Neuroscientific Basis – Applications: Computer Vision, Image Generation, Image Compression.

**UNIT IV DEEP FEEDFORWARD NETWORKS**

**6**

History of Deep Learning- A Probabilistic Theory of Deep Learning- Gradient Learning – Chain Rule and Backpropagation - Regularization: Dataset Augmentation – Noise Robustness -Early Stopping, Bagging and Dropout - batch normalization- VC Dimension and Neural Nets.



## UNIT V RECURRENT NEURAL NETWORKS

6

Recurrent Neural Networks: Introduction – Recursive Neural Networks – Bidirectional RNNs – Deep Recurrent Networks – Applications: Image Generation, Image Compression, Natural Language Processing. Complete Auto encoder, Regularized Autoencoder, Stochastic Encoders and Decoders, Contractive Encoders.

30 PERIODS

### LAB EXPERIMENTS:

30 PERIODS

1. Implement simple vector addition in TensorFlow.
2. Implement a regression model in Keras.
3. Implement a perceptron in TensorFlow/Keras Environment.
4. Implement a Feed-Forward Network in TensorFlow/Keras.
5. Implement an Image Classifier using CNN in TensorFlow/Keras.
6. Improve the Deep learning model by fine tuning hyper parameters.
7. Implement a Transfer Learning concept in Image Classification.
8. Using a pre trained model on Keras for Transfer Learning
9. Perform Sentiment Analysis using RNN
10. Implement an LSTM based Autoencoder in TensorFlow/Keras.
11. Image generation using GAN

### Additional Experiments:

12. Train a Deep learning model to classify a given image using pre trained model
13. Recommendation system from sales data using Deep Learning
14. Implement Object Detection using CNN
15. Implement any simple Reinforcement Algorithm for an NLP problem

**TOTAL: 60 PERIODS**

### COURSE OUTCOMES:

**At the end of this course, the students will be able to:**

**CO1:** Apply Convolution Neural Network for image processing.

**CO2:** Understand the basics of associative memory and unsupervised learning networks.

**CO3:** Apply CNN and its variants for suitable applications.

**CO4:** Analyze the key computations underlying deep learning and use them to build and train deep neural networks for various tasks.

**CO5:** Apply autoencoders and generative models for suitable applications.

### TEXT BOOKS:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016.
2. Francois Chollet, "Deep Learning with Python", Second Edition, Manning Publications, 2021.

### REFERENCES:

1. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn and TensorFlow", Oreilly, 2018.
2. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017.

3. Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", Springer International Publishing, 1st Edition, 2018.
4. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress, 2018
5. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
6. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND, 2017.
7. S Rajasekaran, G A Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm, Synthesis and Applications", PHI Learning, 2017.
8. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress, 2017
9. James A Freeman, David M S Kapura, "Neural Networks Algorithms, Applications, and Programming Techniques", Addison Wesley, 2003.

### CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	2	3	1	-	-	2	1	-	-	2	2	1
2	3	1	2	1	-	-	-	-	-	1	2	2	-	1	-
3	3	3	3	3	3	1	-	-	2	1	-	-	2	2	1
4	3	3	3	3	3	-	-	-	2	-	2	3	2	2	2
5	1	1	3	2	3	-	-	-	2	-	-	-	1	1	-
<b>Avg.</b>	2.6	2	2.8	2.2	2.4	0.4	0	0	1.6	0.6	0.8	1	1.4	1.6	0.8

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS369

TEXT AND SPEECH ANALYSIS

L T P C  
2 0 2 3

#### COURSE OBJECTIVES:

- Understand natural language processing basics
- Apply classification algorithms to text documents
- Build question-answering and dialogue systems
- Develop a speech recognition system
- Develop a speech synthesizer

#### UNIT I NATURAL LANGUAGE BASICS

6

Foundations of natural language processing – Language Syntax and Structure- Text Preprocessing and Wrangling – Text tokenization – Stemming – Lemmatization – Removing stop-words – Feature Engineering for Text representation – Bag of Words model- Bag of N-Grams model – TF-IDF model

#### Suggested Activities

- Flipped classroom on NLP
- Implementation of Text Preprocessing using NLTK
- Implementation of TF-IDF models

#### Suggested Evaluation Methods

- Quiz on NLP Basics
- Demonstration of Programs

## UNIT II TEXT CLASSIFICATION

6

Vector Semantics and Embeddings -Word Embeddings - Word2Vec model – Glove model – FastText model – Overview of Deep Learning models – RNN – Transformers – Overview of Text summarization and Topic Models

### Suggested Activities

- Flipped classroom on Feature extraction of documents
- Implementation of SVM models for text classification
- External learning: Text summarization and Topic models

### Suggested Evaluation Methods

- Assignment on above topics
- Quiz on RNN, Transformers
- Implementing NLP with RNN and Transformers

## UNIT III QUESTION ANSWERING AND DIALOGUE SYSTEMS

9

Information retrieval – IR-based question answering – knowledge-based question answering – language models for QA – classic QA models – chatbots – Design of dialogue systems -- evaluating dialogue systems

### Suggested Activities:

- Flipped classroom on language models for QA
- Developing a knowledge-based question-answering system
- Classic QA model development

### Suggested Evaluation Methods

- Assignment on the above topics
- Quiz on knowledge-based question answering system
- Development of simple chatbots

## UNIT IV TEXT-TO-SPEECH SYNTHESIS

6

Overview. Text normalization. Letter-to-sound. Prosody, Evaluation. Signal processing - Concatenative and parametric approaches, WaveNet and other deep learning-based TTS systems

### Suggested Activities:

- Flipped classroom on Speech signal processing
- Exploring Text normalization
- Data collection
- Implementation of TTS systems

### Suggested Evaluation Methods

- Assignment on the above topics
- Quiz on wavenet, deep learning-based TTS systems
- Finding accuracy with different TTS systems

## UNIT V AUTOMATIC SPEECH RECOGNITION

6

Speech recognition: Acoustic modelling – Feature Extraction - HMM, HMM-DNN systems

### Suggested Activities:

- Flipped classroom on Speech recognition.

- Exploring Feature extraction

### Suggested Evaluation Methods

- Assignment on the above topics
- Quiz on acoustic modelling

**30 PERIODS**

### PRACTICAL EXERCISES

**30 PERIODS**

1. Create Regular expressions in Python for detecting word patterns and tokenizing text
2. Getting started with Python and NLTK - Searching Text, Counting Vocabulary, Frequency Distribution, Collocations, Bigrams
3. Accessing Text Corpora using NLTK in Python
4. Write a function that finds the 50 most frequently occurring words of a text that are not stop words.
5. Implement the Word2Vec model
6. Use a transformer for implementing classification
7. Design a chatbot with a simple dialog system
8. Convert text to speech and find accuracy
9. Design a speech recognition system and find the error rate

**TOTAL: 60 PERIODS**

### COURSE OUTCOMES:

On completion of the course, the students will be able to

**CO1:** Explain existing and emerging deep learning architectures for text and speech processing

**CO2:** Apply deep learning techniques for NLP tasks, language modelling and machine translation

**CO3:** Explain coreference and coherence for text processing

**CO4:** Build question-answering systems, chatbots and dialogue systems

**CO5:** Apply deep learning models for building speech recognition and text-to-speech systems

### TEXTBOOK

1. Daniel Jurafsky and James H. Martin, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Third Edition, 2022.

### REFERENCES:

1. Dipanjan Sarkar, "Text Analytics with Python: A Practical Real-World approach to Gaining Actionable insights from your data", APress, 2018.
2. Tanveer Siddiqui, Tiwary U S, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008.
3. Lawrence Rabiner, Biing-Hwang Juang, B. Yegnanarayana, "Fundamentals of Speech Recognition" 1st Edition, Pearson, 2009.
4. Steven Bird, Ewan Klein, and Edward Loper, "Natural language processing with Python", O'REILLY.

### CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	1	3	-	-	-	1	2	1	2	1	1	1
2	3	1	2	1	3	-	-	-	2	2	1	3	3	2	1
3	2	2	1	3	1	-	-	-	3	3	1	2	3	3	1
4	2	1	1	1	2	-	-	-	2	1	2	2	3	1	1

5	1	3	2	2	1	-	-	-	3	2	1	1	2	3	1
AVg.	2.2	1.8	1.8	1.6	2	-	-	-	2.2	2	1.2	2	2.4	2	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCW331

BUSINESS ANALYTICS

L T P C  
2 0 2 3

**COURSE OBJECTIVES:**

- To understand the Analytics Life Cycle.
- To comprehend the process of acquiring Business Intelligence
- To understand various types of analytics for Business Forecasting
- To model the supply chain management for Analytics.
- To apply analytics for different functions of a business

**UNIT I INTRODUCTION TO BUSINESS ANALYTICS 6**

Analytics and Data Science – Analytics Life Cycle – Types of Analytics – Business Problem Definition – Data Collection – Data Preparation – Hypothesis Generation – Modeling – Validation and Evaluation – Interpretation – Deployment and Iteration

**UNIT II BUSINESS INTELLIGENCE 6**

Data Warehouses and Data Mart - Knowledge Management –Types of Decisions - Decision Making Process - Decision Support Systems – Business Intelligence –OLAP – Analytic functions

**UNIT III BUSINESS FORECASTING 6**

Introduction to Business Forecasting and Predictive analytics - Logic and Data Driven Models –Data Mining and Predictive Analysis Modelling –Machine Learning for Predictive analytics.

**UNIT IV HR & SUPPLY CHAIN ANALYTICS 6**

Human Resources – Planning and Recruitment – Training and Development - Supply chain network - Planning Demand, Inventory and Supply – Logistics – Analytics applications in HR & Supply Chain - Applying HR Analytics to make a prediction of the demand for hourly employees for a year.

**UNIT V MARKETING & SALES ANALYTICS 6**

Marketing Strategy, Marketing Mix, Customer Behaviour –selling Process – Sales Planning – Analytics applications in Marketing and Sales - predictive analytics for customers' behaviour in marketing and sales.

**30 PERIODS**

**LIST OF EXPERIMENTS:**

Use MS-Excel and Power-BI to perform the following experiments using a Business data set, and make presentations.

Students may be encouraged to bring their own real-time socially relevant data set.

I Cycle – MS Excel

1. Explore the features of Ms-Excel.
2. (i) Get the input from user and perform numerical operations (MAX, MIN, AVG, SUM, SQRT, ROUND)  
ii) Perform data import/export operations for different file formats.

3. Perform statistical operations - Mean, Median, Mode and Standard deviation, Variance, Skewness, Kurtosis
4. Perform Z-test, T-test & ANOVA
5. Perform data pre-processing operations i) Handling Missing data ii) Normalization
6. Perform dimensionality reduction operation using PCA, KPCA & SVD
7. Perform bivariate and multivariate analysis on the dataset.
8. Apply and explore various plotting functions on the data set.

#### II Cycle – Power BI Desktop

9. Explore the features of Power BI Desktop
10. Prepare & Load data
11. Develop the data model
12. Perform DAX calculations
13. Design a report
14. Create a dashboard and perform data analysis
15. Presentation of a case study

**30 PERIODS**

#### COURSE OUTCOMES:

**CO1:** Explain the real world business problems and model with analytical solutions.

**CO2:** Identify the business processes for extracting Business Intelligence

**CO3 :** Apply predictive analytics for business fore-casting

**CO4:** Apply analytics for supply chain and logistics management

**CO5:** Use analytics for marketing and sales.

**TOTAL :60 PERIODS**

#### TEXT BOOKS

1. R. Evans James, Business Analytics, 2nd Edition, Pearson, 2017
2. R N Prasad, Seema Acharya, Fundamentals of Business Analytics, 2nd Edition, Wiley, 2016
3. Philip Kotler and Kevin Keller, Marketing Management, 15th edition, PHI, 2016
4. VSP RAO, Human Resource Management, 3rd Edition, Excel Books, 2010.
5. Mahadevan B, "Operations Management -Theory and Practice",3rd Edition, Pearson Education,2018.

#### CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
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2	3	3	3	2	3	-	-	-	1	2	2	2	3	1	2
3	2	2	3	3	2	-	-	-	3	1	1	3	3	1	2
4	2	1	1	2	2	-	-	-	3	3	2	1	1	3	1
5	2	3	2	3	2	-	-	-	3	3	1	3	3	1	1
<b>Avg.</b>	2.2	2.2	2.4	2.2	2	-	-	-	2.2	2.2	1.4	2	2.6	1.6	1.4

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES:**

- To understand the basics of image processing techniques for computer vision.
- To learn the techniques used for image pre-processing.
- To discuss the various object detection techniques.
- To understand the various Object recognition mechanisms.
- To elaborate on the video analytics techniques.

<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>6</b>
Computer Vision – Image representation and image analysis tasks - Image representations – digitization – properties – color images – Data structures for Image Analysis - Levels of image data representation - Traditional and Hierarchical image data structures.		
<b>UNIT II</b>	<b>IMAGE PRE-PROCESSING</b>	<b>6</b>
Local pre-processing - Image smoothing - Edge detectors - Zero-crossings of the second derivative - Scale in image processing - Canny edge detection - Parametric edge models - Edges in multi-spectral images - Local pre-processing in the frequency domain - Line detection by local pre-processing operators - Image restoration.		
<b>UNIT III</b>	<b>OBJECT DETECTION USING MACHINE LEARNING</b>	<b>6</b>
Object detection– Object detection methods – Deep Learning framework for Object detection– bounding box approach-Intersection over Union (IoU) –Deep Learning Architectures-R-CNN-Faster R-CNN-You Only Look Once(YOLO)-Salient features-Loss Functions-YOLO architectures		
<b>UNIT IV</b>	<b>FACE RECOGNITION AND GESTURE RECOGNITION</b>	<b>6</b>
Face Recognition-Introduction-Applications of Face Recognition-Process of Face Recognition-DeepFace solution by Facebook-FaceNet for Face Recognition- Implementation using FaceNet-Gesture Recognition.		
<b>UNIT V</b>	<b>VIDEO ANALYTICS</b>	<b>6</b>
Video Processing – use cases of video analytics-Vanishing Gradient and exploding gradient problem-RestNet architecture-RestNet and skip connections-Inception Network-GoogleNet architecture-Improvement in Inception v2-Video analytics-RestNet and Inception v3.		

<b>LIST OF EXERCISES</b>	<b>30 PERIODS</b>
	<b>30 PERIODS</b>

1. Write a program that computes the T-pyramid of an image.
2. Write a program that derives the quad tree representation of an image using the homogeneity criterion of equal intensity
3. Develop programs for the following geometric transforms: (a) Rotation (b) Change of scale (c) Skewing (d) Affine transform calculated from three pairs of corresponding points (e) Bilinear transform calculated from four pairs of corresponding points.
4. Develop a program to implement Object Detection and Recognition
5. Develop a program for motion analysis using moving edges, and apply it to your image sequences.
6. Develop a program for Facial Detection and Recognition
7. Write a program for event detection in video surveillance system

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

**At the end of this course, the students will be able to:**

- CO1:** Understand the basics of image processing techniques for computer vision and video analysis.
- CO2:** Explain the techniques used for image pre-processing.
- CO3:** Develop various object detection techniques.
- CO4:** Understand the various face recognition mechanisms.
- CO5:** Elaborate on deep learning-based video analytics.

**TEXT BOOK:**

1. Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision", 4nd edition, Thomson Learning, 2013.
2. Vaibhav Verdhan,(2021, Computer Vision Using Deep Learning Neural Network Architectures with Python and Keras,Apress 2021(UNIT-III,IV and V)

**REFERENCES**

1. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer Verlag London Limited,2011.
2. Caifeng Shan, FatihPorikli, Tao Xiang, Shaogang Gong, "Video Analytics for Business Intelligence", Springer, 2012.
3. D. A. Forsyth, J. Ponce, "Computer Vision: A Modern Approach", Pearson Education, 2003.
4. E. R. Davies, (2012), "Computer & Machine Vision", Fourth Edition, Academic Press.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	2	2	2	-	-	-	3	3	2	1	2	1	3
2	2	2	3	3	3	-	-	-	3	2	1	1	2	2	1
3	1	2	2	2	3	-	-	-	1	2	1	2	1	1	3
4	1	2	3	2	3	-	-	-	2	2	2	3	2	2	2
5	3	2	1	3	2	-	-	-	2	1	1	3	3	2	1
<b>AVg.</b>	2	1.8	2.2	2.4	2.6	-	-	-	2.2	2	1.4	2	2	1.6	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CCS338**

**COMPUTER VISION**

**L T P C**

**2 0 2 3**

**COURSE OBJECTIVES:**

- To understand the fundamental concepts related to Image formation and processing.
- To learn feature detection, matching and detection
- To become familiar with feature based alignment and motion estimation
- To develop skills on 3D reconstruction
- To understand image based rendering and recognition

**UNIT I INTRODUCTION TO IMAGE FORMATION AND PROCESSING**

**6**

Computer Vision - Geometric primitives and transformations - Photometric image formation - The digital camera - Point operators - Linear filtering - More neighborhood operators - Fourier transforms - Pyramids and wavelets - Geometric transformations - Global optimization.



**UNIT II                      FEATURE DETECTION, MATCHING AND SEGMENTATION                      6**

Points and patches - Edges - Lines - Segmentation - Active contours - Split and merge - Mean shift and mode finding - Normalized cuts - Graph cuts and energy-based methods.

**UNIT III                      FEATURE-BASED ALIGNMENT & MOTION ESTIMATION                      6**

2D and 3D feature-based alignment - Pose estimation - Geometric intrinsic calibration - Triangulation - Two-frame structure from motion - Factorization - Bundle adjustment - Constrained structure and motion - Translational alignment - Parametric motion - Spline-based motion - Optical flow - Layered motion.

**UNIT IV                      3D RECONSTRUCTION                      6**

Shape from X - Active rangefinding - Surface representations - Point-based representations- Volumetric representations - Model-based reconstruction - Recovering texture maps and albedos.

**UNIT V                      IMAGE-BASED RENDERING AND RECOGNITION                      6**

View interpolation Layered depth images - Light fields and Lumigraphs - Environment mattes - Video-based rendering-Object detection - Face recognition - Instance recognition - Category recognition - Context and scene understanding- Recognition databases and test sets.

**30 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

**LABORATORY EXPERIMENTS:**

**Software needed:**

OpenCV computer vision Library for OpenCV in Python / PyCharm or C++ / Visual Studio or or equivalent

- OpenCV Installation and working with Python
- Basic Image Processing - loading images, Cropping, Resizing, Thresholding, Contour analysis, Blob detection
- Image Annotation – Drawing lines, text circle, rectangle, ellipse on images
- Image Enhancement - Understanding Color spaces, color space conversion, Histogram equalization, Convolution, Image smoothing, Gradients, Edge Detection
- Image Features and Image Alignment – Image transforms – Fourier, Hough, Extract ORB Image features, Feature matching, cloning, Feature matching based image alignment
- Image segmentation using Graphcut / Grabcut
- Camera Calibration with circular grid
- Pose Estimation
- 3D Reconstruction – Creating Depth map from stereo images
- Object Detection and Tracking using Kalman Filter, Camshift

1. docs.opencv.org
2. <https://opencv.org/opencv-free-course/>

**TOTAL : 60 PERIODS**

## COURSE OUTCOMES:

At the end of this course, the students will be able to:

**CO1:**To understand basic knowledge, theories and methods in image processing and computer vision.

**CO2:**To implement basic and some advanced image processing techniques in OpenCV.

**CO3:**To apply 2D a feature-based based image alignment, segmentation and motion estimations.

**CO4:**To apply 3D image reconstruction techniques

**CO5:**To design and develop innovative image processing and computer vision applications.

## TEXT BOOKS:

1. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer- Texts in Computer Science, Second Edition, 2022.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, Second Edition, 2015.

## REFERENCES:

1. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
2. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006
3. E. R. Davies, Computer and Machine Vision, Fourth Edition, Academic Press, 2012.

## CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	1	1	1	-	-	-	2	1	3	2	2	1	1
2	3	3	3	2	3	-	1	-	2	1	2	2	3	1	2
3	3	3	2	2	3	-	-	-	1	1	2	2	3	2	2
4	2	3	3	2	3	-	-	-	2	1	2	3	2	2	3
5	2	3	3	2	2	2	-	-	3	1	2	3	3	3	3
AVg.	2.6	2.6	2.4	1.8	2.4	0.4	0.25	0	2	1	2.2	2.4	2.6	1.8	2.2

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS334

**BIG DATA ANALYTICS**

**L T P C**

**2 0 2 3**

## COURSE OBJECTIVES:

- To understand big data.
- To learn and use NoSQL big data management.
- To learn mapreduce analytics using Hadoop and related tools.
- To work with map reduce applications
- To understand the usage of Hadoop related tools for Big Data Analytics

## UNIT I UNDERSTANDING BIG DATA

**5**

Introduction to big data – convergence of key trends – unstructured data – industry examples of big data – web analytics – big data applications– big data technologies – introduction to Hadoop – open

source technologies – cloud and big data – mobile business intelligence – Crowd sourcing analytics – inter and trans firewall analytics.

**UNIT II NOSQL DATA MANAGEMENT 7**

Introduction to NoSQL – aggregate data models – key-value and document data models – relationships – graph databases – schemaless databases – materialized views – distribution models – master-slave replication – consistency - Cassandra – Cassandra data model – Cassandra examples – Cassandra clients

**UNIT III MAP REDUCE APPLICATIONS 6**

MapReduce workflows – unit tests with MRUnit – test data and local tests – anatomy of MapReduce job run – classic Map-reduce – YARN – failures in classic Map-reduce and YARN – job scheduling – shuffle and sort – task execution – MapReduce types – input formats – output formats.

**UNIT IV BASICS OF HADOOP 6**

Data format – analyzing data with Hadoop – scaling out – Hadoop streaming – Hadoop pipes – design of Hadoop distributed file system (HDFS) – HDFS concepts – Java interface – data flow – Hadoop I/O – data integrity – compression – serialization – Avro – file-based data structures - Cassandra – Hadoop integration.

**UNIT V HADOOP RELATED TOOLS 6**

Hbase – data model and implementations – Hbase clients – Hbase examples – praxis.  
Pig – Grunt – pig data model – Pig Latin – developing and testing Pig Latin scripts.  
Hive – data types and file formats – HiveQL data definition – HiveQL data manipulation – HiveQL queries.

**30 PERIODS**

**COURSE OUTCOMES:**

**After the completion of this course, students will be able to:**

**CO1:**Describe big data and use cases from selected business domains.

**CO2:**Explain NoSQL big data management.

**CO3:**Install, configure, and run Hadoop and HDFS.

**CO4:**Perform map-reduce analytics using Hadoop.

**CO5:**Use Hadoop-related tools such as HBase, Cassandra, Pig, and Hive for big data analytics.

**LIST OF EXPERIMENTS: 30 PERIODS**

1. Downloading and installing Hadoop; Understanding different Hadoop modes. Startup scripts, Configuration files.
2. Hadoop Implementation of file management tasks, such as Adding files and directories, retrieving files and Deleting files
3. Implement of Matrix Multiplication with Hadoop Map Reduce
4. Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm.
5. Installation of Hive along with practice examples.
7. Installation of HBase, Installing thrift along with Practice examples
8. Practice importing and exporting data from various databases.

**Software Requirements:**

**Cassandra, Hadoop, Java, Pig, Hive and HBase.**

**TOTAL:60 PERIODS**

**TEXT BOOKS:**

1. Michael Minelli, Michelle Chambers, and AmbigaDhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
2. Eric Sammer, "Hadoop Operations", O'Reilley, 2012.
3. Sadalage, Pramod J. "NoSQL distilled", 2013

**REFERENCES:**

1. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012.
2. Lars George, "HBase: The Definitive Guide", O'Reilley, 2011.
3. Eben Hewitt, "Cassandra: The Definitive Guide", O'Reilley, 2010.
4. Alan Gates, "Programming Pig", O'Reilley, 2011.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3	-	-	-	2	2	3	1	1	3	3
2	3	3	2	3	2	-	-	-	2	2	3	3	2	3	2
3	3	3	3	2	3	-	-	-	2	2	1	2	2	3	3
4	2	3	3	3	3	-	-	-	2	2	3	2	3	3	2
5	3	3	3	3	3	-	-	-	3	1	3	2	3	2	3
<b>AVg.</b>	2.8	3	2.8	2.8	2.8	-	-	-	2.2	1.8	2.6	2	2.2	2.8	2.6

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS375

WEB TECHNOLOGIES

L T P C  
2 0 2 3

**COURSE OBJECTIVES:**

- To understand different Internet Technologies
- To learn java-specific web services architecture
- To Develop web applications using frameworks

**UNIT I WEBSITE BASICS, HTML 5, CSS 3, WEB 2.0**

7

Web Essentials: Clients, Servers and Communication – The Internet – World wide web – HTTP Request Message – HTTP Response Message – Web Clients – Web Servers – HTML5 – Tables – Lists – Image – HTML5 control elements – Drag and Drop – Audio – Video controls - CSS3 – Inline, embedded and external style sheets – Rule cascading – Inheritance – Backgrounds – Border Images – Colors – Shadows – Text – Transformations – Transitions – Animations. Bootstrap Framework

**UNIT II CLIENT SIDE PROGRAMMING**

6

Java Script: An introduction to JavaScript–JavaScript DOM Model-Exception Handling-Validation-Built-in objects-Event Handling- DHTML with JavaScript- JSON introduction – Syntax – Function Files.

**UNIT III SERVER SIDE PROGRAMMING**

5

Servlets: Java Servlet Architecture- Servlet Life Cycle- Form GET and POST actions- Session Handling- Understanding Cookies- DATABASE CONNECTIVITY: JDBC.

**UNIT IV PHP and XML****6**

An introduction to PHP: PHP- Using PHP- Variables- Program control- Built-in functions- Form Validation. XML: Basic XML- Document Type Definition- XML Schema, XML Parsers and Validation, XSL ,

**UNIT V INTRODUCTION TO ANGULAR and WEB APPLICATIONS FRAMEWORKS 6**

Introduction to AngularJS, MVC Architecture, Understanding ng attributes, Expressions and data binding, Conditional Directives, Style Directives, Controllers, Filters, Forms, Routers, Modules, Services; Web Applications Frameworks and Tools – Firebase- Docker- Node JS- React- Django- UI & UX.

**COURSE OUTCOMES:**

**CO1:** Construct a basic website using HTML and Cascading Style Sheets

**CO2:** Build dynamic web page with validation using Java Script objects and by applying different event handling mechanisms.

**CO3:** Develop server side programs using Servlets and JSP.

**CO4:** Construct simple web pages in PHP and to represent data in XML format.

**CO5:** Develop interactive web applications.

**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS****List Of Experiments:**

1. Create a web page with the following using HTML.
  - To embed an image map in a web page.
  - To fix the hot spots.
  - Show all the related information when the hot spots are clicked.
2. Create a web page with all types of Cascading style sheets.
3. Client Side Scripts for Validating Web Form Controls using DHTML.
4. Installation of Apache Tomcat web server.
5. Write programs in Java using Servlets:
  - To invoke servlets from HTML forms.
  - Session Tracking.
6. Write programs in Java to create three-tier applications using JSP and Databases
  - For conducting on-line examination.
  - For displaying student mark list. Assume that student information is available in a database which has been stored in a database server.
7. Programs using XML – Schema – XSLT/XSL.

**TOTAL:60 PERIODS****TEXTBOOKS**

1. Deitel and Deitel and Nieto, Internet and World Wide Web - How to Program, Prentice Hall, 5th Edition, 2011.
2. Jeffrey C and Jackson, Web Technologies A Computer Science Perspective, Pearson Education, 2011.
3. Angular 6 for Enterprise-Ready Web Applications, Doguhan Uluca, 1st edition, Packt Publishing

**REFERENCES:**

1. Stephen Wynkoop and John Burke "Running a Perfect Website", QUE, 2nd Edition, 1999.
2. Chris Bates, Web Programming – Building Intranet Applications, 3rd Edition, Wiley Publications, 2009.

- Gopalan N.P. and Akilandeswari J., "Web Technology", Prentice Hall of India, 2011.
- UttamK.Roy, "Web Technologies", Oxford University Press, 2011.
- Angular: Up and Running: Learning Angular, Step by Step, Shyam Seshadri, 1st edition, O'Reilly

#### CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	3	3	-	-	-	1	3	3	1	3	2	3
2	2	2	2	1	2	-	-	-	2	2	1	3	2	2	2
3	1	1	3	2	3	-	-	-	1	2	1	1	1	2	1
4	2	3	3	1	2	-	-	-	3	1	2	2	2	2	2
5	1	2	3	2	2	-	-	-	2	1	3	1	1	1	2
<b>Avg.</b>	1.8	2	2.8	1.8	2.4	-	-	-	1.8	1.8	2	1.6	1.8	1.8	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS332

APP DEVELOPMENT

L T P C  
2 0 2 3

#### COURSE OBJECTIVES:

- To learn development of native applications with basic GUI Components
- To develop cross-platform applications with event handling
- To develop applications with location and data storage capabilities
- To develop web applications with database access

#### UNIT I FUNDAMENTALS OF MOBILE & WEB APPLICATION DEVELOPMENT 6

Basics of Web and Mobile application development, Native App, Hybrid App, Cross-platform App, What is Progressive Web App, Responsive Web design,

#### UNIT II NATIVE APP DEVELOPMENT USING JAVA 6

Native Web App, Benefits of Native App, Scenarios to create Native App, Tools for creating Native App, Cons of Native App, Popular Native App Development Frameworks, Java & Kotlin for Android, Swift & Objective-C for iOS, Basics of React Native, Native Components, JSX, State, Props

#### UNIT III HYBRID APP DEVELOPMENT 6

Hybrid Web App, Benefits of Hybrid App, Criteria for creating Native App, Tools for creating Hybrid App, Cons of Hybrid App, Popular Hybrid App Development Frameworks, Ionic, Apache Cordova,

#### UNIT IV CROSS-PLATFORM APP DEVELOPMENT USING REACT-NATIVE 6

What is Cross-platform App, Benefits of Cross-platform App, Criteria for creating Cross-platform App, Tools for creating Cross-platform App, Cons of Cross-platform App, Popular Cross-platform App Development Frameworks, Flutter, Xamarin, React-Native, Basics of React Native, Native Components, JSX, State, Props

#### UNIT V NON-FUNCTIONAL CHARACTERISTICS OF APP FRAMEWORKS 6

Comparison of different App frameworks, Build Performance, App Performance, Debugging capabilities, Time to Market, Maintainability, Ease of Development, UI/UX, Reusability

**COURSE OUTCOMES:**

- CO1:**Develop Native applications with GUI Components.
- CO2:**Develop hybrid applications with basic event handling.
- CO3:** Implement cross-platform applications with location and data storage capabilities.
- CO4:** Implement cross platform applications with basic GUI and event handling.
- CO5:**Develop web applications with cloud database access.

**30 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

1. Using react native, build a cross platform application for a BMI calculator.
2. Build a cross platform application for a simple expense manager which allows entering expenses and income on each day and displays category wise weekly income and expense.
3. Develop a cross platform application to convert units from imperial system to metric system ( km to miles, kg to pounds etc.,)
4. Design and develop a cross platform application for day to day task (to-do) management.
5. Design an android application using Cordova for a user login screen with username, password, reset button and a submit button. Also, include header image and a label. Use layout managers.
6. Design and develop an android application using Apache Cordova to find and display the current location of the user.
7. Write programs using Java to create Android application having Databases
  - For a simple library application.
  - For displaying books available, books lend, book reservation. Assume that student information is available in a database which has been stored in a database server.

**TOTAL:60 PERIODS**

**TEXT BOOKS**

1. Head First Android Development, Dawn Griffiths, O’Reilly, 1<sup>st</sup> edition
2. Apache Cordova in Action, Raymond K. Camden, Manning. 2015
3. Full Stack React Native: Create beautiful mobile apps with JavaScript and React Native, Anthony Accomazzo, Houssein Djirdeh, Sophia Shoemaker, Devin Abbott, FullStack publishing

**REFERENCES**

1. Android Programming for Beginners, John Horton, Packt Publishing, 2nd Edition
2. Native Mobile Development by Shaun Lewis, Mike Dunn
3. Building Cross-Platform Mobile and Web Apps for Engineers and Scientists: An Active Learning Approach, Pawan Lingras, Matt Triff, Rucha Lingras
4. Apache Cordova 4 Programming, John M Wargo, 2015
5. React Native Cookbook, Daniel Ward, Packt Publishing, 2nd Edition

**CO’s-PO’s & PSO’s MAPPING**

CO’s	PO’s												PSO’s		
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2	2	1	3	2	2	-	-	-	3	2	2	3	3	2	1
3	2	2	2	1	2	-	-	-	1	1	1	1	1	1	2
4	1	3	1	1	3	-	-	-	1	1	3	2	1	3	1
5	1	1	3	1	3	-	-	-	1	1	2	1	3	2	1
<b>AVg.</b>	1.6	1.8	2	1.4	2.6	-	-	-	1.4	1.2	2	1.6	2	2.2	1.6

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES:**

- Introduce Cloud Service Management terminology, definition & concepts
- Compare and contrast cloud service management with traditional IT service management
- Identify strategies to reduce risk and eliminate issues associated with adoption of cloud services
- Select appropriate structures for designing, deploying and running cloud-based services in a business environment
- Illustrate the benefits and drive the adoption of cloud-based services to solve real world problems

**UNIT I CLOUD SERVICE MANAGEMENT FUNDAMENTALS 6**

Cloud Ecosystem, The Essential Characteristics, Basics of Information Technology Service Management and Cloud Service Management, Service Perspectives, Cloud Service Models, Cloud Service Deployment Models

**UNIT II CLOUD SERVICES STRATEGY 6**

Cloud Strategy Fundamentals, Cloud Strategy Management Framework, Cloud Policy, Key Driver for Adoption, Risk Management, IT Capacity and Utilization, Demand and Capacity matching, Demand Queueing, Change Management, Cloud Service Architecture

**UNIT III CLOUD SERVICE MANAGEMENT 6**

Cloud Service Reference Model, Cloud Service LifeCycle, Basics of Cloud Service Design, Dealing with Legacy Systems and Services, Benchmarking of Cloud Services, Cloud Service Capacity Planning, Cloud Service Deployment and Migration, Cloud Marketplace, Cloud Service Operations Management

**UNIT IV CLOUD SERVICE ECONOMICS 6**

Pricing models for Cloud Services, Freemium, Pay Per Reservation, Pay per User, Subscription based Charging, Procurement of Cloud-based Services, Capex vs Opex Shift, Cloud service Charging, Cloud Cost Models

**UNIT V CLOUD SERVICE GOVERNANCE & VALUE 6**

IT Governance Definition, Cloud Governance Definition, Cloud Governance Framework, Cloud Governance Structure, Cloud Governance Considerations, Cloud Service Model Risk Matrix, Understanding Value of Cloud Services, Measuring the value of Cloud Services, Balanced Scorecard, Total Cost of Ownership

**COURSE OUTCOMES:**

**CO1:**Exhibit cloud-design skills to build and automate business solutions using cloud technologies.

**CO2:** Possess Strong theoretical foundation leading to excellence and excitement towards adoption of cloud-based services

**CO3:** Solve the real world problems using Cloud services and technologies

**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS**

1. Create a Cloud Organization in AWS/Google Cloud/or any equivalent Open Source cloud softwares like Openstack, Eucalyptus, OpenNebula with Role-based access control



2. Create a Cost-model for a web application using various services and do Cost-benefit analysis
3. Create alerts for usage of Cloud resources
4. Create Billing alerts for your Cloud Organization
5. Compare Cloud cost for a simple web application across AWS, Azure and GCP and suggest the best one

**TOTAL:60 PERIODS**

### TEXT BOOKS

1. Cloud Service Management and Governance: Smart Service Management in Cloud Era by Enamul Haque, Enel Publications
2. Cloud Computing: Concepts, Technology & Architecture by Thomas Erl, Ricardo Puttini, Zaigham Mohammad 2013
3. Cloud Computing Design Patterns by Thomas Erl, Robert Cope, Amin Naserpour

### REFERENCES

1. Economics of Cloud Computing by Praveen Ayyappa, LAP Lambert Academic Publishing
2. Mastering Cloud Computing Foundations and Applications Programming Rajkumar Buyya, Christian Vechhiola, S. Thamarai Selvi

### CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	1	1	1	-	-	-	2	1	3	2	2	1	3
2	3	1	2	3	2	-	-	-	1	2	3	1	2	2	2
3	1	1	3	1	3	-	-	-	3	3	1	1	3	2	1
4	1	1	1	2	3	-	-	-	2	3	3	1	1	1	1
5	1	3	3	2	2	-	-	-	1	3	1	2	1	3	2
AVg.	1.8	1.8	2	1.8	2.2	-	-	-	1.8	2.4	2.2	1.4	1.8	1.8	1.8

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CCS370**

**UI AND UX DESIGN**

**L T P C**  
**2 0 2 3**

### COURSE OBJECTIVES:

- To provide a sound knowledge in UI & UX
- To understand the need for UI and UX
- To understand the various Research Methods used in Design
- To explore the various Tools used in UI & UX
- Creating a wireframe and prototype

### UNIT I FOUNDATIONS OF DESIGN

**6**

UI vs. UX Design - Core Stages of Design Thinking - Divergent and Convergent Thinking - Brainstorming and Game storming - Observational Empathy

### UNIT II FOUNDATIONS OF UI DESIGN

**6**

Visual and UI Principles - UI Elements and Patterns - Interaction Behaviors and Principles – Branding - Style Guides

**UNIT III FOUNDATIONS OF UX DESIGN 6**

Introduction to User Experience - Why You Should Care about User Experience - Understanding User Experience - Defining the UX Design Process and its Methodology - Research in User Experience Design - Tools and Method used for Research - User Needs and its Goals - Know about Business Goals

**UNIT IV WIREFRAMING, PROTOTYPING AND TESTING 6**

Sketching Principles - Sketching Red Routes - Responsive Design – Wireframing - Creating Wireflows - Building a Prototype - Building High-Fidelity Mockups - Designing Efficiently with Tools - Interaction Patterns - Conducting Usability Tests - Other Evaluative User Research Methods - Synthesizing Test Findings - Prototype Iteration

**UNIT V RESEARCH, DESIGNING, IDEATING, & INFORMATION ARCHITECTURE 6**

Identifying and Writing Problem Statements - Identifying Appropriate Research Methods - Creating Personas - Solution Ideation - Creating User Stories - Creating Scenarios - Flow Diagrams - Flow Mapping - Information Architecture

**30 PERIODS**

**LIST OF EXPERIMENTS**

**30 PERIODS**

1. Designing a Responsive layout for an societal application
2. Exploring various UI Interaction Patterns
3. Developing an interface with proper UI Style Guides
4. Developing Wireflow diagram for application using open source software
5. Exploring various open source collaborative interface Platform
6. Hands on Design Thinking Process for a new product
7. Brainstorming feature for proposed product
8. Defining the Look and Feel of the new Project
9. Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles)
10. Identify a customer problem to solve
11. Conduct end-to-end user research - User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping
12. Sketch, design with popular tool and build a prototype and perform usability testing and identify improvements

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the students will be able to:

**CO1:**Build UI for user Applications

**CO2:**Evaluate UX design of any product or application

**CO3:**Demonstrate UX Skills in product development

**CO4:**Implement Sketching principles

**CO5:**Create Wireframe and Prototype

**TEXT BOOKS**

1. Joel Marsh, "UX for Beginners", O'Reilly , 2022
2. Jon Yablonski, "Laws of UX using Psychology to Design Better Product & Services" O'Reilly 2021

**REFERENCES**

1. Jenifer Tidwell, Charles Brewer, Aynne Valencia, “Designing Interface” 3 rd Edition , O’Reilly 2020
2. Steve Schoger, Adam Wathan “Refactoring UI”, 2018
3. Steve Krug, “Don't Make Me Think, Revisited: A Commonsense Approach to Web & Mobile”, Third Edition, 2015
4. <https://www.nngroup.com/articles/>
5. <https://www.interaction-design.org/literature>.

**CO’s-PO’s & PSO’s MAPPING**

CO’s	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
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2	2	3	1	3	2	-	-	-	1	2	2	2	1	2	2
3	1	3	3	2	2	-	-	-	2	3	1	2	1	3	3
4	1	2	3	3	1	-	-	-	3	2	1	3	3	3	3
5	1	2	3	2	1	-	-	-	2	1	1	1	3	2	2
<b>AVg.</b>	1.6	2.2	2.2	2.6	1.4	-	-	-	2.2	2.2	1.4	1.8	2.2	2.6	2.2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CCS366**

**SOFTWARE TESTING AND AUTOMATION**

**L T P C  
2 0 2 3**

**COURSE OBJECTIVES:**

- To understand the basics of software testing
- To learn how to do the testing and planning effectively
- To build test cases and execute them
- To focus on wide aspects of testing and understanding multiple facets of testing
- To get an insight about test automation and the tools used for test automation

**UNIT I**

**FOUNDATIONS OF SOFTWARE TESTING**

**6**

Why do we test Software?, Black-Box Testing and White-Box Testing, Software Testing Life Cycle, V-model of Software Testing, Program Correctness and Verification, Reliability versus Safety, Failures, Errors and Faults (Defects), Software Testing Principles, Program Inspections, Stages of Testing: Unit Testing, Integration Testing, System Testing

**UNIT II**

**TEST PLANNING**

**6**

The Goal of Test Planning, High Level Expectations, Intergroup Responsibilities, Test Phases, Test Strategy, Resource Requirements, Tester Assignments, Test Schedule, Test Cases, Bug Reporting, Metrics and Statistics.

**UNIT III**

**TEST DESIGN AND EXECUTION**

**6**

Test Objective Identification, Test Design Factors, Requirement identification, Testable Requirements, Modeling a Test Design Process, Modeling Test Results, Boundary Value Testing, Equivalence Class Testing, Path Testing, Data Flow Testing, Test Design Preparedness Metrics, Test Case Design Effectiveness, Model-Driven Test Design, Test Procedures, Test Case Organization and Tracking, Bug Reporting, Bug Life Cycle.

**UNIT IV ADVANCED TESTING CONCEPTS 6**

Performance Testing: Load Testing, Stress Testing, Volume Testing, Fail-Over Testing, Recovery Testing, Configuration Testing, Compatibility Testing, Usability Testing, Testing the Documentation, Security testing, Testing in the Agile Environment, Testing Web and Mobile Applications.

**UNIT V TEST AUTOMATION AND TOOLS 6**

Automated Software Testing, Automate Testing of Web Applications, Selenium: Introducing Web Driver and Web Elements, Locating Web Elements, Actions on Web Elements, Different Web Drivers, Understanding Web Driver Events, Testing: Understanding Testing.xml, Adding Classes, Packages, Methods to Test, Test Reports.

**30 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

1. Develop the test plan for testing an e-commerce web/mobile application (www.amazon.in).
2. Design the test cases for testing the e-commerce application
3. Test the e-commerce application and report the defects in it.
4. Develop the test plan and design the test cases for an inventory control system.
5. Execute the test cases against a client server or desktop application and identify the defects.
6. Test the performance of the e-commerce application.
7. Automate the testing of e-commerce applications using Selenium.
8. Integrate TestNG with the above test automation.
9. Mini Project:
  - a) Build a data-driven framework using Selenium and TestNG
  - b) Build Page object Model using Selenium and TestNG
  - c) Build BDD framework with Selenium, TestNG and Cucumber

**COURSE OUTCOMES:**

**CO1:** Understand the basic concepts of software testing and the need for software testing

**CO2:** Design Test planning and different activities involved in test planning

**CO3:** Design effective test cases that can uncover critical defects in the application

**CO4:** Carry out advanced types of testing

**CO5:-** Automate the software testing using Selenium and TestNG

**TOTAL:60 PERIODS**

**TEXTBOOKS**

1. Yogesh Singh, "Software Testing", Cambridge University Press, 2012
2. Unmesh Gundecha, Satya Avasarala, "Selenium WebDriver 3 Practical Guide" - Second Edition 2018

**REFERENCES**

1. Glenford J. Myers, Corey Sandler, Tom Badgett, The Art of Software Testing, 3<sup>rd</sup> Edition, 2012, John Wiley & Sons, Inc.
2. Ron Patton, Software testing, 2<sup>nd</sup> Edition, 2006, Sams Publishing
3. Paul C. Jorgensen, Software Testing: A Craftsman's Approach, Fourth Edition, 2014, Taylor & Francis Group.
4. Carl Cocchiario, Selenium Framework Design in Data-Driven Testing, 2018, Packt Publishing.
5. Elfriede Dustin, Thom Garrett, Bernie Gaurf, Implementing Automated Software Testing, 2009, Pearson Education, Inc.
6. Satya Avasarala, Selenium WebDriver Practical Guide, 2014, Packt Publishing.
7. Varun Menon, TestNg Beginner's Guide, 2013, Packt Publishing.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
<b>1</b>	3	3	2	1	2	-	-	-	1	1	3	2	3	2	3
<b>2</b>	2	3	1	1	1	-	-	-	2	2	1	2	1	2	3
<b>3</b>	2	2	1	3	1	-	-	-	1	3	1	2	2	3	2
<b>4</b>	2	1	3	2	1	-	-	-	1	1	1	2	3	1	2
<b>5</b>	2	2	1	3	1	-	-	-	1	3	2	1	2	1	3
<b>AVg.</b>	2.2	2.2	1.6	2	1.2	-	-	-	1.2	2	1.6	1.8	2.2	1.8	2.6

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CCS374**

**WEB APPLICATION SECURITY**

**L T P C**  
**2 0 2 3**

**COURSE OBJECTIVES:**

- To understand the fundamentals of web application security
- To focus on wide aspects of secure development and deployment of web applications
- To learn how to build secure APIs
- To learn the basics of vulnerability assessment and penetration testing
- To get an insight about Hacking techniques and Tools

**UNIT I FUNDAMENTALS OF WEB APPLICATION SECURITY 6**

The history of Software Security-Recognizing Web Application Security Threats, Web Application Security, Authentication and Authorization, Secure Socket layer, Transport layer Security, Session Management-Input Validation

**UNIT II SECURE DEVELOPMENT AND DEPLOYMENT 5**

Web Applications Security - Security Testing, Security Incident Response Planning, The Microsoft Security Development Lifecycle (SDL), OWASP Comprehensive Lightweight Application Security Process (CLASP), The Software Assurance Maturity Model (SAMM)

**UNIT III SECURE API DEVELOPMENT 6**

API Security- Session Cookies, Token Based Authentication, Securing Natter APIs: Addressing threats with Security Controls, Rate Limiting for Availability, Encryption, Audit logging, Securing service-to-service APIs: API Keys, OAuth2, Securing Microservice APIs: Service Mesh, Locking Down Network Connections, Securing Incoming Requests.

**UNIT IV VULNERABILITY ASSESSMENT AND PENETRATION TESTING 6**

Vulnerability Assessment Lifecycle, Vulnerability Assessment Tools: Cloud-based vulnerability scanners, Host-based vulnerability scanners, Network-based vulnerability scanners, Database-based vulnerability scanners, Types of Penetration Tests: External Testing, Web Application Testing, Internal Penetration Testing, SSID or Wireless Testing, Mobile Application Testing.

**UNIT V HACKING TECHNIQUES AND TOOLS 7**

Social Engineering, Injection, Cross-Site Scripting(XSS), Broken Authentication and Session Management, Cross-Site Request Forgery, Security Misconfiguration, Insecure Cryptographic

Storage, Failure to Restrict URL Access, Tools: Comodo, OpenVAS, Nexpose, Nikto, Burp Suite, etc.

**30 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

1. Install Wireshark and explore the various protocols
  - a. Analyze the difference between HTTP vs HTTPS
  - b. Analyze the various security mechanisms embedded with different protocols.
2. Identify the vulnerabilities using OWASP ZAP tool
3. Create simple REST API using Python for following operations
  - . GET
  - a. PUSH
  - b. POST
  - c. DELETE
4. Install Burp Suite to do following vulnerabilities:
  - . SQL injection
  - a. cross-site scripting (XSS)
5. Attack the website using Social Engineering method

**COURSE OUTCOMES:**

**CO1:** Understanding the basic concepts of web application security and the need for it

**CO2:** Be acquainted with the process for secure development and deployment of web applications

**CO3:** Acquire the skill to design and develop Secure Web Applications that use Secure APIs

**CO4:** Be able to get the importance of carrying out vulnerability assessment and penetration testing

**CO5:** Acquire the skill to think like a hacker and to use hackers tool sets

**TOTAL :60 PERIODS**

**TEXT BOOKS**

1. Andrew Hoffman, Web Application Security: Exploitation and Countermeasures for Modern Web Applications, First Edition, 2020, O'Reilly Media, Inc.
2. Bryan Sullivan, Vincent Liu, Web Application Security: A Beginner's Guide, 2012, The McGraw-Hill Companies.
3. Neil Madden, API Security in Action, 2020, Manning Publications Co., NY, USA.

**REFERENCES**

1. Michael Cross, Developer's Guide to Web Application Security, 2007, Syngress Publishing, Inc.
2. Ravi Das and Greg Johnson, Testing and Securing Web Applications, 2021, Taylor & Francis Group, LLC.
3. Prabath Siriwardena, Advanced API Security, 2020, Apress Media LLC, USA.
4. Malcom McDonald, Web Security for Developers, 2020, No Starch Press, Inc.
5. Allen Harper, Shon Harris, Jonathan Ness, Chris Eagle, Gideon Lenkey, and Terron Williams Grey Hat Hacking: The Ethical Hacker's Handbook, Third Edition, 2011, The McGraw-Hill Companies.

## CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	2	2	1	3	-	-	-	-	-	-	1	-	-	-
2	2	1	2	1	3	-	-	-	-	-	-	-	-	-	-
3	1	1	1	2	3	-	-	-	-	-	-	1	-	-	-
4	1	2	1	1	2	-	-	-	-	-	-	-	-	-	-
5	1	2	2	2	2	-	-	-	-	-	-	1	-	-	-
AVg.	1.2	1.6	1.6	1.4	2.6	-	-	-	-	-	-	0.6	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS342

DEVOPS

L T P C

2 0 2 3

### COURSE OBJECTIVES:

- To introduce DevOps terminology, definition & concepts
- To understand the different Version control tools like Git, Mercurial
- To understand the concepts of Continuous Integration/ Continuous Testing/ Continuous Deployment)
- To understand Configuration management using Ansible
- Illustrate the benefits and drive the adoption of cloud-based Devops tools to solve real world problems

#### UNIT I INTRODUCTION TO DEVOPS 6

Devops Essentials - Introduction To AWS, GCP, Azure - Version control systems: Git and Github.

#### UNIT II COMPILE AND BUILD USING MAVEN & GRADLE 6

Introduction, Installation of Maven, POM files, Maven Build lifecycle, Build phases(compile build, test, package) Maven Profiles, Maven repositories(local, central, global),Maven plugins, Maven create and build Artifacts, Dependency management, Installation of Gradle, Understand build using Gradle

#### UNIT III CONTINUOUS INTEGRATION USING JENKINS 6

Install & Configure Jenkins, Jenkins Architecture Overview, Creating a Jenkins Job, Configuring a Jenkins job, Introduction to Plugins, Adding Plugins to Jenkins, Commonly used plugins (Git Plugin, Parameter Plugin, HTML Publisher, Copy Artifact and Extended choice parameters). Configuring Jenkins to work with java, Git and Maven, Creating a Jenkins Build and Jenkins workspace.

#### UNIT IV CONFIGURATION MANAGEMENT USING ANSIBLE 6

Ansible Introduction, Installation, Ansible master/slave configuration, YAML basics, Ansible modules, Ansible Inventory files, Ansible playbooks, Ansible Roles, adhoc commands in ansible

#### UNIT V BUILDING DEVOPS PIPELINES USING AZURE 6

Create Github Account, Create Repository, Create Azure Organization, Create a new pipeline, Build a sample code, Modify azure-pipelines.yaml file

### COURSE OUTCOMES:

CO1: Understand different actions performed through Version control tools like Git.

**CO2:** Perform Continuous Integration and Continuous Testing and Continuous Deployment using Jenkins by building and automating test cases using Maven & Gradle.

**CO3:** Ability to Perform Automated Continuous Deployment

**CO4:** Ability to do configuration management using Ansible

**CO5:** Understand to leverage Cloud-based DevOps tools using Azure DevOps

**30 PERIODS**

**30 PERIODS**

**PRACTICAL EXERCISES:**

1. Create Maven Build pipeline in Azure
2. Run regression tests using Maven Build pipeline in Azure
3. Install Jenkins in Cloud
4. Create CI pipeline using Jenkins
5. Create a CD pipeline in Jenkins and deploy in Cloud
6. Create an Ansible playbook for a simple web application infrastructure
7. Build a simple application using Gradle
8. Install Ansible and configure ansible roles and to write playbooks

**TOTAL:60 PERIODS**

**TEXT BOOKS**

1. Roberto Vormittag, “A Practical Guide to Git and GitHub for Windows Users: From Beginner to Expert in Easy Step-By-Step Exercises”, Second Edition, Kindle Edition, 2016.
2. Jason Cannon, “Linux for Beginners: An Introduction to the Linux Operating System and Command Line”, Kindle Edition, 2014

**REFERENCES**

1. Hands-On Azure Devops: Cidc Implementation For Mobile, Hybrid, And Web Applications Using Azure Devops And Microsoft Azure: CICD Implementation for ... DevOps and Microsoft Azure (English Edition) Paperback – 1 January 2020
2. by Mitesh Soni
3. Jeff Geerling, “Ansible for DevOps: Server and configuration management for humans”, First Edition, 2015.
4. David Johnson, “Ansible for DevOps: Everything You Need to Know to Use Ansible for DevOps”, Second Edition, 2016.
5. Mariot Tsitoara, “Ansible 6. Beginning Git and GitHub: A Comprehensive Guide to Version Control, Project Management, and Teamwork for the New Developer”, Second Edition, 2019.
6. <https://www.jenkins.io/user-handbook.pdf>
7. <https://maven.apache.org/guides/getting-started/>

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	3	-	-	-	-	-	-	-	2	2	2
2	3	3	3	2	3	-	-	-	-	-	-	-	2	2	2
3	3	3	3	2	3	-	-	-	-	-	-	-	2	2	2
4	3	3	3	2	3	-	-	-	-	-	-	-	2	2	2
5	3	3	3	2	3	-	-	-	-	-	-	-	2	2	2
<b>AVg.</b>	3	3	3	2	3	-	-	-	-	-	-	-	2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation



**COURSE OBJECTIVES:**

- To understand and describe syntax and semantics of programming languages
- To understand data, data types, and basic statements
- To understand call-return architecture and ways of implementing them
- To understand object-orientation, concurrency, and event handling in programming languages
- To develop programs in non-procedural programming paradigms

**UNIT I SYNTAX AND SEMANTICS****9**

Evolution of programming languages – describing syntax – context-free grammars – attribute grammars – describing semantics – lexical analysis – parsing – recursive-descent – bottom up parsing

**UNIT II DATA, DATA TYPES, AND BASIC STATEMENTS****9**

Names – variables – binding – type checking – scope – scope rules – lifetime and garbage collection – primitive data types – strings – array types – associative arrays – record types – union types – pointers and references – Arithmetic expressions – overloaded operators – type conversions – relational and boolean expressions – assignment statements – mixed mode assignments – control structures – selection – iterations – branching – guarded statements

**UNIT III SUBPROGRAMS AND IMPLEMENTATIONS****9**

Subprograms – design issues – local referencing – parameter passing – overloaded methods – generic methods – design issues for functions – semantics of call and return – implementing simple subprograms – stack and dynamic local variables – nested subprograms – blocks – dynamic scoping

**UNIT IV OBJECT-ORIENTATION, CONCURRENCY, AND EVENT HANDLING****9**

Object-orientation – design issues for OOP languages – implementation of object-oriented constructs – concurrency – semaphores – monitors – message passing – threads – statement level concurrency – exception handling – event handling

**UNIT V FUNCTIONAL AND LOGIC PROGRAMMING LANGUAGES****9**

Introduction to lambda calculus – fundamentals of functional programming languages – Programming with Scheme – Programming with ML – Introduction to logic and logic programming – Programming with Prolog – multi-paradigm languages

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

- CO1:** Describe syntax and semantics of programming languages  
**CO2:** Explain data, data types, and basic statements of programming languages  
**CO3:** Design and implement subprogram constructs  
**CO4:** Apply object-oriented, concurrency, and event handling programming constructs and Develop programs in Scheme, ML, and Prolog  
**CO5:** Understand and adopt new programming languages

**TEXT BOOKS**

1. Robert W. Sebesta, "Concepts of Programming Languages", Twelfth Edition (Global Edition), Pearson, 2022.
2. Michael L. Scott, "Programming Language Pragmatics", Fourth Edition, Elsevier, 2018.

3. R. Kent Dybvig, "The Scheme programming language", Fourth Edition, Prentice Hall, 2011.
4. Jeffrey D. Ullman, "Elements of ML programming", Second Edition, Pearson, 1997.
5. W. F. Clocksin and C. S. Mellish, "Programming in Prolog: Using the ISO Standard", Fifth Edition, Springer, 2003.

### CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	3	2	1	-	-	-	-	-	-	3	2	3	-
2	3	3	3	2	2	-	-	-	-	-	-	3	2	3	-
3	3	3	3	2	2	-	-	-	-	-	-	3	2	3	-
4	3	3	3	3	2	2	-	-	-	-	-	-	3	2	-
5	3	3	3	3	3	3	2	2	1	3	1	3	3	3	-
AVg.	2.8	2.8	3	2.4	2	2.5	2	2	1	3	1	3	2.4	2.8	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS335

CLOUD COMPUTING

L T P C  
2 0 2 3

#### COURSE OBJECTIVES:

- To understand the principles of cloud architecture, models and infrastructure.
- To understand the concepts of virtualization and virtual machines.
- To gain knowledge about virtualization Infrastructure.
- To explore and experiment with various Cloud deployment environments.
- To learn about the security issues in the cloud environment.

#### UNIT I CLOUD ARCHITECTURE MODELS AND INFRASTRUCTURE 6

Cloud Architecture: System Models for Distributed and Cloud Computing – NIST Cloud Computing Reference Architecture – Cloud deployment models – Cloud service models; Cloud Infrastructure: Architectural Design of Compute and Storage Clouds – Design Challenges

#### UNIT II VIRTUALIZATION BASICS 6

Virtual Machine Basics – Taxonomy of Virtual Machines – Hypervisor – Key Concepts – Virtualization structure – Implementation levels of virtualization – Virtualization Types: Full Virtualization – Para Virtualization – Hardware Virtualization – Virtualization of CPU, Memory and I/O devices.

#### UNIT III VIRTUALIZATION INFRASTRUCTURE AND DOCKER 7

Desktop Virtualization – Network Virtualization – Storage Virtualization – System-level of Operating Virtualization – Application Virtualization – Virtual clusters and Resource Management – Containers vs. Virtual Machines – Introduction to Docker – Docker Components – Docker Container – Docker Images and Repositories.

#### UNIT IV CLOUD DEPLOYMENT ENVIRONMENT 6

Google App Engine – Amazon AWS – Microsoft Azure; Cloud Software Environments – Eucalyptus – OpenStack.

**UNIT V CLOUD SECURITY****5**

Virtualization System-Specific Attacks: Guest hopping – VM migration attack – hyperjacking. Data Security and Storage; Identity and Access Management (IAM) - IAM Challenges - IAM Architecture and Practice.

**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS**

1. Install Virtualbox/VMware/ Equivalent open source cloud Workstation with different flavours of Linux or Windows OS on top of windows 8 and above.
2. Install a C compiler in the virtual machine created using a virtual box and execute Simple Programs
3. Install Google App Engine. Create a hello world app and other simple web applications using python/java.
4. Use the GAE launcher to launch the web applications.
5. Simulate a cloud scenario using CloudSim and run a scheduling algorithm that is not present in CloudSim.
6. Find a procedure to transfer the files from one virtual machine to another virtual machine.
7. Install Hadoop single node cluster and run simple applications like wordcount.
8. Creating and Executing Your First Container Using Docker.
9. Run a Container from Docker Hub

**COURSE OUTCOMES:****CO1:** Understand the design challenges in the cloud.**CO2:** Apply the concept of virtualization and its types.**CO3:** Experiment with virtualization of hardware resources and Docker.**CO4:** Develop and deploy services on the cloud and set up a cloud environment.**CO5:** Explain security challenges in the cloud environment.**TOTAL:60 PERIODS****TEXT BOOKS**

1. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
2. James Turnbull, "The Docker Book", O'Reilly Publishers, 2014.
3. Krutz, R. L., Vines, R. D, "Cloud security. A Comprehensive Guide to Secure Cloud Computing", Wiley Publishing, 2010.

**REFERENCES**

1. James E. Smith, Ravi Nair, "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
2. Tim Mather, Subra Kumaraswamy, and Shahed Latif, "Cloud Security and Privacy: an enterprise perspective on risks and compliance", O'Reilly Media, Inc., 2009.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	1	-	-	-	2	3	1	3	2	1	3
2	3	1	2	2	1	-	-	-	1	2	1	3	2	2	1
3	2	3	2	3	1	-	-	-	3	1	1	3	1	1	1
4	1	2	3	3	3	-	-	-	3	3	1	2	1	3	3
5	2	3	3	1	3	-	-	-	2	2	1	2	2	2	3
<b>AVg.</b>	2.2	2.2	2.2	2	1.8	-	-	-	2.2	2.2	1	2.6	1.6	1.8	2.2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES:**

- To Learn the basics and types of Virtualization
- To understand the Hypervisors and its types
- To Explore the Virtualization Solutions
- To Experiment the virtualization platforms

**UNIT I INTRODUCTION TO VIRTUALIZATION 7**

Virtualization and cloud computing - Need of virtualization – cost, administration, fast deployment, reduce infrastructure cost – limitations- Types of hardware virtualization: Full virtualization - partial virtualization - Paravirtualization-Types of Hypervisors

**UNIT II SERVER AND DESKTOP VIRTUALIZATION 6**

Virtual machine basics- Types of virtual machines- Understanding Server Virtualization- types of server virtualization- Business Cases for Server Virtualization – Uses of Virtual Server Consolidation – Selecting Server Virtualization Platform-Desktop Virtualization-Types of Desktop Virtualization

**UNIT III NETWORK VIRTUALIZATION 6**

Introduction to Network Virtualization-Advantages- Functions-Tools for Network Virtualization-VLAN-WAN Architecture-WAN Virtualization

**UNIT IV STORAGE VIRTUALIZATION 5**

Memory Virtualization-Types of Storage Virtualization-Block, File-Address space Remapping-Risks of Storage Virtualization-SAN-NAS-RAID

**UNIT V VIRTUALIZATION TOOLS 6**

VMWare-Amazon AWS-Microsoft HyperV- Oracle VM Virtual Box - IBM PowerVM- Google Virtualization- Case study.

**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS**

1.Create type 2 virtualization in VMWARE or any equivalent Open Source Tool. Allocate memory and storage space as per requirement. Install Guest OS on that VMWARE.

2.

- a.Shrink and extend virtual disk
- b. Create, Manage, Configure and schedule snapshots
- c. Create Spanned, Mirrored and Striped volume
- d. Create RAID 5 volume

3.

- a.Desktop Virtualization using VNC
- b.Desktop Virtualization using Chrome Remote Desktop

4.Create type 2 virtualization on ESXI 6.5 server

5.Create a VLAN in CISCO packet tracer

6.Install KVM in Linux

7.Create Nested Virtual Machine(VM under another VM)

**COURSE OUTCOMES:**

- CO1:** Analyse the virtualization concepts and Hypervisor
- CO2:** Apply the Virtualization for real-world applications
- CO3:** Install & Configure the different VM platforms
- CO4:** Experiment with the VM with various software

**TOTAL:60 PERIODS**

**TEXT BOOKS**

1. Cloud computing a practical approach - Anthony T.Velte , Toby J. Velte Robert Elsenpeter, TATA McGraw- Hill , New Delhi – 2010
2. Cloud Computing (Principles and Paradigms), Edited by Rajkumar Buyya, James Broberg, Andrzej Goscinski, John Wiley & Sons, Inc. 2011
3. David Marshall, Wade A. Reynolds, Advanced Server Virtualization: VMware and Microsoft Platform in the Virtual Data Center, Auerbach
4. Chris Wolf, Erick M. Halter, “Virtualization: From the Desktop to the Enterprise”, APress, 2005.
5. James E. Smith, Ravi Nair, “Virtual Machines: Versatile Platforms for Systems and Processes”, Elsevier/Morgan Kaufmann, 2005.
6. David Marshall, Wade A. Reynolds, “Advanced Server Virtualization: VMware and Microsoft Platform in the Virtual Data Center”, Auerbach Publications, 2006.

**CO’s-PO’s & PSO’s MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	3	1	3	2	-	-	-	1	1	3	1	2	3	2
2	3	2	2	1	2	-	-	-	1	2	2	3	3	2	1
3	3	2	1	3	1	-	-	-	2	2	1	3	3	3	2
4	1	1	2	3	3	-	-	-	3	3	1	1	3	2	2
5	1	3	2	3	1	-	-	-	2	1	3	3	1	1	2
<b>AVg.</b>	1.8	2.2	1.6	2.6	1.8	-	-	-	1.8	1.8	2	2.2	2.4	2.2	1.8

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CCS341**

**DATA WAREHOUSING**

**L T P C**  
**2 0 2 3**

**COURSE OBJECTIVES:**

- To know the details of data warehouse Architecture
- To understand the OLAP Technology
- To understand the partitioning strategy
- To differentiate various schema
- To understand the roles of process manager & system manager

**UNIT I INTRODUCTION TO DATA WAREHOUSE**

**5**

Data warehouse Introduction - Data warehouse components- operational database Vs data warehouse – Data warehouse Architecture – Three-tier Data Warehouse Architecture - Autonomous Data Warehouse- Autonomous Data Warehouse Vs Snowflake - Modern Data Warehouse

**UNIT II ETL AND OLAP TECHNOLOGY 6**

What is ETL – ETL Vs ELT – Types of Data warehouses - Data warehouse Design and Modeling - Delivery Process - Online Analytical Processing (OLAP) - Characteristics of OLAP - Online Transaction Processing (OLTP) Vs OLAP - OLAP operations- Types of OLAP- ROLAP Vs MOLAP Vs HOLAP.

**UNIT III META DATA, DATA MART AND PARTITION STRATEGY 7**

Meta Data – Categories of Metadata – Role of Metadata – Metadata Repository – Challenges for Meta Management - Data Mart – Need of Data Mart- Cost Effective Data Mart- Designing Data Marts- Cost of Data Marts- Partitioning Strategy – Vertical partition – Normalization – Row Splitting – Horizontal Partition

**UNIT IV DIMENSIONAL MODELING AND SCHEMA 6**

Dimensional Modeling- Multi-Dimensional Data Modeling – Data Cube- Star Schema- Snowflake schema- Star Vs Snowflake schema- Fact constellation Schema- Schema Definition - Process Architecture- Types of Data Base Parallelism – Datawarehouse Tools

**UNIT V SYSTEM & PROCESS MANAGERS 6**

Data Warehousing System Managers: System Configuration Manager- System Scheduling Manager - System Event Manager - System Database Manager - System Backup Recovery Manager - Data Warehousing Process Managers: Load Manager – Warehouse Manager- Query Manager – Tuning – Testing

**30 PERIODS  
30 PERIODS**

**PRACTICAL EXERCISES:**

1. Data exploration and integration with WEKA
2. Apply weka tool for data validation
3. Plan the architecture for real time application
4. Write the query for schema definition
5. Design data ware house for real time applications
6. Analyse the dimensional Modeling
7. Case study using OLAP
8. Case study using OTLP
9. Implementation of warehouse testing.

**COURSE OUTCOMES:**

**At the end of the course the students should be able to**

**CO1:** Design data warehouse architecture for various Problems

**CO2:** Apply the OLAP Technology

**CO3:** Analyse the partitioning strategy

**CO4:** Critically analyze the differentiation of various schema for given problem

**CO5:** Frame roles of process manager & system manager

**TOTAL: 60 PERIODS**

**TEXT BOOKS**

1. Alex Berson and Stephen J. Smith “Data Warehousing, Data Mining & OLAP”, Tata McGraw – Hill Edition, Thirteenth Reprint 2008.
2. Ralph Kimball, “The Data Warehouse Toolkit: The Complete Guide to Dimensional Modeling”, Third edition, 2013.

**REFERENCES**

1. Paul Raj Ponniah, "Data warehousing fundamentals for IT Professionals", 2012.
2. K.P. Soman, ShyamDiwakar and V. Ajay "Insight into Data mining Theory and Practice", Easter Economy Edition, Prentice Hall of India, 2006.

**CO's-PO's & PSO's MAPPING**

CO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
1	3	3	3	2	2	-	-	-	3	-	-	3
2	3	2	2	2	3	-	-	-	2	-	2	2
3	3	3	3	3	-	-	-	-	-	-	-	3
4	3	3	3	3	-	-	-	-	-	-	-	3
5	3	2	2	2	-	2	-	-	-	-	2	2
<b>AVg.</b>	3	2.6	2.6	1.2	2.5	1	-	-	2.5	-	2	2.6

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CCS367**

**STORAGE TECHNOLOGIES**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- Characterize the functionalities of logical and physical components of storage
- Describe various storage networking technologies
- Identify different storage virtualization technologies
- Discuss the different backup and recovery strategies
- Understand common storage management activities and solutions

**UNIT I STORAGE SYSTEMS 9**

Introduction to Information Storage: Digital data and its types, Information storage, Key characteristics of data center and Evolution of computing platforms. Information Lifecycle Management. Third Platform Technologies: Cloud computing and its essential characteristics, Cloud services and cloud deployment models, Big data analytics, Social networking and mobile computing, Characteristics of third platform infrastructure and Imperatives for third platform transformation. Data Center Environment: Building blocks of a data center, Compute systems and compute virtualization and Software-defined data center.

**UNIT II INTELLIGENT STORAGE SYSTEMS AND RAID 5**

Components of an intelligent storage system, Components, addressing, and performance of hard disk drives and solid-state drives, RAID, Types of intelligent storage systems, Scale-up and scale-out storage Architecture.

**UNIT III STORAGE NETWORKING TECHNOLOGIES AND VIRTUALIZATION 13**

Block-Based Storage System, File-Based Storage System, Object-Based and Unified Storage. Fibre Channel SAN: Software-defined networking, FC SAN components and architecture, FC SAN topologies, link aggregation, and zoning, Virtualization in FC SAN environment. Internet Protocol SAN: iSCSI protocol, network components, and connectivity, Link aggregation, switch aggregation, and VLAN, FCIP protocol,

connectivity, and configuration. Fibre Channel over Ethernet SAN: Components of FCoE SAN, FCoE SAN connectivity, Converged Enhanced Ethernet, FCoE architecture.

**UNIT IV BACKUP, ARCHIVE AND REPLICATION 12**

Introduction to Business Continuity, Backup architecture, Backup targets and methods, Data deduplication, Cloud-based and mobile device backup, Data archive, Uses of replication and its characteristics, Compute based, storage-based, and network-based replication, Data migration, Disaster Recovery as a Service (DRaaS).

**UNIT V SECURING STORAGE INFRASTRUCTURE 6**

Information security goals, Storage security domains, Threats to a storage infrastructure, Security controls to protect a storage infrastructure, Governance, risk, and compliance, Storage infrastructure management functions, Storage infrastructure management processes.

**COURSE OUTCOMES:**

**CO1:** Demonstrate the fundamentals of information storage management and various models of Cloud infrastructure services and deployment

**CO2:** Illustrate the usage of advanced intelligent storage systems and RAID

**CO3:** Interpret various storage networking architectures - SAN, including storage subsystems and virtualization

**CO4:** Examine the different role in providing disaster recovery and remote replication technologies

**CO5:** Infer the security needs and security measures to be employed in information storage management

**TOTAL:45 PERIODS**

**TEXTBOOKS**

1. EMC Corporation, Information Storage and Management, Wiley, India
2. Jon Tate, Pall Beck, Hector Hugo Ibarra, Shanmuganathan Kumaravel and Libor Miklas, Introduction to Storage Area Networks, Ninth Edition, IBM - Redbooks, December 2017
3. Ulf Troppens, Rainer Erkens, Wolfgang Mueller-Friedt, Rainer Wolafka, Nils Haustein, Storage Networks Explained, Second Edition, Wiley, 2009

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	2	1	3	3	-	-	-	1	1	1	3	1	2	1
2	3	1	2	3	3	-	-	-	3	2	3	2	2	3	1
3	1	1	3	2	2	-	-	-	3	1	1	2	2	3	3
4	3	2	1	2	2	-	-	-	1	1	3	1	3	2	1
5	1	3	2	1	2	-	-	-	1	2	3	1	3	2	1
<b>AVg.</b>	1.8	1.8	1.8	2.2	2.4	-	-	-	1.8	1.4	2.2	1.8	2.2	2.4	1.4

1 - low, 2 - medium, 3 - high, '-' - no correlation



**COURSE OBJECTIVES:**

- To understand the need for SDN and its data plane operations
- To understand the functions of control plane
- To comprehend the migration of networking functions to SDN environment
- To explore various techniques of network function virtualization
- To comprehend the concepts behind network virtualization

**UNIT I SDN: INTRODUCTION****6**

Evolving Network Requirements – The SDN Approach – SDN architecture - SDN Data Plane , Control plane and Application Plane

**UNIT II SDN DATA PLANE AND CONTROL PLANE-****6**

Data Plane functions and protocols - OpenFlow Protocol - Flow Table - Control Plane Functions - Southbound Interface, Northbound Interface – SDN Controllers - Ryu, OpenDaylight, ONOS - Distributed Controllers

**UNIT III SDN APPLICATIONS****6**

SDN Application Plane Architecture – Network Services Abstraction Layer – Traffic Engineering – Measurement and Monitoring – Security – Data Center Networking

**UNIT IV NETWORK FUNCTION VIRTUALIZATION****6**

Network Virtualization - Virtual LANs – OpenFlow VLAN Support - NFV Concepts – Benefits and Requirements – Reference Architecture

**UNIT V NFV FUNCTIONALITY****6**

NFV Infrastructure – Virtualized Network Functions – NFV Management and Orchestration – NFV Use cases – SDN and NFV

**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS**

- 1) Setup your own virtual SDN lab
  - i) Virtualbox/Mininet Environment for SDN - <http://mininet.org>
  - ii) <https://www.kathara.org>
  - iii) GNS3
- 2) Create a simple mininet topology with SDN controller and use Wireshark to capture and visualize the OpenFlow messages such as OpenFlow FLOW MOD, PACKET IN, PACKET OUT etc.
- 3) Create a SDN application that uses the Northbound API to program flow table rules on the switch for various use cases like L2 learning switch, Traffic Engineering, Firewall etc.
- 4) Create a simple end-to-end network service with two VNFs using vim-emu  
<https://github.com/containernet/vim-emu>
- 5) Install OSM and onboard and orchestrate network service.

**COURSE OUTCOMES:**

**After the successful completion of this course, the student will be able to**

**CO1:** Describe the motivation behind SDN

**CO2:** Identify the functions of the data plane and control plane

**CO3:** Design and develop network applications using SDN

**CO4:** Orchestrate network services using NFV

**CO5:** Explain various use cases of SDN and NFV

**TOTAL :60 PERIODS**

**TEXTBOOKS:**

1. William Stallings, “Foundations of Modern Networking: SDN, NFV, QoE, IoT and Cloud”, Pearson Education, 1<sup>st</sup> Edition, 2015.

**REFERENCES:**

1. Ken Gray, Thomas D. Nadeau, “Network Function Virtualization”, Morgan Kauffman, 2016.
2. Thomas D Nadeau, Ken Gray, “SDN: Software Defined Networks”, O’Reilly Media, 2013.
3. Fei Hu, “Network Innovation through OpenFlow and SDN: Principles and Design”, 1<sup>st</sup> Edition, CRC Press, 2014.
4. Paul Goransson, Chuck Black Timothy Culver, “Software Defined Networks: A Comprehensive Approach”, 2<sup>nd</sup> Edition, Morgan Kaufmann Press, 2016.
5. Oswald Coker, Siamak Azodolmolky, “Software-Defined Networking with OpenFlow”, 2<sup>nd</sup> Edition, O’Reilly Media, 2017.

**CO’s-PO’s & PSO’s MAPPING**

CO’s	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	2	3	1	3	-	-	-	2	3	1	3	1	2	1
2	2	1	2	2	3	-	-	-	2	2	2	2	1	3	2
3	2	2	2	3	3	-	-	-	3	1	1	2	1	3	3
4	2	2	2	3	1	-	-	-	1	3	1	2	2	2	2
5	3	3	1	1	3	-	-	-	1	2	1	2	2	1	3
<b>AVg.</b>	2	2	2	2	2.6	-	-	-	1.8	2.2	1.2	2.2	1.4	2.2	2.2

1 - low, 2 - medium, 3 - high, ‘-’ - no correlation

**CCS368**

**STREAM PROCESSING**

**L T P C  
2 0 2 3**

**COURSE OBJECTIVES:**

- Introduce Data Processing terminology, definition & concepts
- Define different types of Data Processing
- Explain the concepts of Real-time Data processing
- Select appropriate structures for designing and running real-time data services in a business environment
- Illustrate the benefits and drive the adoption of real-time data services to solve real world problems

**UNIT I FOUNDATIONS OF DATA SYSTEMS**

**6**

Introduction to Data Processing, Stages of Data processing, Data Analytics, Batch Processing, Stream processing, Data Migration, Transactional Data processing, Data Mining, Data Management Strategy, Storage, Processing, Integration, Analytics, Benefits of Data as a Service, Challenges

**UNIT II REAL-TIME DATA PROCESSING**

**6**

Introduction to Big data, Big data infrastructure, Real-time Analytics, Near real-time solution, Lambda architecture, Kappa Architecture, Stream Processing, Understanding Data Streams, Message Broker, Stream Processor, Batch & Real-time ETL tools, Streaming Data Storage

**UNIT III DATA MODELS AND QUERY LANGUAGES 6**

Relational Model, Document Model, Key-Value Pairs, NoSQL, Object-Relational Mismatch, Many-to-One and Many-to-Many Relationships, Network data models, Schema Flexibility, Structured Query Language, Data Locality for Queries, Declarative Queries, Graph Data models, Cypher Query Language, Graph Queries in SQL, The Semantic Web, CODASYL, SPARQL

**UNIT IV EVENT PROCESSING WITH APACHE KAFKA 6**

Apache Kafka, Kafka as Event Streaming platform, Events, Producers, Consumers, Topics, Partitions, Brokers, Kafka APIs, Admin API, Producer API, Consumer API, Kafka Streams API, Kafka Connect API.

**UNIT V REAL-TIME PROCESSING USING SPARK STREAMING 6**

Structured Streaming, Basic Concepts, Handling Event-time and Late Data, Fault-tolerant Semantics, Exactly-once Semantics, Creating Streaming Datasets, Schema Inference, Partitioning of Streaming datasets, Operations on Streaming Data, Selection, Aggregation, Projection, Watermarking, Window operations, Types of Time windows, Join Operations, Deduplication

**30 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

1. Install MongoDB
2. Design and Implement Simple application using MongoDB
3. Query the designed system using MongoDB
4. Create a Event Stream with Apache Kafka
5. Create a Real-time Stream processing application using Spark Streaming
6. Build a Micro-batch application
7. Real-time Fraud and Anomaly Detection,
8. Real-time personalization, Marketing, Advertising

**COURSE OUTCOMES:**

**CO1:** Understand the applicability and utility of different streaming algorithms.

**CO2:** Describe and apply current research trends in data-stream processing.

**CO3:** Analyze the suitability of stream mining algorithms for data stream systems.

**CO4:** Program and build stream processing systems, services and applications.

**CO5:** Solve problems in real-world applications that process data streams.

**TOTAL:60 PERIODS**

**TEXT BOOKS**

1. Streaming Systems: The What, Where, When and How of Large-Scale Data Processing by Tyler Akidau, Slava Chemyak, Reuven Lax, O'Reilly publication
2. Designing Data-Intensive Applications by Martin Kleppmann, O'Reilly Media
3. Practical Real-time Data Processing and Analytics : Distributed Computing and Event Processing using Apache Spark, Flink, Storm and Kafka, Packt Publishing

**REFERENCES**

1. <https://spark.apache.org/docs/latest/streaming-programming-guide.html>
2. Kafka.apache.org

## CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	3	1	-	-	-	2	3	1	2	1	3	3
2	2	1	1	2	2	-	-	-	3	2	2	3	1	2	1
3	3	1	2	3	3	-	-	-	2	2	1	1	2	2	1
4	2	1	3	3	3	-	-	-	3	3	1	1	1	2	1
5	3	3	1	2	2	-	-	-	3	3	2	3	2	3	2
AVg.	2.6	1.8	1.8	2.6	2.2	-	-	-	2.6	2.6	1.4	2	1.4	2.4	1.6

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS362

SECURITY AND PRIVACY IN CLOUD

L T P C  
2 0 2 3

### COURSE OBJECTIVES:

- To Introduce Cloud Computing terminology, definition & concepts
- To understand the security design and architectural considerations for Cloud
- To understand the Identity, Access control in Cloud
- To follow best practices for Cloud security using various design patterns
- To be able to monitor and audit cloud applications for security

### UNIT I FUNDAMENTALS OF CLOUD SECURITY CONCEPTS 7

Overview of cloud security- Security Services - Confidentiality, Integrity, Authentication, Non-repudiation, Access Control - Basic of cryptography - Conventional and public-key cryptography, hash functions, authentication, and digital signatures.

### UNIT II SECURITY DESIGN AND ARCHITECTURE FOR CLOUD 6

Security design principles for Cloud Computing - Comprehensive data protection - End-to-end access control - Common attack vectors and threats - Network and Storage - Secure Isolation Strategies - Virtualization strategies - Inter-tenant network segmentation strategies - Data Protection strategies: Data retention, deletion and archiving procedures for tenant data, Encryption, Data Redaction, Tokenization, Obfuscation, PKI and Key

### UNIT III ACCESS CONTROL AND IDENTITY MANAGEMENT 6

Access control requirements for Cloud infrastructure - User Identification - Authentication and Authorization - Roles-based Access Control - Multi-factor authentication - Single Sign-on, Identity Federation - Identity providers and service consumers - Storage and network access control options - OS Hardening and minimization - Verified and measured boot - Intruder Detection and prevention

### UNIT IV CLOUD SECURITY DESIGN PATTERNS 6

Introduction to Design Patterns, Cloud bursting, Geo-tagging, Secure Cloud Interfaces, Cloud Resource Access Control, Secure On-Premise Internet Access, Secure External Cloud

### UNIT V MONITORING, AUDITING AND MANAGEMENT 5

Proactive activity monitoring - Incident Response, Monitoring for unauthorized access, malicious traffic, abuse of system privileges - Events and alerts - Auditing – Record generation, Reporting and Management, Tamper-proofing audit logs, Quality of Services, Secure Management, User management, Identity management, Security Information and Event Management

30 PERIODS

30 PERIODS

**PRACTICAL EXERCISES:**

1. Simulate a cloud scenario using Cloud Sim and run a scheduling algorithm not present in Cloud Sim
2. simulate resource management using cloud sim
3. simulate log forensics using cloud sim
4. simulate a secure file sharing using a cloud sim
5. Implement data anonymization techniques over the simple dataset (masking, k-anonymization, etc)
6. Implement any encryption algorithm to protect the images
7. Implement any image obfuscation mechanism
8. Implement a role-based access control mechanism in a specific scenario
9. implement an attribute-based access control mechanism based on a particular scenario
10. Develop a log monitoring system with incident management in the cloud

**COURSE OUTCOMES:**

**CO1:** Understand the cloud concepts and fundamentals.

**CO2:** Explain the security challenges in the cloud.

**CO3:** Define cloud policy and Identity and Access Management.

**CO4:** Understand various risks and audit and monitoring mechanisms in the cloud.

**CO5:** Define the various architectural and design considerations for security in the cloud.

**TOTAL:60 PERIODS**

**TEXTBOOKS**

1. Raj Kumar Buyya , James Broberg, andrzejGoscinski, "Cloud Computing:II, Wiley 2013
2. Dave shackleford, "Virtualization SecurityII, SYBEX a wiley Brand 2013.
3. Mather, Kumaraswamy and Latif, "Cloud Security and PrivacyII, OREILLY 2011

**REFERENCES**

1. Mark C. Chu-Carroll "Code in the CloudII,CRC Press, 2011
2. Mastering Cloud Computing Foundations and Applications Programming RajkumarBuyya, Christian Vechhiola, S. ThamaraiSelvi

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	1	2	-	-	-	1	1	1	3	3	1	2
2	1	3	2	3	1	-	-	-	2	2	3	2	3	1	2
3	3	2	2	3	2	-	-	-	3	1	1	2	2	3	1
4	2	1	2	3	3	-	-	-	3	2	3	3	1	1	2
5	1	3	3	1	1	-	-	-	2	3	3	2	2	3	2
<b>AVg.</b>	2	2.4	2.4	2.2	1.8	-	-	-	2.2	1.8	2.2	2.4	2.2	1.8	1.8

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES:**

- To understand the basics of computer based vulnerabilities.
- To explore different foot printing, reconnaissance and scanning methods.
- To expose the enumeration and vulnerability analysis methods.
- To understand hacking options available in Web and wireless applications.
- To explore the options for network protection.
- To practice tools to perform ethical hacking to expose the vulnerabilities.

**UNIT I INTRODUCTION 6**

Ethical Hacking Overview - Role of Security and Penetration Testers .- Penetration-Testing Methodologies- Laws of the Land - Overview of TCP/IP- The Application Layer - The Transport Layer - The Internet Layer - IP Addressing .- Network and Computer Attacks - Malware - Protecting Against Malware Attacks.- Intruder Attacks - Addressing Physical Security

**UNIT II FOOT PRINTING, RECONNAISSANCE AND SCANNING NETWORKS 6**

Footprinting Concepts - Footprinting through Search Engines, Web Services, Social Networking Sites, Website, Email - Competitive Intelligence - Footprinting through Social Engineering - Footprinting Tools - Network Scanning Concepts - Port-Scanning Tools - Scanning Techniques - Scanning Beyond IDS and Firewall

**UNIT III ENUMERATION AND VULNERABILITY ANALYSIS 6**

Enumeration Concepts - NetBIOS Enumeration – SNMP, LDAP, NTP, SMTP and DNS Enumeration - Vulnerability Assessment Concepts - Desktop and Server OS Vulnerabilities - Windows OS Vulnerabilities - Tools for Identifying Vulnerabilities in Windows- Linux OS Vulnerabilities- Vulnerabilities of Embedded Oss

**UNIT IV SYSTEM HACKING 6**

Hacking Web Servers - Web Application Components- Vulnerabilities - Tools for Web Attackers and Security Testers Hacking Wireless Networks - Components of a Wireless Network – Wardriving- Wireless Hacking - Tools of the Trade –

**UNIT V NETWORK PROTECTION SYSTEMS 6**

Access Control Lists. - Cisco Adaptive Security Appliance Firewall - Configuration and Risk Analysis Tools for Firewalls and Routers - Intrusion Detection and Prevention Systems - Network-Based and Host-Based IDSs and IPSs - Web Filtering - Security Incident Response Teams – Honeypots.

**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS**

1. Install Kali or Backtrack Linux / Metasploitable/ Windows XP
2. Practice the basics of reconnaissance.
3. Using FOCA / SearchDiggity tools, extract metadata and expanding the target list.
4. Aggregates information from public databases using online free tools like Paterva's Maltego.
5. Information gathering using tools like Robtex.
6. Scan the target using tools like Nessus.
7. View and capture network traffic using Wireshark.

8. Automate dig for vulnerabilities and match exploits using Armitage  
 FOCA : <http://www.informatica64.com/foca.aspx>.  
 Nessus : <http://www.tenable.com/products/nessus>.  
 Wireshark : <http://www.wireshark.org>.  
 Armitage : <http://www.fastandeasyhacking.com/>.  
 Kali or Backtrack Linux, Metasploitable, Windows XP

**COURSE OUTCOMES:**

At the end of this course, the students will be able:

- CO1:** To express knowledge on basics of computer based vulnerabilities
- CO2:** To gain understanding on different foot printing, reconnaissance and scanning methods.
- CO3:** To demonstrate the enumeration and vulnerability analysis methods
- CO4:** To gain knowledge on hacking options available in Web and wireless applications.
- CO5:** To acquire knowledge on the options for network protection.
- CO6:** To use tools to perform ethical hacking to expose the vulnerabilities.

**TOTAL:60 PERIODS**

**TEXTBOOKS**

1. Michael T. Simpson, Kent Backman, and James E. Corley, Hands-On Ethical Hacking and Network Defense, Course Technology, Delmar Cengage Learning, 2010.
2. The Basics of Hacking and Penetration Testing - Patrick Engebretson, SYNGRESS, Elsevier, 2013.
3. The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws, Dafydd Stuttard and Marcus Pinto, 2011.

**REFERENCES**

1. Black Hat Python: Python Programming for Hackers and Pentesters, Justin Seitz , 2014.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	3	2	1	-	-	-	1	2	2	1	1	2	3
2	1	2	1	2	1	-	-	-	2	2	1	1	1	2	2
3	2	2	3	3	1	-	-	-	1	2	1	2	2	3	1
4	2	1	1	2	1	-	-	-	1	3	3	3	3	2	1
5	2	3	1	1	2	-	-	-	2	1	1	1	1	1	3
<b>AVg.</b>	1.8	2	1.8	2	1.2	-	-	-	1.4	2	1.6	1.6	1.6	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CCS343**

**DIGITAL AND MOBILE FORENSICS**

**L T P C**  
**2 0 2 3**

**COURSE OBJECTIVES:**

- To understand basic digital forensics and techniques.
- To understand digital crime and investigation.
- To understand how to be prepared for digital forensic readiness.
- To understand and use forensics tools for iOS devices.
- To understand and use forensics tools for Android devices.

**UNIT I INTRODUCTION TO DIGITAL FORENSICS 6**

Forensic Science – Digital Forensics – Digital Evidence – The Digital Forensics Process – Introduction – The Identification Phase – The Collection Phase – The Examination Phase – The Analysis Phase – The Presentation Phase

**UNIT II DIGITAL CRIME AND INVESTIGATION 6**

Digital Crime – Substantive Criminal Law – General Conditions – Offenses – Investigation Methods for Collecting Digital Evidence – International Cooperation to Collect Digital Evidence

**UNIT III DIGITAL FORENSIC READINESS 6**

Introduction – Law Enforcement versus Enterprise Digital Forensic Readiness – Rationale for Digital Forensic Readiness – Frameworks, Standards and Methodologies – Enterprise Digital Forensic Readiness – Challenges in Digital Forensics

**UNIT IV IOS FORENSICS 6**

Mobile Hardware and Operating Systems - iOS Fundamentals – Jailbreaking – File System – Hardware – iPhone Security – iOS Forensics – Procedures and Processes – Tools – Oxygen Forensics – MobilEdit – iCloud

**UNIT V ANDROID FORENSICS 6**

Android basics – Key Codes – ADB – Rooting Android – Boot Process – File Systems – Security – Tools – Android Forensics – Forensic Procedures – ADB – Android Only Tools – Dual Use Tools – Oxygen Forensics – MobilEdit – Android App Decompiling

**COURSE OUTCOMES:**

On completion of the course, the students will be able to:

**CO1:** Have knowledge on digital forensics.

**CO2:** Know about digital crime and investigations.

**CO3:** Be forensic ready.

**CO4:** Investigate, identify and extract digital evidence from iOS devices.

**CO5:** Investigate, identify and extract digital evidence from Android devices.

**30 PERIODS**

**LAB EXPERIMENTS:**

1. Installation of Sleuth Kit on Linux. List all data blocks. Analyze allocated as well as unallocated blocks of a disk image.
2. Data extraction from call logs using Sleuth Kit.
3. Data extraction from SMS and contacts using Sleuth Kit.
4. Install Mobile Verification Toolkit or MVT and decrypt encrypted iOS backups.
5. Process and parse records from the iOS system.
6. Extract installed applications from Android devices.
7. Extract diagnostic information from Android devices through the adb protocol.
8. Generate a unified chronological timeline of extracted records,

**30 PERIODS**

**TOTAL : 60 PERIODS**

**TEXT BOOK:**

1. Andre Arnes, "Digital Forensics", Wiley, 2018.
2. Chuck Easttom, "An In-depth Guide to Mobile Device Forensics", First Edition, CRC Press, 2022.



**REFERENCES**

1. Vacca, J, Computer Forensics, Computer Crime Scene Investigation, 2nd Ed, Charles River Media, 2005, ISBN: 1-58450-389.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	3	2	1	-	-	-	1	1	3	3	1	3	1
2	3	3	3	3	3	-	-	-	2	2	1	2	1	3	1
3	3	3	2	3	1	-	-	-	3	2	1	1	3	2	3
4	3	1	2	2	3	-	-	-	1	3	3	2	1	3	3
5	1	3	2	3	2	-	-	-	2	3	2	3	1	2	1
AVg.	3	2	2	3	2	-	-	-	2	2	2	2	1	3	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CCS363**

**SOCIAL NETWORK SECURITY**

**L T P C**  
**2 0 2 3**

**COURSE OBJECTIVES:**

- To develop semantic web related simple applications
- To explain Privacy and Security issues in Social Networking
- To explain the data extraction and mining of social networks
- To discuss the prediction of human behavior in social communities
- To describe the Access Control, Privacy and Security management of social networks

**UNIT I FUNDAMENTALS OF SOCIAL NETWORKING 6**

Introduction to Semantic Web, Limitations of current Web, Development of Semantic Web, Emergence of the Social Web, Social Network analysis, Development of Social Network Analysis, Key concepts and measures in network analysis, Historical overview of privacy and security, Major paradigms, for understanding privacy and security

**UNIT II SECURITY ISSUES IN SOCIAL NETWORKS 6**

The evolution of privacy and security concerns with networked technologies, Contextual influences on privacy attitudes and behaviors, Anonymity in a networked world

**UNIT III EXTRACTION AND MINING IN SOCIAL NETWORKING DATA 6**

Extracting evolution of Web Community from a Series of Web Archive, Detecting communities in social networks, Definition of community, Evaluating communities, Methods for community detection and mining, Applications of community mining algorithms, Tools for detecting communities social network infrastructures and communities, Big data and Privacy

**UNIT IV PREDICTING HUMAN BEHAVIOR AND PRIVACY ISSUES 6**

Understanding and predicting human behavior for social communities, User data Management, Inference and Distribution, Enabling new human experiences, Reality mining, Context, Awareness, Privacy in online social networks, Trust in online environment, What is Neo4j, Nodes, Relationships, Properties.

**UNIT V ACCESS CONTROL, PRIVACY AND IDENTITY MANAGEMENT 6**

Understand the access control requirements for Social Network, Enforcing Access Control Strategies, Authentication and Authorization, Roles-based Access Control, Host, storage and network access control options, Firewalls, Authentication, and Authorization in Social Network, Identity & Access Management, Single Sign-on, Identity Federation, Identity providers and service consumers, The role of Identity provisioning

**COURSE OUTCOMES:**

- CO1:** Develop semantic web related simple applications
- CO2 :** Address Privacy and Security issues in Social Networking
- CO3:** Explain the data extraction and mining of social networks
- CO4:** Discuss the prediction of human behavior in social communities
- CO5:** Describe the applications of social networks

**30 PERIODS**

**PRACTICALEXERCISES:**

**30 PERIODS**

1. Design own social media application
2. Create a Network model using Neo4j
3. Read and write Data from Graph Database
4. Find “Friend of Friends” using Neo4j
5. Implement secure search in social media
6. Create a simple Security & Privacy detector

**TOTAL:60 PERIODS**

**TEXT BOOKS**

1. Peter Mika, Social Networks and the Semantic Web, First Edition, Springer 2007.
2. Borko Furht, Handbook of Social Network Technologies and Application, First Edition, Springer, 2010.
3. Learning Neo4j 3.x Second Edition By Jérôme Baton, Rik Van Bruggen, Packt publishing
4. David Easley, Jon Kleinberg, Networks, Crowds, and Markets: Reasoning about a Highly Connected Worldll, First Edition, Cambridge University Press, 2010.

**REFERENCES**

1. Easley D. Kleinberg J., Networks, Crowds, and Markets – Reasoning about a Highly Connected Worldll, Cambridge University Press, 2010.
2. Jackson, Matthew O., Social and Economic Networksll, Princeton University Press, 2008.
3. GuandongXu ,Yanchun Zhang and Lin Li, —Web Mining and Social Networking – Techniques and applicationsll, First Edition, Springer, 2011.
4. Dion Goh and Schubert Foo, Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectivelyll, IGI Global Snippet, 2008.
5. Max Chevalier, Christine Julien and Chantal Soulé-Dupuy, Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modelingll, IGI Global Snippet, 2009.
6. John G. Breslin, Alexander Passant and Stefan Decker, The Social Semantic Webll, Springer, 2009.

### CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	2	3	2	-	-	-	3	2	1	2	3	3	2
2	2	2	2	3	3	-	-	-	1	2	2	3	3	3	2
3	2	1	1	3	2	-	-	-	1	2	1	1	1	3	3
4	3	3	3	3	2	-	-	-	1	1	1	1	2	1	3
5	1	3	2	2	2	-	-	-	1	1	3	1	2	3	3
AVg.	2.2	2	2	2.8	2.2	-	-	-	1.4	1.6	1.6	1.6	2.2	2.6	2.6

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS351

MODERN CRYPTOGRAPHY

L T P C

2 0 2 3

#### COURSE OBJECTIVES:

- To learn about Modern Cryptography.
- To focus on how cryptographic algorithms and protocols work and how to use them.
- To build a Pseudorandom permutation.
- To construct Basic cryptanalytic techniques.
- To provide instruction on how to use the concepts of block ciphers and message authentication codes.

#### UNIT I INTRODUCTION

6

Basics of Symmetric Key Cryptography, Basics of Asymmetric Key Cryptography, Hardness of Functions. Notions of Semantic Security (SS) and Message Indistinguishability (MI): Proof of Equivalence of SS and MI, Hard Core Predicate, Trap-door permutation, Goldwasser-Micali Encryption. Goldreich-Levin Theorem: Relation between Hardcore Predicates and Trap-door permutations.

#### UNIT II FORMAL NOTIONS OF ATTACKS

6

Attacks under Message Indistinguishability: Chosen Plaintext Attack (IND-CPA), Chosen Ciphertext Attacks (IND-CCA1 and IND-CCA2), Attacks under Message Non-malleability: NM-CPA and NM-CCA2, Inter-relations among the attack model

#### UNIT III RANDOM ORACLES

6

Provable Security and asymmetric cryptography, hash functions. One-way functions: Weak and Strong one-way functions. Pseudo-random Generators (PRG): Blum-Micali-Yao Construction, Construction of more powerful PRG, Relation between One-way functions and PRG, Pseudo-random Functions (PRF)

#### UNIT IV BUILDING A PSEUDORANDOM PERMUTATION

6

The LubyRackoff Construction: Formal Definition, Application of the LubyRackoff Construction to the construction of Block Ciphers, The DES in the light of LubyRackoff Construction.

#### UNIT V MESSAGE AUTHENTICATION CODES

6

Left or Right Security (LOR). Formal Definition of Weak and Strong MACs, Using a PRF as a MAC, Variable length MAC. Public Key Signature Schemes: Formal Definitions, Signing and Verification, Formal Proofs of Security of Full Domain Hashing. Assumptions for Public Key Signature Schemes:

One-way functions Imply Secure One-time Signatures. Shamir's Secret Sharing Scheme. Formally Analyzing Cryptographic Protocols. Zero Knowledge Proofs and Protocols.

**30 PERIODS**  
**30 PERIODS**

**PRACTICAL EXERCISES:**

1. Implement Feige-Fiat-Shamir identification protocol.
2. Implement GQ identification protocol.
3. Implement Schnorr identification protocol.
4. Implement Rabin one-time signature scheme.
5. Implement Merkle one-time signature scheme.
6. Implement Authentication trees and one-time signatures.
7. Implement GMR one-time signature scheme.

**COURSE OUTCOMES:**

- CO1:** Interpret the basic principles of cryptography and general cryptanalysis.  
**CO2:** Determine the concepts of symmetric encryption and authentication.  
**CO3:** Identify the use of public key encryption, digital signatures, and key establishment.  
**CO4:** Articulate the cryptographic algorithms to compose, build and analyze simple cryptographic solutions.  
**CO5:** Express the use of Message Authentication Codes.

**TOTAL:60 PERIODS**

**TEXT BOOKS:**

1. Hans Delfs and Helmut Knebl, Introduction to Cryptography: Principles and Applications, Springer Verlag.
2. Wenbo Mao, Modern Cryptography, Theory and Practice, Pearson Education (Low Priced Edition)

**REFERENCES:**

1. ShaffiGoldwasser and MihirBellare, Lecture Notes on Cryptography, Available at <http://citeseerx.ist.psu.edu/>.
2. OdedGoldreich, Foundations of Cryptography, CRC Press (Low Priced Edition Available), Part 1 and Part 23
3. William Stallings, "Cryptography and Network Security: Principles and Practice", PHI 3rd Edition, 2006.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	1	-	-	-	2	1	1	2	2	1	1
2	1	3	2	1	2	-	-	-	3	2	2	2	2	1	3
3	1	1	2	3	2	-	-	-	1	1	1	3	1	1	3
4	3	1	2	1	3	-	-	-	3	2	1	2	3	2	1
5	2	3	3	3	3	-	-	-	3	1	1	1	2	1	1
<b>Avg.</b>	2	2.2	2.4	2.2	2.2	-	-	-	2.4	1.4	1.2	2	2	1.2	1.8

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES:**

- Know the importance and need for software security.
- Know about various attacks.
- Learn about secure software design.
- Understand risk management in secure software development.
- Know the working of tools related to software security.

**UNIT I      NEED OF SOFTWARE SECURITY AND LOW-LEVEL ATTACKS      6**

Software Assurance and Software Security - Threats to software security - Sources of software insecurity - Benefits of Detecting Software Security - Properties of Secure Software – Memory-Based Attacks: Low-Level Attacks Against Heap and Stack - Defense Against Memory-Based Attacks

**UNIT II      SECURE SOFTWARE DESIGN      7**

Requirements Engineering for secure software - SQUARE process Model - Requirements elicitation and prioritization- Isolating The Effects of Untrusted Executable Content - Stack Inspection – Policy Specification Languages – Vulnerability Trends – Buffer Overflow – Code Injection - Session Hijacking. Secure Design - Threat Modeling and Security Design Principles

**UNIT III      SECURITY RISK MANAGEMENT      5**

Risk Management Life Cycle – Risk Profiling – Risk Exposure Factors – Risk Evaluation and Mitigation – Risk Assessment Techniques – Threat and Vulnerability Management

**UNIT IV      SECURITY TESTING      8**

Traditional Software Testing – Comparison - Secure Software Development Life Cycle - Risk Based Security Testing – Prioritizing Security Testing With Threat Modeling – Penetration Testing – Planning and Scoping - Enumeration – Remote Exploitation – Web Application Exploitation - Exploits and Client Side Attacks – Post Exploitation – Bypassing Firewalls and Avoiding Detection - Tools for Penetration Testing

**UNIT V      SECURE PROJECT MANAGEMENT      4**

Governance and security - Adopting an enterprise software security framework - Security and project management - Maturity of Practice

**30 PERIODS****PRACTICAL EXERCISES**

1. Implement the SQL injection attack.
2. Implement the Buffer Overflow attack.
3. Implement Cross Site Scripting and Prevent XSS.
4. Perform Penetration testing on a web application to gather information about the system, then initiate XSS and SQL injection attacks using tools like Kali Linux.
5. Develop and test the secure test cases
6. Penetration test using kali Linux

**30 PERIODS****COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

**CO1:** Identify various vulnerabilities related to memory attacks.

**CO2:** Apply security principles in software development.

**CO3:** Evaluate the extent of risks.

**CO4:** Involve selection of testing techniques related to software security in the testing phase of software development.

**CO5:** Use tools for securing software.

**TOTAL: 60 PERIODS**

**TEXT BOOKS:**

1. Julia H. Allen, "Software Security Engineering", Pearson Education, 2008
2. Evan Wheeler, "Security Risk Management: Building an Information Security Risk Management Program from the Ground Up", First edition, Syngress Publishing, 2011
3. Chris Wysopal, Lucas Nelson, Dino Dai Zovi, and Elfriede Dustin, "The Art of Software Security Testing: Identifying Software Security Flaws (Symantec Press)", Addison-Wesley Professional, 2006

**REFERENCES:**

1. Robert C. Seacord, "Secure Coding in C and C++ (SEI Series in Software Engineering)", Addison-Wesley Professional, 2005.
2. Jon Erickson, "Hacking: The Art of Exploitation", 2nd Edition, No Starch Press, 2008.
3. Mike Shema, "Hacking Web Apps: Detecting and Preventing Web Application Security Problems", First edition, Syngress Publishing, 2012
4. Bryan Sullivan and Vincent Liu, "Web Application Security, A Beginner's Guide", Kindle Edition, McGraw Hill, 2012
5. Lee Allen, "Advanced Penetration Testing for Highly-Secured Environments: The Ultimate Security Guide (Open Source: Community Experience Distilled)", Kindle Edition, Packt Publishing, 2012
6. Jason Grembi, "Developing Secure Software"

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	2	3	2	-	-	-	2	1	2	2	2	2	1
2	2	2	2	3	3	-	-	-	2	1	2	2	1	2	1
3	1	2	2	2	1	-	-	-	1	1	2	1	2	2	1
4	2	3	2	2	2	-	-	-	2	1	2	2	2	2	1
5	2	1	2	2	3	-	-	-	2	1	1	2	2	1	2
AVg.	1.8	2.2	2	2.4	2.2	-	-	-	1.8	1	1.8	1.8	1.8	1.8	1.2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CCS339**

**CRYPTOCURRENCY AND BLOCKCHAIN TECHNOLOGIES**

**L T P C**

**2 0 2 3**

**COURSE OBJECTIVES:**

- To understand the basics of Blockchain
- To learn Different protocols and consensus algorithms in Blockchain
- To learn the Blockchain implementation frameworks
- To understand the Blockchain Applications
- To experiment the Hyperledger Fabric, Ethereum networks

<b>UNIT I</b>	<b>INTRODUCTION TO BLOCKCHAIN</b>	<b>7</b>
Blockchain- Public Ledgers, Blockchain as Public Ledgers - Block in a Blockchain, Transactions- The Chain and the Longest Chain - Permissioned Model of Blockchain, Cryptographic -Hash Function, Properties of a hash function-Hash pointer and Merkle tree		
<b>UNIT II</b>	<b>BITCOIN AND CRYPTOCURRENCY</b>	<b>6</b>
A basic crypto currency, Creation of coins, Payments and double spending, FORTH – the precursor for Bitcoin scripting, Bitcoin Scripts , Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay		
<b>UNIT III</b>	<b>BITCOIN CONSENSUS</b>	<b>6</b>
Bitcoin Consensus, Proof of Work (PoW)- Hashcash PoW , Bitcoin PoW, Attacks on PoW ,monopoly problem- Proof of Stake- Proof of Burn - Proof of Elapsed Time - Bitcoin Miner, Mining Difficulty, Mining Pool-Permissioned model and use cases.		
<b>UNIT IV</b>	<b>HYPERLEDGER FABRIC &amp; ETHEREUM</b>	<b>5</b>
Architecture of Hyperledger fabric v1.1- chain code- Ethereum: Ethereum network, EVM, Transaction fee, Mist Browser, Ether, Gas, Solidity.		
<b>UNIT V</b>	<b>BLOCKCHAIN APPLICATIONS</b>	<b>6</b>
Smart contracts, Truffle Design and issue- DApps- NFT. Blockchain Applications in Supply Chain Management, Logistics, Smart Cities, Finance and Banking, Insurance,etc- Case Study.		
<b>COURSE OUTCOMES:</b>		
<b>CO1:</b> Understand emerging abstract models for Blockchain Technology		
<b>CO2:</b> Identify major research challenges and technical gaps existing between theory and practice in the crypto currency domain.		
<b>CO3:</b> It provides conceptual understanding of the function of Blockchain as a method of securing distributed ledgers, how consensus on their contents is achieved, and the new applications that they enable.		
<b>CO4:</b> Apply hyperledger Fabric and Ethereum platform to implement the Block chain Application.		
		<b>30 PERIODS</b>
<b>PRACTICAL</b>		<b>30 PERIODS</b>
<ol style="list-style-type: none"> <li>1. Install and understand Docker container, Node.js, Java and Hyperledger Fabric, Ethereum and perform necessary software installation on local machine/create instance on cloud to run.</li> <li>2. Create and deploy a blockchain network using Hyperledger Fabric SDK for Java Set up and initialize the channel, install and instantiate chain code, and perform invoke and query on your blockchain network.</li> <li>3. Interact with a blockchain network. Execute transactions and requests against a blockchain network by creating an app to test the network and its rules.</li> <li>4. Deploy an asset-transfer app using blockchain. Learn app development within a Hyperledger Fabric network.</li> <li>5. Use blockchain to track fitness club rewards. Build a web app that uses Hyperledger Fabric to track and trace member rewards.</li> </ol>		

- Car auction network: A Hello World example with Hyperledger Fabric Node SDK and IBM Blockchain Starter Plan. Use Hyperledger Fabric to invoke chain code while storing results and data in the starter plan

**TOTAL: 60 PERIODS**

### TEXT BOOKS

- Bashir and Imran, Mastering Blockchain: Deeper insights into decentralization, cryptography, Bitcoin, and popular Blockchain frameworks, 2017.
- 2.Andreas Antonopoulos, "Mastering Bitcoin: Unlocking Digital Cryptocurrencies", O'Reilly, 2014.

### REFERENCES:

- Daniel Drescher, "Blockchain Basics", First Edition, Apress, 2017.
- Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016.
- Melanie Swan, "Blockchain: Blueprint for a New Economy", O'Reilly, 2015
- Ritesh Modi, "Solidity Programming Essentials: A Beginner's Guide to Build Smart Contracts for Ethereum and Blockchain", Packt Publishing
- Handbook of Research on Blockchain Technology, published by Elsevier Inc. ISBN: 9780128198162, 2020.

### CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	1	-	-	-	1	-	-	2	3	1	1
2	3	3	3	3	1	-	-	-	2	-	-	2	1	2	1
3	3	3	3	3	2	-	-	-	3	-	-	2	2	3	3
4	3	2	3	2	3	-	-	-	3	-	-	2	2	2	3
<b>AVg.</b>	3	2.75	2.75	2.5	1.75				2.25			2	3	2.75	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CCS354**

**NETWORK SECURITY**

**L T P C**  
**2 0 2 3**

### COURSE OBJECTIVES:

- To learn the fundamentals of cryptography.
- To learn the key management techniques and authentication approaches.
- To explore the network and transport layer security techniques.
- To understand the application layer security standards.
- To learn the real time security practices.

### UNIT I INTRODUCTION

**8**

Basics of cryptography, conventional and public-key cryptography, hash functions, authentication, and digital signatures.

### UNIT II KEY MANAGEMENT AND AUTHENTICATION

**7**

Key Management and Distribution: Symmetric Key Distribution, Distribution of Public Keys, X.509 Certificates, Public-Key Infrastructure. User Authentication: Remote User-Authentication Principles, Remote User-Authentication Using Symmetric Encryption, Kerberos Systems, Remote User Authentication Using Asymmetric Encryption.



**UNIT III ACCESS CONTROL AND SECURITY 4**

Network Access Control: Network Access Control, Extensible Authentication Protocol, IEEE 802.1X Port-Based Network Access Control - IP Security - Internet Key Exchange (IKE). Transport-Level Security: Web Security Considerations, Secure Sockets Layer, Transport Layer Security, HTTPS standard, Secure Shell (SSH) application.

**UNIT IV APPLICATION LAYER SECURITY 5**

Electronic Mail Security: Pretty Good Privacy, S/MIME, DomainKeys Identified Mail. Wireless Network Security: Mobile Device Security

**UNIT V SECURITY PRACTICES 6**

Firewalls and Intrusion Detection Systems: Intrusion Detection Password Management, Firewall Characteristics Types of Firewalls, Firewall Basing, Firewall Location and Configurations. Blockchains, Cloud Security and IoT security

**30 PERIODS**

**PRACTICALEXERCISES:**

**30 PERIODS**

1. Implement symmetric key algorithms
2. Implement asymmetric key algorithms and key exchange algorithms
3. Implement digital signature schemes
4. Installation of Wire shark, tcpdump and observe data transferred in client-server communication using UDP/TCP and identify the UDP/TCP datagram.
5. Check message integrity and confidentiality using SSL
6. Experiment Eavesdropping, Dictionary attacks, MITM attacks
7. Experiment with Sniff Traffic using ARP Poisoning
8. Demonstrate intrusion detection system using any tool.
9. Explore network monitoring tools
10. Study to configure Firewall, VPN

**COURSE OUTCOMES:**

At the end of this course, the students will be able:

**CO1:** Classify the encryption techniques

**CO2:** Illustrate the key management technique and authentication.

**CO3** Evaluate the security techniques applied to network and transport layer

**CO4:** Discuss the application layer security standards.

**CO5:** Apply security practices for real time applications.

**TOTAL:60 PERIODS**

**TEXT BOOKS:**

1. Cryptography and Network Security: Principles and Practice, 6th Edition, William Stallings, 2014, Pearson, ISBN 13:9780133354690.

**REFERENCES:**

1. Network Security: Private Communications in a Public World, M. Speciner, R. Perlman, C. Kaufman, Prentice Hall, 2002.
2. Linux iptables Pocket Reference, Gregor N. Purdy, O'Reilly, 2004, ISBN-13: 978-0596005696.
3. Linux Firewalls, by Michael Rash, No Starch Press, October 2007, ISBN: 978-1-59327-141-1.

4. Network Security, Firewalls And VPNs, J. Michael Stewart, Jones & Bartlett Learning, 2013, ISBN-10: 1284031675, ISBN-13: 978-1284031676.
5. The Network Security Test Lab: A Step-By-Step Guide, Michael Gregg, Dreamtech Press, 2015, ISBN-10:8126558148, ISBN-13: 978-8126558148.

### CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	2	-	-	-	2	1	2	1	2	3	1
2	1	1	3	2	2	-	-	-	2	2	1	1	3	1	2
3	1	2	1	1	2	-	-	-	3	3	1	3	2	1	3
4	2	2	3	2	3	-	-	-	3	3	2	1	2	1	3
5	2	1	3	2	2	-	-	-	2	1	1	3	2	1	1
<b>Avg.</b>	1.8	1.8	2.4	1.8	2.2	-	-	-	2.4	2	1.4	1.8	2.2	1.4	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS333

**AUGMENTED REALITY/VIRTUAL REALITY**

**L T P C**  
**2 0 2 3**

#### COURSE OBJECTIVES:

- To impart the fundamental aspects and principles of AR/VR technologies.
- To know the internals of the hardware and software components involved in the development of AR/VR enabled applications.
- To learn about the graphical processing units and their architectures.
- To gain knowledge about AR/VR application development.
- To know the technologies involved in the development of AR/VR based applications.

#### UNIT I

#### INTRODUCTION

7

Introduction to Virtual Reality and Augmented Reality – Definition – Introduction to Trajectories and Hybrid Space-Three I's of Virtual Reality – Virtual Reality Vs 3D Computer Graphics – Benefits of Virtual Reality – Components of VR System – Introduction to AR-AR Technologies-Input Devices – 3D Position Trackers – Types of Trackers – Navigation and Manipulation Interfaces – Gesture Interfaces – Types of Gesture Input Devices – Output Devices – Graphics Display – Human Visual System – Personal Graphics Displays – Large Volume Displays – Sound Displays – Human Auditory System.

#### UNIT II

#### VR MODELING

6

Modeling – Geometric Modeling – Virtual Object Shape – Object Visual Appearance – Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants –Object Hierarchies – Viewing the 3D World – Physical Modeling – Collision Detection – Surface Deformation – Force Computation – Force Smoothing and Mapping – Behavior Modeling – Model Management.

#### UNIT III

#### VR PROGRAMMING

6

VR Programming – Toolkits and Scene Graphs – World ToolKit – Java 3D – Comparison of World ToolKit and Java 3D

**UNIT IV APPLICATIONS 6**

Human Factors in VR – Methodology and Terminology – VR Health and Safety Issues – VR and Society-Medical Applications of VR – Education, Arts and Entertainment – Military VR Applications – Emerging Applications of VR – VR Applications in Manufacturing – Applications of VR in Robotics – Information Visualization – VR in Business – VR in Entertainment – VR in Education.

**UNIT V AUGMENTED REALITY 5**

Introduction to Augmented Reality-Computer vision for AR-Interaction-Modelling and Annotation-Navigation-Wearable devices

**30 PERIODS  
30 PERIODS**

**PRACTICAL EXERCISES:**

1. Study of tools like Unity, Maya, 3DS MAX, AR toolkit, Vuforia and Blender.
2. Use the primitive objects and apply various projection types by handling camera.
3. Download objects from asset store and apply various lighting and shading effects.
4. Model three dimensional objects using various modelling techniques and apply textures over them.
5. Create three dimensional realistic scenes and develop simple virtual reality enabled mobile applications which have limited interactivity.
6. Add audio and text special effects to the developed application.
7. Develop VR enabled applications using motion trackers and sensors incorporating full haptic interactivity.
8. Develop AR enabled applications with interactivity like E learning environment, Virtual walkthroughs and visualization of historic places.
9. Develop AR enabled simple applications like human anatomy visualization, DNA/RNA structure visualization and surgery simulation.
10. Develop simple MR enabled gaming applications.

**COURSE OUTCOMES:**

**On completion of the course, the students will be able to:**

- CO1:** Understand the basic concepts of AR and VR  
**CO2:** Understand the tools and technologies related to AR/VR  
**CO3:** Know the working principle of AR/VR related Sensor devices  
**CO4:** Design of various models using modeling techniques  
**CO5:** Develop AR/VR applications in different domains

**TOTAL:60 PERIODS**

**TEXTBOOKS:**

1. Charles Palmer, John Williamson, "Virtual Reality Blueprints: Create compelling VR experiences for mobile", Packt Publisher, 2018
2. Dieter Schmalstieg, Tobias Hollerer, "Augmented Reality: Principles & Practice", Addison Wesley, 2016
3. John Vince, "Introduction to Virtual Reality", Springer-Verlag, 2004.
4. William R. Sherman, Alan B. Craig: Understanding Virtual Reality – Interface, Application, Design", Morgan Kaufmann, 2003

## CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	-	3	-	-	-	2	2	1	2	2	1	2
2	3	2	2	1	3	-	-	-	3	2	2	3	3	1	2
3	3	3	2	2	3	-	-	-	3	2	1	2	3	2	2
4	3	3	3	2	3	-	-	-	3	2	2	3	3	2	2
5	3	3	3	3	3	-	-	-	3	3	3	3	3	3	3
AVg.	3.00	2.60	2.40	2.00	3.00	-	-	-	2.80	2.20	1.80	2.60	2.80	1.80	2.20

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS352

MULTIMEDIA AND ANIMATION

L T P C  
2 0 2 3

### COURSE OBJECTIVES:

- To grasp the fundamental knowledge of Multimedia elements and systems
- To get familiar with Multimedia file formats and standards
- To learn the process of Authoring multimedia presentations
- To learn the techniques of animation in 2D and 3D and for the mobile UI
- To explore different popular applications of multimedia

#### UNIT I INTRODUCTION TO MULTIMEDIA

6

Definitions, Elements, Multimedia Hardware and Software, Distributed multimedia systems, challenges: security, sharing / distribution, storage, retrieval, processing, computing. Multimedia metadata, Multimedia databases, Hypermedia, Multimedia Learning.

#### UNIT II MULTIMEDIA FILE FORMATS AND STANDARDS

6

File formats – Text, Image file formats, Graphic and animation file formats, Digital audio and Video file formats, Color in image and video, Color Models. Multimedia data and file formats for the web.

#### UNIT III MULTIMEDIA AUTHORIZING

6

Authoring metaphors, Tools Features and Types: Card and Page Based Tools, Icon and Object Based Tools, Time Based Tools, Cross Platform Authoring Tools, Editing Tools, Painting and Drawing Tools, 3D Modeling and Animation Tools, Image Editing Tools, audio Editing Tools, Digital Movie Tools, Creating interactive presentations, virtual learning, simulations.

#### UNIT IV ANIMATION

6

Principles of animation: staging, squash and stretch, timing, onion skinning, secondary action, 2D, 2 ½ D, and 3D animation, Animation techniques: Keyframe, Morphing, Inverse Kinematics, Hand Drawn, Character rigging, vector animation, stop motion, motion graphics, , Fluid Simulation, skeletal animation, skinning Virtual Reality, Augmented Reality.

#### UNIT V MULTIMEDIA APPLICATIONS

6

Multimedia Big data computing, social networks, smart phones, surveillance, Analytics, Multimedia Cloud Computing, Multimedia streaming cloud, media on demand, security and forensics, Online social networking, multimedia ontology, Content based retrieval from digital libraries.

**TOTAL : 30 PERIODS**

## **LIST OF EXPERIMENTS:**

### **Working with Image Editing tools:**

Install tools like GIMP/ InkScape / Krita / Pencil and perform editing operations:

- Ø Use different selection and transform tools to modify or improve an image
- Ø Create logos and banners for home pages of websites.

### **Working with Audio Editing tools:**

- Ø Install tools like, Audacity / Ardour for audio editing, sound mixing and special effects like fade-in or fade-out etc.,
- Ø Perform audio compression by choosing a proper codec.

### **Working with Video Editing and conversion tools:**

Install tools like OpenShot / Cinelerra / HandBrake for editing video content.

- Ø Edit and mix video content, remove noise, create special effects, add captions.
- Ø Compress and convert video file format to other popular formats.

### **Working with web/mobile authoring tools:**

Adapt / KompoZer/ BlueGriffon / BlueFish / Aptana Studio/ NetBeans / WordPress /Expression Web:

- Ø Design simple Home page with banners, logos, tables quick links etc
- Ø Provide a search interface and simple navigation from the home page to the inside pages of the website.
- Ø Design Responsive web pages for use on both web and mobile interfaces.

### **Working with Animation tools:**

Install tools like, Krita, Wick Editor, Blender:

- Ø Perform a simple 2D animation with sprites
- Ø Perform simple 3D animation with keyframes, kinematics
- Working with Mobile UI animation tools: Origami studio / Lottie / Framer etc.,

### **Working with E-Learning authoring tools:**

Install tools like EdApp / Moovly / CourseLab/ IsEazy and CamStudio/Ampache, VideoLAN:

- Ø Demonstrate screen recording and further editing for e-learning content.
- Ø Create a simple E-Learning module for a topic of your choice.

### **Creating VR and AR applications:**

- Ø Any affordable VR viewer like Google Cardboard and any development platform like Openspace 3D / ARCore etc.

*Note: all tools listed are open source. Usage of any proprietary tools in place of open source tools is not restricted.*

**30 PERIODS**

**WEB REFERENCES:**

1. <https://itsfoss.com/>
2. <https://www.ucl.ac.uk/slade/know/3396>
3. <https://handbrake.fr/>
4. <https://opensource.com/article/18/2/open-source-audio-visual-production-tools>  
<https://camstudio.org/>
5. <https://developer.android.com/training/animation/overview>
6. <https://developer.android.com/training/animation/overview> (UNIT-IV)

**COURSE OUTCOMES:**

- Get the bigger picture of the context of Multimedia and its applications
- Use the different types of media elements of different formats on content pages
- Author 2D and 3D creative and interactive presentations for different target multimedia applications.
- Use different standard animation techniques for 2D, 2 1/2 D, 3D applications
- Understand the complexity of multimedia applications in the context of cloud, security, bigdata streaming, social networking, CBIR etc.,

**TEXT BOOKS:**

1. Ze-Nian Li, Mark S. Drew, Jiangchuan Liu, "Fundamentals of Multimedia", Third Edition, Springer Texts in Computer Science, 2021. (UNIT-I, II, III)

**REFERENCES:**

1. John M Blain, "The Complete Guide to Blender Graphics: Computer Modeling & Animation", CRC press, 3<sup>rd</sup> Edition, 2016.
2. Gerald Friedland, Ramesh Jain, "Multimedia Computing", Cambridge University Press, 2018.
3. Prabhat K. Andleigh, Kiran Thakrar, "Multimedia System Design", Pearson Education, 1<sup>st</sup> Edition, 2015.
4. Mohsen Amini Salehi, Xiangbo Li, "Multimedia Cloud Computing Systems", Springer Nature, 1<sup>st</sup> Edition, 2021.
5. Mark Gaimbruno, "3D Graphics and Animation", Second Edition, New Riders, 2002.
6. Rogers David, "Animation: Master – A Complete Guide (Graphics Series)", Charles River Media, 2006.
7. Rick parent, "Computer Animation: Algorithms and Techniques", Morgan Kaufman, 3<sup>rd</sup> Edition, 2012.
8. Emilio Rodriguez Martinez, Mireia Alegre Ruiz, "UI Animations with Lottie and After Effects: Create, render, and ship stunning After Effects animations natively on mobile with React Native", Packt Publishing, 2022.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	2	3	-	-	-	3	2	1	2	3	2	3
2	3	3	3	3	3	-	-	-	3	3	2	2	3	2	3
3	3	3	3	3	3	-	-	-	3	3	2	3	3	2	3

4	3	3	3	3	3	2	-	-	3	3	3	3	3	3	3
5	3	3	3	3	3	2	-	-	3	3	3	3	3	3	3
AVg.	3.00	2.80	3.00	2.80	3.00	2.00	-	-	3.00	2.80	2.20	2.60	3.00	2.40	3.00

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS371

VIDEO CREATION AND EDITING

L T P C

2 0 2 3

**COURSE OBJECTIVES:**

- To introduce the broad perspective of linear and nonlinear editing concepts.
- To understand the concept of Storytelling styles.
- To be familiar with audio and video recording. To apply different media tools.
- To learn and understand the concepts of AVID XPRESS DV 4.

**UNIT I FUNDAMENTALS**

6

Evolution of filmmaking - linear editing - non-linear digital video - Economy of Expression - risks associated with altering reality through editing.

**UNIT II STORYTELLING**

6

Storytelling styles in a digital world through jump cuts, L-cuts, match cuts, cutaways, dissolves, split edits - Consumer and pro NLE systems - digitizing images - managing resolutions - mechanics of digital editing - pointer files - media management.

**UNIT III USING AUDIO AND VIDEO**

6

Capturing digital and analog video importing audio putting video on exporting digital video to tape recording to CDs and VCDs.

**UNIT IV WORKING WITH FINAL CUT PRO**

6

Working with clips and the Viewer - working with sequences, the Timeline, and the canvas - Basic Editing - Adding and Editing Testing Effects - Advanced Editing and Training Techniques - Working with Audio - Using Media Tools - Viewing and Setting Preferences.

**UNIT V WORKING WITH AVID XPRESS DV 4**

6

Starting Projects and Working with Project Window - Using Basic Tools and Logging - Preparing to Record and Recording - Importing Files - Organizing with Bins - Viewing and Making Footage - Using Timeline and Working in Trim Mode - Working with Audio - Output Options.

**30 PERIODS**

**LIST OF EXPERIMENTS**

**30 PERIODS**

1. Write a Movie Synopsis (Individual/Team Writing)
2. Present team stories in class.
3. Script/Storyboard Writing(Individual Assignment)
4. Pre-Production: Personnel, budgeting, scheduling, location scouting, casting, contracts & agreements
5. Production: Single camera production personnel & equipment, Documentary Production
6. Writing The Final Proposal: Overview, Media Treatments, Summary, Pitching

7. Write Documentary & Animation Treatment
8. Post-production: Editing, Sound design, Finishing

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the students will be able to:

- CO1:** Compare the strengths and limitations of Nonlinear editing.
- CO2:** Identify the infrastructure and significance of storytelling.
- CO3:** Apply suitable methods for recording to CDs and VCDs.
- CO4:** Address the core issues of advanced editing and training techniques.
- CO5:** Design and develop projects using AVID XPRESS DV 4

**TEXT BOOKS**

1. Avid Xpress DV 4 User Guide, 2007.
2. Final Cut Pro 6 User Manual, 2004.
3. Keith Underdahl, "Digital Video for Dummies", Third Edition, Dummy Series, 2001.
4. Robert M. Goodman and Partick McGarth, "Editing Digital Video: The Complete Creative and Technical Guide", Digital Video and Audio, McGraw – Hill 2003.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	2	1	1	-	-	-	1	2	3	2	3	1	1
2	2	3	3	3	1	-	-	-	1	2	2	1	1	1	1
3	2	2	3	3	1	-	-	-	3	1	1	1	2	1	2
4	2	2	2	2	1	-	-	-	3	1	1	1	2	2	2
5	2	1	3	3	1	-	-	-	3	2	1	2	2	2	1
AVg.	2.2	1.8	2.6	2.4	1	-	-	-	2.2	1.6	1.6	1.4	2	1.4	1.4

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CCW332**

**DIGITAL MARKETING**

**L T P C**  
**2 0 2 3**

**COURSE OBJECTIVES:**

- The primary objective of this module is to examine and explore the role and importance of digital marketing in today's rapidly changing business environment.
- It also focuses on how digital marketing can be utilized by organizations and how its effectiveness can be measured.

**UNIT I INTRODUCTION TO ONLINE MARKET**

**6**

Online Market space- Digital Marketing Strategy- Components - Opportunities for building Brand Website - Planning and Creation - Content Marketing.

**UNIT II SEARCH ENGINE OPTIMISATION**

**6**

Search Engine optimisation - Keyword Strategy- SEO Strategy - SEO success factors -On-Page Techniques - Off-Page Techniques. Search Engine Marketing- How Search Engine works- SEM components- PPC advertising -Display Advertisement



**UNIT III E- MAIL MARKETING 6**

E- Mail Marketing - Types of E- Mail Marketing - Email Automation - Lead Generation - Integrating Email with Social Media and Mobile- Measuring and maximizing email campaign effectiveness. Mobile Marketing- Mobile Inventory/channels- Location based; Context based; Coupons and offers, Mobile Apps, Mobile Commerce, SMS Campaigns-Profiling and targeting

**UNIT IV SOCIAL MEDIA MARKETING 6**

Social Media Marketing - Social Media Channels- Leveraging Social media for brand conversations and buzz. Successful /benchmark Social media campaigns. Engagement Marketing- Building Customer relationships - Creating Loyalty drivers - Influencer Marketing.

**UNIT V DIGITAL TRANSFORMATION 6**

Digital Transformation & Channel Attribution- Analytics- Ad-words, Email, Mobile, Social Media, Web Analytics - Changing your strategy based on analysis- Recent trends in Digital marketing.

**30 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

1. Subscribe to a weekly/quarterly newsletter and analyze how its content and structure aid with the branding of the company and how it aids its potential customer segments.
2. Perform keyword search for a skincare hospital website based on search volume and competition using Google keyword planner tool.
3. Demonstrate how to use the Google WebMasters Indexing API
4. Discuss an interesting case study regarding how an insurance company manages leads.
5. Discuss negative and positive impacts and ethical implications of using social media for political advertising.
6. Discuss how Predictive analytics is impacting marketing automation

**COURSE OUTCOMES:**

**CO1:** To examine and explore the role and importance of digital marketing in today's rapidly changing business environment..

**CO2:** To focuses on how digital marketing can be utilized by organizations and how its effectiveness can be measured.

**CO3:** To know the key elements of a digital marketing strategy.

**CO4:** To study how the effectiveness of a digital marketing campaign can be measured

**CO5:** To demonstrate advanced practical skills in common digital marketing tools such as SEO, SEM, Social media and Blogs.

**TOTAL:60 PERIODS**

**TEXT BOOKS**

1. Fundamentals of Digital Marketing by Puneet Singh Bhatia;Publisher: Pearson Education;
2. First edition ( July 2017);ISBN-10: 933258737X;ISBN-13: 978-9332587373.
3. Digital Marketing by Vandana Ahuja ;Publisher: Oxford University Press ( April 2015). ISBN-10: 0199455449
4. Marketing 4.0: Moving from Traditional to Digital by Philip Kotler;Publisher: Wiley; 1st edition ( April 2017); ISBN10: 9788126566938;ISBN 13: 9788126566938;ASIN: 8126566930.
5. Ryan, D. (2014 ). Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation, Kogan Page Limited..
6. Barker, Barker, Bormann and Neher(2017), Social Media Marketing: A Strategic Approach, 2E South-Western ,Cengage Learning.
7. Pulizzi,J Beginner's Guide to Digital Marketing , Mcgraw Hill Education

## CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
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1	3	3	2	1	3	-	-	-	1	2	3	3	3	3	3
2	2	2	2	1	3	-	-	-	1	2	3	3	3	3	3
3	1	1	1	2	2	-	-	-	1	2	1	1	3	2	1
4	3	2	2	3	1	-	-	-	1	3	2	3	2	3	2
5	2	3	1	3	3	-	-	-	2	3	1	2	1	2	1
<b>AVg.</b>	2.2	2.2	1.6	2	2.4	-	-	-	1.2	2.4	2	2.4	2.4	2.6	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS373

VISUAL EFFECTS

L T P C  
2 0 2 3

### COURSE OBJECTIVES

- To get a basic idea on animation principles and techniques
- To get exposure to CGI, color and light elements of VFX
- To have a better understanding of basic special effects techniques
- To have a knowledge of state of the art vfx techniques
- To become familiar with popular compositing techniques

### UNIT I ANIMATION BASICS 6

VFX production pipeline, Principles of animation, Techniques: Keyframe, kinematics, Full animation, limited animation, Rotoscoping, stop motion, object animation, pixilation, rigging, shape keys, motion paths.

### UNIT II CGI, COLOR, LIGHT 6

CGI – virtual worlds, Photorealism, physical realism, function realism, 3D Modeling and Rendering: color - Color spaces, color depth, Color grading, color effects, HDRI, Light – Area and mesh lights, image based lights, PBR lights, photometric light, BRDF shading model

### UNIT III SPECIAL EFFECTS 6

Special Effects – props, scaled models, animatronics, pyrotechniques, Schufftan process, Particle effects – wind, rain, fog, fire

### UNIT IV VISUAL EFFECTS TECHNIQUES 6

Motion Capture, Matt Painting, Rigging, Front Projection. Rotoscoping, Match Moving – Tracking, camera reconstruction, planar tracking, Calibration, Point Cloud Projection, Ground plane determination, 3D Match Moving

### UNIT V COMPOSITING 6

Compositing – chroma key, blue screen/green screen, background projection, alpha compositing, deep image compositing, multiple exposure, matting, VFX tools - Blender, Natron, GIMP.

**30 PERIODS**

## **Laboratory Experiments:**

### **Using Natron:**

- o Understanding Natron Environment:
- o Working with color and using color grading
- o using Channels
- o Merging images
- o Using Rotopaint
- o performing Tracking and stabilizing
- o Transforming elements
- o Stereoscopic compositing

### **Using Blender:**

- Ø Motion Tracking – camera and object tracking
- Ø Camera fx, color grading, vignettes
- Ø Compositing images and video files
- Ø Multilayer rendering

**30 PERIODS  
TOTAL: 60 PERIODS**

## **COURSE OUTCOMES**

At the end of the course, the student will be able to:

**CO1:**To implement animation in 2D / 3D following the principles and techniques

**CO2:**To use CGI, color and light elements in VFX applications

**CO3:**To create special effects using any of the state of the art tools

**CO4:**To apply popular visual effects techniques using advanced tools

**CO5:**To use compositing tools for creating VFX for a variety of applications

## **TEXT BOOKS:**

1. Chris Roda, Real Time Visual Effects for the Technical Artist, CRC Press, 1<sup>st</sup> Edition, 2022.
2. Steve Wright, Digital Compositing for film and video, Routledge, 4<sup>th</sup> Edition, 2017.
3. John Gress, Digital Visual Effects and Compositing, New Riders Press, 1<sup>st</sup> Edition, 2014.

## **REFERENCES:**

1. Jon Gress, "Digital Visual Effects and Compositing", New Riders Press, 1<sup>st</sup> Edition, 2014.
2. Robin Brinkman, The Art and Science of Digital Compositing: Techniques for Visual Effects, Animation and Motion Graphics", Morgan Kauffman, 2008.
3. Luiz Velho, Bruno Madeira, "Introduction to Visual Effects A Computational Approach", Routledge, 2023.
4. Jasmine Katatikarn, Michael Tanzillo, "Lighting for Animation: The art of visual storytelling", Routledge, 1<sup>st</sup> Edition, 2016.
5. Eran Dinur, "The Complete guide to Photorealism, for Visual Effects, Visualization
6. Jeffrey A. Okun, Susan Zwerman, Christopher McKittrick, " The VES Handbook of Visual Effects: Industry Standard VFX Practices and Procedures", Third Edition, 2020.and Games", Routledge, 1<sup>st</sup> Edition, 2022.
7. <https://www.blender.org/features/vfx/>
8. <https://natrongithub.github.io/>

### CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
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1	3	3	3	3	1	-	-	-	1	2	1	1	3	3	2
2	1	3	3	2	1	-	-	-	3	2	2	2	1	1	1
3	2	3	3	2	1	-	-	-	1	2	1	2	2	2	2
4	3	3	2	2	3	-	-	-	3	3	2	2	2	3	1
5	1	2	1	1	2	-	-	-	1	3	2	3	2	3	1
<b>AVg.</b>	2	2.8	2.4	2	1.6	-	-	-	1.8	2.4	1.6	2	2	2.4	1.4

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS347

GAME DEVELOPMENT

L T P C  
2 0 2 3

#### COURSE OBJECTIVES:

- To know the basics of 2D and 3D graphics for game development.
- To know the stages of game development.
- To understand the basics of a game engine.
- To survey the gaming development environment and tool kits.
- To learn and develop simple games using Pygame environment

#### UNIT I 3D GRAPHICS FOR GAME DESIGN

6

Genres of Games, Basics of 2D and 3D Graphics for Game Avatar, Game Components – 2D and 3D Transformations – Projections – Color Models – Illumination and Shader Models – Animation – Controller Based Animation.

#### UNIT II GAME DESIGN PRINCIPLES

6

Character Development, Storyboard Development for Gaming – Script Design – Script Narration, Game Balancing, Core Mechanics, Principles of Level Design – Proposals – Writing for Preproduction, Production and Post – Production.

#### UNIT III GAME ENGINE DESIGN

6

Rendering Concept – Software Rendering – Hardware Rendering – Spatial Sorting Algorithms – Algorithms for Game Engine– Collision Detection – Game Logic – Game AI – Pathfinding.

#### UNIT IV OVERVIEW OF GAMING PLATFORMS AND FRAMEWORKS

6

Pygame Game development – Unity – Unity Scripts – Mobile Gaming, Game Studio, Unity Single player and Multi-Player games.

#### UNIT V GAME DEVELOPMENT USING PYGAME

6

Developing 2D and 3D interactive games using Pygame – Avatar Creation – 2D and 3D Graphics Programming – Incorporating music and sound – Asset Creations – Game Physics algorithms Development – Device Handling in Pygame – Overview of Isometric and Tile Based arcade Games – Puzzle Games.

30 PERIODS

**COURSE OUTCOMES:****CO1:** Explain the concepts of 2D and 3d Graphics**CO2:** Design game design documents.**CO3:** Implementation of gaming engines.**CO4:** Survey gaming environments and frameworks.**CO5:** Implement a simple game in Pygame.**EXPERIMENTS:****30 PERIODS**

1. Installation of a game engine, e.g., Unity, Unreal Engine, familiarization of the GUI. Conceptualize the theme for a 2D game.
2. Character design, sprites, movement and character control
3. Level design: design of the world in the form of tiles along with interactive and collectible objects.
4. Design of interaction between the player and the world, optionally using the physics engine.
5. Developing a 2D interactive using Pygame
6. Developing a Puzzle game
7. Design of menus and user interaction in mobile platforms.
8. Developing a 3D Game using Unreal
9. Developing a Multiplayer game using unity

**TOTAL: 60 PERIODS****REFERENCES**

1. Sanjay Madhav, "Game Programming Algorithms and Techniques: A Platform Agnostic Approach", Addison Wesley, 2013.
2. Will McGugan, "Beginning Game Development with Python and Pygame: From Novice to Professional", Apress, 2007.
3. Paul Craven, "Python Arcade games", Apress Publishers, 2016.
4. David H. Eberly, "3D Game Engine Design: A Practical Approach to Real-Time Computer Graphics", Second Edition, CRC Press, 2006.
5. Jung Hyun Han, "3D Graphics for Game Programming", Chapman and Hall/CRC, 2011.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	2	-	-	-	-	-	-	-	2	2	2
2	1	2	2	1	2	-	-	-	-	-	-	-	2	2	1
3	1	1	1	2	1	-	-	-	-	-	-	-	2	2	2
4	3	3	1	3	3	-	-	-	-	-	-	-	2	2	3
5	3	3	2	1	3	-	-	-	-	-	-	-	2	2	3
<b>AVg.</b>	2.2	2.2	1.6	1.6	2.2	-	-	-	-	-	-	-	2	2	2.2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CCS353****MULTIMEDIA DATA COMPRESSION AND STORAGE****L T P C****2 0 2 3****COURSE OBJECTIVES:**

- To understand the basics of compression techniques
- To understand the categories of compression for text, image and video
- To explore the modalities of text, image and video compression algorithms
- To know about basics of consistency of data availability in storage devices
- To understand the concepts of data streaming services

<b>UNIT I</b>	<b>BASICS OF DATA COMPRESSION</b>	<b>6</b>
Introduction —Lossless and LossyCompression– Basics of Huffmann coding- Arithmetic coding- Dictionary techniques- Context based compression – Applications		
<b>UNIT II</b>	<b>IMAGE COMPRESSION</b>	<b>6</b>
Lossless Image compression – JPEG-CALIC-JPEG LS-Prediction using conditional averages – Progressive Image Transmission – Lossless Image compression formats – Applications - Facsimile encoding		
<b>UNIT III</b>	<b>VIDEO COMPRESSION</b>	<b>6</b>
Introduction – Motion Compensation – Video Signal Representation – H.261 – MPEG-1- MPEG-2- H.263.		
<b>UNIT IV</b>	<b>DATA PLACEMENT ON DISKS</b>	<b>6</b>
Statistical placement on Disks – Striping on Disks – Replication Placement on Disks – Constraint allocation on Disks – Tertiary storage Devices – Continuous Placement on Hierarchical storage system – Statistical placement on Hierarchical storage systems – Constraint allocation on Hierarchical storage system		
<b>UNIT V</b>	<b>DISK SCHEDULING METHODS</b>	<b>6</b>
Scheduling methods for disk requests – Feasibility conditions of concurrent streams– Scheduling methods for request streams		

**30 PERIODS**

**LIST OF EXPERIMENTS**

1. Construct Huffman codes for given symbol probabilities.
2. Encode run lengths with fixed-length code.
3. Lempel-Ziv algorithm for adaptive variable-length encoding
4. Compress the given word using arithmetic coding based on the frequency of the letters.
5. Write a shell script, which converts all images in the current directory in JPEG.
6. Write a program to split images from a video without using any primitives.
7. Create a photo album of a trip by applying appropriate image dimensions and format.
8. Write the code for identifying the popularity of content retrieval from media server.
9. Write the code for ensuring data availability in disks using strip based method.
10. Program for scheduling requests for data streams.

**30 PERIODS**

**TOTAL : 60 PERIODS**

**COURSE OUTCOMES:**

- CO1:** Understand the basics of text, Image and Video compression  
**CO2:** Understand the various compression algorithms for multimedia content  
**CO3:** Explore the applications of various compression techniques  
**CO4:** Explore knowledge on multimedia storage on disks  
**CO5:** Understand scheduling methods for request streams

## TEXT BOOKS

1. Khalid Sayood, Introduction to Data Compression, Morgan Kaufmann Series in Multimedia Information and Systems, 2018, 5th Edition.
2. Philip K.C.Tse, Multimedia Information Storage and Retrieval: Techniques and Technologies, 2008

## REFERENCES

1. David Salomon, A concise introduction to data compression, 2008.
2. Lenald Best, Best's Guide to Live Stream Video Broadcasting, BCB Live Teaching series, 2017.
3. Yun-Qing Shi, Image And Video Compression For Multimedia Engineering Fundamentals Algorithms And Standards, Taylor& Francis,2019
4. Irina Bocharova, Compression for Multimedia, Cambridge University Press; 1st edition, 2009

## CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	1	-	-	-	-	-	-	-	2	2	2
2	3	2	2	1	2	-	-	-	-	-	-	-	2	2	2
3	3	2	2	1	2	-	-	-	-	-	-	-	2	2	2
4	3	2	2	1	1	-	-	-	-	-	-	-	2	2	2
5	3	2	2	1	1	-	-	-	-	-	-	-	2	2	2
AVg.	3	2	2	1	1.4	-	-	-	-	-	-	-	2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS361

ROBOTIC PROCESS AUTOMATION

L T P C  
2 0 2 3

### COURSE OBJECTIVES:

- To understand the basic concepts of Robotic Process Automation.
- To expose to the key RPA design and development strategies and methodologies.
- To learn the fundamental RPA logic and structure.
- To explore the Exception Handling, Debugging and Logging operations in RPA.
- To learn to deploy and Maintain the software bot.

### UNIT I INTRODUCTION TO ROBOTIC PROCESS AUTOMATION

6

Emergence of Robotic Process Automation (RPA), Evolution of RPA, Differentiating RPA from Automation - Benefits of RPA - Application areas of RPA, Components of RPA, RPA Platforms. Robotic Process Automation Tools - Templates, User Interface, Domains in Activities, Workflow Files.

### UNIT II AUTOMATION PROCESS ACTIVITIES

6

Sequence, Flowchart & Control Flow: Sequencing the Workflow, Activities, Flowchart, Control Flow for Decision making. Data Manipulation: Variables, Collection, Arguments, Data Table, Clipboard management, File operations Controls: Finding the control, waiting for a control, Act on a control, UiExplorer, Handling Events

**UNIT III APP INTEGRATION, RECORDING AND SCRAPING 6**

App Integration, Recording, Scraping, Selector, Workflow Activities. Recording mouse and keyboard actions to perform operation, Scraping data from website and writing to CSV. Process Mining.

**UNIT IV EXCEPTION HANDLING AND CODE MANAGEMENT 6**

Exception handling, Common exceptions, Logging- Debugging techniques, Collecting crash dumps, Error reporting. Code management and maintenance: Project organization, Nesting workflows, Reusability, Templates, Commenting techniques, State Machine.

**UNIT V DEPLOYMENT AND MAINTENANCE 6**

Publishing using publish utility, Orchestration Server, Control bots, Orchestration Server to deploy bots, License management, Publishing and managing updates. RPA Vendors - Open Source RPA, Future of RPA

**30 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

**Setup and Configure a RPA tool and understand the user interface of the tool:**

1. Create a Sequence to obtain user inputs display them using a message box;
2. Create a Flowchart to navigate to a desired page based on a condition;
3. Create a State Machine workflow to compare user input with a random number.
4. Build a process in the RPA platform using UI Automation Activities.
5. Create an automation process using key System Activities, Variables and Arguments
6. Also implement Automation using System Trigger
7. Automate login to (web)Email account
8. Recording mouse and keyboard actions.
9. Scraping data from website and writing to CSV
10. Implement Error Handling in RPA platform
11. Web Scraping
12. Email Query Processing

**TOTAL:60 PERIODS**

**COURSE OUTCOMES:**

**By the end of this course, the students will be able to:**

- Enunciate the key distinctions between RPA and existing automation techniques and platforms.
- Use UiPath to design control flows and work flows for the target process
- Implement recording, web scraping and process mining by automation
- Use UiPath Studio to detect, and handle exceptions in automation processes
- Implement and use Orchestrator for creation, monitoring, scheduling, and controlling of automated bots and processes.

**TEXT BOOKS:**

1. Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath by Alok Mani Tripathi, Packt Publishing, 2018.
2. Tom Taulli , "The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems", Apress publications, 2020.



## REFERENCES:

1. Frank Casale (Author), Rebecca Dilla (Author), Heidi Jaynes (Author), Lauren Livingston (Author), Introduction to Robotic Process Automation: a Primer, Institute of Robotic Process Automation, Amazon Asia-Pacific Holdings Private Limited, 2018
2. Richard Murdoch, Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant, Amazon Asia-Pacific Holdings Private Limited, 2018
3. A Gerardus Blokdyk, "Robotic Process Automation Rpa A Complete Guide ", 2020

## CO's-PO's & PSO's MAPPING

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2	1	1	2	3	3	-	-	-	1	2	3	1	3	2	1
3	2	3	2	3	3	-	-	-	2	3	1	1	3	3	3
4	1	2	1	2	2	-	-	-	1	2	1	3	3	3	2
5	3	3	3	3	3	-	-	-	3	1	1	1	3	2	1
AVg.	2	2.2	2	2.4	2.8	-	-	-	1.6	2.2	1.8	1.6	2.8	2.4	1.6

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS340

CYBER SECURITY

L T P C  
2 0 2 3

### COURSE OBJECTIVES:

- To learn cybercrime and cyberlaw.
- To understand the cyber attacks and tools for mitigating them.
- To understand information gathering.
- To learn how to detect a cyber attack.
- To learn how to prevent a cyber attack.

### UNIT I INTRODUCTION

6

Cyber Security – History of Internet – Impact of Internet – CIA Triad; Reason for Cyber Crime – Need for Cyber Security – History of Cyber Crime; Cybercriminals – Classification of Cybercrimes – A Global Perspective on Cyber Crimes; Cyber Laws – The Indian IT Act – Cybercrime and Punishment.

### UNIT II ATTACKS AND COUNTERMEASURES

6

OSWAP; Malicious Attack Threats and Vulnerabilities: Scope of Cyber-Attacks – Security Breach – Types of Malicious Attacks – Malicious Software – Common Attack Vectors – Social engineering Attack – Wireless Network Attack – Web Application Attack – Attack Tools – Countermeasures.

### UNIT III RECONNAISSANCE

5

Harvester – Whois – Netcraft – Host – Extracting Information from DNS – Extracting Information from E-mail Servers – Social Engineering Reconnaissance; Scanning – Port Scanning – Network Scanning and Vulnerability Scanning – Scanning Methodology – Ping Sweer Techniques – Nmap Command Switches – SYN – Stealth – XMAS – NULL – IDLE – FIN Scans – Banner Grabbing and OS Finger printing Techniques.

**UNIT IV INTRUSION DETECTION****5**

Host -Based Intrusion Detection – Network -Based Intrusion Detection – Distributed or Hybrid Intrusion Detection – Intrusion Detection Exchange Format – Honeypots – Example System Snort.

**UNIT V INTRUSION PREVENTION****5**

Firewalls and Intrusion Prevention Systems: Need for Firewalls – Firewall Characteristics and Access Policy – Types of Firewalls – Firewall Basing – Firewall Location and Configurations – Intrusion Prevention Systems – Example Unified Threat Management Products.

**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS**

1. Install Kali Linux on Virtual box
2. Explore Kali Linux and bash scripting
3. Perform open source intelligence gathering using Netcraft, Whois Lookups, DNS Reconnaissance, Harvester and Maltego
4. Understand the nmap command and scan a target using nmap
5. Install metasploitable2 on the virtual box and search for unpatched vulnerabilities
6. Use Metasploit to exploit an unpatched vulnerability
7. Install Linux server on the virtual box and install ssh
8. Use Fail2banto scan log files and ban Ips that show the malicious signs
9. Launch brute-force attacks on the Linux server using Hydra.
10. Perform real-time network traffic analysis and data packet logging using Snort

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

- CO1:** Explain the basics of cyber security, cyber crime and cyber law (K2)
- CO2:** Classify various types of attacks and learn the tools to launch the attacks (K2)
- CO3:** Apply various tools to perform information gathering (K3)
- CO4:** Apply intrusion techniques to detect intrusion (K3)
- CO5:** Apply intrusion prevention techniques to prevent intrusion (K3)

**TOTAL:60 PERIODS****TEXTBOOKS**

1. Anand Shinde, "Introduction to Cyber Security Guide to the World of Cyber Security", Notion Press, 2021 (Unit 1)
2. Nina Godbole, Sunit Belapure, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley Publishers, 2011 (Unit 1)
3. <https://owasp.org/www-project-top-ten/>

**REFERENCES**

1. David Kim, Michael G. Solomon, "Fundamentals of Information Systems Security", Jones & Bartlett Learning Publishers, 2013 (Unit 2)
2. Patrick Engebretson, "The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made easy", Elsevier, 2011 (Unit 3)
3. Kimberly Graves, "CEH Official Certified Ethical hacker Review Guide", Wiley Publishers, 2007 (Unit 3)
4. William Stallings, Lawrie Brown, "Computer Security Principles and Practice", Third Edition, Pearson Education, 2015 (Units 4 and 5)
5. Georgia Weidman, "Penetration Testing: A Hands-On Introduction to Hacking", No Starch Press, 2014 (Lab)

## CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	1	-	1	-	-	-	-	1	-	2	2	2
2	1	3	1	3	2	1	-	-	-	-	-	-	2	2	1
3	2	1	1	1	-	1	-	-	-	-	1	-	2	2	2
4	3	3	2	2	2	1	-	-	-	-	-	-	2	2	3
5	3	2	1	1	1	1	-	1	-	-	1	-	2	2	2
AVg.	2	2	1.2	1.6	1	1	0	0.2	0	0	0.6	0	2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS359

QUANTUM COMPUTING

L T P C  
2 0 2 3

### COURSE OBJECTIVES:

- To know the background of classical computing and quantum computing.
- To learn the fundamental concepts behind quantum computation.
- To study the details of quantum mechanics and its relation to Computer Science.
- To gain knowledge about the basic hardware and mathematical models of quantum computation.
- To learn the basics of quantum information and the theory behind it.

### UNIT I QUANTUM COMPUTING BASIC CONCEPTS 6

Complex Numbers - Linear Algebra - Matrices and Operators - Global Perspectives Postulates of Quantum Mechanics – Quantum Bits - Representations of Qubits - Superpositions

### UNIT II QUANTUM GATES AND CIRCUITS 5

Universal logic gates - Basic single qubit gates - Multiple qubit gates - Circuit development - Quantum error correction

### UNIT III QUANTUM ALGORITHMS 7

Quantum parallelism - Deutsch's algorithm - The Deutsch–Jozsa algorithm - Quantum Fourier transform and its applications - Quantum Search Algorithms: Grover's Algorithm

### UNIT IV QUANTUM INFORMATION THEORY 6

Data compression - Shannon's noiseless channel coding theorem - Schumacher's quantum noiseless channel coding theorem - Classical information over noisy quantum channels

### UNIT V QUANTUM CRYPTOGRAPHY 6

Classical cryptography basic concepts - Private key cryptography - Shor's Factoring Algorithm - Quantum Key Distribution - BB84 - Ekert 91

30 PERIODS  
30 PERIODS

### PRACTICAL EXERCISES

1. Single qubit gate simulation - Quantum Composer
2. Multiple qubit gate simulation - Quantum Composer
3. Composing simple quantum circuits with q-gates and measuring the output into classical bits.
4. IBM Qiskit Platform Introduction

5. Implementation of Shor's Algorithms
6. Implementation of Grover's Algorithm
7. Implementation of Deutsch's Algorithm
8. Implementation of Deutsch-Jozsa's Algorithm
9. Integer factorization using Shor's Algorithm
10. QKD Simulation
11. Mini Project such as implementing an API for efficient search using Grover's Algorithms or

### COURSE OUTCOMES:

**On completion of the course, the students will be able to:**

**CO1:** Understand the basics of quantum computing.

**CO2:** Understand the background of Quantum Mechanics.

**CO3:** Analyze the computation models.

**CO4:** Model the circuits using quantum computation environments and frameworks.

**CO5:** Understand the quantum operations such as noise and error–correction.

**TOTAL:60 PERIODS**

### TEXTBOOKS:

1. Parag K Lala, Mc Graw Hill Education, "Quantum Computing, A Beginners Introduction", First edition (1 November 2020).
2. Michael A. Nielsen, Issac L. Chuang, "Quantum Computation and Quantum Information", Tenth Edition, Cambridge University Press, 2010.
3. Chris Bernhardt, The MIT Press; Reprint edition (8 September 2020), "Quantum Computing for Everyone".

### REFERENCES

1. Scott Aaronson, "Quantum Computing Since Democritus", Cambridge University Press, 2013.
2. N. David Mermin, "Quantum Computer Science: An Introduction", Cambridge University Press, 2007.

### CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	2	-	-	-	-	2	-	-	-	2	3	2
2	3	2	2	2	-	-	-	-	2	-	-	-	2	3	1
3	3	3	3	3	2	-	-	-	3	-	-	-	3	2	2
4	3	3	3	3	3	-	-	-	3	-	-	-	1	3	2
5	3	3	2	3	-	-	-	-	2	-	-	-	1	3	3
<b>AVg.</b>	3	2.6	2.4	2.6	1	-	-	-	2.4	-	-	-	1.8	2.8	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES:**

- To discuss on basics of 3D printing  
To explain the principles of 3D printing technique
- To explain and illustrate inkjet technology
- To explain and illustrate laser technology
- To discuss the applications of 3D printing

**UNIT I INTRODUCTION****6**

Introduction; Design considerations – Material, Size, Resolution, Process; Modelling and viewing - 3D; Scanning; Model preparation – Digital; Slicing; Software; File formats

**UNIT II PRINCIPLE****6**

Processes – Extrusion, Wire, Granular, Lamination, Photopolymerisation; Materials - Paper, Plastics, Metals, Ceramics, Glass, Wood, Fiber, Sand, Biological Tissues, Hydrogels, Graphene; Material Selection - Processes, applications, limitations;

**UNIT III INKJET TECHNOLOGY****6**

Printer - Working Principle, Positioning System, Print head, Print bed, Frames, Motion control; Print head Considerations – Continuous Inkjet, Thermal Inkjet, Piezoelectric Drop-On-Demand; Material Formulation for jetting; Liquid based fabrication – Continuous jet, Multijet; Powder based fabrication – Colourjet.

**UNIT IV LASER TECHNOLOGY****6**

Light Sources – Types, Characteristics; Optics – Deflection, Modulation; Material feeding and flow – Liquid, powder; Printing machines – Types, Working Principle, Build Platform, Print bed Movement, Support structures;

**UNIT V INDUSTRIAL APPLICATIONS****6**

Product Models, manufacturing – Printed electronics, Biopolymers, Packaging, Healthcare, Food, Medical, Biotechnology, Displays; Future trends;

**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS**

1. Study the interface and basic tools in the CAD software.
2. Study 3D printer(s) including print heads, build envelope, materials used and related support removal system(s).
3. Review of geometry terms of a 3D mesh.
4. Commands for moving from 2D to 3D.
5. Advanced CAD commands to navigate models in 3D space
6. Design any four everyday objects  
Refer to web sites like Thingiverse, Shapeways and GitFab to design four everyday objects that utilize the advantages of 3D printing
- . Choose four models from a sharing site like Thingiverse, Shapeways or Gitfab.
- a. Improve upon a file and make it your own. Some ideas include:
  - Redesign it with a specific user in mind

- Redesign it for a slightly different purpose
  - Improve the look of the product
    7. Use the CAM software to prepare files for 3D printing.
    8. Manipulate machine movement and material layering.
    9. Repair a 3D mesh using
- a) Freeware utilities: Autodesk MeshMixer (<http://goo.gl/x5nhYc>), MeshLab (<http://goo.gl/fgztLI>) or Netfabb Basic or Cloud Service (<http://goo.gl/Q1P47a>)
- b) Freeware tool tutorials: Netfabb Basic or Cloud Service (<http://goo.gl/Q1P47a>), Netfabb and MeshLab (<http://goo.gl/WPOVec>)
- c) Professional tools: Magics or Netfabb
- Equipment : one 3D printer for every 10-15 students

### COURSE OUTCOMES:

At the end of this course, the students will be able to:

**CO1:** Outline and examine the basic concepts of 3D printing technology

**CO2:** Outline 3D printing workflow`

**CO3:** Explain and categorise the concepts and working principles of 3D printing using inkjet technique

**CO4:** Explain and categorise the working principles of 3D printing using laser technique

**CO5:** Explain various method for designing and modeling for industrial applications

**TOTAL:60 PERIODS**

### TEXT BOOKS

1. Christopher Barnatt, 3D Printing: The Next Industrial Revolution, CreateSpace Independent Publishing Platform, 2013.
2. Ian M. Hutchings, Graham D. Martin, Inkjet Technology for Digital Fabrication, John Wiley & Sons, 2013.

### REFERENCES:

1. Chua, C.K., Leong K.F. and Lim C.S., Rapid prototyping: Principles and applications, second edition, World Scientific Publishers, 2010
2. Ibrahim Zeid, Mastering CAD CAM Tata McGraw-Hill Publishing Co., 2007
3. Joan Horvath, Mastering 3D Printing, APress, 2014

### CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	2	2	3	1	-	-	2	-	2	2	3	2	1
2	3	2	3	3	3	2	-	-	3	-	3	2	3	2	3
3	2	2	2	2	2	2	-	-	2	-	2	2	3	2	2
4	2	2	2	2	3	2	-	-	2	-	2	2	3	3	2
5	1	3	3	3	3	3	-	-	3	-	3	3	3	3	1
<b>AVg.</b>	1.8	2	2.4	2.4	2.8	2	-	-	2.4	-	2.4	2.2	3	2.4	1.8

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES:**

- To understand the basics of Knowledge Engineering.
- To discuss methodologies and modeling for Agent Design and Development.
- To design and develop ontologies.
- To apply reasoning with ontologies and rules.
- To understand learning and rule learning.

**UNIT I REASONING UNDER UNCERTAINTY 6**

Introduction – Abductive reasoning – Probabilistic reasoning: Enumerative Probabilities – Subjective Bayesian view – Belief Functions – Baconian Probability – Fuzzy Probability – Uncertainty methods - Evidence-based reasoning – Intelligent Agent – Mixed-Initiative Reasoning – Knowledge Engineering.

**UNIT II METHODOLOGY AND MODELING 6**

Conventional Design and Development – Development tools and Reusable Ontologies – Agent Design and Development using Learning Technology – Problem Solving through Analysis and Synthesis – Inquiry-driven Analysis and Synthesis – Evidence-based Assessment – Believability Assessment – Drill-Down Analysis, Assumption-based Reasoning, and What-If Scenarios.

**UNIT III ONTOLOGIES – DESIGN AND DEVELOPMENT 6**

Concepts and Instances – Generalization Hierarchies – Object Features – Defining Features – Representation – Transitivity – Inheritance – Concepts as Feature Values – Ontology Matching. Design and Development Methodologies – Steps in Ontology Development – Domain Understanding and Concept Elicitation – Modelling-based Ontology Specification.

**UNIT IV REASONING WITH ONTOLOGIES AND RULES 6**

Production System Architecture – Complex Ontology-based Concepts – Reduction and Synthesis rules and the Inference Engine – Evidence-based hypothesis analysis – Rule and Ontology Matching – Partially Learned Knowledge – Reasoning with Partially Learned Knowledge.

**UNIT V LEARNING AND RULE LEARNING 6**

Machine Learning – Concepts – Generalization and Specialization Rules – Types – Formal definition of Generalization. Modelling, Learning and Problem Solving – Rule learning and Refinement – Overview – Rule Generation and Analysis – Hypothesis Learning.

**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS**

1. Perform operations with Evidence Based Reasoning.
2. Perform Evidence based Analysis.
3. Perform operations on Probability Based Reasoning.
4. Perform Believability Analysis.
5. Implement Rule Learning and refinement.
6. Perform analysis based on learned patterns.
7. Construction of Ontology for a given domain.

**COURSE OUTCOMES:**

**At the end of this course, the students will be able to:**

- CO1:** Understand the basics of Knowledge Engineering.
- CO2:** Apply methodologies and modelling for Agent Design and Development.
- CO3:** Design and develop ontologies.
- CO4:** Apply reasoning with ontologies and rules.
- CO5:** Understand learning and rule learning.

**TOTAL: 60 PERIODS**

**TEXT BOOKS:**

1. Gheorghe Tecuci, Dorin Marcu, Mihai Boicu, David A. Schum, Knowledge Engineering Building Cognitive Assistants for Evidence-based Reasoning, Cambridge University Press, First Edition, 2016. (Unit 1 – Chapter 1 / Unit 2 – Chapter 3,4 / Unit 3 – Chapter 5, 6 / Unit 4 - 7 , Unit 5 – Chapter 8, 9 )

**REFERENCES:**

1. Ronald J. Brachman, Hector J. Levesque: Knowledge Representation and Reasoning, Morgan Kaufmann, 2004.
2. Ela Kumar, Knowledge Engineering, I K International Publisher House, 2018.
3. John F. Sowa: Knowledge Representation: Logical, Philosophical, and Computational Foundations, Brooks/Cole, Thomson Learning, 2000.
4. King , Knowledge Management and Organizational Learning , Springer, 2009.
5. Jay Liebowitz, Knowledge Management Learning from Knowledge Engineering, 1st Edition,2001.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	1	1	1	1	-	-	1	2	1	2	1	1	1
2	3	2	3	2	2	-	-	-	2	1	2	1	3	3	1
3	2	2	3	2	2	-	-	-	3	2	2	2	3	2	3
4	2	2	3	1	1	-	-	-	2	2	2	2	2	1	1
5	2	2	2	1	1	-	-	-	2	1	1	1	2	1	1
<b>AVg.</b>	2.4	1.8	2.4	1.4	1.4	0.2	0	0	2	1.6	1.6	1.6	2.2	1.6	1.4

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS364

**SOFT COMPUTING**

**L T P C  
2 0 2 3**

**COURSE OBJECTIVES:**

- To introduce the ideas of fuzzy sets, fuzzy logic and use of heuristics based on human experience.
- To provide the mathematical background for carrying out the optimization associated with neural network learning
- To learn various evolutionary Algorithms.
- To become familiar with neural networks that can learn from available examples and generalize to form appropriate rules for inference systems.
- To introduce case studies utilizing the above and illustrate the Intelligent behavior of programs based on soft computing



**UNIT 1 INTRODUCTION TO SOFT COMPUTING AND FUZZY LOGIC 6**

Introduction - Fuzzy Logic - Fuzzy Sets, Fuzzy Membership Functions, Operations on Fuzzy Sets, Fuzzy Relations, Operations on Fuzzy Relations, Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems

**UNIT II NEURAL NETWORKS 6**

Supervised Learning Neural Networks – Perceptrons - Backpropagation -Multilayer Perceptrons – Unsupervised Learning Neural Networks – Kohonen Self-Organizing Networks

**UNIT III GENETIC ALGORITHMS 6**

Chromosome Encoding Schemes -Population initialization and selection methods - Evaluation function - Genetic operators- Cross over – Mutation - Fitness Function – Maximizing function

**UNIT IV NEURO FUZZY MODELING 6**

ANFIS architecture – hybrid learning – ANFIS as universal approximator – Coactive Neuro fuzzy modeling – Framework – Neuron functions for adaptive networks – Neuro fuzzy spectrum - Analysis of Adaptive Learning Capability

**UNIT V APPLICATIONS 6**

Modeling a two input sine function - Printed Character Recognition – Fuzzy filtered neural networks – Plasma Spectrum Analysis – Hand written neural recognition - Soft Computing for Color Recipe Prediction.

**30 PERIODS**

**COURSE OUTCOMES:**

**CO1:** Understand the fundamentals of fuzzy logic operators and inference mechanisms

**CO2:** Understand neural network architecture for AI applications such as classification and clustering

**CO3:** Learn the functionality of Genetic Algorithms in Optimization problems

**CO4:** Use hybrid techniques involving Neural networks and Fuzzy logic

**CO5:** Apply soft computing techniques in real world applications

**PRACTICAL EXERCISES**

**30 PERIODS**

1. Implementation of fuzzy control/ inference system
2. Programming exercise on classification with a discrete perceptron
3. Implementation of XOR with backpropagation algorithm
4. Implementation of self organizing maps for a specific application
5. Programming exercises on maximizing a function using Genetic algorithm
6. Implementation of two input sine function
7. Implementation of three input non linear function

**TOTAL:60 PERIODS**

**TEXT BOOKS:**

1. SaJANG, J.-S. R., SUN, C.-T., & MIZUTANI, E. (1997). Neuro-fuzzy and soft computing: A computational approach to learning and machine intelligence. Upper Saddle River, NJ, Prentice Hall,1997
2. Himanshu Singh, Yunis Ahmad Lone, Deep Neuro-Fuzzy Systems with Python
3. With Case Studies and Applications from the Industry, Apress, 2020

## REFERENCES

1. roj Kaushik and Sunita Tiwari, Soft Computing-Fundamentals Techniques and Applications, 1st Edition, McGraw Hill, 2018.
2. S. Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI, 2003.
3. Samir Roy, Udit Chakraborty, Introduction to Soft Computing, Neuro Fuzzy and Genetic Algorithms, Pearson Education, 2013.
4. S.N. Sivanandam, S.N. Deepa, Principles of Soft Computing, Third Edition, Wiley India Pvt Ltd, 2019.
5. R.Eberhart, P.Simpson and R.Dobbins, "Computational Intelligence - PC Tools", AP Professional, Boston, 1996

## CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	3	3	-	-	-	3	1	3	2	3	1	2
2	2	3	3	2	3	-	-	-	3	2	3	2	2	1	3
3	1	3	2	2	1	-	-	-	3	1	1	2	1	3	2
4	1	2	1	3	2	-	-	-	3	3	1	1	2	1	1
5	2	3	1	2	1	-	-	-	3	3	3	2	1	2	3
AVg.	1.8	2.6	2	2.4	2	-	-	-	3	2	2.2	1.8	1.8	1.6	2.2

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS357

**OPTIMIZATION TECHNIQUES**

**L T P C**  
**2 0 2 3**

### COURSE OBJECTIVES:

The objective of this course is to enable the student to

- Formulate and solve linear programming problems (LPP)
- Evaluate Integer Programming Problems, Transportation and Assignment Problems.
- Obtain a solution to network problems using CPM and PERT techniques.
- Able to optimize the function subject to the constraints.
- Identify and solve problems under Markovian queuing models.

### UNIT I LINEAR MODELS

6

Introduction of Operations Research - mathematical formulation of LPP- Graphical Methods to solve LPP- Simplex Method- Two-Phase method

### UNIT II INTEGER PROGRAMMING AND TRANSPORTATION PROBLEMS

6

Integer programming: Branch and bound method- Transportation and Assignment problems - Traveling salesman problem.

### UNIT III PROJECT SCHEDULING

6

Project network -Diagram representation – Floats - Critical path method (CPM) – PERT- Cost considerations in PERT and CPM.

**UNIT IV CLASSICAL OPTIMIZATION THEORY 6**

Unconstrained problems – necessary and sufficient conditions - Newton-Raphson method, Constrained problems – equality constraints – inequality constraints - Kuhn-Tucker conditions.

**UNIT V QUEUING MODELS 6**

Introduction, Queuing Theory, Operating characteristics of a Queuing system, Constituents of a Queuing system, Service facility, Queue discipline, Single channel models, multiple service channels.

**30 PERIODS**

**PRACTICALS**

1. Solving simplex maximization problems using R programming.
2. Solving simplex minimization problems using R programming.
3. Solving mixed constraints problems – Big M & Two phase method using TORA.
4. Solving transportation problems using R.
5. Solving assignment problems using R.
6. Solving optimization problems using LINGO.
7. Studying Primal-Dual relationships in LP using TORA.
8. Solving LP problems using dual simplex method using TORA.
9. Sensitivity & post optimality analysis using LINGO.
10. Solving shortest route problems using optimization software
11. Solving Project Management problems using optimization software
12. Testing random numbers and random variates for their uniformity.
13. Testing random numbers and random variates for their independence
14. Solve single server queuing model using simulation software package.
15. Solve multi server queuing model using simulation software package.

**30 PERIODS**

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

**On successful completion of this course, the student will able to**

**CO1:** Formulate and solve linear programming problems (LPP)

**CO2:** Evaluate Integer Programming Problems, Transportation and Assignment Problems.

**CO3:** Obtain a solution to network problems using CPM and PERT techniques.

**CO4:** Able to optimize the function subject to the constraints.

**CO5:** Identify and solve problems under Markovian queuing models

**TEXT BOOK:**

1. Hamdy A Taha, Operations Research: An Introduction, Pearson, 10<sup>th</sup> Edition, 2017.

**REFERENCES:**

1. ND Vohra, Quantitative Techniques in Management, Tata McGraw Hill, 4<sup>th</sup> Edition, 2011.
2. J. K. Sharma, Operations Research Theory and Applications, Macmillan, 5<sup>th</sup> Edition, 2012.
3. Hiller F.S, Liberman G.J, Introduction to Operations Research, 10<sup>th</sup> Edition McGraw Hill, 2017.
4. Jit. S. Chandran, Mahendran P. Kawatra, KiHoKim, Essentials of Linear Programming, Vikas Publishing House Pvt.Ltd. New Delhi, 1994.
5. Ravindran A., Philip D.T., and Solberg J.J., Operations Research, John Wiley, 2<sup>nd</sup> Edition, 2007.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	1	1	-	-	-	2	1	1	2	3	3	3
2	3	1	2	2	3	-	-	-	3	2	3	1	2	1	1
3	2	3	3	2	2	-	-	-	3	3	1	3	1	3	1
4	2	2	1	1	3	-	-	-	2	1	3	1	2	1	2
5	2	1	1	3	2	-	-	-	3	3	1	3	3	2	1
<b>AVg.</b>	2.4	2	1.8	1.8	2.2	-	-	-	2.6	2	1.8	2	2.2	2	1.6

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CCS348**

**GAME THEORY**

**L T P C**

**2 0 2 3**

**COURSE OBJECTIVES:**

- To introduce the student to the notion of a game, its solutions concepts, and other basic notions and tools of game theory, and the main applications for which they are appropriate, including electronic trading markets.
- To formalize the notion of strategic thinking and rational choice by using the tools of game theory, and to provide insights into using game theory in modelling applications.
- To draw the connections between game theory, computer science, and economics, especially emphasizing the computational issues.
- To introduce contemporary topics in the intersection of game theory, computer science, and economics.
- To apply game theory in searching, auctioning and trading.

**UNIT I INTRODUCTION**

**6**

Introduction — Making rational choices: basics of Games — strategy — preferences — payoffs — Mathematical basics — Game theory — Rational Choice — Basic solution concepts-non-cooperative versus cooperative games — Basic computational issues — finding equilibria and learning in games- Typical application areas for game theory (e.g. Google's sponsored search, eBay auctions, electricity trading markets).

**UNIT II GAMES WITH PERFECT INFORMATION**

**6**

Games with Perfect Information — Strategic games — prisoner's dilemma, matching pennies - Nash equilibria —mixed strategy equilibrium — zero-sum games

**UNIT III GAMES WITH IMPERFECT INFORMATION**

**6**

Games with Imperfect Information — Bayesian Games — Motivational Examples — General Definitions — Information aspects — Illustrations — Extensive Games with Imperfect — Information — Strategies — Nash Equilibrium —Repeated Games — The Prisoner's Dilemma — Bargaining

**UNIT IV NON-COOPERATIVE GAME THEORY**

**6**

Non-cooperative Game Theory — Self-interested agents — Games in normal form — Analyzing games: from optimality to equilibrium — Computing Solution Concepts of Normal — Form Games — Computing Nash equilibria of two-player, zero-sum games —Computing Nash equilibria of two-player, general- sum games — Identifying dominated strategies

## UNIT V MECHANISM DESIGN

6

Aggregating Preferences — Social Choice — Formal Model — Voting — Existence of social functions — Ranking systems — Protocols for Strategic Agents: Mechanism Design — Mechanism design with unrestricted preferences

**30 PERIODS**

### COURSE OUTCOMES:

**Upon Completion of the course, the students will be able to**

**CO1:** Discuss the notion of a strategic game and equilibria and identify the characteristics of main applications of these concepts.

**CO2:** Discuss the use of Nash Equilibrium for other problems.

**CO3:** Identify key strategic aspects and based on these be able to connect them to appropriate game theoretic concepts given a real world situation.

**CO4:** Identify some applications that need aspects of Bayesian Games.

**CO5:** Implement a typical Virtual Business scenario using Game theory.

### LABORATORY EXERCISES:

1. Prisoner's dilemma
2. Pure Strategy Nash Equilibrium
3. Extensive Form – Graphs and Trees, Game Trees
4. Strategic Form – Elimination of dominant strategy
5. Minimax theorem, minimax strategies
6. Perfect information games: trees, players assigned to nodes, payoffs, backward Induction, subgame perfect equilibrium,
7. imperfect-information games - Mixed Strategy Nash Equilibrium - Finding mixed-strategy Nash equilibria for zero sum games, mixed versus behavioral strategies.
8. Repeated Games
9. Bayesian Nash equilibrium

**30 PERIODS**

**TOTAL: 60 PERIODS**

### TEXT BOOKS:

1. M. J. Osborne, An Introduction to Game Theory. Oxford University Press, 2012.
2. M. Machler, E. Solan, S. Zamir, Game Theory, Cambridge University Press, 2013.
3. N. Nisan, T. Roughgarden, E. Tardos, and V. V. Vazirani, Algorithmic Game Theory. Cambridge University Press, 2007.
4. A. Dixit and S. Skeath, Games of Strategy, Second Edition. W W Norton & Co Inc, 2004.
5. Yoav Shoham, Kevin Leyton-Brown, Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Cambridge University Press 2008.
6. Zhu Han, Dusit Niyato, Walid Saad, Tamer Basar and Are Hjorungnes, "Game Theory in Wireless and Communication Networks", Cambridge University Press, 2012.
7. Y. Narahari, "Game Theory and Mechanism Design", IISC Press, World Scientific.
8. William Spaniel, "Game Theory 101: The Complete Textbook", CreateSpace Independent Publishing, 2011.

## CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	3	3	-	-	-	-	-	-	-	1	1	3
2	3	3	3	2	3	-	-	-	-	-	-	-	1	1	1
3	1	1	3	3	3	-	-	-	-	-	-	-	1	1	2
4	2	1	1	1	1	-	-	-	-	-	-	-	1	1	2
5	2	2	3	2	1	-	-	-	-	-	-	-	1	1	2
AVg.	2.2	2	2.4	2.2	2.2	-	-	-	-	-	-	-	1	1	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS337

COGNITIVE SCIENCE

L T P C  
2 0 2 3

### COURSE OBJECTIVES:

- To know the theoretical background of cognition.
- To understand the link between cognition and computational intelligence.
- To explore probabilistic programming language.
- To study the computational inference models of cognition.
- To study the computational learning models of cognition.

#### UNIT I PHILOSOPHY, PSYCHOLOGY AND NEUROSCIENCE 6

Philosophy: Mental-physical Relation – From Materialism to Mental Science – Logic and the Sciences of the Mind – Psychology: Place of Psychology within Cognitive Science – Science of Information Processing –Cognitive Neuroscience – Perception – Decision – Learning and Memory – Language Understanding and Processing.

#### UNIT II COMPUTATIONAL INTELLIGENCE 6

Machines and Cognition – Artificial Intelligence – Architectures of Cognition – Knowledge Based Systems – Logical Representation and Reasoning – Logical Decision Making –Learning – Language – Vision.

#### UNIT III PROBABILISTIC PROGRAMMING LANGUAGE 6

WebPPL Language – Syntax – Using Javascript Libraries – Manipulating probability types and distributions – Finding Inference – Exploring random computation – Coroutines: Functions that receive continuations –Enumeration

#### UNIT IV INFERENCE MODELS OF COGNITION 6

Generative Models – Conditioning – Causal and statistical dependence – Conditional dependence – Data Analysis – Algorithms for Inference.

#### UNIT V LEARNING MODELS OF COGNITION 6

Learning as Conditional Inference – Learning with a Language of Thought – Hierarchical Models– Learning (Deep) Continuous Functions – Mixture Models.

30 PERIODS

### PRACTICAL EXERCISES

1. Demonstration of Mathematical functions using WebPPL.
2. Implementation of reasoning algorithms.

3. Developing an Application system using generative model.
4. Developing an Application using conditional inference learning model.
5. Application development using hierarchical model.
6. Application development using Mixture model.

**30 PERIODS**

**COURSE OUTCOMES:**

**At the end of this course, the students will be able to:**

- CO1:** Understand the underlying theory behind cognition.
- CO2:** Connect to the cognition elements computationally.
- CO3:** Implement mathematical functions through WebPPL.
- CO4:** Develop applications using cognitive inference model.
- CO5:** Develop applications using cognitive learning model.

**TOTAL: 60 PERIODS**

**TEXT BOOK:**

1. Vijay V Raghavan, Venkat N. Gudivada, Venu Govindaraju, C.R. Rao, Cognitive Computing: Theory and Applications: (Handbook of Statistics 35), Elsevier publications, 2016
2. Judith Hurwitz, Marcia Kaufman, Adrian Bowles, Cognitive Computing and Big Data Analytics, Wiley Publications, 2015
3. Robert A. Wilson, Frank C. Keil, "The MIT Encyclopedia of the Cognitive Sciences", The MIT Press, 1999.
4. Jose Luis Bermúdez, Cognitive Science -An Introduction to the Science of the Mind, Cambridge University Press 2020

**REFERENCES:**

1. Noah D. Goodman, Andreas Stuhlmüller, "The Design and Implementation of Probabilistic Programming Languages", Electronic version of book, <https://dippl.org/>.
2. Noah D. Goodman, Joshua B. Tenenbaum, The ProbMods Contributors, "Probabilistic Models of Cognition", Second Edition, 2016, <https://probmods.org/>.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	3	2	2	-	-	-	1	1	2	2	1	2	2
2	2	2	1	1	2	-	-	-	3	2	3	1	2	3	2
3	1	3	1	3	3	-	-	-	1	3	1	3	3	1	2
4	2	1	1	2	3	-	-	-	1	2	3	1	3	3	1
5	1	2	3	2	2	-	-	-	1	2	2	2	2	2	1
<b>AVG</b>	1.8	1.8	1.8	2	2.4	-	-	-	1.4	2	2.2	1.8	2.2	2.2	1.6

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CCS345**

**ETHICS AND AI**

**L T P C**  
**2 0 2 3**

**COURSE OBJECTIVES:**

- Study the morality and ethics in AI
- Learn about the Ethical initiatives in the field of artificial intelligence

- Study about AI standards and Regulations
- Study about social and ethical issues of Robot Ethics
- Study about AI and Ethics- challenges and opportunities

**UNIT I INTRODUCTION 6**

Definition of morality and ethics in AI-Impact on society-Impact on human psychology-Impact on the legal system-Impact on the environment and the planet-Impact on trust

**UNIT II ETHICAL INITIATIVES IN AI 6**

International ethical initiatives-Ethical harms and concerns-Case study: healthcare robots, Autonomous Vehicles , Warfare and weaponization.

**UNIT III AI STANDARDS AND REGULATION 6**

Model Process for Addressing Ethical Concerns During System Design - Transparency of Autonomous Systems-Data Privacy Process- Algorithmic Bias Considerations - Ontological Standard for Ethically Driven Robotics and Automation Systems

**UNIT IV ROBOETHICS: SOCIAL AND ETHICAL IMPLICATION OF ROBOTICS 6**

Robot-Roboethics- Ethics and Morality- Moral Theories-Ethics in Science and Technology - Ethical Issues in an ICT Society- Harmonization of Principles- Ethics and Professional Responsibility- Roboethics Taxonomy.

**UNIT V AI AND ETHICS- CHALLENGES AND OPPORTUNITIES 6**

Challenges - Opportunities- ethical issues in artificial intelligence- Societal Issues Concerning the Application of Artificial Intelligence in Medicine- decision-making role in industries-National and International Strategies on AI.

**30 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the students will be able to

**CO1:** Learn about morality and ethics in AI

**CO2:** Acquire the knowledge of real time application ethics, issues and its challenges.

**CO3:** Understand the ethical harms and ethical initiatives in AI

**CO4:** Learn about AI standards and Regulations like AI Agent, Safe Design of Autonomous and Semi-Autonomous Systems

**CO5:** Understand the concepts of Roboethics and Morality with professional responsibilities.

**CO6:** Learn about the societal issues in AI with National and International Strategies on AI

**PRACTICAL EXERCISES**

**30 PERIODS**

1. Recent case study of ethical initiatives in healthcare, autonomous vehicles and defense
2. Exploratory data analysis on a 2 variable linear regression model
3. Experiment the regression model without a bias and with bias
4. Classification of a dataset from UCI repository using a perceptron with and without bias
5. Case study on ontology where ethics is at stake
6. Identification on optimization in AI affecting ethics

**TOTAL: 60 PERIODS**

**TEXT BOOKS:**

1. y. Eleanor Bird, Jasmin Fox-Skelly, Nicola Jenner, Ruth Larbey, Emma Weitkamp and Alan Winfield ,”The ethics of artificial intelligence: Issues and initiatives”, EPRS | European



Parliamentary Research Service Scientific Foresight Unit (STOA) PE 634.452 – March 2020

- Patrick Lin, Keith Abney, George A Bekey,” Robot Ethics: The Ethical and Social Implications of Robotics”, The MIT Press- January 2014.

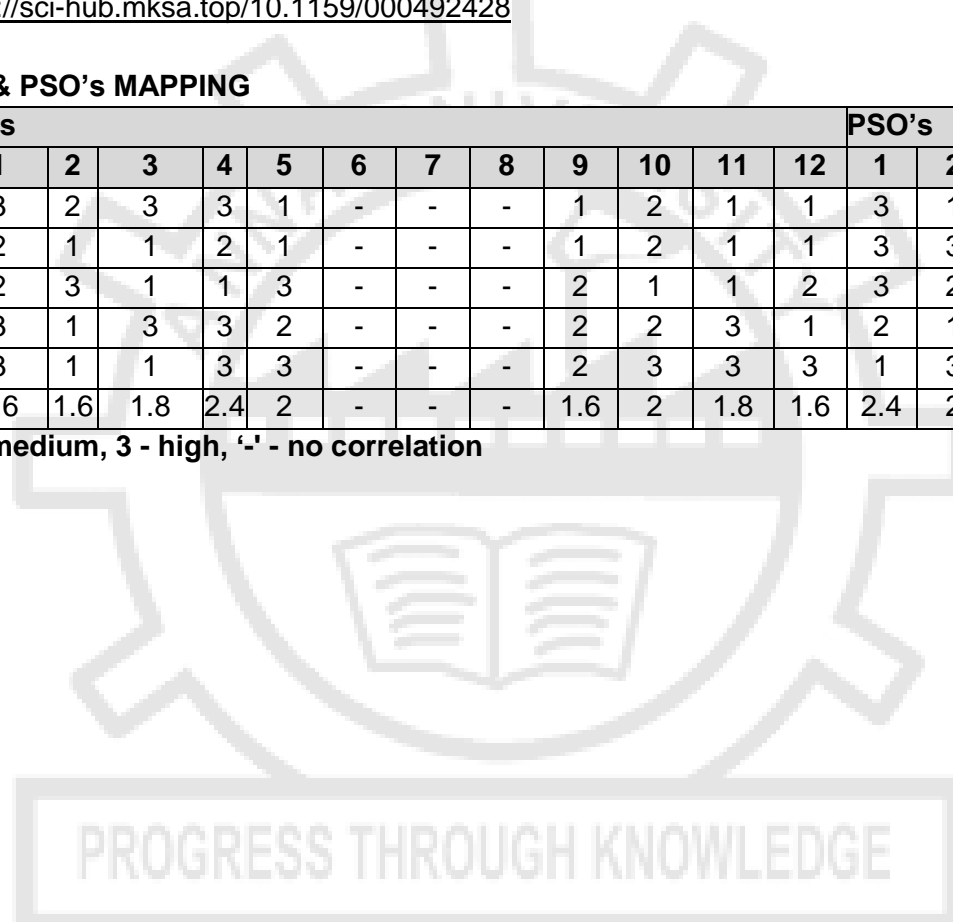
**REFERENCES:**

- Towards a Code of Ethics for Artificial Intelligence (Artificial Intelligence: Foundations, Theory, and Algorithms) by Paula Boddington, November 2017
- Mark Coeckelbergh,” AI Ethics”, The MIT Press Essential Knowledge series, April 2020
- Web link:
- [https://sci-hub.mkksa.top/10.1007/978-3-540-30301-5\\_65](https://sci-hub.mkksa.top/10.1007/978-3-540-30301-5_65)
- <https://www.scu.edu/ethics/all-about-ethics/artificial-intelligence-and-ethics-sixteen-challenges-and-opportunities/>
- <https://www.weforum.org/agenda/2016/10/top-10-ethical-issues-in-artificial-intelligence/>
- <https://sci-hub.mkksa.top/10.1159/000492428>

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	3	1	-	-	-	1	2	1	1	3	1	1
2	2	1	1	2	1	-	-	-	1	2	1	1	3	3	1
3	2	3	1	1	3	-	-	-	2	1	1	2	3	2	2
4	3	1	3	3	2	-	-	-	2	2	3	1	2	1	3
5	3	1	1	3	3	-	-	-	2	3	3	3	1	3	3
<b>AVg.</b>	2.6	1.6	1.8	2.4	2	-	-	-	1.6	2	1.8	1.6	2.4	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation



## SOFT CORE – MANAGEMENT

GE3751

### PRINCIPLES OF MANAGEMENT

L	T	P	C
3	0	0	3

#### COURSE OBJECTIVES:

- Sketch the Evolution of Management.
- Extract the functions and principles of management.
- Learn the application of the principles in an organization.
- Study the various HR related activities.
- Analyze the position of self and company goals towards business.

#### UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9

Definition of Management – Science or Art – Manager Vs Entrepreneur- types of managers- managerial roles and skills – Evolution of Management –Scientific, human relations, system and contingency approaches– Types of Business organization- Sole proprietorship, partnership, company-public and private sector enterprises- Organization culture and Environment – Current trends and issues in Management.

#### UNIT II PLANNING 9

Nature and purpose of planning – Planning process – Types of planning – Objectives – Setting objectives – Policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.

#### UNIT III ORGANISING 9

Nature and purpose – Formal and informal organization – Organization chart – Organization structure – Types – Line and staff authority – Departmentalization – delegation of authority – Centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.

#### UNIT IV DIRECTING 9

Foundations of individual and group behaviour– Motivation – Motivation theories – Motivational techniques – Job satisfaction – Job enrichment – Leadership – types and theories of leadership – Communication – Process of communication – Barrier in communication – Effective communication – Communication and IT.

#### UNIT V CONTROLLING 9

System and process of controlling – Budgetary and non - Budgetary control techniques – Use of computers and IT in Management control – Productivity problems and management – Control and performance – Direct and preventive control – Reporting.

**TOTAL: 45 PERIODS**

#### COURSE OUTCOMES:

- CO1:** Upon completion of the course, students will be able to have clear understanding of managerial functions like planning, organizing, staffing, leading & controlling.
- CO2:** Have same basic knowledge on international aspect of management.
- CO3:** Ability to understand management concept of organizing.
- CO4:** Ability to understand management concept of directing.

**CO5:** Ability to understand management concept of controlling.

**TEXT BOOKS:**

1. Harold Koontz and Heinz Weihrich “Essentials of management” Tata McGraw Hill, 1998.
2. Stephen P. Robbins and Mary Coulter, “ Management”, Prentice Hall (India) Pvt. Ltd., 10<sup>th</sup> Edition, 2009.

**REFERENCES:**

1. Robert Kreitner and Mamata Mohapatra, “ Management”, Biztantra, 2008.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, “Fundamentals of Management” Pearson Education, 7th Edition, 2011.
3. Tripathy PC and Reddy PN, “Principles of Management”, Tata McGraw Hill, 1999.

**CO’s-PO’s & PSO’s MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3		-	-	-	1	-	-	-	-	-	-	2	1	1
2	-	1	1	-	-	-	-	-	-	-	-	-	2	1	-
3	1		-	2	-	-	1	-	2	-	1	1	-	-	2
4	-	1	1	1	2	-	-	1	2	-	-	-	1	1	1
5	1		-	-	1	1	-	-	-	3	-	1	1	-	1
<b>Avg.</b>	1.66	1	1	1.5	1.5	1	1	1	2	3	1	1	1.5	1	1.25

1 - low, 2 - medium, 3 - high, ‘-’ - no correlation

**GE3752**

**TOTAL QUALITY MANAGEMENT**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- Teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
- Explain the TQM Principles for application.
- Define the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
- Describe Taguchi's Quality Loss Function, Performance Measures and apply Techniques like QFD, TPM, COQ and BPR.
- Illustrate and apply QMS and EMS in any organization.

**UNIT I**

**INTRODUCTION**

**9**

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality –Definition of TQM-- Basic concepts of TQM - Gurus of TQM (Brief introduction) -- TQM Framework- Barriers to TQM –Benefits of TQM.

**UNIT II**

**TQM PRINCIPLES**

**9**

Leadership - Deming Philosophy, Quality Council, Quality statements and Strategic planning- Customer Satisfaction –Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal-- Continuous process improvement –Juran Trilogy, PDCA cycle, 5S and Kaizen - Supplier partnership – Partnering,

Supplier selection, Supplier Rating and Relationship development.

**UNIT III TQM TOOLS & TECHNIQUES I 9**

The seven traditional tools of quality - New management tools - Six-sigma Process Capability- Bench marking - Reasons to benchmark, Benchmarking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, Learning from the data, Using the findings, Pitfalls and Criticisms of Benchmarking - FMEA - Intent , Documentation, Stages: Design FMEA and Process FMEA.

**UNIT IV TQM TOOLS & TECHNIQUES II 9**

Quality circles – Quality Function Deployment (QFD) - Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures- Cost of Quality - BPR.

**UNIT V QUALITY MANAGEMENT SYSTEM 9**

Introduction-Benefits of ISO Registration-ISO 9000 Series of Standards-Sector-Specific Standards - AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements-Implementation-Documentation- Internal Audits-Registration-ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001-Benefits of EMS.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- CO1:** Ability to apply TQM concepts in a selected enterprise.
- CO2:** Ability to apply TQM principles in a selected enterprise.
- CO3:** Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
- CO4:** Ability to understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.
- CO5:** Ability to apply QMS and EMS in any organization.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		3										3	2		3
2						3						3		2	
3					3				3					2	3
4		2			3	2	3	2				3	3	2	
5			3			3	3	2							
<b>AVg.</b>		2.5	3		3	2.6	3	2	3			3	2.5	2	3

1 - low, 2 - medium, 3 - high, ‘-’ - no correlation

**TEXT BOOK:**

1. Dale H.Besterfield, Carol B.Michna,Glen H. Bester field,MaryB.Sacre, HemantUrdhwareshe and RashmiUrdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.

**REFERENCES:**

1. Joel.E. Ross, "Total Quality Management – Text and Cases",Routledge.,2017.
2. Kiran.D.R, "Total Quality Management: Key concepts and case studies, Butterworth –

Heinemann Ltd, 2016.

3. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.
4. Suganthi, L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006 .

**GE3753 ENGINEERING ECONOMICS AND FINANCIAL ACCOUNTING**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- Understanding the concept of Engineering Economics.
- Implement various micro economics concept in real life.
- Gaining knowledge in the field of macro economics to enable the students to have better understanding of various components of macro economics.
- Understanding the different procedures of pricing.
- Learn the various cost related concepts in micro economics.

**UNIT I DEMAND & SUPPLY ANALYSIS 9**

Managerial Economics - Relationship with other disciplines - Firms: Types, objectives and goals - Managerial decisions - Decision analysis. Demand - Types of demand - Determinants of demand - Demand function – Demand elasticity - Demand forecasting - Supply - Determinants of supply - Supply function - Supply elasticity.

**UNIT II PRODUCTION AND COST ANALYSIS 9**

Production function - Returns to scale - Production optimization - Least cost input - Isoquants - Managerial uses of production function. Cost Concepts - Cost function - Determinants of cost - Short run and Long run cost curves - Cost Output Decision - Estimation of Cost.

**UNIT III PRICING 9**

Determinants of Price - Pricing under different objectives and different market structures - Price discrimination - Pricing methods in practice.

**UNIT IV FINANCIAL ACCOUNTING (ELEMENTARY TREATMENT) 9**

Balance sheet and related concepts - Profit & Loss Statement and related concepts - Financial Ratio Analysis - Cash flow analysis - Funds flow analysis - Comparative financial statements - Analysis & Interpretation of financial statements.

**UNIT V CAPITAL BUDGETING (ELEMENTARY TREATMENT) 9**

Investments - Risks and return evaluation of investment decision - Average rate of return - Payback Period - Net Present Value - Internal rate of return.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**Students able to**

**CO1:** Upon successful completion of this course, students will acquire the skills to apply the basics of economics and cost analysis to engineering and take economically sound decisions

**CO2:** Evaluate the economic theories, cost concepts and pricing policies

**CO3:** Understand the market structures and integration concepts

**CO4:** Understand the measures of national income, the functions of banks and concepts of globalization

**CO5:** Apply the concepts of financial management for project appraisal

**TEXT BOOKS:**

1. Panneer Selvam, R, "Engineering Economics", Prentice Hall of India Ltd, New Delhi, 2001.
2. Managerial Economics: Analysis, Problems and Cases - P. L. Mehta, Edition, 13. Publisher, Sultan Chand, 2007.

**REFERENCES:**

1. Chan S.Park, "Contemporary Engineering Economics", Prentice Hall of India, 2011.
2. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg. Press, Texas, 2010.
3. Degarmo, E.P., Sullivan, W.G and Canada, J.R, "Engineering Economy", Macmillan, New York, 2011.
4. Zahid A khan: Engineering Economy, "Engineering Economy", Dorling Kindersley, 2012
5. Dr. S. N. Maheswari and Dr. S.K. Maheshwari: Financial Accounting, Vikas, 2009

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	-	3	-	-	-	-	-	-	-	2	-	-	1	3	-
2	-	3	-	-	-	-	-	-	-	-	-	-	-	2	2
3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
4	2	3	3	-	2	-	-	-	-	-	-	-	2	3	-
5	3	3	3	-	2	-	-	-	-	-	-	-	2	-	2
<b>AVg.</b>	2.5	2.4	3	-	2	-	-	-	-	2	-	-	1.8	2.6	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**GE3754**

**HUMAN RESOURCE MANAGEMENT**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVE:**

- To provide knowledge about management issues related to staffing,
- To provide knowledge about management issues related to training,
- To provide knowledge about management issues related to performance
- To provide knowledge about management issues related to compensation
- To provide knowledge about management issues related to human factors consideration and compliance with human resource requirements.

**UNIT I INTRODUCTION TO HUMAN RESOURCE MANAGEMENT**

**9**

The importance of human resources – Objective of Human Resource Management - Human resource policies - Role of human resource manager.

**UNIT II HUMAN RESOURCE PLANNING**

**9**

Importance of Human Resource Planning – Internal and External sources of Human Resources - Recruitment - Selection – Socialization.

<b>UNIT III</b>	<b>TRAINING AND EXECUTIVE DEVELOPMENT</b>	<b>9</b>
Types of training and Executive development methods – purpose – benefits.		
<b>UNIT IV</b>	<b>EMPLOYEE COMPENSATION</b>	<b>9</b>
Compensation plan – Reward – Motivation – Career Development - Mentor – Protege relationships.		
<b>UNIT V</b>	<b>PERFORMANCE EVALUATION AND CONTROL</b>	<b>9</b>
Performance evaluation – Feedback - The control process – Importance – Methods – grievances – Causes – Redressal methods.		
		<b>TOTAL: 45 PERIODS</b>

**COURSE OUTCOMES:**

- CO1:** Students would have gained knowledge on the various aspects of HRM
- CO2:** Students will gain knowledge needed for success as a human resources professional.
- CO3:** Students will develop the skills needed for a successful HR manager.
- CO4:** Students would be prepared to implement the concepts learned in the workplace.
- CO5:** Students would be aware of the emerging concepts in the field of HRM

**TEXT BOOKS:**

1. Decenzo and Robbins, "Human Resource Management", 8th Edition, Wiley, 2007.
2. John Bernardin. H., "Human Resource Management – An Experimental Approach", 5th Edition, Tata McGraw Hill, 2013, New Delhi.

**REFERENCES:**

1. Luis R., Gomez-Mejia, DavidB. Balkin and Robert L. Cardy, "Managing Human Resources", 7<sup>th</sup> Edition, PHI, 2012.
2. Dessler, "Human Resource Management", Pearson Education Limited, 2007.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	1	2	2	2	1	1	2	1	1	1	1	1	1
2	3	3	2	3	2	2	2	2	3	1	2	1	1	2	1
3	3	3	3	3	3	3	2	2	3	1	2	1	1	2	1
4	3	3	2	3	3	2	2	2	2	1	1	1	1	1	1
5	3	3	1	2	2	2	2	2	2	1	1	1	1	1	1
<b>AVg.</b>	2.8	2.8	1.8	2.6	2.6	2.2	1.8	1.8	2.4	1	1.4	1	1	1.4	1

1 - low, 2 - medium, 3 - high, ‘-’- no correlation

<b>GE3755</b>	<b>KNOWLEDGE MANAGEMENT</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

**COURSE OBJECTIVES:**

The student should be made to:

- Learn the Evolution of Knowledge management.
- Be familiar with tools.
- Be exposed to Applications.
- Be familiar with some case studies.

**UNIT I INTRODUCTION 9**

Introduction: An Introduction to Knowledge Management - The foundations of knowledge management- including cultural issues- technology applications organizational concepts and processes- management aspects- and decision support systems. The Evolution of Knowledge management: From Information Management to Knowledge Management - Key Challenges Facing the Evolution of Knowledge Management - Ethics for Knowledge Management.

**UNIT II CREATING THE CULTURE OF LEARNING AND KNOWLEDGE SHARING 9**

Organization and Knowledge Management - Building the Learning Organization. Knowledge Markets: Cooperation among Distributed Technical Specialists – Tacit Knowledge and Quality Assurance.

**UNIT III KNOWLEDGE MANAGEMENT-THE TOOLS 9**

Telecommunications and Networks in Knowledge Management - Internet Search Engines and Knowledge Management - Information Technology in Support of Knowledge Management - Knowledge Management and Vocabulary Control - Information Mapping in Information Retrieval - Information Coding in the Internet Environment - Repackaging Information.

**UNIT IV KNOWLEDGE MANAGEMENT APPLICATION 9**

Components of a Knowledge Strategy - Case Studies (From Library to Knowledge Center, Knowledge Management in the Health Sciences, Knowledge Management in Developing Countries).

**UNIT V FUTURE TRENDS AND CASE STUDIES 9**

Advanced topics and case studies in knowledge management - Development of a knowledge management map/plan that is integrated with an organization's strategic and business plan - A case study on Corporate Memories for supporting various aspects in the process life -cycles of an organization.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, the student should be able to:

**CO1:** Understand the process of acquiring knowledge from experts

**CO2:** Understand the learning organization.

**CO3:** Use the knowledge management tools.

**CO4:** Develop knowledge management Applications.

**CO5:** Design and develop enterprise applications.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1					1											
2					2								1			
3					2									2		
4				1	1				1					1		
5				1	1				1					1		
<b>AVg.</b>				1	1.4				1				1	1.33		

1 - low, 2 - medium, 3 - high, ‘-’- no correlation

**TEXT BOOK:**

1. Srikantiah, T.K., Koenig, M., "Knowledge Management for the Information Professional" Information Today, Inc., 2000.



**REFERENCE:**

1. Nonaka, I., Takeuchi, H., "The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation", Oxford University Press, 1995.

**GE3792****INDUSTRIAL MANAGEMENT**

L	T	P	C
3	0	0	3

**COURSE OBJECTIVES**

- To study the basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.
- To study the planning; organizing and staffing functions of management in professional organization.
- To study the leading; controlling and decision making functions of management in professional organization.
- To learn the organizational theory in professional organization.
- To learn the principles of productivity and modern concepts in management in professional organization.

**UNIT I INTRODUCTION TO MANAGEMENT****9**

Management: Introduction; Definition and Functions – Approaches to the study of Management – Mintzberg's Ten Managerial Roles – Principles of Taylor; Fayol; Weber; Parker – Forms of Organization: Sole Proprietorship; Partnership; Company (Private and Public); Cooperative – Public Sector Vs Private Sector Organization – Business Environment: Economic; Social; Political; Legal – Trade Union: Definition; Functions; Merits & Demerits.

**UNIT II FUNCTIONS OF MANAGEMENT - I****9**

Planning: Characteristics; Nature; Importance; Steps; Limitation; Planning Premises; Strategic Planning; Vision & Mission statement in Planning– Organizing: Organizing Theory; Principles; Types; Departmentalization; Centralization and Decentralization; Authority & Responsibility – Staffing: Systems Approach; Recruiting and Selection Process; Human Resource Development (HRD) Concept and Design.

**UNIT III FUNCTIONS OF MANAGEMENT - II****9**

Directing (Leading): Leadership Traits; Style; Morale; Managerial Grids (Blake-Mounton, Reddin) – Communication: Purpose; Model; Barriers – Controlling: Process; Types; Levels; Guidelines; Audit (External, Internal, Merits); Preventive Control – Decision Making: Elements; Characteristics; Nature; Process; Classifications.

**UNIT IV ORGANIZATION THEORY****9**

Organizational Conflict: Positive Aspects; Individual; Role; Interpersonal; Intra Group; Inter Group; Conflict Management – Maslow's hierarchy of needs theory; Herzberg's motivation-hygiene theory; McClelland's three needs motivation theory; Vroom's valence-expectancy theory – Change Management: Concept of Change; Lewin's Process of Change Model; Sources of Resistance; Overcoming Resistance; Guidelines to managing Conflict.

**UNIT – V PRODUCTIVITY AND MODERN TOPICS****9**

Productivity: Concept; Measurements; Affecting Factors; Methods to Improve – Modern Topics (concept, feature/characteristics, procedure, merits and demerits): Business Process Reengineering (BPR); Benchmarking; SWOT/SWOC Analysis; Total Productive Maintenance; Enterprise Resource Planning (ERP); Management of Information Systems (MIS).

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

At the end of the course the students would be able to

- CO1** Explain basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.
- CO2** Discuss the planning; organizing and staffing functions of management in professional organization.
- CO3** Apply the leading; controlling and decision making functions of management in professional organization.
- CO4** Discuss the organizational theory in professional organization.
- CO5** Apply principles of productivity and modern concepts in management in professional organization.

**TEXTBOOKS:**

1. M. Govindarajan and S. Natarajan, "Principles of Management", Prentice Hall of India, New Delhi, 2009.
2. Koontz. H. and Wehrich. H., "Essentials of Management: An International Perspective", 8<sup>th</sup> Edition, Tata McGrawhill, New Delhi, 2010.

**REFERENCES:**

1. Joseph J, Massie, "Essentials of Management", 4<sup>th</sup> Edition, Pearson Education, 1987.
2. Saxena, P. K., "Principles of Management: A Modern Approach", Global India Publications, 2009.
3. S.Chandran, "Organizational Behaviours", Vikas Publishing House Pvt. Ltd., 1994.
4. Richard L. Daft, "Organization Theory and Design", South Western College Publishing, 11<sup>th</sup> Edition, 2012.
5. S. Trevis Certo, "Modern Management Concepts and Skills", Pearson Education, 2018.

**CO's-PO's & PSO's MAPPING**

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
2	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
3	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
4	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
5	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

## MANDATORY COURSES I

<b>MX3081</b>	<b>INTRODUCTION TO WOMEN AND GENDER STUDIES</b>	<b>L T P C</b> <b>3 0 0 0</b>
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### **COURSE OUTLINE**

#### **UNIT I            CONCEPTS**

Sex vs. Gender, masculinity, femininity, socialization, patriarchy, public/ private, essentialism, binaryism, power, hegemony, hierarchy, stereotype, gender roles, gender relation, deconstruction, resistance, sexual division of labour.

#### **UNIT II            FEMINIST THEORY**

Liberal, Marxist, Socialist, Radical, Psychoanalytic, postmodernist, ecofeminist.

#### **UNIT III           WOMEN'S MOVEMENTS: GLOBAL, NATIONAL AND LOCAL**

Rise of Feminism in Europe and America.  
Women's Movement in India.

#### **UNIT IV            GENDER AND LANGUAGE**

Linguistic Forms and Gender.  
Gender and narratives.

#### **UNIT V            GENDER AND REPRESENTATION**

Advertising and popular visual media.

Gender and Representation in Alternative Media.  
Gender and social media.

**TOTAL : 45 PERIODS**

<b>MX3082</b>	<b>ELEMENTS OF LITERATURE</b>	<b>L T P C</b> <b>3 0 0 0</b>
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### **COURSE OBJECTIVE:**

- To make the students aware about the finer sensibilities of human existence through an art form. The students will learn to appreciate different forms of literature as suitable modes of expressing human experience.

### **1. COURSE CONTENTS**

Introduction to Elements of Literature

#### **1.    Relevance of literature**

- a) Enhances Reading, thinking, discussing and writing skills.
- b) Develops finer sensibility for better human relationship.
- c) Increases understanding of the problem of humanity without bias.

- d) Providing space to reconcile and get a cathartic effect.

## **2. Elements of fiction**

- a) Fiction, fact and literary truth.
- b) Fictional modes and patterns.
- c) Plot character and perspective.

## **3. Elements of poetry**

- a) Emotions and imaginations.
- b) Figurative language.
- c) (Simile, metaphor, conceit, symbol, pun and irony).
- d) Personification and animation.
- e) Rhetoric and trend.

## **4. Elements of drama**

- a) Drama as representational art.
- b) Content mode and elements.
- c) Theatrical performance.
- d) Drama as narration, mediation and persuasion.
- e) Features of tragedy, comedy and satire.

## **3. READINGS:**

1. An Introduction to the Study of English Literature, W.H. Hudson, Atlantic, 2007.
2. An Introduction to Literary Studies, Mario Klarer, Routledge, 2013.
3. The Experience of Poetry, Graham Mode, Open college of Arts with Open Univ Press, 1991.
4. The Elements of Fiction: A Survey, Ulf Wolf (ed), Wolfstuff, 2114.
5. The Elements of Drama, J.L.Styan, Literary Licensing, 2011.

### **3.1 Textbook:**

3.2 \*Reference Books:: To be decided by the teacher and student, on the basis of individual student so as to enable him or her to write the term paper.

## **4. OTHER SESSION:**

### **4.1\*Tutorials:**

4.2\*Laboratory:

4.3\*Project: The students will write a term paper to show their understanding of a particular piece of literature

### 5.\*ASSESSMENT:

5.1HA:

5.2Quizzes-HA:

5.3Periodical Examination: one

5.4Project/Lab: one (under the guidance of the teachers the students will take a volume of poetry, fiction or drama and write a term paper to show their understanding of it in a given context; sociological, psychological, historical, autobiographical etc.

5.5Final Exam:

**TOTAL : 45 PERIODS**

### OUTCOME OF THE COURSE:

- Students will be able to understand the relevance of literature in human life and appreciate its aspects in developing finer sensibilities.

**MX3083**

**FILM APPRECIATION**

**LT PC  
3 0 0 0**

In this course on film appreciation, the students will be introduced broadly to the development of film as an art and entertainment form. It will also discuss the language of cinema as it evolved over a century. The students will be taught as to how to read a film and appreciate the various nuances of a film as a text. The students will be guided to study film joyfully.

### Theme - A: The Component of Films

A-1: The material and equipment

A-2: The story, screenplay and script

A-3: The actors, crew members, and the director

A-4: The process of film making... structure of a film

### Theme - B: Evolution of Film Language

B-1: Film language, form, movement etc.

B-2: Early cinema... **silent film** (Particularly French)

B-3: The emergence of feature films: **Birth of a Nation**

B-4: Talkies

### Theme - C: Film Theories and Criticism/Appreciation

C-1: Realist theory; Auteurists

C-2: Psychoanalytic, Ideological, Feminists

C-3: How to read films?  
C-4: Film Criticism / Appreciation

### **Theme – D: Development of Films**

D-1: Representative Soviet films  
D-2: Representative Japanese films  
D-3: Representative Italian films  
D-4: Representative Hollywood film and the studio system

### **Theme - E: Indian Films**

E-1: The early era  
E-2: The important films made by the directors  
E-3: The regional films  
E-4: The documentaries in India

### **READING:**

A Reader containing important articles on films will be prepared and given to the students. The students must read them and present in the class and have discussion on these.

**MX3084                      DISASTER RISK REDUCTION AND MANAGEMENT                      L T P C**  
**3 0 0 0**

### **COURSE OBJECTIVE**

- To impart knowledge on concepts related to disaster, disaster risk reduction, disaster management
- To acquaint with the skills for planning and organizing disaster response

### **UNIT I                      HAZARDS, VULNERABILITY AND DISASTER RISKS                      9**

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Types of Disasters: Natural, Human induced, Climate change induced –Earthquake, Landslide, Flood, Drought, Fire etc – Technological disasters- Structural collapse, Industrial accidents, oil spills -Causes, Impacts including social, Economic, political, environmental, health, psychosocial, etc.- Disaster vulnerability profile of India and Tamil Nadu - Global trends in disasters: urban disasters, pandemics, Complex emergencies, -, Inter relations between Disasters and Sustainable development Goals

### **UNIT II                      DISASTER RISK REDUCTION (DRR)                      9**

Sendai Framework for Disaster Risk Reduction, Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community Based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Early Warning System – Advisories from Appropriate Agencies.- Relevance of indigenous Knowledge, appropriate technology and Local resources.

### **UNIT III                      DISASTER MANAGEMENT                      9**

Components of Disaster Management – Preparedness of rescue and relief, mitigation, rehabilitation and reconstruction- Disaster Risk Management and post disaster management – Compensation

and Insurance- Disaster Management Act (2005) and Policy - Other related policies, plans, programmers and legislation - Institutional Processes and Framework at State and Central Level- (NDMA –SDMA-DDMA-NRDF- Civic Volunteers)

**UNIT IV TOOLS AND TECHNOLOGY FOR DISASTER MANAGEMENT 9**

Early warning systems -Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment. - Elements of Climate Resilient Development –Standard operation Procedure for disaster response – Financial planning for disaster Management

**UNIT V DISASTER MANAGEMENT: CASE STUDIES 9**

Discussion on selected case studies to analyse the potential impacts and actions in the contest of disasters-Landslide Hazard Zonation: Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.- Field work-Mock drill -

**TOTAL : 45 PERIODS**

**TEXT BOOKS:**

- 1 Taimpo (2016), Disaster Management and Preparedness, CRC Publications
- 2 Singh R (2017), Disaster Management Guidelines for earthquakes, Landslides, Avalanches and tsunami, Horizon Press Publications
- 3 Singhal J.P. “Disaster Management”, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
- 4 Tushar Bhattacharya, “Disaster Science and Management”, McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10:** 1259007367, **ISBN-13:** 978-1259007361]

**REFERENCES**

1. Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005.
2. Government of India, National Disaster Management Policy, 2009.
3. Shaw R (2016), Community based Disaster risk reduction, Oxford University Press

**COURSE OUTCOME:**

**CO1:** To impart knowledge on the concepts of Disaster, Vulnerability and Disaster Risk reduction (DRR)

**CO2:** To enhance understanding on Hazards, Vulnerability and Disaster Risk Assessment prevention and risk reduction

**CO3:** To develop disaster response skills by adopting relevant tools and technology

**CO4:** Enhance awareness of institutional processes for Disaster response in the country and

**CO5:** Develop rudimentary ability to respond to their surroundings with potential Disaster response in areas where they live, with due sensitivity

## CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	3	-	-	2	2	-	-	2	-	2	-	1
2	3	3	3	3	-	-	2	1	-	-	2	-	2	-	1
3	3	3	3	3	-	-	2	2	-	-	-	-	2	-	1
4	3	3	2	3	-	-	2	1	-	-	2	-	2	-	1
5	3	3	2	3	-	-	2	2	-	-	2	-	3	-	1
<b>AVG</b>	3	3	3	3	-	-	2	2	-	-	2	-	2	-	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

### MANDATORY COURSES II

MX3085

**WELL-BEING WITH TRADITIONAL PRACTICES-YOGA, AYURVEDA AND SIDDHA**

**L T P C**  
**3 0 0 0**

#### **COURSE OBJECTIVES:**

- To enjoy life happily with fun filled new style activities that help to maintain health also
- To adapt a few lifestyle changes that will prevent many health disorders
- To be cool and handbill every emotion very smoothly in every walk of life
- To learn to eat cost effective but healthy foods that are rich in essential nutrients
- To develop immunity naturally that will improve resistance against many health disorders

#### **UNIT I HEALTH AND ITS IMPORTANCE**

**2+4**

**Health: Definition - Importance of maintaining health** - More importance on prevention than treatment

Ten types of health one has to maintain - Physical health - Mental health - Social health - Financial health - Emotional health - Spiritual health - Intellectual health - Relationship health - Environmental health - Occupational/Professional health.

**Present health status** - The life expectancy-present status - mortality rate - dreadful diseases - Non-communicable diseases (NCDs) the leading cause of death - 60% - heart disease – cancer – diabetes - chronic pulmonary diseases - risk factors – tobacco – alcohol - unhealthy diet - lack of physical activities.

**Types of diseases and disorders** - Lifestyle disorders – Obesity – Diabetes - Cardiovascular diseases – Cancer – Strokes – COPD - Arthritis - Mental health issues.

**Causes of the above diseases / disorders - Importance of prevention of illness** - Takes care of health - Improves quality of life - Reduces absenteeism - Increase satisfaction - Saves time

**Simple lifestyle modifications to maintain health** - Healthy Eating habits (Balanced diet according to age) Physical Activities (Stretching exercise, aerobics, resisting exercise) - Maintaining BMI-Importance and actions to be taken



## UNIT II DIET

4+6

**Role of diet in maintaining health** - energy one needs to keep active throughout the day - nutrients one needs for growth and repair - helps one to stay strong and healthy - helps to prevent diet-related illness, such as some cancers - keeps active and - helps one to maintain a healthy weight - helps to reduce risk of developing lifestyle disorders like diabetes – arthritis – hypertension – PCOD – infertility – ADHD – sleeplessness -helps to reduce the risk of heart diseases - keeps the teeth and bones strong.

**Balanced Diet and its 7 Components** - Carbohydrates – Proteins – Fats – Vitamins – Minerals - Fibre and Water.

**Food additives and their merits & demerits** - Effects of food additives - Types of food additives - Food additives and processed foods - Food additives and their reactions

### Definition of BMI and maintaining it with diet

Importance - Consequences of not maintaining BMI - different steps to maintain optimal BM

### Common cooking mistakes

Different cooking methods, merits and demerits of each method

## UNIT III ROLE OF AYURVEDA & SIDDHA SYSTEMS IN MAINTAINING HEALTH 4+4

**AYUSH systems and their role in maintaining health** - preventive aspect of AYUSH - AYUSH as a soft therapy.

**Secrets of traditional healthy living** - Traditional Diet and Nutrition - Regimen of Personal and Social Hygiene - Daily routine (Dinacharya) - Seasonal regimens (Ritucharya) - basic sanitation and healthy living environment - Sadvritta (good conduct) - for conducive social life.

**Principles of Siddha & Ayurveda systems** - Macrocosm and Microcosm theory - Pancheekarana Theory / (Five Element Theory) 96 fundamental Principles - Uyir Thathukkal (Tri-Dosha Theory) - Udal Thathukkal

### Prevention of illness with our traditional system of medicine

Primary Prevention - To decrease the number of new cases of a disorder or illness - Health promotion/education, and - Specific protective measures - Secondary Prevention - To lower the rate of established cases of a disorder or illness in the population (prevalence) - Tertiary Prevention - To decrease the amount of disability associated with an existing disorder.

## UNIT IV MENTAL WELLNESS

3+4

**Emotional health** - Definition and types - Three key elements: the subjective experience - the physiological response - the behavioral response - Importance of maintaining emotional health - Role of emotions in daily life -Short term and long term effects of emotional disturbances - Leading a healthy life with emotions - Practices for emotional health - Recognize how thoughts influence emotions - Cultivate positive thoughts - Practice self-compassion - Expressing a full range of emotions.

**Stress management** - Stress definition - Stress in daily life - How stress affects one's life - Identifying the cause of stress - Symptoms of stress - Managing stress (habits, tools, training, professional help) - Complications of stress mismanagement.

**Sleep** - Sleep and its importance for mental wellness - Sleep and digestion.

**Immunity - Types and importance - Ways to develop immunity**

**UNIT V YOGA**

**2+12**

**Definition and importance of yoga** - Types of yoga - How to Choose the Right Kind for individuals according to their age - The Eight Limbs of Yoga - Simple yogasanas for cure and prevention of health disorders - What yoga can bring to our life.

**TOTAL : 45 PERIODS**

**TEXT BOOKS:**

1. Nutrition and Dietetics - Ashley Martin, Published by White Word Publications, New York, NY 10001, USA
2. Yoga for Beginners\_ 35 Simple Yoga Poses to Calm Your Mind and Strengthen Your Body, by Cory Martin, Copyright © 2015 by Althea Press, Berkeley, California

**REFERENCES:**

1. WHAT WE KNOW ABOUT EMOTIONAL INTELLIGENCE How It Affects Learning, Work, Relationships, and Our Mental Health, by Moshe Zeidner, Gerald Matthews, and Richard D. Roberts
2. A Bradford Book, The MIT Press, Cambridge, Massachusetts, London, England The Mindful Self-Compassion Workbook, Kristin Neff, Ph.D Christopher Germer, Ph.D, Published by The Guilford Press A Division of Guilford Publications, Inc.370 Seventh Avenue, Suite 1200, New York, NY 10001
1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4799645/>
2. **Simple lifestyle modifications to maintain health** <https://www.niddk.nih.gov/health-information/diet-nutrition/changing-habits-better-health#:~:text=Make%20your%20new%20healthy%20habit,t%20have%20time%20to%20cook.>
3. **Read more:** <https://www.legit.ng/1163909-classes-food-examples-functions.html>
4. <https://www.yaclass.in/p/science-state-board/class-9/nutrition-and-health-5926>
5. **Benefits of healthy eating** <https://www.cdc.gov/nutrition/resources-publications/benefits-of-healthy-eating.html>
6. **Food additives** <https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/food-additives>
7. **BMI** <https://www.hsph.harvard.edu/nutritionsource/healthy-weight/>  
<https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle---who-recommendations>
8. **Yoga** <https://www.healthifyme.com/blog/types-of-yoga/>  
<https://yogamedicine.com/guide-types-yoga-styles/>  
**Ayurveda** : <https://vikaspedia.in/health/ayush/ayurveda-1/concept-of-healthy-living-in-ayurveda>
9. **Siddha** : [http://www.tkdl.res.in/tkdl/langdefault/Siddha/Sid\\_Siddha\\_Concepts.asp](http://www.tkdl.res.in/tkdl/langdefault/Siddha/Sid_Siddha_Concepts.asp)
10. **CAM** : <https://www.hindawi.com/journals/ecam/2013/376327/>
11. **Preventive** herbs : <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3847409/>

**COURSE OUTCOMES:**

After completing the course, the students will be able to:

**CO1:** Learn the importance of different components of health

**CO2:** Gain confidence to lead a healthy life

**CO3:** Learn new techniques to prevent lifestyle health disorders

**CO4:** Understand the importance of diet and workouts in maintaining health

**UNIT I CONCEPTS AND PERSPECTIVES**

Meaning of History

Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history  
Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation  
verses evidence, concept of historical inevitability, Historical Positivism.

Science and Technology-Meaning, Scope and Importance, Interaction of science, technology &  
society, Sources of history on science and technology in India.

**UNIT II HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA**

Introduction to the works of D.D. Kosambi, Dharmpal, Debiprasad Chattopadhyay, Rehman, S. Irfan  
Habib, Deepak Kumar, Dhruv Raina, and others.

**UNIT III SCIENCE AND TECHNOLOGY IN ANCIENT INDIA**

Technology in pre-historic period

Beginning of agriculture and its impact on technology

Science and Technology during Vedic and Later Vedic times

Science and technology from 1<sup>st</sup> century AD to C-1200.

**UNIT IV SCIENCE AND TECHNOLOGY IN MEDIEVAL INDIA**

Legacy of technology in Medieval India, Interactions with Arabs

Development in medical knowledge, interaction between Unani and Ayurveda and alchemy

Astronomy and Mathematics: interaction with Arabic Sciences

Science and Technology on the eve of British conquest

**UNIT V SCIENCE AND TECHNOLOGY IN COLONIAL INDIA**

Science and the Empire

Indian response to Western Science

Growth of techno-scientific institutions

**UNIT VI SCIENCE AND TECHNOLOGY IN A POST-INDEPENDENT INDIA**

Science, Technology and Development discourse

Shaping of the Science and Technology Policy

Developments in the field of Science and Technology

Science and technology in globalizing India

Social implications of new technologies like the Information Technology and Biotechnology

**TOTAL : 45 PERIODS**

**MX3087 POLITICAL AND ECONOMIC THOUGHT FOR A HUMANE SOCIETY**

Pre-Requisite: None. (Desirable: Universal Human Values 1, Universal Human Values 2)

## **COURSE OBJECTIVES:**

- This course will begin with a short overview of human needs and desires and how different political-economic systems try to fulfill them. In the process, we will end with a critique of different systems and their implementations in the past, with possible future directions.

## **COURSE TOPICS:**

Considerations for humane society, holistic thought, human being's desires, harmony in self, harmony in relationships, society, and nature, societal systems. **(9 lectures, 1 hour each)**

(Refs: A Nagaraj, M K Gandhi, JC Kumarappa)

Capitalism – Free markets, demand-supply, perfect competition, laissez-faire, monopolies, imperialism. Liberal democracy. **(5 lectures)**

(Refs: Adam Smith, J S Mill)

Fascism and totalitarianism. World war I and II. Cold war. **(2 lectures)**

Communism – Mode of production, theory of labour, surplus value, class struggle, dialectical materialism, historical materialism, Russian and Chinese models.

(Refs: Marx, Lenin, Mao, M N Roy) **(5 lectures)**

Welfare state. Relation with human desires. Empowered human beings, satisfaction. **(3 lectures)**

Gandhian thought. Swaraj, Decentralized economy & polity, Community. Control over one's lives. Relationship with nature. **(6 lectures)**

(Refs: M K Gandhi, Schumacher, Kumarappa)

Essential elements of Indian civilization. **(3 lectures)**

(Refs: Pt Sundarlal, R C Mazumdar, Dharampal)

Technology as driver of society, Role of education in shaping of society. Future directions. **(4 lectures)** (Refs: Nandkishore Acharya, David Dixon, Lewis Mumford)

**Conclusion (2 lectures)**

**Total lectures: 39**

**Preferred Textbooks:** See Reference Books

**Reference Books:** Authors mentioned along with topics above. Detailed reading list will be provided.

**GRADING:**

Mid sems	30
End sem	20
Home Assign	10
Term paper	40

**TOTAL : 45 PERIODS****COURSE OUTCOME:**

- The students will get an understanding of how societies are shaped by philosophy, political and economic system, how they relate to fulfilling human goals & desires with some case studies of how different attempts have been made in the past and how they have fared.

**MX3088****STATE, NATION BUILDING AND POLITICS IN INDIA****L T P C****3 0 0 0****COURSE OBJECTIVE:**

The objective of the course is to provide an understanding of the state, how it works through its main organs, primacy of politics and political process, the concept of sovereignty and its changing contours in a globalized world. In the light of this, an attempt will be made to acquaint the students with the main development and legacies of national movement and constitutional development in India, reasons for adopting a Parliamentary-federal system, the broad philosophy of the Constitution of India and the changing nature of Indian Political System. Challenges/ problems and issues concerning national integration and nation-building will also be discussed in the contemporary context with the aim of developing a future vision for a better India.

**TOPICS:**

Understanding the need and role of State and politics.

Development of Nation-State, sovereignty, sovereignty in a globalized world.

Organs of State – Executive, Legislature, Judiciary. Separation of powers, forms of government-unitary-federal, Presidential-Parliamentary,  
The idea of India.

1857 and the national awakening.

1885 Indian National Congress and development of national movement – its legacies. Constitution making and the Constitution of India.

Goals, objective and philosophy.

Why a federal system?

National integration and nation-building.

Challenges of nation-building – State against democracy (Kothari)

New social movements.

The changing nature of Indian Political System, the future scenario.

What can we do?

## OUTCOME OF THE COURSE:

It is expected that this course will make students aware of the theoretical aspect of the state, its organs, its operationalization aspect, the background and philosophy behind the founding of the present political system, broad streams and challenges of national integration and nation-building in India. It will equip the students with the real understanding of our political system/ process in correct perspective and make them sit up and think for devising ways for better participation in the system with a view to making the governance and delivery system better for the common man who is often left unheard and unattended in our democratic setup besides generating a lot of dissatisfaction and difficulties for the system.

## SUGGESTED READING:

- i. Sunil Khilnani, The Idea of India. Penguin India Ltd., New Delhi.
- ii. Madhav Khosla, The Indian Constitution, Oxford University Press. New Delhi, 2012.
- iii. Brij Kishore Sharma, Introduction to the Indian Constitution, PHI, New Delhi, latest edition.
- iv. Sumantra Bose, Transforming India: Challenges to the World's Largest Democracy, Picador India, 2013.
- v. Atul Kohli, Democracy and Discontent: India's Growing Crisis of Governability, Cambridge University Press, Cambridge, U. K., 1991.
- vi. M. P. Singh and Rekha Saxena, Indian Politics: Contemporary Issues and Concerns, PHI, New Delhi, 2008, latest edition.
- vii. Rajni Kothari, Rethinking Democracy, Orient Longman, New Delhi, 2005.

**TOTAL : 45 PERIODS**

**MX3089**

**INDUSTRIAL SAFETY**

**L T P C  
3 0 0 0**

## COURSE OBJECTIVES

- To Understand the Introduction and basic Terminologies safety.
- To enable the students to learn about the Important Statutory Regulations and standards.
- To enable students to Conduct and participate the various Safety activities in the Industry.
- To have knowledge about Workplace Exposures and Hazards.
- To assess the various Hazards and consequences through various Risk Assessment Techniques.

## UNIT I SAFETY TERMINOLOGIES

Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators- lag Indicators-Flammability- Toxicity Time-weighted Average (TWA) - Threshold LimitValue (TLV) - Short Term Exposure Limit (STEL)- Immediately dangerous to life or health (IDLH)- acute and chronic Effects- Routes of Chemical Entry-Personnel Protective Equipment- Health and Safety Policy-Material Safety Data Sheet MSDS

## UNIT II STANDARDS AND REGULATIONS

Indian Factories Act-1948- Health- Safety- Hazardous materials and Welfare- ISO 45001:2018 occupational health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998- Hazard Identification and Risk Analysis- code of practice IS 15656:2006

### **UNIT III SAFETY ACTIVITIES**

Toolbox Talk- Role of safety Committee- Responsibilities of Safety Officers and Safety Representatives- Safety Training and Safety Incentives- Mock Drills- On-site Emergency Action Plan- Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment

### **UNIT IV WORKPLACE HEALTH AND SAFETY**

Noise hazard- Particulate matter- musculoskeletal disorder improper sitting poster and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety- Toxic gas Release

### **UNIT V HAZARD IDENTIFICATION TECHNIQUES**

Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment- Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment

**TOTAL : 45 PERIODS**

### **COURSE OUTCOMES:**

Course outcomes on completion of this course the student will be able:

**CO1:** Understand the basic concept of safety.

**CO2:** Obtain knowledge of Statutory Regulations and standards.

**CO3:** Know about the safety Activities of the Working Place.

**CO4:** Analyze on the impact of Occupational Exposures and their Remedies

**CO5:** Obtain knowledge of Risk Assessment Techniques.

### **TEXTBOOKS**

1. R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems KHANNA PUBLISHER
2. L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education

### **REFERENCES**

1. Frank Lees (2012) 'Lees' Loss Prevention in Process Industries. Butterworth-Heinemann publications, UK, 4th Edition.
2. John Ridley & John Channing (2008) Safety at Work: Routledge, 7th Edition.
3. Dan Petersen (2003) Techniques of Safety Management: A System Approach.
4. Alan Waring. (1996). Safety management system: Chapman & Hall, England
5. Society of Safety Engineers, USA

### **ONLINE RESOURCES**

ISO 45001:2018 occupational health and safety (OH&S) International Organization for Standardization <https://www.iso.org/standard/63787.html>

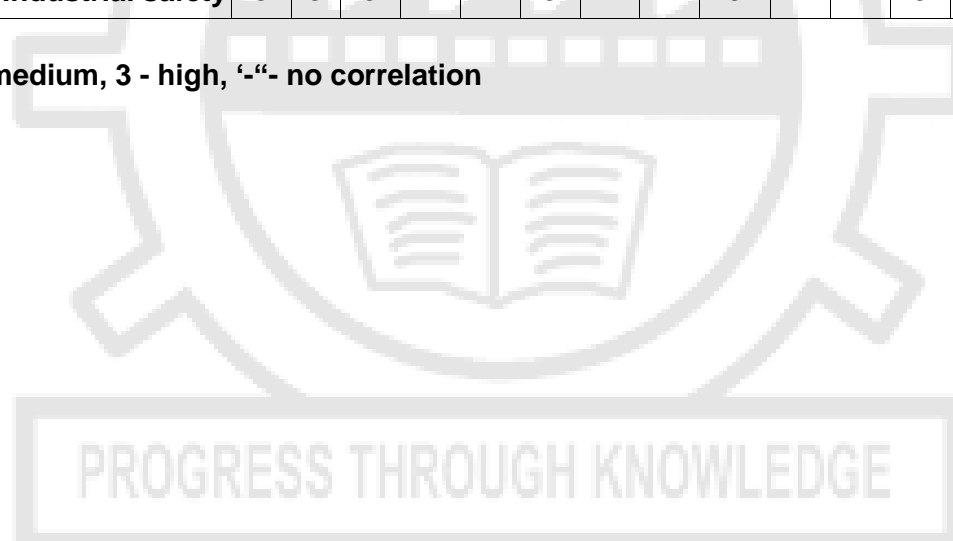
Indian Standard code of practice on occupational safety and health audit <https://law.resource.org/pub/in/bis/S02/is.14489.1998.pdf>

Indian Standard code of practice on Hazard Identification and Risk Analysis IS 15656:2006 <https://law.resource.org/pub/in/bis/S02/is.15656.2006.pdf>

### CO's-PO's & PSO's MAPPING

Course Outcome s	Statement	Program Outcome														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	Understand the basic concept of safety.	3	3	3	1	1	3	2	2	3	3	1	3	3	3	3
CO2	Obtain knowledge of Statutory Regulations and standards.	2	3	2	2	1	3	2	3	3	2	1	3	3	3	3
CO3	Know about the safety Activities of the Working Place.	2	2	2	2	1	2	2	2	3	2	1	2	3	3	3
CO4	Analyze on the impact of Occupational Exposures and their Remedies	3	3	3	2	2	3	2	2	3	2	1	3	3	3	3
CO5	Obtain knowledge of Risk Assessment Techniques.	3	2	3	2	2	3	2	2	3	2	2	3	3	3	3
<b>Industrial safety</b>		3	3	3	2	1	3	2	2	3	2	1	3	3	3	3

1 - low, 2 - medium, 3 - high, '-' - no correlation





## OPEN ELECTIVE I

OAS351

SPACE SCIENCE

L T P C  
3 0 0 3

### **COURSE OBJECTIVES:**

- To outline the space environment and their effects.
- To extend the origin of universe and development.
- To classify the galaxies and their evolution.
- To interpret the variable stars in the galaxies.
- To explain theory of formation of our solar system.

### **UNIT I INTRODUCTION**

**9**

Introduction to space science and applications – historical development – Space Environment- Vacuum and its Effects, Plasma & Radiation Environments and their Effects, Debris Environment and its Effects - Newton's Law of gravitation – Fundamental Physical Principles.

### **UNIT II ORIGIN OF UNIVERSE**

**9**

Early history of the universe – Big-Bang and Hubble expansion model of the universe – cosmic microwave background radiation – dark matter and dark energy.

### **UNIT III GALAXIES**

**7**

Galaxies, their evolution and origin – active galaxies and quasars – Galactic rotation – Stellar populations – galactic magnetic field and cosmic rays.

### **UNIT IV STARS**

**10**

Stellar spectra and structure – stellar evolution – Nucleo-synthesis and formation of elements – Classification of stars – Harvard classification system – Hertzsprung-Russel diagram – Luminosity of star – variable stars – composite stars (white dwarfs, Neutron stars, black hole, star clusters, supernova and binary stars) – Chandrasekhar limit.

### **UNIT V SOLAR SYSTEM**

**10**

Nebular theory of formation of our Solar System – Solar wind and nuclear reaction as the source of energy – Sun and Planets: Brief description about shape size – period of rotation about axis and period of revolution – distance of planets from sun – Bode's law – Kepler's Laws of planetary motion – Newton's deductions from Kepler's Laws – correction of Kepler's third law – determination of mass of earth – determination of mass of planets with respect to earth – Brief description of Asteroids – Satellites and Comets.

**TOTAL: 45 PERIODS**

### **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1:** Obtain a broad, basic knowledge of the space sciences.

**CO2:** Explain the scientific concepts such as evolution by means of natural selection, age of the Earth and solar system and the Big-Bang.

**CO3:** Describe the main features and formation theories of the various types of observed galaxies, in particular the Milky Way.

**CO4:** Explain stellar evolution, including red giants, supernovas, neutron stars, pulsars, white dwarfs and black holes, using evidence and presently accepted theories;

**CO5:** Describe the presently accepted formation theories of the solar system based upon observational and physical constraints;

**TEXT BOOKS:**

1. Hess W., "Introduction to Space Science", Gordon & Breach Science Pub; Revised Ed., 1968.
2. Krishnaswami K. S., "Astrophysics: A modern Perspective", New Age International, 2006.

**REFERENCES:**

1. Arnab Rai Choudhuri, "Astrophysics for Physicists", Cambridge University Press, New York, 2010.
2. Krishnaswami K. S., "Understanding cosmic Panorama", New Age International, 2008.

**OIE351**

**INTRODUCTION TO INDUSTRIAL ENGINEERING**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

The objective of this course is to provide foundation in Industrial Engineering in order to enable the students to make significant contributions for improvements in diverse organizations.

- Explain the concepts productivity and productivity measurement approaches.
- Explain the basic principles in facilities planning and plant location.
- Apply work study and ergonomic principles to design workplaces for the improvement of human performance
- Impart knowledge to design and implement Statistical Process control in any industry.
- Recognize the concept of Production and Operations Management in creating and enhancing a firm's competitive advantages

**UNIT I INTRODUCTION**

**9**

Concepts of Industrial Engineering – History and development of Industrial Engineering – Roles of Industrial Engineer – Applications of Industrial Engineering – Production Management Vs Industrial Engineering – Production System – Input Output Model – Productivity – Factors affecting Productivity – Increasing Productivity of resources – Kinds of Productivity measures.

**UNIT II PLANT LOCATION AND LAYOUT**

**9**

Factors affecting Plant location – COURSE OBJECTIVES of Plant Layout – Principles of Plant Layout – Types of Plant Layout – Methods of Plant and Facility Layout – Storage Space requirements – Plant Layout procedure – Line Balancing methods.

**UNIT III WORK SYSTEM DESIGN & ERGONOMICS**

**9**

Need – COURSE OBJECTIVES – Method Study procedure – Principles of Motion Economy – Work Measurement procedures – Time Study – Work sampling- Ergonomics and its areas of application in the work system - Physical work load and energy expenditure, Anthropometry – measures – design procedure, Work postures-sitting, standing.

**UNIT IV STATISTICAL QUALITY CONTROL**

**9**

Definition and Concepts – Fundamentals – Control Charts for variables – Control Charts for attributes – Acceptance Sampling- O.C curve – Single sampling plan- Double sampling plan.

**UNIT V PRODUCTION PLANNING AND CONTROL****9**

Forecasting – Qualitative and Quantitative forecasting techniques – Types of production – Process planning – Economic Batch Quantity– Loading – Scheduling and control of production – Dispatching–Progress control.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

At the end of the course, Students will be able to

**CO1:** Ability To define the concepts of productivity and productivity measurement approaches.

**CO2:** Ability to evaluate appropriate location models for various facility types and design various facility layouts

**CO3:** Ability To conduct a method study and time study to improve the efficiency of the system.

**CO4:** Ability to Control the quality of processes using control charts in manufacturing/service industries.

**CO5:** Ability to define the Planning strategies and Material Requirement Plan.

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2											1		1	
2	2	2	3	2											
3	2	2	2	1	1			2			1		2		
4	2	2	3	1	1										
5	1	2	2									1			3
AVg.	2.2	2	2.5	1.3	1			2			1	1	2	1	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

**TEXT BOOK:**

1. O.P.Khanna, 2010, Industrial Engineering and Management, Dhanpat Rai Publications.

**REFERENCES:**

1. Ravi Shankar, 2009, Industrial Engineering and Management, Galgotia Publications & Private Limited.

2. Martand Telsang, 2006, Industrial Engineering and Production Management, S. Chand and Company

**OBT351****FOOD, NUTRITION AND HEALTH****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- Build knowledge and an overview on general aspects of nutrition and health.
- Distinguish the nutritive value of various food items, BMI calculation differentiating super junk, and functional foods in the market.
- To Solve the real-world problems based on nutrition and health

**UNIT I FOOD AND MICROBIOLOGY OF HEALTH:****9**

Food resources (plant, animal, microbes); Overview of current production systems; constraints and necessity of novel strategies. Functional and "Super" Foods - role in optimal nutrition. Sugar, protein and fat substitutes. Food and behaviour- physiological disturbances in alcoholism, drug abuse and

smoking. Food Related Laws: Inspection – Microbial Indicators of product quality – Indicators of food safety – 229 Microbiological safety of foods - control strategies – Hazard Analysis Critical Point System (HACCP concept)- Microbiological criteria.

**UNIT II NUTRIENTS AND FOOD ADDITIVES: 9**

Macro nutrients- carbohydrates, proteins and lipids. Micronutrients-Minerals: Calcium, Magnesium, Iron, Zinc, Copper and Selenium; Vitamins. Nutritional Physiology: Digestion, absorption, and utilization of major and minor nutrients. Biotechnology of food additives- Bioflavors and colors, microbial polysaccharides, recombinant enzymes in food sector.

**UNIT III NANO FOOD TECHNOLOGY: 9**

Nano materials as food components, food packaging and nano materials, policies on usage of nanomaterials in foods. Food product development: steps involved in food product development, shelf-life assessment.

**UNIT IV FOOD RELATED NUTRITIONAL DISORDERS AND ENERGY CALCULATION: 9**

Type I Disorders-Causes of life style and stress related diseases. Cardio-vascular diseases, hypertension, obesity. Type-II Disorders: Cancer, diabetics, ulcers, electrolyte and water imbalance. Health indices. Preventive and remedial measures. Energy balance and methods to calculate individual nutrient and energy needs. Planning a healthy diet.

**UNIT V CONSUMERS ON GM FOODS AND CONTEMPORARY ISSUES: 9**

Global perspective of consumers on GM foods; Major concerns of transgenic, foods GM ingredients in food products. (labeling, bioavailability, safety aspects); regulatory agencies involved in GM foods, Case studies- GM foods.

**TOTAL:45 PERIODS**

**TEXT BOOK(S):**

1. P.J. Fellows.2009. Food Processing Technology -Principles and Practice (Third Edition). A volume in Woodhead Publishing Series in Food Science, Technology and Nutrition.
2. Kalidas Shetty, Gopinadhan Paliyath, Anthony Pometto, Robert E. Levin. 2015. Food Biotechnology. CRC Press. Second edition.

**REFERENCE BOOKS:**

1. Understanding Nutrition. 2010. Ellie Whitney, Sharon Rady Rolfes, 11e. Thompson Wadsworth. 2.
2. Nutritional Sciences- From Fundamentals to Food.2013. Michelle McGuire, Kathy A. Beerman, 2 nd e. Thompson Wadsworth.
3. Yasmine Motarjemi, Huub Lelieveld, Food Safety Management - A Practical Guide for the Food Industry (2014), 1st Edition, Academic Press, London, UK

**EXPECTED COURSE OUTCOME:**

CO1:To be able to understand the nutritional values of the various types of foods

CO2:To be able to Analyze the role of food in the metabolic activity of the healthy diet

CO3:To be able to Infer the BMI calculation and stress related diseases.

CO4:To be able to Elaborate the independent decision on the choice of food to prevent life style disorders and diseases

CO5:To be able to Assess about the food laws governance

CO6:To be able to Compare junk, modified and super foods

**OCE351 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT L T P C  
3 0 0 3**

**COURSE OBJECTIVE:**

- To impart the knowledge and skills to identify, assess and mitigate the environmental and social impacts of developmental projects

**UNIT I INTRODUCTION 9**

Impacts of Development on Environment – Rio Principles of Sustainable Development- Environmental Impact Assessment (EIA) – Objectives – Historical development – EIA Types – EIA in project cycle –EIA Notification and Legal Framework–Stakeholders and their Role in EIA– Selection & Registration Criteria for EIA Consultants

**UNIT II ENVIRONMENTAL ASSESSMENT 9**

Screening and Scoping in EIA – Drafting of Terms of Reference, Baseline monitoring, Prediction and Assessment of Impact on land, water, air, noise and energy, flora and fauna - Matrices – Networks – Checklist Methods - Mathematical models for Impact prediction – Analysis of alternatives

**UNIT III ENVIRONMENTAL MANAGEMENT PLAN 9**

Plan for mitigation of adverse impact on water, air and land, water, energy, flora and fauna – Environmental Monitoring Plan – EIA Report Preparation – Review of EIA Reports – Public Hearing- Environmental Clearance Post Project Monitoring

**UNIT IV SOCIO ECONOMIC ASSESSMENT 9**

Baseline monitoring of Socio economic environment – Identification of Project Affected Personal – Rehabilitation and Resettlement Plan- Economic valuation of Environmental impacts – Cost benefit Analysis-

**UNIT V CASE STUDIES 9**

EIA case studies pertaining to Infrastructure Projects – Real Estate Development - Roads and Bridges – Mass Rapid Transport Systems - Ports and Harbor – Airports - Dams and Irrigation projects - Power plants – CETPs- Waste Processing and Disposal facilities – Mining Projects.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

The students completing the course will have ability to

**CO1:**carry out scoping and screening of developmental projects for environmental and social assessments

**CO2:**explain different methodologies for environmental impact prediction and assessment

**CO3:**plan environmental impact assessments and environmental management plans

**CO4:**evaluate environmental impact assessment reports

**TEXTBOOKS:**

1. Canter, R.L, "Environmental impact Assessment ", 2nd Edition, McGraw Hill Inc, New Delhi,1995.
2. Lohani, B., J.W. Evans, H. Ludwig, R.R. Everitt, Richard A. Carpenter, and S.L. Tu, "Environmental Impact Assessment for Developing Countries in Asia", Volume 1 – Overview, Asian Development Bank,1997.
3. Peter Morris, Riki Therivel "Methods of Environmental Impact Assessment", Routledge Publishers,2009.

**REFERENCES:**

1. Becker H. A., Frank Vanclay,"The International handbook of social impact assessment" conceptual and methodological advances, Edward Elgar Publishing, 2003.
2. Barry Sadler and Mary McCabe, "Environmental Impact Assessment Training Resource Manual", United Nations Environment Programme, 2002.
3. Judith Petts, "Handbook of Environmental Impact Assessment Vol. I and II", Blackwell Science New York, 1998.
4. Ministry of Environment and Forests EIA Notification and Sectoral Guides, Government of India, New Delhi, 2010.

**OEE351****RENEWABLE ENERGY SYSTEM****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- To Provide knowledge about various renewable energy technologies
- To enable students to understand and design a PV system.
- To provide knowledge about wind energy system.
- To Provide knowledge about various possible hybrid energy systems
- To gain knowledge about application of various renewable energy technologies

**UNIT I INTRODUCTION****9**

Primary energy sources, renewable vs. non-renewable primary energy sources, renewable energy resources in India, Current usage of renewable energy sources in India, future potential of renewable energy in power production and development of renewable energy technologies.

**UNIT II SOLAR ENERGY****9**

Solar Radiation and its measurements, Solar Thermal Energy Conversion from plate Solar Collectors, Concentrating Collectors and its Types, Efficiency and performance of collectors,. Direct Solar Electricity Conversion from Photovoltaic, types of solar cells and its application of battery charger, domestic lighting, street lighting, and water pumping, power generation schemes. Recent Advances in PV Applications: Building Integrated PV, Grid Connected PV Systems,

**UNIT III WIND ENERGY****9**

Wind energy principles, wind site and its resource assessment, wind assessment, Factors influencing wind, wind turbine components, wind energy conversion systems (WECS), Classification of WECS devices, wind electric generating and control systems, characteristics and applications.

**UNIT IV BIO-ENERGY****9**

Energy from biomass, Principle of biomass conversion technologies/process and their classification, Bio gas generation, types of biogas plants, selection of site for biogas plant, classification of biogas plants, Advantage and disadvantages of biogas generation, thermal gasification of biomass, biomass gasifies, Application of biomass and biogas plants and their economics.

**UNIT V OTHER TYPES OF ENERGY****9**

Energy conversion from Hydrogen and Fuel cells, Geo thermal energy Resources, types of wells, methods of harnessing the energy, potential in India. OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants and their economics.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

At the end of the course students will be able to:

**CO1:** Attained knowledge about various renewable energy technologies

**CO2:** Ability to understand and design a PV system.

**CO3:** Understand the concept of various wind energy system.

**CO4:** Gained knowledge about various possible hybrid energy systems

**CO5:** Attained knowledge about various application of renewable energy technologies

**REFERENCES**

1. Twidell & Wier, 'Renewable Energy Resources' CRC Press( Taylor & Francis).
2. Tiwari and Ghosal/ Narosa, 'Renewable energy resources'.
3. D.P.Kothari, K.C.Singhal, 'Renewable energy sources and emerging technologies', P.H.I.
4. D.S.Chauhan, S.K. Srivastava, 'Non – Conventional Energy Resources', New Age Publishers, 2006.
5. B.H.Khan, 'Non – Conventional Energy Resources', Tata Mc Graw Hill, 2006.

**CO's-PO's & PSO's MAPPING**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
<b>CO1</b>	3	-	-	-	-	-	-	-	-	-	-	2	3	3	3
<b>CO2</b>	3	2	-	-	-	-	-	-	-	-	-	2	3	3	3
<b>CO3</b>	3	2	-	-	-	-	-	-	-	-	-	2	3	3	3
<b>CO4</b>	3	2	-	-	-	-	-	-	-	-	-	2	3	3	3
<b>CO5</b>	3	2	-	-	-	-	-	-	-	-	-	2	3	3	3
<b>AVg.</b>	3	2	-	-	-	-	-	-	-	-	-	2	3	3	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OEI351****INTRODUCTION TO INDUSTRIAL INSTRUMENTATION AND CONTROL****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- To introduce common unit operations carried out in process industries.
- To impart knowledge about the important unit operations taking place in process industries.

- To prepare them to take up a case study on selected process industries like petrochemical industry, power plant industry and paper & pulp industry to make the students understand the different measurement and control techniques for important processes.
- Facilitate the students to apply knowledge to select appropriate measurement technique and control strategy for a given process.

**UNIT I COMMON UNIT OPERATIONS IN PROCESS INDUSTRIES -I 9**  
 Unit Operation, Measurement and Control:-Transport of solid, liquid and gases - Evaporators – Crystallizers-Dryers.

**UNIT II COMMON UNIT OPERATIONS IN PROCESS INDUSTRIES -II 9**  
 Unit Operation, Measurement and Control: - Distillation – Refrigeration processes – Chemical reactors.

**UNIT III PROCESS MEASUREMENT AND CONTROL IN PETROCHEMICAL INDUSTRY 9**  
 Process flow diagram of Petro Chemical Industry - Gas oil separation in production platform – wet gas processing – Fractionation Column – Catalytic Cracking unit – Catalytic reforming unit

**UNIT IV PROCESS MEASUREMENT AND CONTROL IN THERMAL POWER PLANT INDUSTRY 9**  
 Process flow diagram of Coal fired thermal Power Plant– Coal pulverizer - Deaerator – Boiler drum - Superheater – Turbines.

**UNIT V PROCESS MEASUREMENT AND CONTROL IN PAPER & PULP INDUSTRY 9**  
 Process flow diagram of paper and pulp industry – Batch digester – Continuous sulphated digester – Control problems on the paper machine.

**TOTAL: 45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 5**

Study the characteristics of various processing units involved in chemical plant.  
 Develop the process model by using predefined unit operations (e.g. mixing, distillation, heating) from the library of any process simulator.  
 Analyse the functioning of each processing units with help of virtual unit operations packages.  
 Perform a physical property analysis using simulation packages  
 Implement distillation column analysis using simulation software.  
 Create process flow models and diagrams

**COURSE OUTCOMES:**

**Students able to**

- CO1** understand common unit operations in process industries. L2
- CO2** Identify the dynamics of important unit operations in petro chemical industry. L2
- CO3** develop understanding of important processes taking place selected case studies namely petrochemical industry, power plant industry and paper & pulp industry. L5
- CO4** Select appropriate measurement techniques for selective processes. L5
- CO5** Develop controller structure based on the process knowledge. L5



**CO6** Analyze the operation and challenges in integrated industrial processes. L4

**TEXT BOOKS:**

1. Balchen ,J.G., and Mumme, K.J., “ Process Control structures and applications”, Van Nostrand Reinhold Co., New York, 1988
2. Warren L. McCabe, Julian C. Smith and Peter Harriot, “Unit Operations of Chemical Engineering”, McGraw-Hill International Edition, New York, Sixth Edition, 2001.

**REFERENCES:**

1. Liptak B.G., “Instrument and Automation Engineers' Handbook: Process Measurement and Analysis”, Fifth Edition, CRC Press, 2016.
2. James R.couper, Roy Penny, W., James R.Fair and Stanley M.Walas, “Chemical ProcessEquipment: Selection and Design”, Gulf Professional Publishing, 2010.
3. Austin G.T and Shreeves, A.G.T., “Chemical Process Industries”, McGraw–Hill International student, Singapore, 1985.
4. Luyben W.C., “Process Modeling, Simulation and Control for Chemical Engineers”, McGraw-Hill International edition, USA, 1989.
5. K. Krishnaswamy, Process Control, new age publishers , 2009.

**List of Open Source Software/ Learning website:**

1. <https://www.aspentech.com/en>
2. <http://avtechscientific.com/>
3. <https://www.chemstations.com/CHEMCAD/>
4. <https://www.prosim.net/en/product/prosimplus-steady-state-simulation-and-optimization-of-processes/>
5. <https://www.cocosimulator.org/>
6. <https://dwsim.fossee.in/>

**CO's-PO's & PSO's MAPPING**

PO,PSO CO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
<b>CO1</b>	3	3	1					1		1					
<b>CO2</b>	3	3	1					1		1	2				2
<b>CO3</b>	3	3	1					1		1					
<b>CO4</b>	3	3	1	3	3			1		1			3	3	
<b>CO5</b>	3	3	3			3		1		1			3	3	3
<b>CO6</b>	3	3	2	3	2	1	2	1		2	1	1			2
<b>Avg</b>	3	3	1.5	3	2.5	2	2	1		1.16	1.5	1	3	3	2.3 3

1- low, 2-medium, 3-high, ‘-‘- no correlation

**COURSE OBJECTIVES**

- To understand the graph models and basic concepts of graphs.
- To study the characterization and properties of trees and graph connectivity.
- To provide an exposure to the Eulerian and Hamiltonian graphs.
- To introduce Graph colouring and explain its significance.
- To provide an understanding of Optimization Graph Algorithms.

**UNIT I INTRODUCTION TO GRAPHS 9**

Graphs and Graph Models – Connected graphs – Common classes of graphs – Multi graphs and Digraphs – Degree of a vertex – Degree Sequence – Graphs and Matrices – Isomorphism of graphs.

**UNIT II TREES AND CONNECTIVITY 9**

Bridges – Trees – Characterization and properties of trees – Cut vertices – Connectivity.

**UNIT III TRAVERSABILITY 9**

Eulerian graphs – Characterization of Eulerian graphs – Hamiltonian graphs – Necessary condition for Hamiltonian graphs – Sufficient condition for Hamiltonian graphs.

**UNIT IV PLANARITY AND COLOURING 9**

Planar Graphs – The Euler Identity – Non planar Graphs – Vertex Colouring – Lower and Upper bounds of chromatic number.

**UNIT V OPTIMIZATION GRAPH ALGORITHMS 9**

Dijkstra's shortest path algorithm – Kruskal's and Prim's minimum spanning tree algorithms – Transport Network – The Max-Flow Min-Cut Theorem – The Labeling Procedure – Maximum flow problem.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

At the end of this course, the student will be able to

**CO1:**Apply graph models for solving real world problem.

**CO2:**Understand the importance the natural applications of trees and graph connectivity.

**CO3:**Understand the characterization study of Eulerian graphs and Hamiltonian graphs.

**CO4:**Apply the graph colouring concepts in partitioning problems.

**CO5:**Apply the standard optimization graph algorithms in solving application problems.

**TEXT BOOKS**

1. Gary Chartrand and Ping Zhang, "Introduction to Graph Theory", Tata McGraw – Hill companies Inc., New York, 2006.
2. Ralph P. Grimaldi, "Discrete and Combinatorial Mathematics, An applied introduction" Fifth edition, Pearson Education, Inc, Singapore, 2004.

**REFERENCES**

1. Balakrishnan R. and Ranganathan K., "A Text Book of Graph Theory", Springer – Verlag, New York, 2012.

2. Douglas B. West, "Introduction to Graph Theory", Pearson, Second Edition, New York, 2018.

**CO's-PO's & PSO's MAPPING**

	PO 01	PO 02	PO0 3	PO0 4	PO0 5	PO0 6	PO0 7	PO0 8	PO0 9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3
CO1	3	3	3												
CO2		2	2		2										
CO3		2	2	2						2					
CO4	2	2	2												
CO5		3	2		2					3					
CO6															

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OPEN ELECTIVE II**

**OIE352**

**RESOURCE MANAGEMENT TECHNIQUES**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- Learn to formulate linear programming problems and solve LPP using simple algorithm
- Learn to solve networking problems
- Learn to formulate and solve integer programming problems
- Learn to solve Non Linear programming problems
- Learn to understand and solve project management problems

**UNIT I LINEAR PROGRAMMING**

**9**

Principal components of decision problem – Modeling phases – LP formulation and graphic solution – Resource allocation problems – simplex method – sensitivity analysis.

**UNIT II DUALITY AND NETWORKS**

**9**

Definition of dual problems – primal – Dual relationships – Dual simplex method –post optimality analysis – Transportation and assignment model – Shortest route problem.

**UNIT III INTEGER PROGRAMMING**

**9**

Cutting plan algorithm – Branch and bound methods, Multistage (Dynamic) programming.

**UNIT IV CLASSICAL OPTIMISATION THEROY:**

**9**

Unconstrained external problems, Newton – Ralphson method – Equality constraints –Jacobean methods – Lagrangian method – Kuhn – Tucker conditions – Simple problems.

**UNIT V OBJECT SCHEDULOING:**

**9**

Network diagram representation – Critical path method – Time charts and resource leveling – PERT.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of the course, the students should be able to:

**CO1** : Understand to formulate linear programming problems and solve LPP using simple algorithm

- CO2** : Understand to solve networking problems  
**CO3** : Understand to formulate and solve integer programming problems  
**CO4** : Understand to solve Non Linear programming problems  
**CO5** : Understand to understand and solve project management problems

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		3	3	2									3	2	3
2		3	3	2									3	2	3
3		3	3	2									3	2	3
4		3	3	2									3	2	3
5		3	3	2									3	2	3
AVg.		3	3	2									3	2	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

**TEXT BOOK:**

- H.A. Taha, "Operation Research", Prentice Hall of India, 2002.

**REFERENCES:**

- Panier selvam, 'Operations Research' Prentice Hall of India, 2002.
- Anderson 'Quantitative Methods for Business', 8<sup>th</sup> Edition, Thomson Learning, 2002.
- Winston 'Operations Research for Business', Thomson Learning, 2003.
- Vohra, 'Quantitative Techniques in Management', Tata Mc Graw Hill, 2002.
- Anand sarma, 'Operation Research' Himalaya Publishing House, 2003.

**OMG351**

**FINTECH REGULATION**

**LT PC  
3 0 0 3**

**COURSE OBJECTIVES:**

- To learn about Laws and Regulation
- To acquire the knowledge of Regulations of Fintech firm and their role in Market

**UNIT I INTRODUCTION**

**9**

The Role of the Regulators, Equal Treatment and Competition, Need for a regulatory assessment of Fintech, India Regulations, The Risks to Consider, Regtech and SupTech, The rise of TechFins, Regulatory sandboxes, compliance and whistleblowing.

**UNIT II INNOVATION AND REGULATION**

**9**

The technology, market and the law, Regulation and Innovation in Banking and Finance, Regulations of Fintech Firms and their role in Market-Based Chains, Current Regulatory Approach, Fintech Innovations in Banking, Asset Management, Insurance, Pensions and Healthcare Schemes, Patentability of FinTech inventions.

**UNIT III CROWDFUNDING AND DIGITAL ASSETS**

**9**

Types of crowdfunding, The Jobs Act, Regulation crowdfunding, Regulation A+, Regulation D crowdfunding, Intrastate offerings, Digital Assets – Three uses of Digital Assets, A world of Altcoins,

Stablecoins, Digital Asset Forks, Initial Coin Offerings, Regulatory Framework for Digital and Crypto Assets, Central Bank Digital Currencies.

**UNIT IV MARKETPLACE LENDING AND MOBILE PAYMENTS 9**

Online Lending Business Models, Payday Loans, Consumer Protection Laws, Debt Collection, Equal Credit Opportunity Act, Contract Formation and the E-Sign Act, Military Lending Act, Securities Laws Considerations, Mobile Devices, Payment Cards and the Law, Truth in Lending Act and Regulation Z, Card Act, Electronic Fund Transfer Act and Regulation E, Fair Credit Reporting Act, Federal Bank Secrecy Act, State Money Transmitter Laws.

**UNIT V ANTI-MONEY LAUNDERING AND CYBERSECURITY 9**

Reporting requirements under the Bank Secrecy Act, Patriot Act, Penalties for violating the BSA, Virtual currencies and the Bank Secrecy Act, Cybersecurity Frameworks, Cybersecurity Act of 2015, Contractual and Self Regulatory obligations.

**TOTAL:45 PERIODS**

**REFERENCES**

1. Jelena Madir, FinTech – Law and Regulation, Edward Elgar Publishing Limited, 2019
2. Valerio Lemma, Fintech Regulation : Exploring New Challenges of the Capital Markets Union, Palgrave Macmillan, 2020
3. Chris Brummer, Fintech Law in a Nutshell, West Academic Publishing, 2020
4. Bernardo Nicoletti, The Future of Fintech, Integrating Finance and Technology in Financial Services, Springer Nature, 2017
5. Kevin C. Taylor, FinTech Law : A Guide to Technology Law in the Financial Services Industry, BNA Books, 2014
6. Lee Reiners, FinTech Law and Policy, 2018

**OFD351**

**HOLISTIC NUTRITION**

**L T P C  
3 0 0 3**

**UNIT I NUTRITION AND HEALTH 9**

Introduction to the principles of nutrition; Basics of nutrition including; micronutrients (vitamins and minerals), the energy-yielding nutrients (Carbohydrates, Lipids and Proteins), metabolism, digestion, absorption and energy balance. Lipids: their functions, classification, dietary requirements, digestion & absorption, metabolism and links to the major fatal diseases, heart disease and cancer.

**UNIT II AYURVEDA – MIND/BODY HEALING 9**

Philosophy of Holistic Nutrition with spiritual and psychological approaches towards attaining optimal health; Principles and practical applications of Ayurveda, the oldest healing system in the world. Three forces – Vata, Pitta and Kapha, that combine in each being into a distinct constitution. Practical dietary and lifestyle recommendations for different constitutions will also be explored in real case studies.

**UNIT III NUTRITION AND ENVIRONMENT 9**

Based on an underlying philosophy that environments maintain and promote health and that individuals have a right to self-determination and self-knowledge, Nutrition principles which promote

health and prevent disease. Safety of our food supply, naturally occurring and environmental toxins in foods, microbes and food poisoning.

#### **UNIT IV COMPARATIVE DIETS**

**9**

Evaluating principles of food dynamics, nutrient proportions, holistic individuality, the law of opposites, food combining, and more. Therapeutic benefits and limitations of several alternative diet approaches, including: modern diets (intermittent fasting, macrobiotics), food combining (colour-therapy/rainbow diet), high protein diets (Ketogenic, Paleo), Vegetarian approaches (plant-based/vegetarian/vegan variations, fruitarian, raw food), as well as cleansing and detoxification diets (caffeine, alcohol, and nicotine detoxes, juice fasts).

#### **UNIT V PREVENTIVE HEALTH CARE**

**9**

Proper nutrition protection against, reverse and/or retard many ailments including: osteoporosis, diabetes, atherosclerosis and high blood pressure, arthritis, cancer, anemia, kidney disease and colon cancer. Current research developments on phytochemicals, antioxidants and nutraceuticals will be explored.

**TOTAL: 45 PERIODS**

#### **COURSE OUTCOMES**

**CO1** Discuss the role of essential nutrients in physical, mental and emotional wellness

**CO2** Discuss the role of deficiencies in essential nutrients in the disease process

**CO3** Explain how the standard American diet relates to the disease process

**CO4** Identify five contemporary eating “styles” and lists the pros and cons of each

**CO5** Discuss the concept of whole foods nutrition and its relationship to wellness

#### **TEXTBOOKS**

1. Desai, B. B., Handbook of Nutrition and Diet. Marcel Dekker, New York. 2000
2. Macrae, R., Rolonson Roles and Sadlu, M.J. 1994. Encyclopedia of Food Science & Technology & Nutrition. Vol. XI. Academic Press

#### **REFERENCES**

1. Modern Nutrition in Health & Disease by Young & Shils.
2. Food, Nutrition and Diet Therapy – by Krause and Mahan 1996, Publisher- W.B. Saunders, ISBN: 0721658350
3. Nutritive Value of Indian Foods.- by C. Gopalan, B. V. Rama Sastri, S. C. Balasubramanian Published by National Institute of Nutrition, Indian Council of Medical Research, 1989

**AI3021**

**IT IN AGRICULTURAL SYSTEM**

**L T P C**  
**3 0 0 3**

#### **COURSE OBJECTIVES:**

- To introduce the students to areas of agricultural systems in which IT and computers play a major role.
- To also expose the students to IT applications in precision farming, environmental control systems, agricultural systems management and weather prediction models.

#### **UNIT I PRECISION FARMING**

**9**

Precision agriculture and agricultural management – Ground based sensors, Remote sensing, GPS, GIS and mapping software, Yield mapping systems, Crop production modeling.

**UNIT II ENVIRONMENT CONTROL SYSTEMS 9**

Artificial light systems, management of crop growth in greenhouses, simulation of CO<sub>2</sub> consumption in greenhouses, on-line measurement of plant growth in the greenhouse, models of plant production and expert systems in horticulture.

**UNIT III AGRICULTURAL SYSTEMS MANAGEMENT 9**

Agricultural systems - managerial overview, Reliability of agricultural systems, Simulation of crop growth and field operations, Optimizing the use of resources, Linear programming, Project scheduling, Artificial intelligence and decision support systems.

**UNIT IV WEATHER PREDICTION MODELS 9**

Importance of climate variability and seasonal forecasting, Understanding and predicting world's climate system, Global climatic models and their potential for seasonal climate forecasting, General systems approach to applying seasonal climate forecasts.

**UNIT V E-GOVERNANCE IN AGRICULTURAL SYSTEMS 9**

Expert systems, decision support systems, Agricultural and biological databases, e-commerce, e-business systems & applications, Technology enhanced learning systems and solutions, e-learning, Rural development and information society.

**TOTAL: 45 PERIODS**

**TEXTBOOKS:**

1. National Research Council, "Precision Agriculture in the 21st Century", National Academies Press, Canada, 1997.
2. H. Krug, Liebig, H.P. "International Symposium on Models for Plant Growth, Environmental Control and Farm Management in Protected Cultivation", 1989.

**REFERENCES:**

1. Peart, R.M., and Shoup, W. D., "Agricultural Systems Management", Marcel Dekker, New York, 2004.
2. Hammer, G.L., Nicholls, N., and Mitchell, C., "Applications of Seasonal Climate", Springer, Germany, 2000.

**COURSE OUTCOME:**

**CO1:**The students shall be able to understand the applications of IT in remote sensing applications such as Drones etc.

**CO2:**The students will be able to get a clear understanding of how a greenhouse can be automated and its advantages.

**CO3:**The students will be able to apply IT principles and concepts for management of field operations.

**CO4:**The students will get an understanding about weather models, their inputs and applications.

**CO5:**The students will get an understanding of how IT can be used for e-governance in agriculture.

## CO's-PO's & PSO's MAPPING

PO/PSO		Course Outcome					Overall correlation of CO s to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	2	3	2	3	2	2
PO2	Problem Analysis	3	3	3	3	3	3
PO3	Design/ Development of Solutions	3	3	3	3	3	3
PO4	Investigations	2	3	2	1	2	2
PO5	Modern Tool Usage	3	3	3	3	3	3
PO6	Individual and Team work	1	1	2	2	3	2
PO7	Communication	3	3	3	3	3	3
PO8	The Engineer and Society	3	3	2	3	3	3
PO9	Ethics	1	1	2	1	2	1
PO10	Environment and Sustainability	3	3	3	3	3	3
PO11	Project Management and Finance	3	3	3	3	3	3
PO12	Life Long Learning	3	3	3	3	3	3
PSO1	To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	1	1	2	2	3	2
PSO2	To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.	1	1	2	2	3	2
PSO3	To inculcate entrepreneurial skills through strong Industry-Institution linkage.	1	1	2	2	3	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

OEI352

INTRODUCTION TO CONTROL ENGINEERING

L T P C

3 0 0 3

### COURSE OBJECTIVES:

- To introduce the control system components and transfer function model with their graphical representation
- To understand the analysis of system in time domain along with steady state error.



- To introduce frequency response analysis of systems.
- To accord basic knowledge in design of compensators.
- To introduce the state space models.

**UNIT I MATHEMATICAL MODELLING 9**

Introduction – transfer function – simple electrical, mechanical, pneumatic, hydraulic and thermal systems–analogies

**UNIT II FEEDBACK CONTROL SYSTEMS 9**

Control system components - Block diagram representation of control systems, Reduction of block diagrams, Signal flow graphs, Output to input ratios

**UNIT III TIME DOMAIN ANALYSIS 9**

Response of systems to different inputs viz., Step impulse, pulse, parabolic and sinusoidal inputs, Time response of first and second order systems, steady state errors and error constants of unity feedback circuit.

**UNIT IV STABILITY ANALYSIS 9**

Necessary and sufficient conditions, Routh-Hurwitz criteria of stability, Rootlocus and Bode techniques, Concept and construction, frequency response.

**UNIT V STATE SPACE TECHNIQUE 9**

State vectors–state space models-Digital Controllers–design aspects.

**TOTAL: 45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 5**

1. Explore various controllers presently used in industries.
2. Develop control structures for industrial processes.
3. Implement the controllers for various transfer functions of industrial systems.
4. Using software tools for practical exposures to the controllers used in industries by undergoing training.
5. Realisation of various stability criterion techniques for economical operation of process.

**COURSE OUTCOMES:**

- CO1** To represent and develop systems in different forms using the knowledge gained (L5).
- CO2** To analyse the system in time and frequency domain (L4).
- CO3** Ability to Derive Transfer function Model of Electrical and Mechanical Systems. (L2)
- CO4** Ability to Obtain the transfer Function by the Reduction of Block diagram & Signal flow graph (L3)
- CO5** To analyse the stability of physical systems(L4).
- CO6** To acquire and analyse knowledge in State variable model for MIMO systems(L1)

**TEXT BOOKS:**

1. Nagarath, I.J. and Gopal, M., "Control Systems Engineering", New Age International Publishers, 2017.
2. Benjamin C. Kuo, "Automatic Control Systems", Wiley, 2014

## REFERENCES:

1. Katsuhiko Ogata, "Modern Control Engineering", Pearson, 2015.
2. Richard C. Dorf and Bishop, R.H., "Modern Control Systems", Pearson Education, 2009.
3. John J.D., Azzo Constantine, H. and Houpis Stuart, N Sheldon, "Linear Control System Analysis and Design with MATLAB", CRC Taylor & Francis Reprint 2009.
4. Ramesh C. Panda and T. Thyagarajan, "An Introduction to Process Modelling Identification and Control of Engineers", Narosa Publishing House, 2017.
5. M. Gopal, "Control System: Principle and design", McGraw Hill Education, 2012.
6. NPTEL Video Lecture Notes on "Control Engineering" by Prof. S. D. Agashe, IIT Bombay.

## List of Open Source Software/ Learning website:

1. <https://nptel.ac.in/courses/112107240>
2. [https://onlinecourses.nptel.ac.in/noc20\\_me25/preview](https://onlinecourses.nptel.ac.in/noc20_me25/preview)
3. [https://onlinecourses.nptel.ac.in/noc20\\_ee90/preview](https://onlinecourses.nptel.ac.in/noc20_ee90/preview)
4. <https://www.classcentral.com/course/swayam-automatic-control-9850>

## CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1 L5	3	3	3	3	-	-	-	1	-	1	-	1			
2 L4	3	3	3	2	-	-	-	1	-	1	-	1			
3 L2	2	1	2	1	-	-	-	1	-	1	-	1			
4 L5	3	3	3	3	-	-	-	1	-	1	-	1			
5 L4	3	3	3	2	-	-	-	1	-	1	-	1			
6 L4	3	3	3	2	-	-	-	1	-	1	-	1			
AVg.	2.8	2.6	3	2.1	-	-	-	1	-	1	-	1			

1-low, 2-medium, 3-high, "--" - no correlation

**Note:** The average value of this course to be used for program articulation matrix.

OPY351

PHARMACEUTICAL NANOTECHNOLOGY

L T P C

3 0 0 3

## COURSE OBJECTIVES:

- The goal of this course is to provide an insight into the fundamentals of nanotechnology in biomedical and Pharmaceutical research. It will also guide the students to understand how nanomaterials can be used for a diversity of analytical and medicinal rationales.

## UNIT I NANOSTRUCTURES

9

Preparation, properties and characterization - Self-assembling nanostructure - vesicular and micellar polymerization-nanofilms - Metal Nanoparticles- lipid nanoparticles- nanoemulsion - Molecular nanomaterials: dendrimers, etc.,

## UNIT II NANOTECHNOLOGY IN BIOMEDICAL INDUSTRY

9

Reconstructive Intervention and Surgery- Nanomaterials in bone substitutes and dentistry – Implants and Prosthesis -in vivo imaging- genetic defects and other disease states — Nanorobotics in Surgery –Nanocarriers: sustained, controlled, targeted drug delivery systems.

**UNIT III NANOTECHNOLOGY IN CANCER THERAPY 9**

Cancer Cell Targeting and Detection- Polymeric Nanoparticles for cancer treatment – mechanism of drug delivery to tumors -advantages and limitations - Multifunctional Agents - Cancer Imaging – Magnetic Resonance Imaging- Cancer Immunotherapy.

**UNIT IV NANOTECHNOLOGY IN COSMETICS 9**

Polymers in cosmetics: Film Formers – Thickeners – Hair Colouring – Conditioning Polymers: conditioning, Cleansing – Silicons – Emulsions – Stimuli Responsive Polymeric Systems - Formulation of Nano Gels, Shampoos, Hair-conditioners -Micellar self-assembly Sun-screen dispersions for UV protection – Color cosmetics.

**UNIT V NANOTOXICITY 9**

NanoToxicology- introduction, dose relationship- Hazard Classification-Risk assessment and management - factors affecting nano toxicity- Dermal Effects of Nanomaterials, Pulmonary, Neuro and Cardiovascular effects of Nanoparticles - Gene–Cellular and molecular Interactions of Nanomaterials.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

The student will be able to

**CO1:**Identify the process for the preparation and characterization of the different nanostructured materials.

**CO2:**Apply the nanotechnology in biomedical discipline with related to drug delivery and disease diagnosis

**CO3:**Develop the process, experiments and apply in identifying in a societal and global context.

**CO4:**Design and develop the process with suitable equipment for the preparation of nanomaterials in developing cosmetic products.

**CO5:**Understand the ethical principles to confirm the safety of the nano products with respect to risk assessment and its management.

**CO6:**Have the knowledge about nanotechnology products and its different applications in a societal and global context.

**TEXT BOOKS:**

1. Springer Handbook of Nanotechnology- Ed. by B. Bhushan, Springer-Verlag 2004
2. Nanobiotechnology: Concepts, Applications and Perspectives,. CM.Niemeyer C A. Mirkin, (Eds) , Wiley, 2004
3. Nanotechnology: Health and Environmental Risks, Jo Anne Shatkin, Second Edition, CRC Press, 2013
4. Sarah E. Morgan, Kathleen O. Havelka, Robert Y. Lochhead “Cosmetic Nanotechnology: Polymers and Colloids in Cosmetics”, American Chemical Society, 2006.

**REFERENCES:**

1. Nanotechnology in Biology and Medicine: Methods, Devices and Applications, Tuan VoDinh, CRC Press, 2007
2. The Chemistry of Nanomaterials: Synthesis, Properties and Applications, C.N.R. Rao, A. Muller, A. K. Cheetham (Eds), Wiley-VCH Verlag 2004
3. Nanotechnology: Environmental Health and safety, Risks, Regulation and Management, Matthew Hull and Diana Bowman, Elsevier, 2010.

## CO's-PO's & PSO's MAPPING

Course Outcome Statements	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3							1	2		2	3			2
CO2	3	3			2	2	3							3		
CO3		3	3	3	2	2			1				3		3	
CO4			3	3		2			1						3	
CO5						3		3	2			2	3			3
CO6	3		3			2						2	3		3	2
Overall CO	3	3							1	2		2	3			2

1 - low, 2 - medium, 3 - high, '-' - no correlation

(1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.)

OAE351

AVIATION MANAGEMENT

L T P C  
3 0 0 3

### COURSE OBJECTIVES:

- To acquire solid background of managerial skills in aviation management
- To develop personality to face business difficulties.
- To control multicultural conditions.
- To identify the relevant analytical and logical skills to deal with problems in the airline industry.
- To learn the concepts of performing well in teams, professionalism, and the knowledge acquired in the field of airport planning, airport security, passengers forecasting, aerodromes work etc

### UNIT I INTRODUCTION

9

History of aviation – organisation, global, social & ethical environment – history of Aviation in India – major players in the airline industry - swot analysis of the different Airline companies in India – market potential of airline industry in India – new airport Development plans – current challenges in the airline industry - competition in the Airline industry – domestic and international from an Indian perspective

### UNIT II AIRPORT INFRASTRUCTURE AND MANAGEMENT

8

Airport planning – terminal planning design and operation – airport operations – Airport functions – organisation structure in an airline - airport authority of India - Comparison of global and Indian airport management – role of AAI -airline privatisation - full Privatisation - gradual privatisation – partial privatization

### UNIT III AIR TRANSPORT SERVICES

12

Various airport services - international air transport services – Indian scenario – an Overview of airports in Delhi, Mumbai, Hyderabad and Bangalore – the role of private Operators – airport development fees, rates, tariffs

**UNIT IV INSTITUTIONAL FRAMEWORK****8**

Role of DGCA - slot allocation – methodology followed by AFC and DGCA -management of Bilaterals – economic regulations

**UNIT V CONTROLLING****8**

Role of air traffic control - airspace and navigational aids – control process – case Studies in airline industry – Mumbai Delhi airport privatisation – Navi Mumbai airport Tendering process – 6 cases in the airline industry

**TOTAL : 45 PERIODS****TEXT BOOKS**

1. Graham.A. Managing Airports: An International Perspective - Butterworth - Heinemann, Oxford 2001.
2. Wells.A. Airport Planning and Management, 4th Edition McGraw- Hill, London 2000.

**REFERENCES**

1. Doganis. R. The Airport Business Routledge, London 1992
2. Alexander T. Wells, Seth Young, Principles of Airport Management, McGraw Hill 2003
3. P S Senguttavan Fundamentals of Air Transport Management , Excel Books 2007
4. Richard de Neuffille, Airport Systems: Planning, Design and Management, McGraw-Hill London 2007.
- 5.. Manual of Aerodrome licensing of AAI airports – AAI website – freely downloadable – issue may 2010

**COURSE OUTCOMES:**

**CO1:**To interpret business difficulties.

**CO2:**To Dissect multicultural conditions.

**CO3:**To identify and apply the relevant analytical and logical skills to deal with problems in the airline industry.

**CO4:**To Develop well in teams, professionalism etc.

**CO5:**To apply the knowledge acquired in the field of airport planning, airport security, passengers forecasting, aerodromes work etc.

PROGRESS THROUGH KNOWLEDGE

### OPEN ELCTIVE III

OHS351

ENGLISH FOR COMPETITIVE EXAMINATIONS

L T P C

3 0 0 3

#### **Course Description:**

Students aspiring to take up competitive exams of which the English language is a vital component will find this course useful. Designed for students in the higher semesters, the course will help students to familiarise themselves with those aspects of English that are tested in these examinations.

#### **COURSE OBJECTIVES:**

- To train the students in the language components essential to face competitive examinations both at the national (UPSC, Banking, Railway, Defence) and the international level (GRE, TOEFL, IELTS).
- To enhance an awareness of the specific patterns in language testing and the respective skills to tackle verbal reasoning and verbal ability tests.
- To inculcate effective practices in language-learning in order to improve accuracy in usage of grammar and coherence in writing.
- To improve students' confidence to express their ideas and opinions in formal contexts
- To create awareness of accuracy and precision in communication

#### **UNIT I**

9

Orientation on different formats of competitive exams - Vocabulary – Verbal ability – Verbal reasoning - Exploring the world of words – Essential words – Meaning and their usage – Synonyms-antonyms – Word substitution – Word analogy – Idioms and phrases – Commonly confused words – Spellings – Word expansion – New words in use.

#### **UNIT II**

9

Grammar – Sentence improvement –Sentence completion – Rearranging phrases into sentences – Error identification –Tenses – Prepositions – Adjectives – Adverbs – Subject-verb agreement – Voice – Reported speech – Articles – Clauses – Speech patterns.

#### **UNIT III**

9

Reading - Specific information and detail – Identifying main and supporting ideas – Speed reading techniques – Improving global reading skills – Linking ideas – Summarising – Understanding argument – Identifying opinion/attitude and making inferences - Critical reading.

#### **UNIT IV**

9

Writing – Pre-writing techniques – Mindmap - Describing pictures and facts - Paragraph structure – organising points – Rhetoric writing – Improving an answer – Drafting, writing and developing an argument – Focus on cohesion – Using cohesive devices –Analytic writing – Structure and types of essay – Mind maps – Structure of drafts, letters, memos, emails – Statements of Purpose – Structure, Content and Style.

#### **UNIT V**

9

Listening and Speaking – Contextual listening – Listening to instructions – Listening for specific information – Identifying detail, main ideas – Following signpost words – Stress, rhythm and intonation - Speaking to respond and elicit ideas – Guided speaking – Opening phrases – Interactive

communication – Dysfluency -Sentence stress – Speaking on a topic – Giving opinions – Giving an oral presentation – Telling a story or a personal anecdote – Talking about oneself - Utterance – Speech acts- Brainstorming ideas – Group discussion.

**TOTAL: 45 PERIODS**

**LEARNING OUTCOMES:**

At the end of the course, learners will be able

- expand their vocabulary and gain practical techniques to read and comprehend a wide range of texts with the emphasis required
- identify errors with precision and write with clarity and coherence
- understand the importance of task fulfilment and the usage of task-appropriate vocabulary
- communicate effectively in group discussions, presentations and interviews
- write topic based essays with precision and accuracy

**CO's-PO's & PSO's MAPPING**

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	3	3	1	3	3	3	3	1	3	1	3	-	-	-
2	2	3	3	2	3	3	3	3	1	3	3	3	-	-	-
3	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
4	2	2	2	2	2	2	2	2	3	3	3	3	-	-	-
5	2	2	2	2	2	2	2	2	2	3	2	3	-	-	-
AVg.	2	2.6	2.6	2	2.6	2.6	2.6	2.6	2	3	2.4	3	-	-	-

1 - low, 2 - medium, 3 - high, ‘-’- no correlation

**Note:** The average value of this course to be used for program articulation matrix.

**Teaching Methods:**

Instructional methods will involve discussions, taking mock tests on various question papers – Objective, multiple-choice and descriptive. Peer evaluation, self-check on improvement and peer feedback - Practice sessions on speaking assessments, interview and discussion – Using multimedia.

**Evaluative Pattern:**

Internal Tests – 50%

End Semester Exam - 50%

**TEXTBOOKS:**

1. R.P.Bhatnagar - *General English for Competitive Examinations*. Macmillan India Limited, 2009.

**REFERENCEBOOKS:**

1. Educational Testing Service - *The Official Guide to the GRE Revised General Test*, Tata McGraw Hill, 2010.
2. *The Official Guide to the TOEFL Test*, Tata McGraw Hill, 2010.
3. R Rajagopalan- *General English for Competitive Examinations*, McGraw Hill Education (India) Private Limited, 2008.

## Websites

<http://www.examenglish.com/>, <http://www.ets.org/>, <http://www.bankxams.com/>  
<http://civilservicesmentor.com/>, <http://www.educationobserver.com>  
<http://www.cambridgeenglish.org/in/>

**OMG352**

**NGOS AND SUSTAINABLE DEVELOPMENT**

**L T P C**

**3 0 0 3**

## COURSE OBJECTIVES

- to understand the importance of sustainable development
- to acquire a reasonable knowledge on the legal frameworks pertaining to pollution control and environmental management
- to comprehend the role of NGOs in attaining sustainable development

### **Unit I ENVIRONMENTAL CONCERNS**

**9**

Introduction to sustainable development goals, Global responsibility of environmental concern, Importance of environmental preservation, Environmental threats, Pollution and its types, Effects of Pollution, Pollution control, Treatment of wastes

### **UNIT II ROLE OF NGOS**

**9**

Role of NGO's in national development, NGO's and participatory management, Challenges and limitations of NGO's, Community Development programmes, Role of NGO's in Community Development programmes, Participation of NGO's in environment management, Corporate Social responsibility, NGO's and corporate social responsibility

### **UNIT III SUSTAINABLE DEVELOPMENT**

**9**

Issues and Challenges of Sustainable Development, Bioenergy, Sustainable Livelihoods and Rural Poor in Sustainable Development, Protecting ecosystem services for sustainable development, Non-renewable sources of energy and its effect, Renewable sources of energy for sustainability, Nuclear resources and Legal Regulation of Hazardous Substances, Sustainable Development: Programme and Policies, Sustainability assessment and Indicators

### **UNIT IV NGO'S FOR SUSTAINABILITY**

**9**

Civil Society Initiatives in Environment Management, Civil Society Initiatives for Sustainable Development, Global Initiatives in Protecting Global Environment, World Summit on Sustainable Development (Johannesburg Summit 2002), Ecological economics, Environmental sustainability, Social inclusion, Health for all, education for all, Food security and Water security, NGOs and Sustainable Development strategies

### **UNIT V LEGAL FRAMEWORKS**

**9**

Need for a Legal framework and its enforcement, Legal measures to control pollution, Environmental Legislations in India, Mechanism to implement Environmental Laws in India, Legal Protection of Forests Act 1927, Legal Protection of Wild Life, Role of NGO's in implementing environmental laws, Challenges in the implementation of environmental legislation

**TOTAL 45 : PERIODS**



## COURSE OUTCOMES

Upon completion of this course, the student will :

- CO1** Have a thorough grounding on the issues and challenges being faced in attaining sustainable development
- CO2** have a knowledge on the role of NGOs towards sustainable development
- CO3** present strategies for NGOs in attaining sustainable development
- CO4** recognize the importance of providing energy, food security and health equity to all members of the society without damaging the environment
- CO5** understand the environmental legislations

## REFERENCE BOOKS

1. Kulsange, S and Kamble, R. (2019). Environmental NGO's: Sustainability Stewardship, Lap Lambert Academic Publishing, India, ISBN-13: 978-6200442444.
2. Dodds, F. (2007). NGO diplomacy: The influence of nongovernmental organizations in international environmental negotiations. Mit Press, Cambridge, ISBN-13: 978-0262524766.
3. Ghosh, S. (Ed.). (2019). Indian environmental law: Key concepts and principles. Orient BlackSwan, India, ISBN-13: 978-9352875795.
4. Alan Fowler and Chiku Malunga (2010) NGO Management: The Earthscan Companion, Routledge, ISBN-13 : 978-1849711197.

**OMG353**

## DEMOCRACY AND GOOD GOVERNANCE

**L T P C**  
**3 0 0 3**

### UNIT I

Structure and Process of Governance: Indian Model of Democracy, Parliament, Party Politics and Electoral Behaviour, Federalism, the Supreme Court and Judicial Activism, Units of Local Governance **(9)**

### UNIT II

Regulatory Institutions – SEBI, TRAI, Competition Commission of India, **(9)**

### UNIT III

Lobbying Institutions: Chambers of Commerce and Industries, Trade Unions, Farmers Associations, etc. **(9)**

### UNIT IV

Contemporary Political Economy of Development in India: Policy Debates over Models of Development in India, Recent trends of Liberalisation of Indian Economy in different sectors, E-governance **(9)**

### UNIT V

Dynamics of Civil Society: New Social Movements, Role of NGO's, Understanding the political significance of Media and Popular Culture. **(9)**

**TOTAL 45 : PERIODS**

## REFERENCES:

1. Atul Kohli (ed.): The Success of India's Democracy, Cambridge University Press, 2001.
2. Corbridge, Stuart and John Harris: Reinventing India: Liberalisation, Hindu Nationalism and Popular Democracy, Oxford University Press, 2000.
3. J.Dreze and A.Sen, India: Economic Development and Social Opportunity, Clarendon, 1995.
4. Saima Saeed: Screening the Public Sphere: Media and Democracy in India, 2013
5. Himat Singh: Green Revolution Reconsidered: The Rural World of Punjab, OUP, 2001.
6. Jagdish Bhagwati: India in Transition: Freeing The Economy, 1993.
7. Smitu Kothari: Social Movements and the Redefinition of Democracy, Boulder, Westview, 1993.

**CME365**

**RENEWABLE ENERGY TECHNOLOGIES**

**L T P C**

**3 0 0 3**

## COURSE OBJECTIVES

- To know the Indian and global energy scenario
- To learn the various solar energy technologies and its applications.
- To educate the various wind energy technologies.
- To explore the various bio-energy technologies.
- To study the ocean and geothermal technologies.

### UNIT I ENERGY SCENARIO

**9**

Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status- Potential of various renewable energy sources-Global energy status-Per capita energy consumption - Future energy plans

### UNIT II SOLAR ENERGY

**9**

Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications.

### UNIT III WIND ENERGY

**9**

Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.

### UNIT IV BIO-ENERGY

**9**

Bio resources – Biomass direct combustion – thermochemical conversion - biochemical conversion- mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration – Carbonisation – Pyrolysis - Biogas plants – Digesters – Biodiesel production – Ethanol production - Applications.

### UNIT V OCEAN AND GEOTHERMAL ENERGY

**9**

Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES:

At the end of the course the students would be able to

- Discuss the Indian and global energy scenario.
- Describe the various solar energy technologies and its applications.
- Explain the various wind energy technologies.
- Explore the various bio-energy technologies.
- Discuss the ocean and geothermal technologies.

## TEXT BOOKS:

1. Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, cGraw Hill; First edition (10 December 2020), ISBN-10 : 9390385636
2. Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 8120344707

## REFERENCES:

1. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012.
2. Rai.G.D., "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2014.
3. Sukhatme.S.P., "Solar Energy: Principles of Thermal Collection and Storage", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
4. Tiwari G.N., "Solar Energy – Fundamentals Design, Modelling and applications", Alpha Science Intl Ltd, 2015.
5. Twidell, J.W. & Weir A., "Renewable Energy Resources", EFNSpon Ltd., UK, 2015.

## CO's-PO's & PSO's MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	1	1	2	3	2	2	1	1	3	2	1	2
2	3	2	2	1	1	1	3	1	1	1	2	3	2	1	2
3	3	2	3	1	2	1	3	1	1	1	1	3	1	1	2
4	2	2	2	1	2	1	3	1	1	1	2	3	2	2	2
5	2	1	2	1	2	1	3	1	1	1	1	3	2	1	2

Low (1) ; Medium (2) ; High (3)

1 - low, 2 - medium, 3 - high, '-' - no correlation

OME354

APPLIED DESIGN THINKING

L T P C

3 0 0 3

## COURSE OBJECTIVES:

The course aims to

- Introduce tools & techniques of design thinking for innovative product development
- Illustrate customer-centric product innovation using on simple use cases
- Demonstrate development of Minimum usable Prototypes
- Outline principles of solution concepts & their evaluation
- Describe system thinking principles as applied to complex systems

<b>UNIT I</b>	<b>DESIGN THINKING PRINCIPLES</b>	<b>9</b>
Exploring Human-centered Design - Understanding the Innovation process, discovering areas of opportunity, Interviewing & empathy-building techniques, Mitigate validation risk with FIR [Forge Innovation rubric] - Case studies		
<b>UNIT II</b>	<b>ENDUSER-CENTRIC INNOVATION</b>	<b>9</b>
Importance of customer-centric innovation - Problem Validation and Customer Discovery - Understanding problem significance and problem incidence - Customer Validation. Target user, User persona & user stories. Activity: Customer development process - Customer interviews and field visit		
<b>UNIT III</b>	<b>APPLIED DESIGN THINKING TOOLS</b>	<b>9</b>
Concept of Minimum Usable Prototype [MUP] - MUP challenge brief - Designing & Crafting the value proposition - Designing and Testing Value Proposition; Design a compelling value proposition; Process, tools and techniques of Value Proposition Design		
<b>UNIT IV</b>	<b>CONCEPT GENERATION</b>	<b>9</b>
Solution Exploration, Concepts Generation and MUP design- Conceptualize the solution concept; explore, iterate and learn; build the right prototype; Assess capability, usability and feasibility. Systematic concept generation; evaluation of technology alternatives and the solution concepts		
<b>UNIT V</b>	<b>SYSTEM THINKING</b>	<b>9</b>
System Thinking, Understanding Systems, Examples and Understandings, Complex Systems		
		<b>TOTAL: 45 PERIODS</b>

### **COURSE OUTCOMES**

**At the end of the course, learners will be able to:**

- CO1:** Define & test various hypotheses to mitigate the inherent risks in product innovations.
- CO2:** Design the solution concept based on the proposed value by exploring alternate solutions to achieve value-price fit.
- CO3:** Develop skills in empathizing, critical thinking, analyzing, storytelling & pitching
- CO4:** Apply system thinking in a real-world scenario

### **TEXT BOOKS**

1. Steve Blank, (2013), The four steps to epiphany: Successful strategies for products that win, Wiley.
2. Alexander Osterwalder, Yves Pigneur, Gregory Bernarda, Alan Smith, Trish Papadacos, (2014), Value
3. Proposition Design: How to Create Products and Services Customers Want, Wiley
4. Donella H. Meadows, (2015), "Thinking in Systems -A Primer", Sustainability Institute.
5. Tim Brown,(2012) "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation", Harper Business.

### **REFERENCES**

1. <https://www.ideou.com/pages/design-thinking#process>
2. [https://blog.forgeforward.in/valuation-risk-versus-validation-risk-in-product-innovations-49f253ca86\\_24](https://blog.forgeforward.in/valuation-risk-versus-validation-risk-in-product-innovations-49f253ca86_24)
3. <https://blog.forgeforward.in/product-innovation-rubric-adf5ebdfd356>
4. <https://blog.forgeforward.in/evaluating-product-innovations-e8178e58b86e>

5. <https://blog.forgeforward.in/user-guide-for-product-innovation-rubric-857181b253dd>
6. <https://blog.forgeforward.in/star-tup-failure-is-like-true-lie-7812cdf9b85>

**MF3003**

**REVERSE ENGINEERING**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- The main learning objective of this course is to prepare students for:
- Applying the fundamental concepts and principles of reverse engineering in product design and development.
- Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- Applying the concept and principles of material identification and process verification in reverse engineering of product design and development.
- Analysing the various legal aspect and applications of reverse engineering in product design and development.
- Understand about 3D scanning hardware & software operations and procedure to generate 3D model

**UNIT I INTRODUCTION & GEOMETRIC FORM**

**9 Hours**

Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

**UNIT II MATERIAL CHARACTERISTICS AND PROCESS IDENTIFICATION**

**9 Hours**

.Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification.

**UNIT III DATA PROCESSING**

**9 Hours**

Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility.

**UNIT IV 3D SCANNING AND MODELLING**

**9 Hours**

Introduction, working principle and operations of 3D scanners: Laser, White Light, Blue Light - Applications- Software for scanning and modelling: Types- Applications- Preparation techniques for Scanning objects- Scanning and Measuring strategies - Calibration of 3D Scanner- Step by step procedure: 3D scanning - Geometric modelling – 3D inspection- Case studies.

**UNIT V INDUSTRIAL APPLICATIONS**

**9 Hours**

Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry. Case studies and Solving Industrial projects in Reverse Engineering.Legality: Patent – Copyrights –Trade Secret – Third-Party Materials.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

**CO1:**Apply the fundamental concepts and principles of reverse engineering in product design and

development.

**CO2:**Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.

**CO3:**Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.

**CO4:**Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.

**CO5:**Analyze the various legal aspect

**CO6:**Applications of reverse engineering in product design and development.

**TEXT BOOKS:**

1. Robert W. Messler, Reverse Engineering: Mechanisms, Structures, Systems & Materials, 1st Edition, McGraw-Hill Education, 2014
2. Wego Wang, Reverse Engineering Technology of Reinvention, CRC Press, 2011

**REFERENCES:**

1. Scott J. Lawrence , Principles of Reverse Engineering, Kindle Edition, 2022
2. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Prentice Hall, 2001
3. Kathryn, A. Ingle, "Reverse Engineering", McGraw-Hill, 1994.
4. Linda Wills, "Reverse Engineering", Kluwer Academic Publishers, 1996
5. Vinesh Raj and Kiran Fernandes, "Reverse Engineering: An Industrial Perspective", Springer-Verlag London Limited 2008.

**OPR351**

**SUSTAINABLE MANUFACTURING**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- To be acquainted with sustainability in manufacturing and its evaluation.
- To provide knowledge in environment and social sustainability.
- To provide the student with the knowledge of strategy to achieve sustainability.
- To familiarize with trends in sustainable operations.
- To create awareness in current sustainable practices in manufacturing industry.

**UNIT I ECONOMIC SUSTAINABILITY**

**9**

Industrial Revolution-Economic sustainability: globalization and international issues Sustainability status - Emerging issues- Innovative products- Reconfiguration manufacturing enterprises - Competitive manufacturing strategies - Performance evaluation- Management for sustainability - Assessments of economic sustainability

**UNIT II SOCIAL AND ENVIRONMENTAL SUSTAINABILITY**

**9**

Social sustainability – Introduction-Work management -Human rights - Societal commitment - Customers -Business practices -Modelling and assessing social sustainability. Environmental issues pertaining to the manufacturing sector: Pollution - Use of resources -Pressure to reduce costs - Environmental management: Processes that minimize negative environmental impacts - environmental legislation and energy costs - need to reduce the carbon footprint of manufacturing Operations-Modelling and assessing environmental sustainability

**UNIT III SUSTAINABILITY PRACTICES 9**

Sustainability awareness - Measuring Industry Awareness-Drivers and barriers -Availability of sustainability indicators -Analysis of sustainability practicing -Modeling and assessment of sustainable practicing -Sustainability awareness -Sustainability drivers and barriers - Availability of sustainability indicators- Designing questionnaires- Optimizing Sustainability Indexes-Elements – Cost and time model.

**UNIT IV MANUFACTURING STRATEGY FOR SUSTAINABILITY 9**

Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.

**UNIT V TRENDS IN SUSTAINABLE OPERATIONS 9**

Principles of sustainable operations - Life cycle assessment manufacturing and service activities - influence of product design on operations - Process analysis – Capacity management - Quality management -Inventory management - Just-In-Time systems - Resource efficient design - Consumerism and sustainable well-being.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

- CO1:** Discuss the importance of economic sustainability.
- CO2:** Describe the importance of sustainable practices.
- CO3:** Identify drivers and barriers for the given conditions.
- CO4:** Formulate strategy in sustainable manufacturing.
- CO5:** Plan for sustainable operation of industry with environmental, cost consciousness.

**TEXT BOOKS:**

1. Ibrahim Garbie, “Sustainability in Manufacturing Enterprises Concepts, Analyses and Assessments for Industry 4.0”, Springer International Publishing., United States, 2016, ISBN-13: 978-3319293042.
2. Davim J.P., “Sustainable Manufacturing”, John Wiley & Sons., United States, 2010,ISBN: 978-1-848-21212-1.

**REFERENCES:**

1. Jovane F, Eµper, W.E. and Williams, D.J., “The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing”, Springer,2009, United States, ISBN 978-3-540-77011-4.
2. Kutz M., “Environmentally Conscious Mechanical Design”, John Wiley & Sons., United States, 2007, ISBN: 978-0-471-72636-4.
3. Seliger G., “Sustainable Manufacturing: Shaping Global Value Creation”, Springer, United States, 2012, ISBN 978-3-642-27289-9.

**CO’s-PO’s & PSO’s MAPPING**

Mapping of COs with POs and PSOs															
COs/Pos &PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	-	2	-	-	-	2	2	-	1	1	2	2	2	1

CO2	3	-	-	-	-	-	2	-	-	1	1	2	1	2	2
CO3	3	-	-	-	-	-	2	3	-	1	1	2	1	2	2
CO4	3	-	3	-	-	-	2		-	1	1	2	2	2	1
CO5	3	-	3	-	-	-	2	2	-	1	1	2	2	2	1
CO/PO & PSO Average	3	-	3	-	-	-	2	2	-	1	1	2	2	2	1
<b>1 - low, 2 - medium, 3 - high, ‘-‘- no correlation</b>															

**AU3791**

**ELECTRIC AND HYBRID VEHICLES**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- The objective of this course is to prepare the students to know about the general aspects of Electric and Hybrid Vehicles (EHV), including architectures, modelling, sizing, and sub system design and hybrid vehicle control.

**UNIT I DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES 9**

Need for Electric vehicle- Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. - Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refuelling Systems.

**UNIT II ENERGY SOURCES 9**

Battery Parameters- - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion-Sodium based- Metal Air. Battery Modelling - Equivalent circuits, Battery charging- Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System.

**UNIT III MOTORS AND DRIVES 9**

Types of Motors- DC motors- AC motors, PMSM motors, BLDC motors, Switched reluctance motors working principle, construction and characteristics.

**UNIT IV POWER CONVERTERS AND CONTROLLERS 9**

Solid state Switching elements and characteristics – BJT, MOSFET, IGBT, SCR and TRIAC - Power Converters – rectifiers, inverters and converters - Motor Drives - DC, AC motor, PMSM motors, BLDC motors, Switched reluctance motors – four quadrant operations –operating modes

**UNIT V HYBRID AND ELECTRIC VEHICLES 9**

Main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of this course, the student will be able to

**CO1:**Understand the operation and architecture of electric and hybrid vehicles

**CO2:**Identify various energy source options like battery and fuel cell



**CO3:**Select suitable electric motor for applications in hybrid and electric vehicles.

**CO4:**Explain the role of power electronics in hybrid and electric vehicles

**CO5:**Analyze the energy and design requirement for hybrid and electric vehicles.

**TEXT BOOKS:**

1. Iqbal Husain, “ Electric and Hybrid Vehicles-Design Fundamentals”, CRC Press,2003
2. Mehrdad Ehsani, “ Modern Electric, Hybrid Electric and Fuel Cell Vehicles”, CRCPress,2005.

**REFERENCES:**

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained “ John Wiley & Sons,2003
2. Lino Guzzella, “ Vehicle Propulsion System” Springer Publications,2005
3. Ron HodKinson, “Light Weight Electric/ Hybrid Vehicle Design”, Butterworth Heinemann Publication,2005.

**CO’s-PO’s & PSO’s MAPPING**

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	2	1		3	2					2		1	3
2	1	1	2	1		3	2					2		1	3
3	1	1	2	1		3	2					2		1	3
4	1	1	2	1		3	2					2		1	3
5	1	1	2	1		3	2					2		1	3
Avg.	1	1	2	1		3	2					2		1	3

1 - low, 2 - medium, 3 - high, ‘-’- no correlation

**OAS352**

**SPACE ENGINEERING**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- Use the standard atmosphere tables and equations.
- Find lift and drag coefficient data from NACA plots.
- Apply the concept of static stability to flight vehicles.
- Describe the concepts of stress, strain, Young’s modulus, Poisson’s ratio, yield strength.
- Demonstrate a basic knowledge of dynamics relevant to orbital mechanics.

**UNIT I STANDARD ATMOSPHERE**

**6**

History of aviation – standard atmosphere - pressure, temperature and density altitude.

**UNIT II AERODYNAMICS**

**10**

Aerodynamic forces – Lift generation Viscosity and its implications - Shear stress in a velocity profile - Lagrangian and Eulerian flow field - Concept of a streamline – Aircraft terminology and geometry - Aircraft types - Lift and drag coefficients using NACA data.

**UNIT III PERFORMANCE AND PROPULSION**

**9**

Viscous and pressure drag - flow separation - aerodynamic drag - thrust calculations -thrust/power available and thrust/power required.

**UNIT IV AIRCRAFT STABILITY AND STRUCTURAL THEORY 10**  
Degrees of freedom of aircraft motions - stable, unstable and neutral stability - concept of static stability - Hooke's Law- brittle and ductile materials - moment of inertia - section modulus.

**UNIT V SPACE APPLICATIONS 10**  
History of space research - spacecraft trajectories and basic orbital manoeuvres - six orbital elements - Kepler's laws of orbits - Newtons law of gravitation.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- CO1:** Illustrate the history of aviation & developments over the years
- CO2:** Ability to identify the types & classifications of components and control systems
- CO3:** Explain the basic concepts of flight & Physical properties of Atmosphere
- CO4:** Identify the types of fuselage and constructions.
- CO5:** Distinguish the types of Engines and explain the principles of Rocket

**TEXT BOOKS:**

1. John D. Anderson, Introduction to Flight, 8 th Ed., McGraw-Hill Education, New York,2015.
2. E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021.
3. Stephen. A. Brandt, "Introduction to Aeronautics: A design perspective &quot; American Institute of Aeronautics & Astronautics,1997.

**REFERENCE:**

1. Kermode, A.C., "Mechanics of Flight", Himalayan Book, 1997.

**OIM351 INDUSTRIAL MANAGEMENT L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce fundamental concepts of industrial management
- To understand the approaches to the study of Management
- To learn about Decision Making, Organizing and leadership
- To analyze the Managerial Role and functions
- To know about the Supply Chain Management'

**UNIT I INTRODUCTION 9**  
Technology Management - Definition - Functions - Evolution of Modern Management - Scientific Management Development of Management Thought. Approaches to the study of Management, Forms of Organization -Individual Ownership - Partnership - Joint Stock Companies - Co-operative Enterprises - Public Sector Undertakings, Corporate Frame Work- Share Holders - Board of Directors - Committees - Chief Executive Line and Functional Managers,-Financial-Legal-Trade Union

**UNIT II FUNCTIONS OF MANAGEMENT 9**  
Planning - Nature and Purpose - Objectives - Strategies – Policies and Planning Premises - Decision Making - Organizing - Nature and Process - Premises - Departmentalization - Line and staff - Decentralization -Organizational culture, Staffing - selection and training .Placement - Performance appraisal - Career Strategy – Organizational Development. Leading - Managing human factor -

Leadership .Communication, Controlling - Process of Controlling - Controlling techniques, productivity and operations management - Preventive control, Industrial Safety.

**UNIT III ORGANIZATIONAL BEHAVIOUR 9**

Definition - Organization - Managerial Role and functions -Organizational approaches, Individual behaviour - causes - Environmental Effect - Behaviour and Performance, Perception - Organizational Implications. Personality - Contributing factors - Dimension – Need Theories - Process Theories - Job Satisfaction, Learning and Behaviour-Learning Curves, Work Design and approaches.

**UNIT IV GROUPOYNAMICS 9**

Group Behaviour - Groups - Contributing factors - Group Norms, Communication - Process - Barriers to communication - Effective communication, leadership - formal and informal characteristics – Managerial Grid - Leadership styles - Group Decision Making - Leadership Role in Group Decision, Group Conflicts - Types -Causes - Conflict Resolution -Inter group relations and conflict, Organization centralization and decentralization - Formal and informal - Organizational Structures Organizational Change and Development -Change Process – Resistance to Change - Culture and Ethics.

**UNIT V MODERN CONCEPTS 9**

Management by Objectives (MBO) - Management by Exception (MBE),Strategic Management - Planning for Future direction - SWOT Analysis -Evolving development strategies, information technology in management Decisions support system-Management Games Business Process Re-engineering(BPR) –Enterprises Resource Planning (ERP) - Supply Chain Management (SCM) - Activity Based Management (AM) - Global Perspective - Principles and Steps Advantages and disadvantage

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- CO1:** Understand the basic concepts of industrial management
- CO2:** Identify the group conflicts and its causes.
- CO3:** Perform swot analysis
- CO4 :** Analyze the learning curves
- CO5 :** Understand the placement and performance appraisal

**REFERENCES:**

1. Maynard H.B, "Industrial Engineering Hand book", McGraw-Hill, sixth 2008

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1											2	1	
2		3	2	3											2
3	2	3	2	3									1	2	3
4	2	2	3	3										3	3
5	2	2											2		
<b>AVg.</b>	2	2.2	2.3	3									1.8	2	2.6

1 - low, 2 - medium, 3 - high, '-'- no correlation

**COURSE OBJECTIVES**

- Developing a clear knowledge in the basics of various quality concepts.
- Facilitating the students in understanding the application of control charts and its techniques.
- Developing the special control procedures for service and processor oriented industries.
- Analyzing and understanding the process capability study.
- Developing the acceptance sampling procedures for incoming raw material.

**UNIT I INTRODUCTION****9**

Quality Dimensions–Quality definitions–Inspection–Quality control–Quality Assurance–Quality planning–Quality costs–Economics of quality– Quality loss function

**UNIT II CONTROL CHARTS****9**

Chance and assignable causes of process variation, statistical basis of the control chart, control charts for variables-  $\bar{X}$ , R and S charts, attribute control charts - p, np, c and u- Construction and application.

**UNIT III SPECIAL CONTROL PROCEDURES****9**

Warning and modified control limits, control chart for individual measurements, multi-vari chart, X chart with a linear trend, chart for moving averages and ranges, cumulative-sum and exponentially weighted moving average control charts.

**UNIT IV STATISTICAL PROCESS CONTROL****9**

Process stability, process capability analysis using a Histogram or probability plots and control chart. Gauge capability studies, setting specification limits.

**UNIT V ACCEPTANCE SAMPLING****9**

The acceptance sampling fundamental, OC curve, sampling plans for attributes, simple, double, multiple and sequential, sampling plans for variables, MIL-STD-105D and MIL-STD-414E & IS 2500 standards.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

Students will be able to:

**CO1:** Control the quality of processes using control charts for variables in manufacturing industries.

**CO2:** Control the occurrence of defective product and the defects in manufacturing companies.

**CO3:** Control the occurrence of defects in services.

**CO4:** Analyzing and understanding the process capability study.

**CO5:** Developing the acceptance sampling procedures for incoming raw material.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	3		3			1	2			2	1		
2		3	3		3	3			3			3		2	
3	3	3	3		3				3			3	1		
4	3		2		3						1		1		



## COURSE OUTCOMES

On completion of the course the student will be able to

**CO1:** Understand the effect of fire on materials used for construction

**CO2:** Understand the method of test for non-combustibility and fire resistance; and will be able to select different structural elements and their dimensions for a particular fire resistance rating of a building.

**CO3:** To understand the design concept of fire walls, fire screens, local barriers and fire doors and able to select them appropriately to prevent fire spread.

**CO4:** To decide the method of fire protection to RCC, steel, and wooden structural elements and their repair methods if damaged due to fire.

**CO5:** Describe the safety techniques and improve the analytical and intelligence to take the right decision at right time.

## TEXT BOOKS

- Roytman, M. Y., "Principles of fire safety standards for building construction". Amerind Publishing Co. Pvt. Ltd., New Delhi, 1975
- John A. Purkiss, "Fire safety engineering design of structures" (2nd edn.), Butterworth Heinemann, Oxford, UK, 2009.

## REFERENCES:

- Smith, E.E. and Harmathy, T.Z. (Editors), "Design of buildings for fire safety". ASTM Special Publication 685, American Society for Testing and Materials, Boston, U.S.A, 1979.
- Butcher, E. G. and Parnell, A. C, "Designing of fire safety". JohnWiley and Sons Ltd., New York, U.S.A. 1983.
- Jain, V.K, "Fire safety in buildings" (2nd edn.). New Age International(P) Ltd., New Delhi, 2010.
- Hazop&Hazan, "Identifying and Assessing Process Industry Hazards", Fourth Edition , 1999
- Frank R. Spellman, Nancy E. Whiting, "The Handbook of Safety Engineering: Principles and Applications", 2009

## CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1	2	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-
2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
3	1	-	2	-	-	-	3	-	-	1	-	-	-	-	-	-
4	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
5	2	-	1	-	-	1	1	1	-	1	-	1	-	-	-	-
<b>AVg.</b>	1.3	-	1.75	-	-	1	1.3	1		1	-	1	-	-	-	-

1 - low, 2 - medium, 3 - high, '-'- no correlation

**OML351**

**INTRODUCTION TO NON-DESTRUCTIVE TESTING**

**L T P C**

**3 0 0 3**

## COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Understanding the basic importance of NDT in quality assurance.

- Imbibing the basic principles of various NDT techniques, its applications, limitations, codes and standards.
- Equipping themselves to locate a flaw in various materials, products.
- Applying apply the testing methods for inspecting materials in accordance with industry specifications and standards.
- Acquiring the knowledge on the selection of the suitable NDT technique for a given application

**UNIT I INTRODUCTION TO NDT & VISUAL TESTING 9**

Concepts of Non-destructive testing-relative merits and limitations-NDT Versus mechanical testing, Fundamentals of Visual Testing – vision, lighting, material attributes, environmental factors, visual perception, direct and indirect methods – mirrors, magnifiers, boroscopes and fibrosopes – light sources and special lighting.

**UNIT II LIQUID PENETRANT & MAGNETIC PARTICLE TESTING 9**

Liquid Penetrant Inspection: principle, applications, advantages and limitations, dyes, developers and cleaners, Methods & Interpretation.  
Magnetic Particle Inspection: Principles, applications, magnetization methods, magnetic particles, Testing Procedure, demagnetization, advantages and limitations, – Interpretation and evaluation of test indications.

**UNIT III EDDY CURRENT TESTING & THERMOGRAPHY 9**

Eddy Current Testing: Generation of eddy currents– properties– eddy current sensing elements, probes, Instrumentation, Types of arrangement, applications, advantages, limitations – Factors affecting sensing elements and coil impedance, calibration, Interpretation/Evaluation.  
Thermography- Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal – Concept, example, advantages & limitations. Electromagnetic spectrum, infrared thermography- approaches, IR detectors, Instrumentation and methods, applications.

**UNIT IV ULTRASONIC TESTING & AET 9**

Ultrasonic Testing: Types of ultrasonic waves, characteristics, attenuation, couplants, probes, EMAT. Inspection methods-pulse echo, transmission and phased array techniques, types of scanning and displays, angle beam inspection of welds, time of flight diffraction (TOFD) technique, Thickness determination by ultrasonic method, Study of A, B and C scan presentations, calibration. Acoustic Emission Technique – Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages & Limitations, Interpretation of Results, Applications.

**UNIT V RADIOGRAPHY TESTING 9**

Sources-X-rays and Gamma rays and their characteristics-absorption, scattering. Filters and screens, Imaging modalities-film radiography and digital radiography (Computed, Direct, Real Time, CT scan). Problems in shadow formation, exposure factors, inverse square law, exposure charts, Penetrameters, safety in radiography.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the students will be able to

**CO1:**Realize the importance of NDT in various engineering fields.

**CO2:**Have a basic knowledge of surface NDE techniques which enables to carry out various inspection in accordance with the established procedures.

**CO3:**Calibrate the instrument and inspect for in-service damage in the components by means of Eddy current testing as well as Thermography testing.

**CO4:**Differentiate various techniques of UT and AET and select appropriate NDT methods for better evaluation.

**CO5:**Interpret the results of Radiography testing and also have the ability to analyse the influence of various parameters on the testing.

**TEXT BOOKS:**

1. Baldev Raj, T. Jayakumar and M. Thavasimuthu, Practical Non Destructive Testing, Alpha Science International Limited, 3rd edition, 2002.
2. J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition, 2011.
3. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010.

**REFERENCES:**

1. ASM Metals Handbook, V-17, "Nondestructive Evaluation and Quality Control", American Society of Metals, USA, 2001.
2. Barry Hull and Vernon John, "Nondestructive Testing", Macmillan, 1989.
3. Chuck Hellier, "Handbook of Nondestructive Evaluation", Mc Graw Hill, 2012.
4. Louis Cartz, "Nondestructive Testing", ASM International, USA, 1995.

**CO's-PO's & PSO's MAPPING**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
C01	2	2	2	3			2	2				2	1	2	
C02	3	1	2	2			2	2				2	2	2	1
C03	3	2	1	2			2	2				2	2	2	
CO4	3	1	2	2			2	2				2	2	2	2
CO5	3	2	2	2			2	2				2	2	2	1
Avg	2.8	1.6	1.8	2.2			2	2				2	1.8	2	1.3

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OMR351**

**MECHATRONICS**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Selecting sensors to develop mechatronics systems.
- Explaining the architecture and timing diagram of microprocessor, and also interpret and develop programs.
- Designing appropriate interfacing circuits to connect I/O devices with microprocessor.
- Applying PLC as a controller in mechatronics system.
- Designing and develop the apt mechatronics system for an application.



**UNIT I INTRODUCTION AND SENSORS 9**

Introduction to Mechatronics – Systems – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and Dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance Sensors – Strain Gauges – Eddy Current Sensor – Hall Effect Sensor – Temperature Sensors – Light Sensors.

**UNIT II 8085 MICROPROCESSOR 9**

Introduction – Pin Configuration - Architecture of 8085 – Addressing Modes – Instruction set, Timing diagram of 8085.

**UNIT III PROGRAMMABLE PERIPHERAL INTERFACE 9**

Introduction – Architecture of 8255, Keyboard Interfacing, LED display – Interfacing, ADC and DAC Interface, Temperature Control – Stepper Motor Control – Traffic Control Interface.

**UNIT IV PROGRAMMABLE LOGIC CONTROLLER 9**

Introduction – Architecture – Input / Output Processing – Programming with Timers, Counters and Internal relays – Data Handling – Selection of PLC.

**UNIT V ACTUATORS AND MECHATRONICS SYSTEM DESIGN 9**

Types of Stepper and Servo motors – Construction – Working Principle – Characteristics, Stages of Mechatronics Design Process – Comparison of Traditional and Mechatronics Design Concepts with Examples – Case studies of Mechatronics Systems – Pick and Place Robot – Engine Management system – Automatic Car Park Barrier.

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

**CO1:** Select sensors to develop mechatronics systems.

**CO2:** Explain the architecture and timing diagram of microprocessor, and also interpret and develop programs.

**CO3:** Design appropriate interfacing circuits to connect I/O devices with microprocessor.

**CO 4:** Apply PLC as a controller in mechatronics system.

**CO 5:** Design and develop the apt mechatronics system for an application.

<b>CO's-PO's &amp; PSO's MAPPING</b>															
<b>COs/POs &amp; PSOs</b>	<b>POs</b>												<b>PSOs</b>		
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>1</b>	<b>2</b>	<b>3</b>
CO1	3	2	1	3		2						2	3	2	3
CO2	3	2	1	3		2						2	3	2	3
CO3	3	2	1	3		2						2	3	2	3
CO4	3	2	1	3		2						2	3	2	3
CO5	3	2	1	3		2						2	3	2	3
CO/PO & PSO Average	3	2	1	3		2						2	3	2	3
<b>1 - low, 2 - medium, 3 - high, '-' - no correlation</b>															

**TEXT BOOKS**

1. Bolton W., "Mechatronics", Pearson Education, 6th Edition, 2015.

- Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Penram International Publishing Private Limited, 6th Edition, 2013.

## REFERENCES

- Bradley D.A., Dawson D., Buru N.C. and Loader A.J., "Mechatronics", Chapman and Hall, 1993.
- Davis G. Alciatore and Michael B. Hstand, "Introduction to Mechatronics and Measurement systems", McGraw Hill Education, 2011.
- Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", Cengage Learning, 2010.
- Nitaigour Premchand Mahalik, "Mechatronics Principles, Concepts and Applications", McGraw Hill Education, 2015.
- Smaili. A and Mrad. F, "Mechatronics Integrated Technologies for Intelligent Machines", Oxford University Press, 2007.

<b>ORA351</b>	<b>FOUNDATION OF ROBOTICS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

## COURSE OBJECTIVES:

- To study the kinematics, drive systems and programming of robots.
- To study the basics of robot laws and transmission systems.
- To familiarize students with the concepts and techniques of robot manipulator, its kinematics.
- To familiarize students with the various Programming and Machine Vision application in robots.
- To build confidence among students to evaluate, choose and incorporate robots in engineering systems.

## UNIT I FUNDAMENTALS OF ROBOT 9

Robot – Definition – Robot Anatomy – Co-ordinate systems, Work Envelope, types and classification – specifications – Pitch, yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and their functions – Need for Robots – Different Applications.

## UNIT II ROBOT KINEMATICS 9

Forward kinematics, inverse kinematics and the difference: forward kinematics and inverse Kinematics of Manipulators with two, three degrees of freedom (in 2 dimensional), four degrees of freedom (in 3 dimensional) – derivations and problems. Homogeneous transformation matrices, translation and rotation matrices.

## UNIT III ROBOT DRIVE SYSTEMS AND END EFFECTORS 9

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of All These Drives. End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic grippers, vacuum grippers, internal grippers and external grippers, selection and design considerations of a gripper

**UNIT IV      SENSORS IN ROBOTICS****9**

Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors, safety considerations in robotic cell, proximity sensors, fail safe hazard sensor systems, and compliance mechanism. Machine vision system - camera, frame grabber, sensing and digitizing image data – signal conversion, image storage, lighting techniques, image processing and analysis – data reduction, segmentation, feature extraction, object recognition, other algorithms, applications – Inspection, identification, visual serving and navigation.

**UNIT V      PROGRAMMING AND APPLICATIONS OF ROBOT****9**

Teach pendant programming, lead through programming, robot programming languages – VAL programming – Motion Commands, Sensors commands, End-Effector Commands, and simple programs - Role of robots in inspection, assembly, material handling, underwater, space and medical fields.

**TOTAL : 45 PERIODS****COURSE OUTCOMES**

At the end of the course, students will be able to:

**CO1:** Interpret the features of robots and technology involved in the control.

**CO2:** Apply the basic engineering knowledge and laws for the design of robotics.

**CO3:** Explain the basic concepts like various configurations, classification and parts of end effectors compare various end effectors and grippers and tools and sensors used in robots.

**CO4:** Explain the concept of kinematics, degeneracy, dexterity and trajectory planning.

**CO5:** Demonstrate the image processing and image analysis techniques by machine vision system.

<b>CO's-PO's &amp; PSO's MAPPING</b>															
<b>COs/POs &amp; PSOs</b>	<b>POs</b>												<b>PSOs</b>		
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>1</b>	<b>2</b>	<b>3</b>
CO1	3	2	1	1								1			3
CO2	3	2	1	1								1			3
CO3	3	2	1	1								1			3
CO4	3	2	1	1								1			3
CO5	3	2	1	1								1			3
CO/PO & PSO Average															
<b>1 - low, 2 - medium, 3 - high, ‘-’- no correlation</b>															

**TEXT BOOKS:**

1. Ganesh.S.Hedge, "A textbook of Industrial Robotics", Lakshmi Publications, 2006.
2. Mikell.P.Groover , "Industrial Robotics – Technology, Programming and applications" McGraw Hill 2<sup>ND</sup> edition 2012.

**REFERENCES:**

1. Fu K.S. Gonalz R.C. and ice C.S.G."Robotics Control, Sensing, Vision and Intelligence", McGraw Hill book co. 2007.
2. YoramKoren, "Robotics for Engineers", McGraw Hill Book, Co., 2002.

3. Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill 2005.
4. John. J.Craig, "Introduction to Robotics: Mechanics and Control" 2nd Edition, 2002.
5. 5. Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer India reprint, 2010.

**OAE352**

**FUNDAMENTALS OF AERONAUTICAL ENGINEERING**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- To acquire the knowledge on the Historical evaluation of Airplanes
- To learn the different component systems and functions
- To know the concepts of basic properties and principles behind the flight
- To learn the basics of different structures & construction
- To learn the various types of power plants used in aircrafts

**UNIT I HISTORY OF FLIGHT**

**8**

Balloon flight-ornithopter-Early Airplanes by Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

**UNIT II AIRCRAFT CONFIGURATIONS AND ITS CONTROLS**

**10**

Different types of flight vehicles, classifications-Components of an airplane and their functions-Conventional control, powered control- Basic instruments for flying-Typical systems for control actuation.

**UNIT III BASICS OF AERODYNAMICS**

**9**

Physical Properties and structures of the Atmosphere, Temperature, pressure and altitude relationships, Newton's Law of Motions applied to Aeronautics-Evolution of lift, drag and moment. Aerofoils, Mach number, Maneuvers.

**UNIT IV BASICS OF AIRCRAFT STRUCTURES**

**9**

General types of construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Metallic and non-metallic materials. Use of Aluminium alloy, titanium, stainless steel and composite materials. Stresses and strains-Hooke's law- stress-strain diagrams-elastic constants-Factor of Safety.

**UNIT V BASICS OF PROPULSION**

**9**

Basic ideas about piston, turboprop and jet engines – use of propeller and jets for thrust production-Comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

- CO1:** Illustrate the history of aircraft & developments over the years  
**CO2:** Ability to identify the types & classifications of components and control systems  
**CO3:** Explain the basic concepts of flight & Physical properties of Atmosphere  
**CO4:** Identify the types of fuselage and constructions.  
**CO5:** Distinguish the types of Engines and explain the principles of Rocket

## TEXT BOOKS

1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition , 2015
2. E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021
3. Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.

## REFERENCE

1. SADHU SINGH, "INTERNAL COMBUSTION ENGINES AND GAS TURBINE"-, SS Katariaia & sons, 2015
2. KERMODE , "FLIGHT WITHOUT FORMULAE", -, Pitman; 4th Revised edition 1989

**OGI351**

**REMOTE SENSING CONCEPTS**

**L T P C**

**3 0 0 3**

### COURSE OBJECTIVES:

- To introduce the concepts of remote sensing processes and its components.
- To expose the various remote sensing platforms and sensors and to introduce the elements of data interpretation

### **UNIT I                    REMOTE SENSING AND ELECTROMAGNETIC RADIATION                    9**

Definition – components of RS – History of Remote Sensing – Merits and demerits of data collation between conventional and remote sensing methods - Electromagnetic Spectrum – Radiation principles - Wave theory, Planck's law, Wien's Displacement Law, Stefan's Boltzmann law, Kirchoff's law – Radiation sources: active & passive - Radiation Quantities

### **UNIT II                    EMR INTERACTION WITH ATMOSPHERE AND EARTH MATERIAL                    9**

Standard atmospheric profile – main atmospheric regions and its characteristics – interaction of radiation with atmosphere – Scattering, absorption and refraction – Atmospheric windows - Energy balance equation – Specular and diffuse reflectors – Spectral reflectance & emittance – Spectroradiometer – Spectral Signature concepts – Typical spectral reflectance curves for vegetation, soil and water – solid surface scattering in microwave region.

### **UNIT III                    ORBITS AND PLATFORMS                    9**

Motions of planets and satellites – Newton's law of gravitation - Gravitational field and potential - Escape velocity - Kepler's law of planetary motion - Orbit elements and types – Orbital perturbations and maneuvers – Types of remote sensing platforms - Ground based, Airborne platforms and Space borne platforms – Classification of satellites – Sun synchronous and Geosynchronous satellites – Lagrange Orbit.

### **UNIT IV                    SENSING TECHNIQUES                    9**

Classification of remote sensors – Resolution concept : spatial, spectral, radiometric and temporal resolutions - Scanners - Along and across track scanners – Optical-infrared sensors – Thermal sensors – microwave sensors – Calibration of sensors - High Resolution Sensors - LIDAR , UAV – Orbital and sensor characteristics of live Indian earth observation satellites

### **UNIT V                    DATA PRODUCTS AND INTERPRETATION                    9**

Photographic and digital products – Types, levels and open source satellite data products –

selection and procurement of data– Visual interpretation: basic elements and interpretation keys - Digital interpretation – Concepts of Image rectification, Image enhancement and Image classification

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the student is expected to

- CO 1** Understand the concepts and laws related to remote sensing
- CO 2** Understand the interaction of electromagnetic radiation with atmosphere and earth material
- CO 3** Acquire knowledge about satellite orbits and different types of satellites
- CO 4** Understand the different types of remote sensors
- CO 5** Gain knowledge about the concepts of interpretation of satellite imagery

**TEXTBOOKS:**

1. Thomas M.Lillesand, Ralph W. Kiefer and Jonathan W. Chipman, Remote Sensing and Image interpretation, John Wiley and Sons, Inc, New York,2015.
2. George Joseph and C Jeganathan, Fundamentals of Remote Sensing,Third Edition Universities Press (India) Private limited, Hyderabad, 2018

**REFERENCES:**

1. Janza, F.Z., Blue H.M. and Johnson,J.E. Manual of Remote Sensing. Vol.1, American Society of Photogrametry, Virginia, USA, 2002.
2. Verbyla, David, Satellite Remote Sensing of Natural Resources. CRC Press, 1995
3. Paul Curran P.J. Principles of Remote Sensing. Longman, RLBS, 1988.
4. Introduction to Physics and Techniques of Remote Sensing , Charles Elachi and Jacob Van Zyl, 2006 Edition II, Wiley Publication.
5. Basudeb Bhatta, Remote Sensing and GIS, Oxford University Press, 2011

**CO's-PO's & PSO's MAPPING**

PO	Graduate Attribute	Course Outcome					Average
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering Knowledge	3	3	3	3	3	3
PO2	Problem Analysis				3	3	3
PO3	Design/Development of Solutions				3	3	3
PO4	Conduct Investigations of Complex Problems				3	3	3
PO5	Modern Tool Usage				3	3	3
PO6	The Engineer and Society						
PO 7	Environment and Sustainability						
PO 8	Ethics						
PO 9	Individual and Team Work						
PO 10	Communication						
PO 11	Project Management and Finance						
PO 12	Life-long Learning	3		3	3	3	3
PSO 1	Knowledge of Geoinformatics discipline	3	3	3	3	3	3
PSO 2	Critical analysis of Geoinformatics Engineering problems and innovations	3	3	3	3	3	3
PSO 3	Conceptualization and evaluation of Design solutions	3	3	3	3	3	3

1 - low, 2 - medium, 3 - high, ‘-‘- no correlation

**COURSE OBJECTIVES:**

- To introduce the students the principles of agricultural crop production and the production practices of crops in modern ways.
- To delineate the role of agricultural engineers in relation to various crop production practices.

**UNIT I INTRODUCTION****9**

Benefits of urban agriculture- economic benefits, environmental benefits, social and cultural benefits, educational, skill-building and job training benefits, health, nutrition and food accessibility benefits.

**UNIT II VERTICAL FARMING****9**

**Vertical farming- types**, green facade, living/green wall-modular green wall , vegetated mat wall- Structures and components for green wall system: plant selection, growing media, irrigation and plant nutrition: Design, light, benefits of vertical gardening. Roof garden and its types. Kitchen garden, hanging baskets: The house plants/ indoor plants

**UNIT III SOIL LESS CULTIVATION****9**

Hydroponics, aeroponics, aquaponics: merits and limitations, costs and Challenges, backyard gardens- tactical gardens- street landscaping- forest gardening, greenhouses, urban beekeeping

**UNIT IV MODERN CONCEPTS****9**

Growth of plants in vertical pipes in terraces and inside buildings, micro irrigation concepts suitable for roof top gardening, rain hose system, Green house, polyhouse and shade net system of crop production on roof tops

**UNIT V WASTE MANAGEMENT****9**

Concept, scope and maintenance of waste management- recycle of organic waste, garden wastes- solid waste management-scope, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, waste utilization.

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

**CO1:**Demonstrate the principles behind crop production and various parameters that influences the crop growth on roof tops

**CO2:**Explain different methods of crop production on roof tops

**CO3:**Explain nutrient and pest management for crop production on roof tops

**CO4:**Illustrate crop water requirement and irrigation water management on roof tops

**CO5:**Explain the concept of waste management on roof tops

**TEXT BOOKS:**

1. Martellozzo F and J S Landry. 2020. Urban Agriculture. Scitus Academics Llc.
2. Rob Roggema. 2016. Sustainable Urban Agriculture and Food Planning. Routledge Taylor and Francis Group.
3. Akrong M O. 2012. Urban Agriculture. LAP Lambert Academic Publishing.

**REFERENCES:**

1. Agha Rokh A. 2008. Evaluation of ornamental flowers and fishes breeding in Bushehr urban wastewater using a pilot-scale aquaponic system. Water and Wastewater, 19 (65): 47–53.

2. Agrawal M, Singh B, Rajput M, Marshall F and Bell J. N. B. 2003. Effect of air pollution on peri-urban agriculture: A case study. Environmental Pollution, 126 (3): 323–329. <https://www.sciencedirect.com/science/article/pii/S0269749103002458#aep-section-id24>.
3. Jac Smit and Joe Nasr. 1992. Urban agriculture for sustainable cities: using wastes and idle land and water bodies as resources. Environment and Urbanization, 4 (2):141-152.

#### CO's-PO's & PSO's MAPPING

PO/PSO		CO1	CO2	CO3	CO4	CO5	Overall correlation of COs with POs
PO1	Engineering Knowledge	1	2	1	1	2	1
PO2	Problem Analysis	1	1	1	1	1	2
PO3	Design/ Development of Solutions	1	2	1	1	3	2
PO4	Conduct Investigations of Complex Problems	1	1	2	2	1	1
PO5	Modern Tool Usage	1	2	1	1	1	2
PO6	The Engineer and Society	1	2	1	2	1	1
PO7	Environment and sustainability	1	2	1	1	2	1
PO8	Ethics	2	1	1	1	2	1
PO9	Individual and team work:	1	1	2	1	1	1
PO10	Communication	1	2	1	1	2	1
PO11	Project management and finance	1	1	1	1	1	2
PO12	Life-long learning:	1	2	1	1	3	2
PSO1	To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	1	2	1	1	2	1
PSO2	To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.	2	1	2	1	1	1
PSO3	To inculcate entrepreneurial skills through strong Industry-Institution linkage.	1	2	1	2	1	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

OEN351

DRINKING WATER SUPPLY AND TREATMENT

L T P C

3 0 0 3

#### COURSE OBJECTIVE:

- To equip the students with the principles and design of water treatment units and distribution system.

#### UNIT I SOURCES OF WATER

9

Public water supply system – Planning, Objectives, Design period, Population forecasting; Water demand – Sources of water and their characteristics, Surface and Groundwater – Impounding Reservoir – Development and selection of source – Source Water quality – Characterization –



Significance – Drinking Water quality standards.

**UNIT II CONVEYANCE FROM THE SOURCE 9**

Water supply – intake structures – Functions; Pipes and conduits for water – Pipe materials – Hydraulics of flow in pipes – Transmission main design – Laying, jointing and testing of pipes – appurtenances – Types and capacity of pumps – Selection of pumps and pipe materials.

**UNIT III WATER TREATMENT 9**

Objectives – Unit operations and processes – Principles, functions, and design of water treatment plant units, aerators of flash mixers, Coagulation and flocculation – sand filters - Disinfection – Construction, Operation and Maintenance aspects.

**UNIT IV ADVANCED WATER TREATMENT 9**

Water softening – Desalination- R.O. Plant – demineralization – Adsorption - Ion exchange– Membrane Systems - Iron and Manganese removal - Defluoridation - Construction and Operation and Maintenance aspects

**UNIT V WATER DISTRIBUTION AND SUPPLY 9**

Requirements of water distribution – Components – Selection of pipe material – Service reservoirs - Functions – Network design – Economics - Computer applications – Appurtenances – Leak detection - Principles of design of water supply in buildings – House service connection – Fixtures and fittings, systems of plumbing and types of plumbing.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

**CO1:** an understanding of water quality criteria and standards, and their relation to public health

**CO2:** the ability to design the water conveyance system

**CO3:** the knowledge in various unit operations and processes in water treatment

**CO4:** an ability to understand the various systems for advanced water treatment

**CO5:** an insight into the structure of drinking water distribution system

**TEXTBOOKS :**

1. Garg. S.K., "Water Supply Engineering", Khanna Publishers, Delhi, September 2008.
2. Punmia B.C, Arun K.Jain, Ashok K.Jain, " Water supply Engineering" Lakshmi publication private limited, New Delhi, 2016.
3. Rangwala "Water Supply and Sanitary Engineering", February 2022
4. Birdie.G.S., "Water Supply and Sanitary Engineering", Dhanpat Rai and sons, 2018.

**REFERENCES :**

1. Fair. G.M., Geyer.J.C., "Water Supply and Wastewater Disposal", John Wiley and Sons, 1954.
2. Babbitt.H.E, and Donald.J.J, "Water Supply Engineering" , McGraw Hill book Co, 1984.
3. Steel. E.W.et al., "Water Supply Engineering" , Mc Graw Hill International book Co, 1984.
4. Duggal. K.N., "Elememts of public Health Engineering", S.Chand and Company Ltd, New Delhi, 1998.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		3						3		3			3		
2		3		2		2				3			3		
3				2		2				3			3		
4			3	2				3	2	3			3		
5			3	2			1		2	3		1			
Avg.		3	3	2		2	1	3	2	3		1	3		

1.low, 2-medium, 3-high, '-'- no correlation

Note: The average value of this course to be used for program articulation matrix.

OEE352

**ELECTRIC VEHICLE TECHNOLOGY**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES**

- To provide knowledge about electric machines and special machine
- To understand the basics of power converters
- To know the concepts of controlling DC and AC drive systems
- To understand the architecture and power train components.
- To impart knowledge on vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs)

**UNIT I ROTATING POWER CONVERTERS 9**

Magnetic circuits- DC machine and AC machine –Working principle of Generator and Motor-DC and AC - Voltage and torque equations – Characteristics and applications. Working principle of special machines like: Brushless DC motor, Switched reluctance motor and PMSM.

**UNIT II STATIC POWER CONVERTERS 9**

Working and Characteristics of Power Diodes, MOSFET and IGBT. Working of uncontrolled rectifiers, controlled rectifiers (Single phase and Three phase), DC choppers, single and three phase inverters, Multilevel inverters and Matrix Converters.

**UNIT III CONTROL OF DC AND AC MOTOR DRIVES 9**

Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and braking) of induction motor drives, Transformation theory, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives

**UNIT IV HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENTS 9**

History of evolution of Electric Vehicles - Comparison of Electric Vehicles with Internal Combustion Engines - Architecture of Electric Vehicles (EV) and Hybrid Electric Vehicles (HEV) – Plug-in Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes.

**UNIT V MECHANICS OF HYBRID ELECTRIC VEHICLES AND CONTROL OF VEHICLES** **9**

Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of HEV's - motor torque and power rating and battery capacity. HEV supervisory control - Selection of modes - power spilt mode - parallel mode - engine brake mode - regeneration mode - series parallel mode

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1:** Able to understand the principles of conventional and special electrical machines.

**CO2:** Acquired the concepts of power devices and power converters

**CO3:** Able to understand the control for DC and AC drive systems.

**CO4:** Learned the electric vehicle architecture and power train components.

**CO5:** Acquired the knowledge of mechanics of electric vehicles and control of electric vehicles.

**CO's-PO's & PSO's MAPPING**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2			3								3	3	3
CO2	3	2	2			3			3				3	3	3
CO3	3			3		2	2						3	3	3
CO4	3	2	2		3								3	3	3
CO5	3		2								2		3	3	3
Avg	3	2	2	3	3	1	2		3		2		3	3	3

**1 - low, 2 - medium, 3 - high, '-'- no correlation**

**REFERENCES:**

- 1 Stephen D. Umans, "Fitzgerald & Kingsley's Electric Machinery", Tata McGraw Hill, 7<sup>th</sup> Edition, 2020.
- 2 Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011
- 3 Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek "Analysis of Electric Machinery and Drive Systems", 3<sup>rd</sup> Edition, Wiley-IEEE Press, 2013.
- 4 Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Pearson, fourth Edition, 10<sup>th</sup> Impression 2021.
- 5 Iqbal Husain, 'Electric and Hybrid Electric Vehicles', CRC Press, 2021.
- 6 Wei Liu, 'Hybrid Electric Vehicle System Modeling and Control', Second Edition, WILEY, 2017
- 7 James Larminie and John Lowry, 'Electric Vehicle Technology Explained', Second Edition, Wiley, 2012

**OEI353**

**INTRODUCTION TO PLC PROGRAMMING**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- Understand basic PLC terminologies digital principles, PLC architecture and operation.
- Familiarize different programming language of PLC.
- Develop PLC logic for simple applications using ladder logic.
- Understand the hardware and software behind PLC and SCADA.
- Exposures about communication architecture of PLC/SCADA.

<b>UNIT I</b>	<b>INTRODUCTION TO PLC</b>	<b>9</b>
Introduction to PLC: Microprocessor, I/O Ports, Isolation, Filters, Drivers, Microcontrollers/DSP, PLC/DDC- PLC Construction: What is a PLC, PLC Memories, PLC I/O, , PLC Special I/O, PLC Types.		
<b>UNIT II</b>	<b>PLC INSTRUCTIONS</b>	<b>9</b>
PLC Basic Instructions: PLC Ladder Language- Function block Programming- Ladder/Function Block functions- PLC Basic Instructions, Basic Examples (Start Stop Rung, Entry/Reset Rung)- Configuration of Sensors, Switches, Solid State Relays-Interlock examples- Timers, Counters, Examples.		
<b>UNIT III</b>	<b>PLC PROGRAMMING</b>	<b>9</b>
Different types of PLC program, Basic Ladder logic, logic functions, PLC module addressing, registers basics, basic relay instructions, Latching Relays, arithmetic functions, comparison functions, data handling, data move functions, timer-counter instructions, input-output instructions, sequencer instructions		
<b>UNIT IV</b>	<b>COMMUNICATION OF PLC AND SCADA</b>	<b>9</b>
Communication Protocol – Modbus, HART, Profibus- Communication facilities SCADA: - Hardware and software, Remote terminal units, Master Station and Communication architectures		
<b>UNIT V</b>	<b>CASE STUDIES</b>	<b>9</b>
Stepper Motor Control- Elevator Control-CNC Machine Control- conveyor control-Interlocking Problems		

**TOTAL:45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 5**

1. Market survey of the recent PLCs and comparison of their features.
2. Summarize the PLC standards
3. Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)
4. Market survey of Communication Network Used for PLC/SCADA.

**COURSE OUTCOMES:**

- CO1** Know the basic requirement of a PLC input/output devices and architecture. (L1)
- CO2** Ability to apply Basics Instruction Sets used for ladder Logic and Function Block Programming.(L2)
- CO3** Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.(L3)
- CO4** Able to develop a PLC logic for a specific application on real world problem. (L5)
- CO5** Ability to Understand the Concepts of Communication used for PLC/SCADA.(L1)

**TEXT BOOKS:**

1. Frank Petruzzola, Programmable Logic Controllers, Tata Mc-Graw Hill Edition
2. John W. Webb, Ronald A. Reis, Programmable Logic Controllers Principles and Applications, PHI publication

**REFERENCES:**

1. MadhuchandMitra and SamerjitSengupta, Programmable Logic Controllers Industrial Automation an Introduction, Penram International Publishing Pvt. Ltd.
2. J. R. Hackworth and F. D. Hackworth, Programmable Logic Controllers Principles and Applications, Pearson publication

**List of Open Source Software/ Learning website:**

1. <https://nptel.ac.in/courses/108105063>
2. <https://www.electrical4u.com/industrial-automation/>
3. <https://www.etf.ues.rs.ba/~slubura/Procesni%20racunari/Programmable%20Logic%20Controllers%20Programming%20Methods.pdf>
4. <https://www.electrical4u.com/industrial-automation/>

**CO's-PO's & PSO's MAPPING**

PO, PSO CO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1					1		1					
CO2	3	3	2					1		1	2				2
CO3	3	3	3	3	1			1		1					
CO4	3	3		3	3			1		1			3	3	
CO5	3	3	3	2	1			1		1			3	3	3
Avg	3	2.9	2.25	2.6	1.6			1		1			3	3	2.9

1 - low, 2 - medium, 3 - high, ‘-’- no correlation

**OCH351**

**NANO TECHNOLOGY**

**L T P C  
3 0 0 3**

**UNIT I INTRODUCTION**

**8**

General definition and size effects–important nano structured materials and nano particles- importance of nano materials- Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials- surface area - band gap energy and applications. Photochemistry and Electrochemistry of nanomaterials –Ionic properties of nanomaterials- Nano catalysis.

**UNIT II SYNTHESIS OF NANOMATERIALS**

**8**

Bottom up and Top-down approach for obtaining nano materials - Precipitation methods – sol gel technique – high energy ball milling, CVD and PVD methods, gas phase condensation, magnetron sputtering and laser deposition methods – laser ablation, sputtering.

**UNIT III NANO COMPOSITES**

**10**

Definition- importance of nanocomposites- nano composite materials-classification of composites- metal/metal oxides, metal-polymer- thermoplastic based, thermoset based and elastomer based- influence of size, shape and role of interface in composites applications.

**UNIT IV NANO STRUCTURES AND CHARACTERIZATION TECHNIQUES 10**

Classifications of nanomaterials - Zero dimensional, one-dimensional and two-dimensional nanostructures- Kinetics in nanostructured materials- multilayer thin films and superlattice- clusters of metals, semiconductors and nanocomposites. Spectroscopic techniques, Diffraction methods, thermal analysis method, BET analysis method.

**UNIT V APPLICATIONS OF NANO MATERIALS 9**

Overview of nanomaterials properties and their applications, nano painting, nano coating, nanomaterials for renewable energy, Molecular Electronics and Nanoelectronics – Nanobots- Biological Applications. Emerging technologies for environmental applications- Practice of nanoparticles for environmental remediation and water treatment.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

- CO1** understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications.
- CO2** able to acquire knowledge about the different types of nano material synthesis
- CO3** describes about the shape, size, structure of composite nano materials and their interference
- CO4** understand the different characterization techniques for nanomaterials
- CO5** develop a deeper knowledge in the application of nanomaterials in different fields.

**TEXT BOOKS**

1. Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmom, Burkhard Raguse, “ Nano Technology: Basic Science & Engineering Technology”, 2005, Overseas Press
2. G. Cao, “Nanostructures & Nanomaterials: Synthesis, Properties & Applications” Imperial College Press, 2004
3. William A Goddard “Handbook of Nanoscience, Engineering and Technology”, 3<sup>rd</sup> Edition, CRC Taylor and Francis group 2012.

**REFERENCES**

1. R.H.J.Hannink & A.J.Hill, Nanostructure Control, Wood Head Publishing Ltd., Cambridge, 2006.
2. C.N.R.Rao, A.Muller, A.K.Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications Vol. I & II, 2nd edition, 2005, Wiley VCH Verlag Gbtl & Co
3. Ivor Brodie and Julius J.Murray, 'The physics of Micro/Nano – Fabrication', Springer International Edition, 2010

**CO's-PO's & PSO's MAPPING**

Course Outcomes	Statement	Program Outcome														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications	2	3	2	3	3	-	-	-	1	1	-	3	1	1	3

<b>CO2</b>	acquire knowledge about the different types of nano material synthesis	2	3	1	3	3	-	-	-	1	1	-	3	2	1	3
<b>CO3</b>	describes about the shape, size, structure of composite nano materials and their interference	2	2	2	3	3	1	1	-	1	1	-	3	2	1	3
<b>CO4</b>	understand the different characterization techniques for nanomaterials	2	2	1	3	3	1	1	1	1	-	1	3	1	1	3
<b>CO5</b>	develop a deeper knowledge in the application of nanomaterials in different fields	2	2	1	3	3	1	1	1	1	-	1	3	2	1	3
Overall CO		3	2	2	1	3	3	1	1	1	1	1	1	3	2	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OCH352**

**FUNCTIONAL MATERIALS**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVE:**

- The course emphasis on the molecular self assembly and materials for polymer electronics

**UNIT I INTRODUCTION**

**9**

Historical Perspectives, Lessons from the Nature, Engineering the Functions, Tuning the functions, Multiscale Modeling and Computation, Classification of Functional Materials, Functional Diversity of Materials, Hybrid Materials, Technological Relevance, Societal Impact.

**UNIT II MOLECULAR SELF ASSEMBLY**

**9**

Molecular Organization, Self-Assembly in Biology, Energetics of Self-Organization, A Few Case Studies, Synthetic Protocols and Challenges, Solvent-assisted Self-Assembly, Directed Assembly- Langmuir-Blodgett and Langmuir-Schaefer techniques, Technological Applications of SAMs.

**UNIT III BIO-INSPIRED MATERIALS**

**9**

Bio-inspired materials, Classification, Biomimicry, Spider Silk, Lotus Leaf, Gecko feet, Synovial fluid, 'Bionics'-Bio-inspired Information Technologies, Artificial Sensory Organs, Biomineralization- En route to Nanotechnology.

**UNIT IV SMART OR INTELLIGENT MATERIALS**

**9**

Criteria for Smartness, Significance of Smart Materials, Representative Examples like Smart Gels and Polymers, Electro/Magneto Rheological Fluids, Smart Electroceramics, Technical Limitations and Challenges, Functional Nanocomposites, Polymer-carbon nanotube composites.

**UNIT V MATERIALS FOR POLYMER ELECTRONICS 9**

Polymers for Electronics, Organic Light Emitting Diodes, Working Principle of OLEDs, Illustrated Examples, Organic Field-Effect Transistors Operating Principle, Design Considerations, Polymer FETs vs Inorganic FETs, Liquid Crystal Displays, Engineering Aspects of Flat Panel Displays, Intelligent Polymers for Data Storage, Polymer-based Data Storage-Principle, Magnetic Vs. Polymer-based Data Storage.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

- Students will be able to differentiate among various functional properties and select appropriate material for certain functional applications, analyze the nature and potential of functional material.

**TEXT BOOK:**

1. Vijayamohanan K. Pillai and MeeraParthasarathy, "Functional Materials: A chemist's perspective", Universities Press Hyderabad (2012).

**REFERENCE:**

1. Stephen Manne "Biomimetic Materials Chemistry" Wiley-VCH Newyork, 1966.

**OFD352**

**TRADITIONAL INDIAN FOODS**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVE:**

- To help students acquire a sound knowledge on diversities of foods, food habits and patterns in India with focus on traditional foods.

**UNIT I HISTORICAL AND CULTURAL PERSPECTIVES 9**

Food production and accessibility - subsistence foraging, horticulture, agriculture and pastoralization, origin of agriculture, earliest crops grown. Food as source of physical sustenance, food as religious and cultural symbols; importance of food in understanding human culture - variability, diversity, from basic ingredients to food preparation; impact of customs and traditions on food habits, heterogeneity within cultures (social groups) and specific social contexts - festive occasions, specific religious festivals, mourning etc. Kosher, Halal foods; foods for religious and other fasts.

**UNIT II TRADITIONAL METHODS OF FOOD PROCESSING 9**

Traditional methods of milling grains – rice, wheat and corn – equipments and processes as compared to modern methods. Equipments and processes for edible oil extraction, paneer, butter and ghee manufacture – comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation – sundrying, osmotic drying, brining, pickling and smoking.

**UNIT III TRADITIONAL FOOD PATTERNS 9**

Typical breakfast, meal and snack foods of different regions of India. Regional foods that have gone Pan Indian / Global. Popular regional foods; Traditional fermented foods, pickles and preserves, beverages, snacks, desserts and sweets, street foods; IPR issues in traditional foods



**UNIT IV COMMERCIAL PRODUCTION OF TRADITIONAL FOODS 9**

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods – types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods – ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters.

**UNIT V HEALTH ASPECTS OF TRADITIONAL FOODS 9**

Comparison of traditional foods with typical fast foods / junk foods – cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**To understand the historical and traditional perspective of foods and food habits

**CO2** To understand the wide diversity and common features of traditional Indian foods and meal patterns.

**TEXT BOOKS:**

1. Sen, Colleen Taylor “Food Culture in India” Greenwood Press, 2005.
2. Davidar, Ruth N. “Indian Food Science: A Health and Nutrition Guide to Traditional Recipes: East West Books, 2001.

**OFD353**

**INTRODUCTION TO FOOD PROCESSING**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVE:**

- The course aims to introduce the students to the area of Food Processing. This is necessary for effective understanding of a detailed study of food processing and technology subjects. This course will enable students to appreciate the importance of food processing with respect to the producer, manufacturer and consumer.

**UNIT I PROCESSING OF FOOD AND ITS IMPORTANCE 9**

Source of food - plant, animal and microbial origin; different foods and groups of foods as raw materials for processing – cereals, pulses, grains, vegetables and fruits, milk and animal foods, sea weeds, algae, oil seeds & fats, sugars, tea, coffee, cocoa, spices and condiments, additives; need and significance of processing these foods.

**UNIT II METHODS OF FOOD HANDLING AND STORAGE 9**

Nature of harvested crop, plant and animal; storage of raw materials and products using low temperature, refrigerated gas storage of foods, gas packed refrigerated foods, sub atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; freezing of raw and processed foods.

**UNIT III LARGE-SCALE FOOD PROCESSING 12**

Milling of grains and pulses; edible oil extraction; Pasteurisation of milk and yoghurt; canning and bottling of foods; drying – Traditional and modern methods of drying, Dehydration of fruits, vegetables, milk, animal products etc; preservation by use of acid, sugar and salt; Pickling and curing

with microorganisms, use of salt, and microbial fermentation; frying, baking, extrusion cooking, snack foods.

**UNIT IV FOOD WASTES IN VARIOUS PROCESSES 6**

Waste disposal-solid and liquid waste; rodent and insect control; use of pesticides; ETP; selecting and installing necessary equipment.

**UNIT V FOOD HYGIENE 9**

Food related hazards – Biological hazards – physical hazards – microbiological considerations in foods. Food adulteration – definition, common food adulterants, contamination with toxic metals, pesticides and insecticides; Safety in food procurement, storage handling and preparation; Relationship of microbes to sanitation, Public health hazards due to contaminated water and food; Personnel hygiene; Training & Education for safe methods of handling and processing food; sterilization and disinfection of manufacturing plant; use of sanitizers, detergents, heat, chemicals, Cleaning of equipment and premises.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course the students are expected to

**CO1** Be aware of the different methods applied to processing foods.

**CO2** Be able to understand the significance of food processing and the role of food and beverage industries in the supply of foods.

**TEXT BOOKS/REFERENCES:**

1. Karnal, Marcus and D.B. Lund "Physical Principles of Food Preservation". Rutledge, 2003.
2. VanGarde, S.J. and Woodburn. M "Food Preservation and Safety Principles and Practice". Surbhi Publications, 2001.
3. Sivasankar, B. "Food Processing & Preservation", Prentice Hall of India, 2002.
4. Khetarpaul, Neelam, "Food Processing and Preservation", Daya Publications, 2005.

**OPY352 IPR FOR PHARMA INDUSTRY L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- To provide the basic fundamental knowledge of different forms of Intellectual Property Rights in national and international level.
- To provide the significance of the Intellectual Property Rights about the patents, copyrights, industrial design, plant and geographical indications.
- This paper is to study significance of the amended patent act on pharma industry.

**UNIT I INTRODUCTION- INTELLECTUAL PROPERTY RIGHTS 9**

Introduction, Types of Intellectual Property Rights -patents, plant varieties protection, geographical indicators, copyright, trademark, trade secrets.

**UNIT II PATENTS 9**

Patents-Objective, Introduction, Requirement for patenting- Novelty, Inventive step (Non-obviousness) and industrial application (utility), Non-patentable inventions, rights of patent owner, assignment of patent rights, patent specification (provisional and complete), parts of complete specification, claims, procedure for obtaining patents, compulsory license.

**UNIT III PLANT VARIETY-TRADITIONAL KNOWLEDGE –GEOGRAPHICAL INDICATIONS 9**

Plant variety- Justification, criteria for protection of plant variety and protection in India. Traditional knowledge- Concept of traditional knowledge, protection of traditional knowledge under Intellectual Property frame works in national level and Traditional knowledge digital library (TKDL). Geographical Indications – Justification for protection, National and International position.

**UNIT IV ENFORCEMENT AND PRACTICAL ASPECTS OF IPR 9**

Introduction – civil remedies – injunction, damage, account of profit – criminal remedies – patent, trademark. Practical aspects – Introduction, benefits of licensing, licensing of basic types of IPR, licensing clauses of IPR. Case studies of patent infringement, compulsory licensing, simple patent license agreements.

**UNIT V INTERNATIONAL BACKGROUND OF INTELLECTUAL PROPERTY 9**

International Background of Intellectual Property- Paris Convention, Berne convention, World Trade Organization (WTO), World Intellectual Property Organization (WIPO), Trade Related Aspects of Intellectual Property Rights (TRIPS) and Patent Co-operation Treaty (PCT).

**TOTAL:45 PERIODS**

**TEXT BOOKS:**

1. N. Nagpal, M. Arora, M.R.D. Usman, S. Rahar, "Intellectual Property Rights" Edu creation Publishing, New Delhi, 2017.
2. The Patents Act, 1970 (Bare Act with Short Notes) (New Delhi: Universal Law Publishing Company Pvt. Ltd. 2012.
3. B.S. Rao, P.V. Appaji, "Intellectual Property Rights in Pharmaceutical Industry: Theory and Practice", 2015.

**REFERENCES:**

1. Patents for Chemicals, Pharmaceuticals, & Biotechnology-Fundamentals of Global Law, Practice and Strategy. Philip W. Grubb, Oxford University Press, 2004.
2. Basic Principles of patent law – Basics principles and acquisition of IPR. Ramakrishna T. CIPRA, NLSIU, Bangalore, 2005
3. S. Lakshmana Prabu, TNK. Suriyaprakash, "Intellectual Property Rights", 1st ed., In Tech open access, Croatia, 2017.

**COURSE OUTCOME**

The student will be able to

- C1** Understand and differentiate the categories of intellectual property rights.
- C2** Describe about patents and procedure for obtaining patents.
- C3** Distinguish plant variety, traditional knowledge and geographical indications under IPR.
- C4** Provide the information about the different enforcements and practical aspects involved in protection of IPR.
- C5** Provide different organizations role and responsibilities in the protection of IPR in the international level.
- C6** Understand the interrelationships between different Intellectual Property Rights on International Society

CO's-PO's & PSO's MAPPING												
IPR FOR PHARMA INDUSTRY												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>C1</b>	3	3		2					2	2		
<b>C2</b>		3	3				2	2				
<b>C3</b>	3	3					2	2				1
<b>C4</b>					2		3	3		2	2	
<b>C5</b>		3					3			2		1
<b>C6</b>	3	2				2	2					2

1 - low, 2 - medium, 3 - high, '-' - no correlation

OTT351

**BASICS OF TEXTILE FINISHING**

**LT PC**

**3 0 0 3**

**COURSE OBJECTIVE:**

- To enable the students to understand the basics and different types of finishes required for textile materials and machines used for finishing.

**UNIT I RESIN FINISHING**

**9**

Importance of finishing and its classification. Resin finishing: Mechanism of creasing, Types of Resins .Anti crease, wash and wear, durable press resin finishing. Study about eco friendly method of anti crease finishing.

**UNIT II FLAME PROOF & WATERPROOF**

**9**

Concept of Flame proof & flame retardancy. Flame retardant finishes for cotton, Concept of waterproof and water repellent Finishes, Durable & Semi durable and Temporary finishes, Concept of Antimicrobial finish.

**UNIT III SOIL RELEASE AND ANTISTATIC FINISHES**

**9**

Soil Release Finishing: Mechanism of soil retention & soil release. Anti pilling Finishing: chemical and mechanical methods to produce anti pilling. Concept of UV Protection finishes- Concept of antistatic finishes.

**UNIT IV MECHANICAL FINISHES**

**9**

Mechanical finishing of textile materials - calendaring, compacting, Sanforising, Peach finishing. Object of Heat setting. Various methods of heat setting and mechanism of heat setting.

**UNIT V STIFFENING AND SOFTENING**

**9**

Concept of stiffening and softening of textile materials. Mechanism in the weight reduction of PET .Concept of Micro encapsulation techniques in finishing process, Nano finish, Plasma Treatment and Bio finishing.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to Understand the CO: 1 Basics of Resin Finishing Process.

CO: 2 Concept of Flame proof & flame retardancy, waterproof and water repellent, Antimicrobial finishes.

CO: 3 Concept of Soil Release, Anti Pilling, UV Protection and Antistatic finishes.

CO: 4 Concept of Mechanical finishing.

CO: 5 Basics of Micro encapsulation techniques, Nano finish, Plasma Treatment.

#### TEXT BOOKS:

1. V.A.Shennai, "Technology of Finishing", Vol X, Sevak Publications, Mumbai
2. Perkins, W.S., "Textile colouration and finishing", Carolina Academic Press., U.K, ISBN: 0890898855.2004.

#### REFERENCES:

1. Microencapsulation in finishing, Review of progress of Colouration, SDC, 2001 62
2. Chakraborty, J.N, Fundamentals and Practices in colouration of Textiles, Woodhead Publishing India, 2009, ISBN-13:978-81-908001-4-3
3. W. D. Schindler and P. J. Hauser "Chemical finishing of textiles", Woodhead Publishing Cambridge England,2004.

**OTT352 INDUSTRIAL ENGINEERING FOR GARMENT INDUSTRY L T P C**  
**3 0 0 3**

#### COURSE OBJECTIVES:

- To enable the students to learn about basics of industrial engineering and different tools of industrial engineering and its application in apparel industry

**UNIT I INTRODUCTION 9**

Scope of industrial engineering in apparel Industry, role of industrial engineers.

**Productivity:** Definition - Productivity, Productivity measures .Reduction of work content due to the product and process, Reduction of ineffective time due to the management, due to the worker. Causes for low productivity in apparel industry and measures for improvement.

**UNIT II WORK STUDY 9**

Definition, Purpose, Basic procedure and techniques of work-study.

**Work environment** – Lighting, Ventilation, Climatic condition on productivity. Temperature control, humidity control, noise control measures. Safety and ergonomics on work station and work environment

**Material Handling** – Objectives, Classification and characteristics of material handling equipments, Specialized material handling equipments.

**UNIT III METHOD STUDY 9**

Definition, Objectives, Procedure, Process charts and symbols. Various charts – Charts indicating process sequence: Outline process chart, flow process chart (man type, material type and equipment type); Charts using time scale – multiple activity chart. Diagrams indicating movement – flow diagram, string diagram, cycle graph, chrono cycle graph, travel chart

**MOTION STUDY:** Principle of motion economy, Two handed process chart, micro motion analysis – therbligs, SIMO chart.

**UNIT IV WORK MEASUREMENT 9**

Definition, purpose, procedure, equipments, techniques. Time study - Definition, basics of

time study- equipments. Time study forms, Stop watch procedure. Predetermined motion time standards (PMTS). Time Study rating, calculation of standard time, Performance rating – relaxation and other allowances. Calculation of SAM for different garments, GSD.

## UNIT V WORK STUDY APPLICATION

9

Application of work study techniques in cutting, stitching and packing in garment industry. Workaids in sewing, Pitch diagram, Line balancing, Capacity planning, scientific method of training.

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:

Upon the completion of the course the student shall be able to understand

**CO1:** Fundamental concepts of industrial Engineering and productivity

**CO2:** Method study

**CO3:** Motion analysis

**CO4:** Work measurement and SAM

**CO5:** Ergonomics and its application to garment industry

### TEXTBOOKS:

1. George Kanwaty, "Introduction to Work Study ", ILO, Geneva, 1996, ISBN: 9221071081 | ISBN-13: 9789221071082
2. Enrick N. L., "Time study manual for Textile industry", Wiley Eastern (P) Ltd., 1989, ISBN: 0898740444 | ISBN-13: 9780898740448
3. Khanna O. P., and Sarup A., "Industrial Engineering and Management", Dhanpat Rai Publications, New Delhi, 2010, ISBN: 818992835X / ISBN: 978-8189928353

### REFERENCES

1. Norberd Lloyd Enrick., "Industrial Engineering Manual for Textile Industry", Wiley Eastern (P) Ltd., New Delhi, 1988, ISBN: 0882756311 | ISBN-13: 9780882756318
2. Chuter A. J., "Introduction to Clothing Production Management", Wiley-Black well Science, U.S. A., 1995, ISBN: 0632039396 | ISBN-13: 9780632039395
3. GordanaColovic., "Ergonomics in the garment industry", Wood publishing India Pvt. Ltd., India, 2014, ISBN: 0857098225 | ISBN-13: 9780857098221
4. Rajesh Bheda, "Managing Productivity in Apparel Industry "CBS Publishers & Distributors, 2008

### CO's-PO's & PSO's MAPPING

Course Outcome	Statement	Program Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Fundamental concepts of industrialEngineering and productivity	2	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO2	Method study	1	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO3	Motion analysis	1	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO4	Work measurement and SAM	1	2	3	3	2	1	1	2	2	1	3	2	1	1	-
CO5	Ergonomics and itsapplication to garment industry	1	2	3	3	2	1	2	2	2	1	3	2	1	1	-
<b>Overall CO</b>		1.2	2	3	3	2	1	1.2	2	2	1	2.4	2	1	1	-

1 - low, 2 - medium, 3 - high, ‘-‘- no correlation

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OTT353**

**BASICS OF TEXTILE MANUFACTURE**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- To enable the students to learn about the basics of fibre forming, yarn production, fabric formation, coloration of fabrics and garment manufacturing

**UNIT I NATURAL FIBRES**

**9**

Introduction: Definition of staple fibre, filament; Classification of natural and man-made fibres, essential and desirable properties of fibres. Production and cultivation of Natural Fibres: Cultivation of cotton, production of silk (sericulture), wool and jute – physical and chemical structure of these fibres..

**UNIT II REGENERATED AND SYNTHETIC FIBRES**

**9**

Production sequence of regenerated and modified cellulosic fibres: viscose rayon, Acetate Rayon, high wet modulus and high tenacity fibres; synthetic fibres – chemical structure, fibre forming polymers, production principles.

**UNIT III BASICS OF SPINNING**

**9**

Spinning – principle of yarn formation, sequence of machines for yarn production with short staple fibres and blends, principles of opening and cleaning machines; yarn numbering – calculations

**UNIT IV BASICS OF WEAVING**

**9**

Woven fabric – warp, weft, weaving, path of warp; looms – classification, handloom and its parts, powerloom, automatic looms, shuttleless looms, special type of looms; preparatory machines for weaving process and their objectives; basic weaving mechanism - primary, secondary and auxiliary mechanisms,

**UNIT V BASICS OF KNITTING AND NONWOVEN**

**9**

Knitting – classification, principle, types of fabrics; nonwoven process –classification, principle, types of fabrics.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

On completion of this course, the students shall have the basic knowledge on

**CO1:** Classification of fibres and production of natural fibres

**CO2:** Regenerated and synthetic fibres

**CO3:** Yarn spinning

**CO4:** Weaving

**CO5:** Knitting and nonwoven

**TEXTBOOKS**

1. Mishra S. P. , “A Text Book of Fibre Science and Technology”, New Age Publishers, 2000, ISBN: 8122412505
2. Marks R., and Robinson. T.C., “Principles of Weaving”, The Textile Institute, Manchester, 1989, ISBN: 0 900739 258.

3. Spencer D.J., "Knitting Technology", III Ed., Textile Institute, Manchester, 2001, ISBN: 185573 333 1.

#### REFERENCES:

1. Hornberer M., Eberle H., Kilgus R., Ring W. and Hermeling H., "Clothing Technology: From Fibre to Fabric", Europa LehrmittelVerlag, 2008, ISBN: 3808562250 / ISBN: 978-3808562253.
2. Wynne A., "Motivate Series-Textiles", Maxmillan Publications, London, 1997.
3. Carr H. and Latham B., "The Technology of Clothing Manufacture" Backwell Science, U.K., 1994, ISBN: 0632037482 / ISBN:13: 9780632037483. Klein W., "The Rieter Manual of Spinning, Vol.1", Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-1-4 / ISBN 13 978-3-9523173-1-0.
4. Klein W., "The Rieter Manual of Spinning, Vol.2", Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-2-2 / ISBN 13 978-3-9523173-2-7.
5. Klein W., "The Rieter Manual of Spinning, Vol.1-3", Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-3-0 / ISBN 13 978-3-9523173-3-4.
6. Talukdar. M.K., Sriramulu. P.K., and Ajgaonkar. D.B., "Weaving: Machines, Mechanisms, Management", Mahajan Publishers, Ahmedabad, 1998, ISBN: 81-85401-16-0.
7. Morton W. E., and Hearle J. W. S., "Physical Properties of Textile Fibres", The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95
8. Gohl E. P. G., "Textile Science", CBS Publishers and distributors, 1987, ISBN 0582685958

#### CO's-PO's & PSO's MAPPING

Course Outcomes	Statement	Program Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1.	Classification of fibres and production of natural fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO2.	Regenerated and synthetic fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO3.	Yarn spinning	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO4.	Weaving	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO5.	Knitting and nonwoven	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>Overall CO</b>		-	-	-	-	-	-	-	2	1	-	1	1	-	1	-

1 - low, 2 - medium, 3 - high, '-' - no correlation



**COURSE OBJECTIVE:**

- The course is aimed to

Gain knowledge about petroleum refining process and production of petrochemical products.

**UNIT I ORIGIN, FORMATION AND REFINING OF CRUDE OIL 9**

Origin, Formation and Evaluation of Crude Oil. Testing of Petroleum Products. Refining of Petroleum - Atmospheric and Vacuum Distillation.

**UNIT II CRACKING 9**

Cracking, Thermal Cracking, Vis-breaking, Catalytic Cracking (FCC), Hydro Cracking, Coking and Air Blowing of Bitumen

**UNIT III REFORMING AND HYDROTREATING 9**

Catalytic Reforming of Petroleum Feed Stocks. Lube oil processing- Solvent Treatment Processes, Dewaxing, Clay Treatment and Hydrofining. Treatment Techniques: Removal of Sulphur Compounds in all Petroleum Fractions to improve performance.

**UNIT IV INTRODUCTION TO PETROCHEMICALS 9**

Petrochemicals - Cracking of Naphtha and Feed stock gas for the production of Ethylene, Propylene, Isobutylene and Butadiene. Production of Acetylene from Methane, and Extraction of Aromatics.

**UNIT V PRODUCTION OF PETROCHEMICALS 9**

Production of Petrochemicals like Dimethyl Terephthalate(DMT), Ethylene Glycol, Synthetic glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate (MMA), Vinyl Acetate Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol, Acetone, Methanol, Formaldehyde, Acetaldehyde, Pentaerythritol and production of Carbon Black.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

On the completion of the course students are expected to

**CO1:** Understand the classification, composition and testing methods of crude petroleum and its products. Learn the mechanism of refining process.

**CO2:** Understand the insights of primary treatment processes to produce the precursors.

**CO3:** Study the secondary treatment processes cracking, vis-breaking and coking to produce more petroleum products.

**CO4:** Appreciate the need of treatment techniques for the removal of sulphur and other impurities from petroleum products.

**CO5:** Understand the societal impact of petrochemicals and learn their manufacturing processes.

**CO6:** Learn the importance of optimization of process parameters for the high yield of petroleum products.

**TEXT BOOKS**

1. Nelson, W. L., "Petroleum Refinery Engineering", 4th Edition., McGraw Hill, New York, 1985.
2. Wiseman. P., "Petrochemicals", UMIST Series in Science and Technology, John Wiley & Sons, 1986.

## REFERENCES

1. Bhaskara Rao, B. K., "Modern Petroleum Refining Processes", 2nd Edition, Oxford and IBH Publishing Company, New Delhi, 1990.
2. Bhaskara Rao, B. K. "A Text on Petrochemicals", 1st Edition, Khanna Publishers

**CPE334**

## **ENERGY CONSERVATION AND MANAGEMENT**

**L T P C**

**3 0 0 3**

### **OBJECTIVES:**

At the end of the course, the student is expected to

- understand and analyse the energy data of industries
- carryout energy accounting and balancing
- conduct energy audit and suggest methodologies for energy savings and
- utilise the available resources in optimal ways

### **UNIT I INTRODUCTION**

**9**

Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

### **UNIT II ELECTRICAL SYSTEMS**

**9**

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

### **UNIT III THERMAL SYSTEMS**

**9**

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

### **UNIT IV ENERGY CONSERVATION IN MAJOR UTILITIES**

**9**

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets

### **UNIT V ECONOMICS**

**9**

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept

**TOTAL: 45 PERIODS**

### **COURSE OUTCOMES:**

Upon completion of this course, the students can able to analyze the energy data of industries.

**CO1:** Remember the knowledge for Basic combustion and furnace design and selection of thermal and mechanical energy equipment.

**CO2:** Study the Importance of Stoichiometry relations, Theoretical air required for complete combustion.

**CO3:** Skills on combustion thermodynamics and kinetics.

**CO4:** Apply calculation and design tube still heaters.

**CO5:** Studied different heat treatment furnace.

**CO6:** Practical and theoretical knowledge burner design.

### **TEXT BOOKS:**

1. Energy Manager Training Manual (4 Volumes) available at [www.energymanagertraining.com](http://www.energymanagertraining.com). a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.

### **REFERENCES:**

1. Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988.
2. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford, 1981.
3. Dryden. I.G.C., "The Efficient Use of Energy" Butterworths, London, 1982
4. Turner. W.C., "Energy Management Hand book", Wiley, New York, 1982.
5. Murphy. W.R. and G. Mc KAY, "Energy Management", Butterworths, London 1987

**OPT351**

**BASICS OF PLASTICS PROCESSING**

**L T P C  
3 0 0 3**

### **COURSE OBJECTIVES**

- Understand the fundamentals of plastics processing, such as the relationships between material structural properties and required processing parameters, and so on
- To gain practical knowledge on the polymer selection and its processing
- Understanding the major plastic material processing techniques (Extrusion, Injection molding, Compression and Transfer molding, Blow molding, Thermoforming and casting)
- To understand suitable additives for plastics compounding
- To Propose troubleshooting mechanisms for defects found in plastics products manufactured by various processing techniques

### **UNIT I INTRODUCTION TO PLASTICS PROCESSING**

**9**

Introduction to plastic processing – Principles of plastic processing: processing of plastics vs. metals and ceramics. Factors influencing the efficiency of plastics processing: molecular weight, viscosity and rheology. Difference in approach for thermoplastic and thermoset processing. Additives for plastics compounding and processing: antioxidants, light stabilizers, UV stabilizers, lubricants, impact modifiers, flame retardants, antistatic agents, stabilizers and plasticizers. Compounding: plastic compounding techniques, plasticization, pelletization.

## **UNIT II            EXTRUSION**

**9**

Extrusion – Principles of extrusion. Features of extruder: barrel, screw, types of screws, drive mechanism, specifications, heating & cooling systems, types of extruders. Flow mechanism: process variables, die entry effects and exit instabilities. Die swell, Defects: melt fracture, shark skin, bambooing. Factors determining efficiency of an extruder. Extrusion of films: blown and cast films. Tube/pipe extrusion. Extrusion coating: wire & cable. Twin screw extruder and its applications. Applications of extrusion and new developments.

## **UNIT III            INJECTION MOLDING**

**9**

Injection molding – Principles and processing outline, machinery, accessories and functions, specifications, process variables, mould cycle. Types of clamping: hydraulic and toggle mechanisms. Start-up and shut down procedures-Cylinder nozzles- Press capacity projected area -Shot weight Basic theoretical concepts and their relationship to processing - Interaction of moulding process aspect effects in quoted variables. Basic mould types. Reciprocating vs. plunger type injection moulding. Thermoplastic vs. thermosetting injection moulding. Injection moulding vs. other plastic processing techniques. State-of-the art injection moulding techniques - Introduction to trouble shooting

## **UNIT IV            COMPRESSION AND TRANSFER MOLDING**

**9**

Compression moulding – Basic principles of compression and transfer moulding-Meaning of terms-Bulk factor and flow properties, moulding materials, process variables and process cycle, Inter relation between flow properties-Curing time-Mould temperature and Pressure requirements. Preforms and preheating- Techniques of preheating. Machines used-Types of compression mould- positive, semi-positive and flash. Common moulding faults and their correction- Finishing of mouldings. Transfer moulding: working principle, equipment, Press capacity-Integral moulds and auxiliary ram moulds, moulding cycle, moulding tolerances, pot transfer, plunger transfer and screw transfer moulding techniques, advantages over compression moulding

## **UNIT V            BLOW MOLDING, THERMOFORMING AND CASTING**

**9**

Blow moulding: principles and terminologies. Injection blow moulding. Extrusion blow moulding. Design guidelines for optimum product performance and appearance. Thermoforming: principle, vacuum forming, pressure forming mechanical forming. Casting: working principle, types and applications.

**TOTAL: 45 PERIODS**

### **COURSE OUTCOMES**

**CO1:**Ability to find out the correlation between various processing techniques with product properties.

**CO2:**Understand the major plastics processing techniques used in moulding (injection, blow, compression, and transfer), extrusion, thermoforming, and casting.

**CO3:**Acquire knowledge on additives for plastic compounding and methods employed for the same

**CO4:**Familiarize with the machinery and ancillary equipment associated with various plastic processing techniques.

**CO5:**Select an appropriate processing technique for the production of a plastic product

## REFERENCES

1. S. S. Schwartz, S. H. Goodman, *Plastics Materials and Processes*, Van Nostrand Reinhold Company Inc. (1982).
2. F. Hensen (Ed.), *Plastic Extrusion Technology*, Hanser Gardner (1997).
3. W. S. Allen and P. N. Baker, *Hand Book of Plastic Technology, Volume-1, Plastic Processing Operations [Injection, Compression, Transfer, Blow Molding]*, CBS Publishers and Distributors (2004).
4. M. Chanda, S. K. Roy, *Plastic Technology handbook*, 4th Edn., CRC Press (2007).
5. I. I. Rubin, *Injection Molding Theory & Practice*, Society of Plastic Engineers, Wiley (1973).
6. D.V. Rosato, M. G. Rosato, *Injection Molding Hand Book*, Springer (2012).
7. M. L. Berins (Ed.), *SPI Plastic Engineering Hand Book of Society of Plastic Industry Inc.*, Springer (2012).
8. B. Strong, *Plastics: Material & Processing, A*, Pearson Prentice hall (2005).
9. D.V Rosato, *Blow Molding Hand Book*, Carl HanserVerlag GmbH & Co (2003).

OEC351

**SIGNALS AND SYSTEMS**

**L T P C**  
**3 0 0 3**

### COURSE OBJECTIVES :

- To understand the basic properties of signal & systems
- To know the methods of characterization of LTI systems in time domain
- To analyze continuous time signals and system in the Fourier and Laplace domain
- To analyze discrete time signals and system in the Fourier and Z transform domain

### **UNIT I CLASSIFICATION OF SIGNALS AND SYSTEMS 9**

Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids\_ Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals - Classification of systems- CT systems and DT systems- – Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable.

### **UNIT II ANALYSIS OF CONTINUOUS TIME SIGNALS 9**

Fourier series for periodic signals - Fourier Transform – properties- Laplace Transforms and Properties

### **UNIT III LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS 9**

Impulse response - convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems - Systems connected in series / parallel.

### **UNIT IV ANALYSIS OF DISCRETE TIME SIGNALS 9**

Baseband signal Sampling–Fourier Transform of discrete time signals (DTFT)– Properties of DTFT - Z Transform & Properties

### **UNIT V LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS 9**

Impulse response–Difference equations-Convolution sum- Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:****At the end of the course, the student will be able to:****CO1:**determine if a given system is linear/causal/stable**CO2:** determine the frequency components present in a deterministic signal**CO3:**characterize continuous LTI systems in the time domain and frequency domain**CO4:**characterize discrete LTI systems in the time domain and frequency domain**CO5:**compute the output of an LTI system in the time and frequency domains**TEXT BOOKS:**

1. Oppenheim, Willsky and Hamid, "Signals and Systems", 2nd Edition, Pearson Education, New Delhi, 2015.(Units I - V)
2. Simon Haykin, Barry Van Veen, "Signals and Systems", 2nd Edition, Wiley, 2002

**REFERENCES :**

1. B. P. Lathi, "Principles of Linear Systems and Signals", 2<sup>nd</sup> Edition, Oxford, 2009.
2. M. J. Roberts, "Signals and Systems Analysis using Transform methods and MATLAB", McGraw- Hill Education, 2018.
3. John Alan Stuller, "An Introduction to Signals and Systems", Thomson, 2007.

**CO's-PO's & PSO's MAPPING**

C O	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
1	3	-	3	-	3	2	-	-	-	-		3	-	-	1
2	3	-	3	-	-	2	-	-	-	-		3	-	3	-
3	3	3	-	-	3	2	-	-	-	-		3	2	-	-
4	3	3	-	-	3	2	-	-	-	-		3	-	3	1
5	3	3	-	3	3	2	-	-	-	-		3	-	3	1
<b>C</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	-	-	-	-	-	<b>3</b>	<b>2</b>	<b>3</b>	<b>1</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation



**COURSE OBJECTIVES :**

- To give a comprehensive exposure to all types of devices and circuits constructed with discrete components. This helps to develop a strong basis for building linear and digital integrated circuits
- To analyze the frequency response of small signal amplifiers
- To design and analyze single stage and multistage amplifier circuits
- To study about feedback amplifiers and oscillators principles
- To understand the analysis and design of multi vibrators

**UNIT I SEMICONDUCTOR DEVICES****9**

PN junction diode, Zener diode, BJT, MOSFET, UJT –structure, operation and V-I characteristics, Rectifiers – Half Wave and Full Wave Rectifier, Zener as regulator

**UNIT II AMPLIFIERS****9**

Load line, operating point, biasing methods for BJT and MOSFET, BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response –Analysis of CS and Source follower – Gain and frequency response- High frequency analysis.

**UNIT III MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER****9**

Cascode amplifier, Differential amplifier – Common mode and Difference mode analysis – Tuned amplifiers – Gain and frequency response – Neutralization methods.

**UNIT IV FEEDBACK AMPLIFIERS AND OSCILLATORS****9**

Advantages of negative feedback – Analysis of Voltage / Current, Series , Shunt feedback Amplifiers – positive feedback–Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.

**UNIT V POWER AMPLIFIERS AND DC/DC CONVERTERS****9**

Power amplifiers- class A-Class B-Class AB-Class C-Temperature Effect- Class AB Power amplifier using MOSFET –DC/DC convertors – Buck, Boost, Buck-Boost analysis and design.

**TOTAL: 45 PERIODS****COURSE OUTCOMES :**

At the end of the course the students will be able to

**CO1:** Explain the structure and working operation of basic electronic devices.

**CO2:** Design and analyze amplifiers.

**CO3:** Analyze frequency response of BJT and MOSFET amplifiers

**CO4:** Design and analyze feedback amplifiers and oscillator principles.

**CO5:** Design and analyze power amplifiers and supply circuits

**TEXT BOOKS :**

1. David A. Bell, "Electronic Devices and Circuits", Oxford Higher Education press, 5 th Edition, 2010.
2. Robert L. Boylestad and Louis Nasheresky, "Electronic Devices and Circuit Theory", 10th Edition, Pearson Education / PHI, 2008.

- Adel .S. Sedra, Kenneth C. Smith, "Micro Electronic Circuits", Oxford University Press, 7 th Edition, 2014.

#### REFERENCES :

- Donald.A. Neamen, "Electronic Circuit Analysis and Design", Tata McGraw Hill, 3 rd Edition, 2010.
- D.Schilling and C.Belove, "Electronic Circuits", McGraw Hill, 3 rd Edition, 1989
- Muhammad H.Rashid, "Power Electronics", Pearson Education / PHI , 2004.

#### CO's-PO's & PSO's MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
1	3	3	3	3	2	1	-	-	-	-	-	1	2	1	1
2	3	2	2	3	2	2	-	-	-	-	-	1	2	1	1
3	3	3	3	2	1	2	-	-	-	-	-	1	2	1	1
4	3	3	2	3	2	2	-	-	-	-	-	1	2	1	1
5	3	2	3	2	2	1	-	-	-	-	-	1	2	1	1
CO	3	3	3	3	2	2	-	-	-	-	-	1	2	1	1

1 - low, 2 - medium, 3 - high, "--" - no correlation

**CBM348 FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT L T P C**  
**3 0 0 3**

#### COURSE OBJECTIVES:

- To understand the global trends and development methodologies of various types of products and services
- To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
- To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification
- To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
- To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

#### UNIT I BASICS OF PRODUCT DEVELOPMENT 9

Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies - Product Life Cycle – Product Development Planning and Management.

#### UNIT II REQUIREMENTS AND SYSTEM DESIGN 9

Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - System Design & Modeling - Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.



**UNIT III DESIGN AND TESTING****9**

Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines - Concept Screening & Evaluation - Detailed Design - Component Design and Verification – Mechanical, Electronics and Software Subsystems - High Level Design/Low Level Design of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping - Introduction to Rapid Prototyping and Rapid Manufacturing - System Integration, Testing, Certification and Documentation

**UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT****9**

Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - Sustenance -Maintenance and Repair – Enhancements - Product EoL - Obsolescence Management – Configuration Management - EoL Disposal

**UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY****9**

The Industry - Engineering Services Industry - Product Development in Industry versus Academia – The IPD Essentials - Introduction to Vertical Specific Product Development processes - Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

Upon completion of the course, the students will be able to:

**CO1:** Define, formulate, and analyze a problem

**CO2:** Solve specific problems independently or as part of a team

**CO3:** Gain knowledge of the Innovation & Product Development process in the Business Context

**CO4:** Work independently as well as in teams

**CO5:** Manage a project from start to finish

**TEXT BOOKS:**

1. Book specially prepared by NASSCOM as per the MoU.
2. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011.
3. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.

**REFERENCES:**

1. Hiriappa B, "Corporate Strategy – Managing the Business", Author House, 2013.
2. Peter F Drucker, "People and Performance", Butterworth – Heinemann [Elsevier], Oxford, 2004.
3. Vinod Kumar Garg and Venkita Krishnan N K, "Enterprise Resource Planning – Concepts", Second Edition, Prentice Hall, 2003.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013

## CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	1						1		1			
2	3	2	3	1						1		1			
3	3	2	3	1	1			1	1	1		1			
4	3	2	3	1	1			1	1	1		1			
5	3	2	3	1	1			1	1	1		1			
AVg.															

1 - low, 2 - medium, 3 - high, "--" - no correlation

CBM333

ASSISTIVE TECHNOLOGY

L T P C  
3 0 0 3

### COURSE OBJECTIVES:

The student should be made to:

- To know the hardware requirement various assistive devices
- To understand the prosthetic and orthotic devices
- To know the developments in assistive technology

#### UNIT I CARDIAC ASSIST DEVICES

9

Cardiac functions and parameters, principle of External counter pulsation techniques, intra aortic balloon pump, Auxillary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves, cardiac pacemaker.

#### UNIT II HEMODIALYSERS

9

Physiology of kidney, Artificial kidney, Dialysis action, hemodialyser unit, membrane dialysis, portable dialyser monitoring and functional parameters.

#### UNIT III HEARING AIDS

9

Anatomy of ear, Common tests – audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids – principles, drawbacks in the conventional unit, DSP based hearing aids.

#### UNIT IV PROSTHETIC AND ORTHODIC DEVICES

9

Hand and arm replacement – different types of models, externally powered limb prosthesis, feedback in orthotic system, functional electrical stimulation, sensory assist devices.

#### UNIT V RECENT TRENDS

9

Transcutaneous electrical nerve stimulator, bio-feedback, assistive devices in drug delivery

**TOTAL :45 PERIODS**

### COURSE OUTCOMES:

On successful completion of this course, the student will be able to

**CO1:** Interpret the various mechanical techniques that will help in assisting the heart functions.

**CO2:** Describe the underlying principles of hemodialyzer machine.

**CO3:** Indicate the methodologies to assess the hearing loss.

**CO4:** Evaluate the types of assistive devices for mobilization.

**CO5:** Explain about TENS and biofeedback system.

**TEXT BOOKS**

1. Joseph D. Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press,2006
2. Marion. A. Hersh, Michael A. Johnson,Assistive Technology for visually impaired and blind, Springer Science & Business Media, 1st edition, 12-May-2010
3. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, CRC Press, 1st edition,2010.

**REFERENCES**

1. Kenneth J. Turner Advances in Home Care Technologies: Results of the match Project, Springer, 1st edition, 2011.
2. Gerr M. Craddock Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003.
3. 3D Printing in Orthopaedic Surgery, Matthew Dipaola , Elsevier 2019 ISBN 978 -0-323-662116
4. Cardiac Assist Devices, Daniel Goldstein (Editor), Mehmet Oz (Editor), Wiley-Blackwell April 2000 ISBN: 978-0-879-93449-1

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1	3	1	1	1	1											
2	3	1	1	1	1											
3	3	1	1	1	1											
4	3	1	1	1	1											
5	3	1	1	1	1											
<b>AVg.</b>	3	1	1	1	1											

1 - low, 2 - medium, 3 - high, ‘-’- no correlation

**OMA352**

**OPERATIONS RESEARCH**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

This course will help the students to

- determine the optimum solution for Linear programming problems.
- study the Transportation and assignment models and various techniques to solve them.
- acquire the knowledge of optimality, formulation and computation of integer programming problems.
- acquire the knowledge of optimality, formulation and computation of dynamic programming problems.
- determine the optimum solution for non-linear programming problems.

**UNIT I LINEAR PROGRAMMING**

**9**

Formulation of linear programming models – Graphical solution – Simplex method - Big M Method – Two phase simplex method - Duality - Dual simplex method.

**UNIT II TRANSPORTATION AND ASSIGNMENT PROBLEMS**

**9**

Matrix form of Transportation problems – Loops in T.P – Initial basic feasible solution – Transportation algorithm – Assignment problem – Unbalanced assignment problems .

**UNIT III INTEGER PROGRAMMING****9**

Introduction – All and mixed I.P.P – Gomory's method – Cutting plane algorithm – Branch and bound algorithm – Zero – one programming.

**UNIT IV DYNAMIC PROGRAMMING PROBLEMS****9**

Recursive nature of computation – Forward and backward recursion – Resource Allocation model – Cargo – loading model – Work – force size model - Investment model – Solution of L.P.P by dynamic programming .

**UNIT V NON - LINEAR PROGRAMMING PROBLEMS****9**

Lagrange multipliers – Equality constraints – Inequality constraints – Kuhn – Tucker Conditions – Quadratic programming.

**TOTAL:45 PERIODS****COURSE OUTCOMES :**

At the end of the course, students will be able to

**CO1:**Could develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems.

**CO2:**analyze the concept of developing, formulating, modeling and solving transportation and assignment problems.

**CO3:**solve the integer programming problems using various methods.

**CO4:**conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming.

**CO5:**determine the optimum solution for non linear programming problems.

**TEXT BOOKS:**

1. Kanti Swarup, P.K.Gupta and Man Mohan, " Operations Research " , Sultan Chand & Sons, New Delhi, Fifth Edition , 1990.
2. Taha. H.A, " Operations Research – An Introduction , Pearson Education, Ninth Edition , New Delhi, 2012.

**REFERENCES :**

1. J.K.Sharma , " Operations Research - Theory and Applications " Mac Millan India Ltd , Second Edition , New Delhi , 2003.
2. Richard Bronson & Govindasami Naadimuthu , " Operations Research " ( Schaum's Outlines – TMH Edition) Tata McGraw Hill, Second Edition, New Delhi, 2004.
3. Pradeep Prabhakar Pai , " Operations Research and Practice", Oxford University Press, New Delhi , 2012.
4. J.P.Singh and N.P.Singh , " Operations Research , Ane Books Pvt.Ltd, New Delhi , 2014.
5. F.S.Hillier and G.J. Lieberman, " Introduction to Operations Research " , Tata McGraw Hill, Eighth Edition , New Delhi, 2005.

**CO's-PO's & PSO's MAPPING**

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO2</b>	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
<b>CO3</b>	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-

<b>CO4</b>	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO5</b>	3	3	2	2	0	0	0	0	2	0	0	2	-	-	-
<b>Avg</b>	3	3	1	0.8	0	0	0	0	2	0	0	2	-	-	-

1 - low, 2 - medium, 3 - high, ‘-’- no correlation

OMA353

ALGEBRA AND NUMBER THEORY

L T P C

3 0 0 3

**COURSE OBJECTIVES :**

- To introduce the basic notions of groups, rings, fields which will then be used to solve related problems.
- To examine the key questions in the Theory of Numbers.
- To give an integrated approach to number theory and abstract algebra, and provide a firm basis for further reading and study in the subject.

**UNIT I GROUPS AND RINGS**

9

Groups: Definition - Properties - Homomorphism - Isomorphism - Cyclic groups - Cosets - Lagrange's theorem.

Rings: Definition - Sub rings - Integral domain - Field - Integer modulo n - Ring homomorphism.

**UNIT II FINITE FIELDS AND POLYNOMIALS**

9

Rings - Polynomial rings - Irreducible polynomials over finite fields - Factorization of polynomials over finite fields.

**UNIT III DIVISIBILITY THEORY AND CANONICAL DECOMPOSITIONS**

9

Division algorithm- Base-b representations – Number patterns – Prime and composite numbers – GCD – Euclidean algorithm – Fundamental theorem of arithmetic – LCM.

**UNIT IV DIOPHANTINE EQUATIONS AND CONGRUENCES**

9

Linear Diophantine equations – Congruence's – Linear Congruence's - Applications : Divisibility tests - Modular exponentiation - Chinese remainder theorem – 2x2 linear systems.

**UNIT V CLASSICAL THEOREMS AND MULTIPLICATIVE FUNCTIONS**

9

Wilson's theorem – Fermat's Little theorem – Euler's theorem – Euler's Phi functions – Tau and Sigma functions.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES :**

**CO1:** Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.

**CO2:** Demonstrate accurate and efficient use of advanced algebraic techniques.

**CO3:** The students should be able to demonstrate their mastery by solving non-trivial problems related to the concepts, and by proving simple theorems about the, statements proven by the text

**TEXT BOOKS :**

1. Grimaldi, R.P and Ramana, B.V., "Discrete and Combinatorial Mathematics", Pearson Education, 5<sup>th</sup> Edition, New Delhi, 2007.
2. Thomas Koshy, "Elementary Number Theory with Applications", Elsevier Publications, New Delhi, 2002.

**REFERENCES:**

1. San Ling and Chaoping Xing, "Coding Theory – A first Course", Cambridge Publications, Cambridge, 2004.
2. Niven.I, Zuckerman.H.S., and Montgomery, H.L., "An Introduction to Theory of Numbers" , John Wiley and Sons , Singapore, 2004.
3. Lidl.R., and Pitz. G, "Applied Abstract Algebra", Springer Verlag, New Delhi, 2<sup>nd</sup> Edition , 2006.

**CO's-PO's & PSO's MAPPING**

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	3	1	2	-	-	-	2	1	-	1	2	2	-	-	-
<b>CO2</b>	3	3	1	1	3	1	2	1	1	1	2	2	-	-	-
<b>CO3</b>	3	3	2	1	3	1	3	1	1	1	2	3	-	-	-
<b>CO4</b>	3	3	2	2	3	2	2	1	1	1	2	3	-	-	-
<b>CO5</b>	2	2	1	-	3	1	2	1	1	1	3	3	-	-	-
<b>Avg</b>	2.8	2.4	1.6	0.8	2.4	1	2.2	1	0.8	1	2.2	2.6	-	-	-

1 - low, 2 - medium, 3 - high, "--" - no correlation

**OMA354****LINEAR ALGEBRA****LT P C  
3 0 0 3****COURSE OBJECTIVES:**

- To test the consistency and solve system of linear equations.
- To find the basis and dimension of vector space.
- To obtain the matrix of linear transformation and its eigenvalues and eigenvectors.
- To find orthonormal basis of inner product space and find least square approximation.
- To find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.

**UNIT I MATRICES AND SYSTEM OF LINEAR EQUATIONS****9**

Matrices - Row echelon form - Rank - System of linear equations - Consistency - Gauss elimination method - Gauss Jordan method.

**UNIT II VECTOR SPACES****9**

Vector spaces over Real and Complex fields - Subspace – Linear space - Linear independence and dependence - Basis and dimension.

**UNIT III LINEAR TRANSFORMATION****9**

Linear transformation - Rank space and null space - Rank and nullity - Dimension theorem– Matrix representation of linear transformation - Eigenvalues and eigenvectors of linear transformation – Diagonalization.

**UNIT IV INNER PRODUCT SPACES****9**

Inner product and norms - Properties - Orthogonal, Orthonormal vectors - Gram Schmidt orthonormalization process - Least square approximation.

**UNIT V EIGEN VALUE PROBLEMS AND MATRIX DECOMPOSITION****9**

Eigen value Problems : Power method, Jacobi rotation method - Singular value decomposition – QR decomposition.

**TOTAL : 45 PERIODS****COURSE OUTCOMES:**

After the completion of the course the student will be able to

**CO1:**Test the consistency and solve system of linear equations.**CO2:**Find the basis and dimension of vector space.**CO3:**Obtain the matrix of linear transformation and its eigenvalues and eigenvectors.**CO4:**Find orthonormal basis of inner product space and find least square approximation.**CO5:**Find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.**TEXT BOOKS**

1. Faires J.D. and Burden R., Numerical Methods, Brooks/Cole (Thomson Publications), New Delhi, 2002.
2. Friedberg A.H, Insel A.J. and Spence L, Linear Algebra, Pearson Education, 5<sup>th</sup> Edition, 2019.

**REFERENCES**

1. Bernard Kolman, David R. Hill, Introductory Linear Algebra, Pearson Educations, New Delhi, 8<sup>th</sup> Edition, 2009.
2. Gerald C.F. and Wheatley P.O, Applied Numerical Analysis, Pearson Educations, New Delhi, 7<sup>th</sup> Edition, 2007.
3. Kumaresan S, Linear Algebra - A geometric approach, Prentice Hall of India, New Delhi, Reprint, 2010.
4. Richard Branson, Matrix Operations, Schaum's outline series, 1989.
5. Strang G, Linear Algebra and its applications, Thomson (Brooks / Cole) New Delhi, 4<sup>th</sup> Edition, 2005.
6. Sundarapandian V, Numerical Linear Algebra, Prentice Hall of India, New Delhi, 2014.

**CO's-PO's & PSO's MAPPING**

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	3	3	3	3	2	2	2	1	1	1	1	3	-	-	-
<b>CO2</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO3</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO4</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO5</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>Avg</b>	3	3	3	3	2.8	2	2	1	1	1	1	3	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OCE353****LEAN CONCEPTS, TOOLS AND PRACTICES****L T P C****3 0 0 3****COURSE OBJECTIVE:**

- To impart knowledge about the basics of lean principles, tools and techniques, and implementation in the construction industry.

- UNIT I INTRODUCTION 9**  
Introduction and overview of the construction project management - Review of Project Management & Productivity Measurement Systems - Productivity in Construction - Daily Progress Report-The state of the industry with respect to its management practices -construction project phases - The problems with current construction management techniques.
- UNIT II LEAN MANAGEMENT 9**  
Introduction to lean management - Toyota's management principle-Evolution of lean in construction industry - Production theories in construction –Lean construction value - Value in construction - Target value design - Lean project delivery system- Forms of waste in construction industry - Waste Elimination.
- UNIT III CORE CONCEPTS IN LEAN 9**  
Concepts in lean thinking – Principles of lean construction – Variability and its impact – Traditional construction and lean construction – Traditional project delivery - Lean construction and workflow reliability – Work structuring – Production control.
- UNIT IV LEAN TOOLS AND TECHNIQUES 9**  
Value Stream Mapping – Work sampling – Last planner system – Flow and pull based production – Last Planner System – Look ahead schedule – constraint analysis – weekly planning meeting- Daily Huddles – Root cause analysis – Continuous improvement – Just in time.
- UNIT V LEAN IMPLEMENTATION IN CONSTRUCTION INDUSTRY 9**  
Lean construction implementation- Enabling lean through information technology - Lean in design - Design Structure - BIM (Building Information Modelling) - IPD (Integrated Project Delivery) – Sustainability through lean construction approach.

**TOTAL : 45 PERIODS**

**COURSE OUTCOME:**

On completion of this course, the student is expected to be able to

- CO1** Explains the contemporary management techniques and the issues in present scenario.  
**CO2** Apply the basics of lean management principles and their evolution from manufacturing industry to construction industry.  
**CO3** Develops a better understanding of core concepts of lean construction tools and techniques and their importance in achieving better productivity.  
**CO4** Apply lean techniques to achieve sustainability in construction projects.  
**CO5** Apply lean construction techniques in design and modeling.

**REFERENCES:**

1. Corfe, C. and Clip, B., Implementing lean in construction: Lean and the sustainability agenda, CIRIA, 2013.
2. Shang Gao and Sui Pheng Low, Lean Construction Management: The Toyota Way, Springer, 2014.
3. Dave, B., Koskela, L., Kiviniemi, A., Owen, R., andTzortzopoulos, P.,Implementing lean in construction: Lean construction and BIM, CIRIA, 2013.
4. Ballard, G., Tommelein, I., Koskela, L. and Howell, G., Lean construction tools and techniques, 2002.



5. Salem, O., Solomon, J., Genaidy, A. and Luegring, M., Site implementation and Assessment of Lean Construction Techniques, Lean Construction Journal, 2005.

**OBT352**

**BASICS OF MICROBIAL TECHNOLOGY**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVE:**

- Enable the Non-biological student's to understand about the basics of life science and their pro and cons for living organisms.

**UNIT I BASICS OF MICROBES AND ITS TYPES**

**9**

Introduction to microbes, existence of microbes, inventions of great scientist and history, types of microorganisms – Bacteria, Virus, Fungi.

**UNIT II MICROBIAL TECHNIQUES**

**9**

Sterilization – types – physical and chemical sterilization, Decontamination, Preservation methods, fermentation, Cultivation and growth of microbes, Diagnostic methods.

**UNIT III PATHOGENIC MICROBES**

**9**

Infectious Disease – Awareness, Causative agent, Prevention and control - Cholera, Dengu, Malaria, Diarrhea, Tuberculosis, Typhoid, Covid, HIV.

**UNIT IV BENEFICIAL MICROBES**

**9**

Applications of microbes – Clinical microbiology, agricultural microbiology, Food Microbiology, Environmental Microbiology, Animal Microbiology, Marine Microbiology.

**UNIT V PRODUCTS FROM MICROBES**

**9**

Fermented products – Fermented Beverages, Curd, Cheese, Mushroom, Agricultural products – Biopesticide, Biofertilizers, Vermi compost, Pharmaceutical products - Antibiotics, Vaccines

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

At the end of the course the students will be able to

**CO1:**Microbes and their types

**CO2:**Cultivation of microbes

**CO3:**Pathogens and control measures for safety

**CO4:**Microbes in different industry for economy.

**TEXT BOOKS**

1. Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993.
2. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.
3. Prescott L.M., Harley J.P., Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 1996.

**COURSE OBJECTIVES:**

- The objective is to offer basic concepts of biochemistry to students with diverse background in life sciences including but not limited to the structure and function of various biomolecules and their metabolism.

**UNIT I CARBOHYDRATES****9**

Introduction to carbohydrate, classification, properties of monosaccharide, structural aspects of monosaccharides. Introduction to disaccharide (lactose, maltose, sucrose) and polysaccharide (Heparin, starch, and glycogen) biological function of carbohydrate.

**UNIT II LIPID AND FATTY ACIDS****9**

Introduction to lipid, occurrence, properties, classification of lipid. Importance of phospholipids, sphingolipid and glycerolipid. Biological function of lipid. Fatty acid, Introduction, Nomenclature and classification of fatty acid Essential and non essential fatty acids.

**UNIT III AMINO ACIDS AND PROTEIN.****9**

Introduction to amino acid, structure, classification of protein based on polarity. Introduction to protein, classification of protein based on solubility, shape, composition and Function. Peptide bond– Structure of peptide bond. Denaturation – renaturation of protein, properties of protein. Introduction to lipoprotein, glycoprotein and nucleoprotein. Biological function of protein.

**UNIT IV NUCLEIC ACIDS****9**

Introduction to nucleic acid, Difference between nucleotide and nucleoside, composition of DNA & RNA; RNA Structure of Nitrogen bases in DNA and RNA along with the nomenclature. DNA double helix (Watson and crick) model, types of DNA, RNA.

**UNIT V VITAMINS AND HORMONES****9**

Different types of vitamins, their diverse biochemical functions and deficiency related diseases. Overview of hormones. Hormone mediated signaling. Mechanism of action of steroid hormones, epinephrine, glucagons and insulin. Role of vitamins and hormones in metabolism; Hormonal disorders; Therapeutic uses of vitamins and hormones.

**COURSE OUTCOMES:**

**CO1:** Students will learn about various kinds of biomolecules and their physiological role.

**CO2:** Students will gain knowledge about various metabolic disorders and will help them to know the importance of various biomolecules in terms of disease correlation.

**TOTAL: 45 PERIODS****TEXT BOOKS**

1. Lehninger Principles of Biochemistry 6th Edition by David L. Nelson, Michael M. Cox W.H. Freeman and Company 2017
2. Satyanarayana, U. and U. Chakerapani, "Biochemistry" 3rd Rev. Edition, Books & Allied (P) Ltd., 2006.
3. Rastogi, S.C. "Biochemistry" 2nd Edition, Tata McGraw-Hill, 2003.
3. Conn, E.E., et al., "Outlines of Biochemistry" 5th Edition, John Wiley & Sons, 1987.
4. Outlines of Biochemistry, 5th Edition: By E E Conn, P K Stumpf, G Bruening and R Y Doi. pp 693. John Wiley and Sons, New York. 1987.

## REFERENCES

1. Berg, Jeremy M. et al. "Biochemistry", 6th Edition, W.H. Freeman & Co., 2006.
2. Murray, R.K., et al "Harper's Illustrated Biochemistry", 31st Edition, McGraw-Hill, 2018.
3. Voet, D. and Voet, J.G., "Biochemistry", 4th Edition, John Wiley & Sons Inc., 2010.

## OBT354                    FUNDAMENTALS OF CELL AND MOLECULAR BIOLOGY

L T P C  
3 0 0 3

### COURSE OBJECTIVES:

- To provide knowledge on the fundamentals of cell biology.
- To understand the signalling mechanisms.
- Understand basic principles of molecular biology at intracellular level to regulate growth, division and development.

### UNIT-I                    INTRODUCTION TO CELL

9

Cell, cell wall and Extracellular Matrix (ECM), composition, cellular dimensions, Evolution, Organisation, differentiation of prokaryotic and Eukaryotic cells, Virus, bacteria, cyanobacteria, mycoplasma and prions.

### UNIT II                    CELL ORGANELLES

9

Molecular organisation, biogenesis and function Mitochondria, endoplasmic reticulum, golgi apparatus, plastids, chloroplast, leucoplast, centrosome, lysosome, ribosome, peroxisome, Nucleus and nucleolus. Endo membrane system, concept of compartmentalisation.

### UNIT III                    BIO-MEMBRANE TRANSPORT

9

Physiochemical properties of cell membranes. Molecular constitute of membranes, asymmetrical organisation of lipids and proteins. Solute transport across membrane's-fick's law, simple diffusion, passive-facilitated diffusion, active transport- primary and secondary, group translocation, transport ATPases, membrane transport in bacteria and animals. Transport mechanism- mobile carriers and pores mechanisms. Transport by vesicle formation, endocytosis, exocytosis, cell respiration.

### UNIT IV                    CELL CYCLE

9

Cell cycle- Cell division by mitosis and meiosis, Comparison of meiosis and mitosis, regulation of cell cycle, cell lysis, Cytokinesis, Cell signaling, Cell communication, Cell adhesion and Cell junction, cell cycle checkpoints.

### UNIT V                    CENTRAL DOGMA

9

Overview of Central dogma DNA replication: Meselson & Stahl experiment, bi-directional DNA replication, Okazaki fragments. Structure and function of mRNA, rRNA and tRNA. RNA synthesis: Initiation, elongation and termination of RNA synthesis Introduction to Genetic code- Steps in translation: Initiation, Elongation and termination of protein synthesis.

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:

**CO1:** Understanding of cell at structural and functional level.

**CO2:** Understand the central dogma of life and its significance.

**CO3:** Comprehend the basic mechanisms of cell division.

### TEXTBOOKS:

1. Cooper, G.M. and R.E. Hansman "The Cell: A Molecular Approach", 8th Edition, Oxford University Press, 2018

2. Friefelder, David. "Molecular Biology." Narosa Publications, 1999
3. Weaver, Robert F. "Molecular Biology" 11nd Edition, Tata McGraw-Hill, 2003.

**REFERENCES:**

1. Lodish H, Berk A, Matsudaira P, Kaiser CA, Krieger M, Schot MP, Zipursky L, Darnell J. Molecular Cell Biology, 6th Edition, 2007.
2. Becker, W.M. et al., "The World of the Cell", 9th Edition, Pearson Education, 2003.
3. Campbell, N.A., J.B. Reece and E.J. Simon "Essential Biology", 11rd Edition, Pearson International, 2007.
4. Alberts, Bruce et al., "Essential Cell Biology", 4th Edition, W.W. Norton, 2013.

**OPEN ELECTIVE IV**

**OHS352**

**PROJECT REPORT WRITING**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVE**

The Course will enable Learners to,

- Understand the essentials of project writing.
- Perceive the difference between general writing and technical writing
- Assimilate the fundamental features of report writing.
- Understand the essential differences that exist between general and technical writing.
- Learn the structure of a technical and project report.

**UNIT I**

**9**

Writing Skills – Essential Grammar and Vocabulary – Passive Voice, Reported Speech, Concord, Signpost words, Cohesive Devices – Paragraph writing - Technical Writing vs. General Writing.

**UNIT II**

**9**

Project Report – Definition, Structure, Types of Reports, Purpose – Intended Audience – Plagiarism – Report Writing in STEM fields – Experiment – Statistical Analysis.

**UNIT III**

**9**

Structure of the Project Report: (Part 1) Framing a Title – Content – Acknowledgement – Funding Details -Abstract – Introduction – Aim of the Study – Background - Writing the research question - Need of the Study/Project Significance, Relevance – Determining the feasibility – Theoretical Framework.

**UNIT IV**

**9**

Structure of the Project Report: (Part 2) – Literature Review, Research Design, Methods of Data Collection - Tools and Procedures - Data Analysis - Interpretation - Findings –Limitations - Recommendations – Conclusion – Bibliography.

**UNIT V**

**9**

Proof reading a report – Avoiding Typographical Errors – Bibliography in required Format – Font – Spacing – Checking Tables and Illustrations – Presenting a Report Orally – Techniques.

**TOTAL:45 PERIODS**

## COURSE OUTCOMES

By the end of the course, learners will be able to

**CO1:**Write effective project reports.

**CO2:**Use statistical tools with confidence.

**CO3:**Explain the purpose and intension of the proposed project coherently and with clarity.

**CO4:**Create writing texts to suit achieve the intended purpose.

**CO5:**Master the art of writing winning proposals and projects.

### CO's-PO's & PSO's MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	1	1	1	3	2	2	3	3	3	3	-	-	-
2	2	2	2	1	1	1	2	1	2	3	2	3	-	-	-
3	2	2	3	3	2	3	2	2	2	3	2	3	-	-	-
4	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
5	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
AVg.	2.4	2.2	2.4	2.2	2	2.6	2.4	2.2	2.6	3	2.6	3	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

**Note:** The average value of this course to be used for program articulation matrix.

## REFERENCES

1. Gerson and Gerson - Technical Communication: Process and Product, 7th Edition, Prentice Hall(2012)
2. Virendra K. Pamecha - Guide to Project Reports, Project Appraisals and Project Finance (2012)
3. Daniel Riordan - Technical Report Writing Today (1998)
4. Darla-Jean Weatherford - Technical Writing for Engineering Professionals (2016) Penwell Publishers.

**OMA355**

**ADVANCED NUMERICAL METHODS**

**L T P C**  
**3 0 0 3**

### COURSE OBJECTIVE:

- To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in engineering and technology. This will also serve as a precursor for future research.

### UNIT I ALGEBRAIC EQUATIONS AND EIGENVALUE PROBLEM 9

System of nonlinear equations : Fixed point iteration method - Newton's method; System of linear equations: Thomas algorithm for tri diagonal system - SOR iteration methods ; Eigen value problems: Given's method - Householder's method.

### UNIT II INTERPOLATION 9

Central difference: Stirling and Bessel's interpolation formulae ; Piecewise spline interpolation: Piecewise linear, piecewise quadratic and cubic spline ; Least square approximation for continuous data (upto 3rd degree).

**UNIT III NUMERICAL METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS 9**

Explicit Adams - Bashforth Techniques - Implicit Adams - Moulton Techniques, Predictor -Corrector Techniques - Finite difference methods for solving two - point linear boundary value problems - Orthogonal Collocation method.

**UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS 9**

Laplace and Poisson's equations in a rectangular region : Five point finite difference schemes - Leibmann's iterative methods - Dirichlet's and Neumann conditions – Laplace equation in polar coordinates : Finite difference schemes .

**UNIT V FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATIONS 9**

Parabolic equations : Explicit and implicit finite difference methods – Weighted average approximation - Dirichlet's and Neumann conditions – First order hyperbolic equations - Method of characteristics - Different explicit and implicit methods; Wave equation : Explicit scheme – Stability of above schemes.

**TOTAL : 45 PERIODS****COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

**CO1:** demonstrate the understandings of common numerical methods for nonlinear equations, system of linear equations and eigenvalue problems;

**CO2:** understand the interpolation theory;

**CO3:** understand the concepts of numerical methods for ordinary differential equations;

**CO4:** demonstrate the understandings of common numerical methods for elliptic equations;

**CO5:** understand the concepts of numerical methods for time dependent partial differential equations

**TEXT BOOKS :**

1. Grewal, B.S., "Numerical Methods in Engineering & Science ", Khanna Publications, Delhi, 2013.
2. Gupta, S.K., "Numerical Methods for Engineers", (Third Edition), New Age Publishers, 2015.
3. Jain, M.K., Iyengar, S.R.K. and Jain, R.K., "Computational Methods for Partial Differential Equations", New Age Publishers, 1994.

**REFERENCES:**

1. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
2. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", 9 th Edition, Cengage Learning, New Delhi, 2016.
3. Gupta S.K., "Numerical Methods for Engineers", 4th Edition, New Age Publishers, 2019.
4. Sastry, S.S., "Introductory Methods of Numerical Analysis", 5th Edition, PHI Learning, 2015.
5. Morton, K.W. and Mayers D.F., "Numerical solution of Partial Differential equations", Cambridge University press, Cambridge, 2002.

**CO's-PO's & PSO's MAPPING**

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	3	3	3	3	2	2	2	1	1	1	1	3	-	-	-
<b>CO2</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO3</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-

<b>CO4</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO5</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>Avg</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

OMA356

RANDOM PROCESSES

L T P C

3 0 0 3

**COURSE OBJECTIVES:**

- To introduce the basic concepts of probability, one and two dimensional random variables with applications to engineering which can describe real life phenomenon.
- To understand the basic concepts of random processes which are widely used in communication networks.
- To acquaint with specialized random processes which are apt for modelling the real time scenario.
- To understand the concept of correlation and spectral densities.
- To understand the significance of linear systems with random inputs.

**UNIT I RANDOM VARIABLES**

9

Discrete and continuous random variables – Moments – Moment generating functions – Joint Distribution- Covariance and Correlation – Transformation of a random variable.

**UNIT II RANDOM PROCESSES**

9

Classification – Characterization – Cross correlation and Cross covariance functions - Stationary Random Processes – Markov process - Markov chain.

**UNIT III SPECIAL RANDOM PROCESSES**

9

Bernoulli Process – Gaussian Process - Poisson process – Random telegraph process.

**UNIT IV CORRELATION AND SPECTRAL DENSITIES**

9

Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties.

**UNIT V LINEAR SYSTEMS WITH RANDOM INPUTS**

9

Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and cross correlation functions of input and output.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

**CO1:** Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.

**CO2:** Apply the concept random processes in engineering disciplines.

**CO3:** Understand and apply the concept of correlation and spectral densities.

**CO4:** Get an exposure of various distribution functions and help in acquiring skills in handling situations involving more than one variable.

**CO5:** Analyze the response of random inputs to linear time invariant systems.

## TEXT BOOKS

1. Ibe, O.C., "Fundamentals of Applied Probability and Random Processes ", 1<sup>st</sup> Indian Reprint, Elsevier, 2007.
2. Peebles, P.Z., "Probability, Random Variables and Random Signal Principles ", Tata McGraw Hill, 4<sup>th</sup> Edition, New Delhi, 2002.

## REFERENCES

1. Cooper. G.R., McGillem. C.D., "Probabilistic Methods of Signal and System Analysis", Oxford University Press, New Delhi, 3<sup>rd</sup> Indian Edition, 2012.
2. Hwei Hsu, "Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes ", Tata McGraw Hill Edition, New Delhi, 2004.
3. Miller. S.L. and Childers. D.G., "Probability and Random Processes with Applications to Signal Processing and Communications ", Academic Press, 2004.
4. Stark. H. and Woods. J.W., "Probability and Random Processes with Applications to Signal Processing ", Pearson Education, Asia, 3<sup>rd</sup> Edition, 2002.
5. Yates. R.D. and Goodman. D.J., "Probability and Stochastic Processes", Wiley India Pvt. Ltd., Bangalore, 2<sup>nd</sup> Edition, 2012.

### CO's-PO's & PSO's MAPPING

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS 01	PS 02	PS 03
CO1	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO2	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO3	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO4	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO5	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
Avg	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-

1 - low, 2 - medium, 3 - high, '-'- no correlation

OMA357

QUEUEING AND RELIABILITY MODELLING

L T P C  
3 0 0 3

### COURSE OBJECTIVES:

- To provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems in communication engineering.
- To understand the concept of queueing models and apply in engineering.
- To provide the required mathematical support in real life problems and develop probabilistic models which can be used in several areas of science and engineering.
- To study the system reliability and hazard function for series and parallel systems.
- To implement Markovian Techniques for availability and maintainability which opens up new avenues for research.

### UNIT I RANDOM PROCESSES

9

Classification – Stationary process – Markov process - Poisson process – Discrete parameter Markov chain – Chapman Kolmogorov equations – Limiting distributions.



**UNIT II MARKOVIAN QUEUEING MODELS 9**  
 Markovian queues – Birth and death processes – Single and multiple server queueing models – Little’s formula - Queues with finite waiting rooms.

**UNIT III ADVANCED QUEUEING MODELS 9**  
 M/G/1 queue – Pollaczek Khinchin formula - M/D/1 and M/E<sub>k</sub>/1 as special cases – Series queues – Open Jackson networks.

**UNIT IV SYSTEM RELIABILITY 9**  
 Reliability and hazard functions- Exponential, Normal, Weibull and Gamma failure distribution – Time - dependent hazard models – Reliability of Series and Parallel Systems.

**UNIT V MAINTAINABILITY AND AVAILABILITY 9**  
 Maintainability and Availability functions – Frequency of failures – Two Unit parallel system with repair – k out of m systems.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

**CO1:**Enable the students to apply the concept of random processes in engineering disciplines.

**CO2:**Students acquire skills in analyzing various queueing models.

**CO3:**Students can understand and characterize phenomenon which evolve with respect to time in a probabilistic manner.

**CO4:**Students can analyze reliability of the systems for various probability distributions.

**CO5:**Students can be able to formulate problems using the maintainability and availability analyses by using theoretical approach.

**TEXT BOOKS**

- Shortle J.F, Gross D, Thompson J.M,Harris C.M., “Fundamentals of Queueing Theory”, John Wiley and Sons, New York,2018.
- Balagurusamy E., “Reliability Engineering”, Tata McGraw Hill Publishing Company Ltd., New Delhi,2010.

**REFERENCES**

- Medhi J, “Stochastic models of Queueing Theory”, Academic Press, Elsevier, Amsterdam, 2003.
- Taha, H.A., "Operations Research", 9<sup>th</sup> Edition, Pearson India Education Services, Delhi, 2016.
- Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications", 2<sup>nd</sup> Edition, John Wiley and Sons, 2002.
- Govil A.K., “Reliability Engineering”, Tata-McGraw Hill Publishing Company Ltd., New Delhi,1983.

**CO’s-PO’s & PSO’s MAPPING**

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO2</b>	3	3	2	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO3</b>	3	3	0	2	0	0	0	0	2	0	0	2	-	-	-
<b>CO4</b>	3	3	2	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO5</b>	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
<b>Avg</b>	3	3	1.4	0.8	0	0	0	0	2	0	0	2	-	-	-

1 - low, 2 - medium, 3 - high, ‘-’- no correlation

## OMG354 PRODUCTION AND OPERATIONS MANAGEMENT FOR ENTREPRENEURS

L	T	P	C
3	0	0	3

### COURSE OBJECTIVES:

- To know the basic concept and function of Production and Operation Management for entrepreneurship.
- To understand the Production process and planning.
- To understand the Production and Operations Management Control for business owners.

### UNIT I INTRODUCTION TO PRODUCTION AND OPERATIONS MANGEMENT 9

Functions of Production Management - Relationship between production and other functions – Production management and operations management, Characteristics of modern production and operation management, organisation of production function, recent trends in production /operations management - production as an organisational function, decision making in production Operations research

### UNIT II PRODUCTION & OPERATION SYSTEMS 9

Production Systems- principles – Models - CAD and CAM- Automation in Production - Functions and significance- Capacity and Facility Planning: Importance of capacity planning- Capacity measurement – Capacity Requirement Planning (CRP) process for manufacturing and service industry

### UNIT III PRODUCTION & OPERATIONS PLANNING 9

Facility Planning – Location of facilities – Location flexibility – Facility design process and techniques – Location break even analysis-Production Process Planning: Characteristic of production process systems – Steps for production process- Production Planning Control Functions – Planning phase- Action phase- Control phase - Aggregate production planning

### UNIT IV PRODUCTION & OPERATIONS MANAGEMENT PROCESS 9

Process selection with PLC phases- Process simulation tools- Work Study – Significance – Methods, evolution of normal/ standard time – Job design and rating - Value Analysis - Plant Layout: meaning – characters – Plant location techniques - Types- MRP and Layout Design - Optimisation and Theory of Constraints (TOC)– Critical Chain Project Management (CCPM)- REL (Relationship) Chart – Assembly line balancing- – Plant design optimisation -Forecasting methods.

### UNIT V CONTROLLING PRODUCTION & OPERATIONS MANAGEMENT 9

Material requirement planning (MRP)- Concept- Process and control - Inventory control systems and techniques – JIT and Lean manufacturing - Network techniques - Quality Management: Preventive Vs Breakdown maintenance for Quality – Techniques for measuring quality - Control Chart (X , R , p , np and C chart ) - Cost of Quality, Continuous improvement (Kaizen) - Quality awards - Supply Chain Management - Total Quality Management - 6 Sigma approach and Zero Defect Manufacturing.

**TOTAL 45 : PERIODS**

### COURSE OUTCOMES

Upon completion of this course the learners will be able :

CO 1 To understand the basics and functions of Production and Operation Management for business owners.

CO 2 To learn about the Production & Operation Systems.

CO 3 To acquaint on the Production & Operations Planning Techniques followed by entrepreneurs in Industries.

CO 4 To know about the Production & Operations Management Processes in organisations.

CO 5 To comprehend the techniques of controlling , Production and Operations in industries.

## REFERENCES

1. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson, 2007.
2. Amitabh Raturi, Production and Inventory Management, , 2008.
3. Adam Jr. Ebert, Production and Operations Management, PHI Publication, 1992.
4. Muhlemann, Okland and Lockyer, Production and Operation Management, Macmillan India, 1992.
6. Chary S.N, Production and Operations Management, TMH Publications, 2010.
7. Terry Hill ,Operation Management. Pal Grave McMillan (Case Study).2005.

**OMG355**

**MULTIVARIATE DATA ANALYSIS**

**L T P C**  
**3 0 0 3**

### COURSE OBJECTIVE:

- To know various multivariate data analysis techniques for business research.

#### UNIT I INTRODUCTION

**9**

Uni-variate, Bi-variate and Multi-variate techniques – Classification of multivariate techniques – Guidelines for multivariate analysis and interpretation.

#### UNIT II PREPARING FOR MULTIVARIATE ANALYSIS

**9**

Conceptualization of research model with variables, collection of data --Approaches for dealing with missing data – Testing the assumptions of multivariate analysis.

#### UNIT III MULTIPLE LINEAR REGRESSION ANALYSIS, FACTOR ANALYSIS

**9**

Multiple Linear Regression Analysis – Inferences from the estimated regression function – Validation of the model. -Approaches to factor analysis – interpretation of results.

#### UNIT IV LATENT VARIABLE TECHNIQUES

**9**

Confirmatory Factor Analysis, Structural equation modelling, Mediation models, Moderation models, Longitudinal studies.

#### UNIT V ADVANCED MULTIVARIATE TECHNIQUES

**9**

Multiple Discriminant Analysis, Logistic Regression, Cluster Analysis, Conjoint Analysis, multidimensional scaling.

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES :

**CO1:** Demonstrate a sophisticated understanding of the concepts and methods; know the exact scopes and possible limitations of each method; and show capability of using multivariate techniques to provide constructive guidance in decision making.

**CO2:** Use advanced techniques to conduct thorough and insightful analysis, and interpret the results correctly with detailed and useful information.

**CO3:** Show substantial understanding of the real problems; conduct deep analysis using correct methods; and draw reasonable conclusions with sufficient explanation and elaboration.

**CO4:**Write an insightful and well-organized report for a real-world case study, including thoughtful and convincing details.

**CO5:**Make better business decisions by using advanced techniques in data analytics. '

#### REFERENCES :

1. Joseph F Hair, Rolph E Anderson, Ronald L. Tatham & William C. Black, Multivariate Data Analysis, Pearson Education, New Delhi, 2005.
2. Barbara G. Tabachnick, Linda S.Fidell, Using Multivariate Statistics, 6th Edition, Pearson, 2012.
3. Richard A Johnson and Dean W.Wichern, Applied Multivariate Statistical Analysis, Prentice Hall, New Delhi, 2005.
4. David R Anderson, Dennis J Seveency, and Thomas A Williams, Statistics for Business and Economics, Thompson, Singapore, 2002

**OME352**

**ADDITIVE MANUFACTURING**

**L T P C**  
**3 0 0 3**

#### COURSE OBJECTIVES:

- To introduce the development, capabilities, applications, of Additive Manufacturing (AM), and its business opportunities.
- To be acquainted with vat polymerization and material extrusion processes
- To be familiar with powder bed fusion and binder jetting processes.
- To gain knowledge on applications of direct energy deposition, and material jetting processes.
- To impart knowledge on sheet lamination and direct write technologies.

#### UNIT I INTRODUCTION

**9**

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain - ASTM/ISO 52900 Classification - Benefits - AM Unique Capabilities - AM File formats: STL, AMF Applications: Building Printing, Bio Printing, Food Printing, Electronics Printing, Automobile, Aerospace, Healthcare. Business Opportunities in AM.

#### UNIT II VAT POLYMERIZATION AND MATERIAL EXTRUSION

**9**

Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process - top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications.

Material Extrusion: Fused Deposition Modeling (FDM) - Process-Materials -Applications and Limitations.

#### UNIT III POWDER BED FUSION AND BINDER JETTING

**9**

Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications.

Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits - Limitations - Applications.

#### UNIT IV MATERIAL JETTING AND DIRECTED ENERGY DEPOSITION

**9**

Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications.

Directed Energy Deposition: Laser Engineered Net Shaping (LENS) - Process - Material Delivery - Materials -Benefits -Applications.

**UNIT V SHEET LAMINATION AND DIRECT WRITE TECHNOLOGY 9**

Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding - Materials - Application and Limitation.

Ink-Based Direct Writing (DW): Nozzle Dispensing Processes, Inkjet Printing Processes, Aerosol DW - Applications of DW.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of this course students shall be able to:

**CO1:** Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.

**CO2:** Acquire knowledge on process vat polymerization and material extrusion processes and its applications.

**CO3:** Elaborate the process and applications of powder bed fusion and binder jetting.

**CO4:** Evaluate the advantages, limitations, applications of material jetting and directed energy deposition processes.

**CO5:** Acquire knowledge on sheet lamination and direct write technology.

**TEXT BOOKS:**

1. Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani “Additive manufacturing technologies”. 3<sup>rd</sup> edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0
2. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1-56990-582-

**REFERENCES:**

1. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
2. Milan Brandt, “Laser Additive Manufacturing: Materials, Design, Technologies, and Applications”, Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.
4. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer., United States ,2006, ISBN: 978-1-4614-9842-1.
5. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press., United States, 2011, ISBN: 9780849334092.

**COURSE OBJECTIVES**

- To introduce the fundamental concepts of the new product development
- To develop material specifications, analysis and process.
- To Learn the Feasibility Studies & reporting of new product development.
- To study the New product qualification and Market Survey on similar products of new product development
- To learn Reverse Engineering. Cloud points generation, converting cloud data to 3D model

**UNIT I FUNDAMENTALS OF NPD 9**

Introduction – Reading of Drawing – Grid reading, Revisions, ECN (Engg. Change Note), Component material grade, Specifications, customer specific requirements – Basics of monitoring of NPD applying Gantt chart, Critical path analysis – Fundamentals of BOM (Bill of Materials), Engg. BOM & Manufacturing BOM. Basics of MIS software and their application in industries like SAP, MS Dynamics, Oracle ERP Cloud – QFD.

**UNIT II MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS 9**

Material specification standards – ISO, DIN, JIS, ASTM, EN, etc. – Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis, ), Fabrications, Welding process. Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis.

**UNIT III ESSENTIALS OF NPD 9**

RFQ (Request of Quotation) Processing – Feasibility Studies & reporting – CFT (Cross Function Team) discussion on new product and reporting – Concept design, Machine selection for tool making, Machining – Manufacturing Process selection, Machining Planning, cutting tool selection – Various Inspection methods – Manual measuring, CMM – GOM (Geometric Optical Measuring), Lay out marking and Cut section analysis. Tool Design and Detail drawings preparation, release of details to machine shop and CAM programming. Tool assembly and shop floor trials. Initial sample submission with PPAP documents.

**UNIT IV CRITERIONS OF NPD 9**

New product qualification for Dimensions, Mechanical & Physical Properties, Internal Soundness proving through X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing frequencies. Market Survey on similar products, Risk analysis, validating samples with simulation results, Lesson Learned & Horizontal deployment in NPD.

**UNIT V REPORTING & FORWARD-THINKING OF NPD 9**

Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) – Purpose & documents, deployment in shop floor. Prototyping & RPT - Concepts, Application and its advantages, 3D Printing – resin models, Sand cores for foundries; Reverse Engineering. Cloud points generation, converting cloud data to 3D model – Advantages & Limitation of RE, CE (Concurrent Engineering) – Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost.)

**TOTAL :45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course the students would be able to

**CO1:**Discuss fundamental concepts and customer specific requirements of the New Product development

**CO2:**Discuss the Material specification standards, analysis and fabrication, manufacturing process.

**CO3:**Develop Feasibility Studies & reporting of New Product development

**CO4:**Analyzing the New product qualification and Market Survey on similar products of new product development

**CO5:**Develop Reverse Engineering. Cloud points generation, converting cloud data to 3D model

**TEXT BOOKS:**

1. Product Development – Sten Jonsson
2. Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger

**REFERENCES:**

1. Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark
2. Change by Design
3. Toyota Product Development System – James Morgan & Jeffrey K. Liker
4. Winning at New Products – Robert Brands 3rd Edition
5. Product Design & Value Engineering – Dr. M.A. Bulsara & Dr. H.R. Thakkar

**CO's-PO's & PSO's MAPPING**

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	3	1				1	1			1	1	3	2
2	1	1	3	1				1	1			1	1	3	2
3	1	1	3	1				1	1			1	1	3	2
4	1	1	3	1				1	1			1	1	3	2
5	1	1	3	1				1	1			1	1	3	2
Low (1) ; Medium (2) ; High (3)															

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OME355 INDUSTRIAL DESIGN & RAPID PROTOTYPING TECHNIQUES**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

The course aims to

- Outline Fundamental concepts in UI & UX
- Introduce the principles of Design and Building an mobile app
- Illustrate the use of CAD in product design
- Outline the choice and use of prototyping tools
- Understanding design of electronic circuits and fabrication of electronic devices

**UNIT I UI/UX**

**9**

Fundamental concepts in UI & UX - Tools - Fundamentals of design principles - Psychology and Human Factors for User Interface Design - Layout and composition for Web, Mobile and Devices - Typography - Information architecture - Color theory - Design process flow, wireframes, best practices in the industry -User engagement ethics - Design alternatives

**UNIT II APP DEVELOPMENT 9**

SDLC - Introduction to App Development - Types of Apps - web Development - understanding Stack - Frontend - backend - Working with Databases - Introduction to API - Introduction to Cloud services - Cloud environment Setup- Reading and writing data to cloud - Embedding ML models to Apps - Deploying application.

**UNIT III INDUSTRIAL DESIGN 9**

Introduction to Industrial Design - Points, lines, and planes - Sketching and concept generation - Sketch to CAD - Introduction to CAD tools - Types of 3D modeling - Basic 3D Modeling Tools - Part creation – Assembly - Product design and rendering basics - Dimensioning & Tolerancing

**UNIT IV MECHANICAL RAPID PROTOTYPING 9**

Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - Mechanical Prototyping; 3D Printing and classification - Laser Cutting and engraving - RD Works - Additive manufacturing

**UNIT V ELECTRONIC RAPID PROTOTYPING 9**

Basics of electronic circuit design - lumped circuits - Electronic Prototyping - Working with simulation tool - simple PCB design with EDA

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

**At the end of the course, learners will be able to:**

**CO1:**Create quick UI/UX prototypes for customer needs

**CO2:**Develop web application to test product traction / product feature

**CO3:**Develop 3D models for prototyping various product ideas

**CO4:**Built prototypes using Tools and Techniques in a quick iterative methodology

**TEXT BOOKS**

1. Peter Fiell, Charlotte Fiell, Industrial Design A-Z, TASCHEN America Llc(2003)
2. Samar Malik, Autodesk Fusion 360 - The Master Guide.
3. Steve Krug, Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability, Pearson,3rd edition(2014)

**REFERENCES**

1. <https://www.adobe.com/products/xd/learn/get-started.html>
2. <https://developer.android.com/guide>
3. <https://help.autodesk.com/view/fusion360/ENU/courses/>
4. [https://help.prusa3d.com/en/category/prusaslicer\\_204](https://help.prusa3d.com/en/category/prusaslicer_204)

**MF3010**

**MICRO AND PRECISION ENGINEERING**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

At the end of this course the student should be able to

- Learn about the precision machine tools
- Learn about the macro and micro components.



- Understand handling and operating of the precision machine tools.
- Learn to work with miniature models of existing machine tools/robots and other instruments.
- Learn metrology for micro system

**UNIT I INTRODUCTION TO MICROSYSTEMS 9**

Design, and material selection, micro-actuators: hydraulic, pneumatic, electrostatic/ magnetic etc. for medical to general purpose applications. Micro-sensors based on Thermal, mechanical, electrical properties; micro-sensors for measurement of pressure, flow, temperature, inertia, force, acceleration, torque, vibration, and monitoring of manufacturing systems.

**UNIT II FABRICATION PROCESSES FOR MICRO-SYSTEMS: 9**

Additive, subtractive, forming process, microsystems-Micro-pumps, micro- turbines, micro engines, micro-robot, and miniature biomedical devices

**UNIT III INTRODUCTION TO PRECISION ENGINEERING 9**

Machine tools, holding and handling devices, positioning fixtures for fabrication/ assembly of microsystems. Precision drives: inch worm motors, ultrasonic motors, stick- slip mechanism and other piezo-based devices.

**UNIT IV PRECISION MACHINING PROCESSES 9**

Precision machining processes for macro components - Diamond turning, fixed and free abrasive processes, finishing processes.

**UNIT V METROLOGY FOR MICRO SYSTEMS 9**

Metrology for micro systems - Surface integrity and its characterization.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon the completion of this course the students will be able to

**CO1:**Select suitable precision machine tools and operate

**CO2:**Apply the macro and micro components for fabrication of micro systems.

**CO3:**Apply suitable machining process

**CO4:**Able to work with miniature models of existing machine tools/robots and other instruments.

**CO5:**Apply metrology for micro system

**TEXT BOOKS:**

1. Davim, J. Paulo, ed. Microfabrication and Precision Engineering: Research and Development. Woodhead Publishing, 2017
2. Gupta K, editor. Micro and Precision Manufacturing. Springer; 2017

**REFERENCES:**

1. Dornfeld, D., and Lee, D. E., Precision Manufacturing, 2008, Springer.
2. H. Nakazawa, Principles of Precision Engineering, 1994, Oxford University Press.
3. Whitehouse, D. J., Handbook of Surface Metrology, Institute of Physics Publishing, Philadelphia PA, 1994.
4. Murthy.R.L, —Precision Engineering in ManufacturingII, New Age International, New Delhi, 2005

**COURSE OBJECTIVES:**

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

**UNIT I INTRODUCTION TO COSTING CONCEPTS 9**

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.'

**UNIT II INTRODUCTION TO PROJECT MANAGEMENT 9**

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts

**UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9**

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing

**UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9**

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

**UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9**

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

**CO1:** Understand the costing concepts and their role in decision making.

**CO2:** Understand the project management concepts and their various aspects in selection.

**CO3:** Interpret costing concepts with project execution.

**CO4:** Gain knowledge of costing techniques in service sector and various budgetary control techniques.

**CO5:** Become familiar with quantitative techniques in cost management.

**TEXT BOOKS:**

1. John M. Nicholas, Herman Steyn Project Management for Engineering, Business and Technology, Taylor & Francis, 2 August 2020, ISBN: 9781000092561.
2. Albert Lester ,Project Management, Planning and Control, Elsevier/Butterworth-Heinemann, 2007, ISBN: 9780750669566, 075066956X.

**REFERENCES:**

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991.
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988.
3. Charles T. Horngren et al Cost Accounting a Managerial Emphasis, Prentice Hall of India, New Delhi, 2011.
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003.
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007.

**AU3002****BATTERIES AND MANAGEMENT SYSTEM****L T P C****3 0 0 3****COURSE OBJECTIVES:**

The objective of this course is to make the students

- to understand the working and characteristics of different types of batteries and their management .

**UNIT I            ADVANCED BATTERIES****9**

Li-ion Batteries-different formats, chemistry, safe operating area, efficiency, aging. Characteristics-SOC,DOD, SOH. Balancing-Passive Balancing Vs Active Balancing. Other Batteries-NCM and NCA Batteries. *NCR18650B* specifications.

**UNIT II            BATTERY PACK****9**

Battery Pack- design, sizing, calculations, flow chart, real and simulation Model.Peak power – definition, testing methods-relationships with Power, Temperature and ohmic Internal Resistance. Cloud based and Local Smart charging.

**UNIT III         BATTERY MODELLING****9**

Battery Modelling Methods-Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model, PNGV model. State space Models-Introduction. Battery Modelling software/simulation frameworks

**UNIT IV         BATTERY STATE ESTIMATION****9**

SOC Estimation- Definition, importance, single cell Vs series batteries SOC. Estimation Methods-Load voltage, Electromotive force, AC impedance, Ah counting, Neural networks, Neuro-fuzzy forecast method, Kalman filter. Estimation Algorithms.

**UNIT V         BMS ARCHITECTURE AND REAL TIME COMPONENTS****9**

Battery Management System- need, operation, classification. BMS ASIC-bq76PL536A-Q1 Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex Ray-CANedge1 package.ARBIN Battery Tester. BMS Development with Modeling software and Model-Based Design.

**TOTAL :45 PERIODS**

## COURSE OUTCOMES:

At the end of this course, students will be able to

**CO1:**Acquire knowledge of different Li-ion Batteries performance.

**CO2:**Design a Battery Pack and make related calculations.

**CO3:**Demonstrate a BatteryModel or Simulation.

**CO4:**Estimate State-of-Charges in a Battery Pack.

**CO5:**Approach different BMS architectures during real world usage.

## TEXT BOOKS

1. Jiuchun Jiang and Caiping Zhang, "Fundamentals and applications of Lithium-Ion batteries in Electric Drive Vehicles", Wiley, 2015.
2. Davide Andrea, "Battery Management Systems for Large Lithium-Ion Battery Packs" ARTECH House, 2010.

## REFERENCE BOOKS

1. Developing Battery Management Systems with Simulink and Model-Based Design-whitepaper
2. Panasonic *NCR18650B- DataSheet*
3. bq76PL536A-Q1- IC DataSheet
4. CC2662R-Q1- IC DataSheet

**AU3008**

**SENSORS AND ACTUATORS**

**L T P C**  
**3 0 0 3**

## COURSE OBJECTIVES:

- The objective of this course is to make the students to list common types of sensor and actuators used in automotive vehicles.

### UNIT I INTRODUCTION TO MEASUREMENTS AND SENSORS

**9**

Sensors: Functions- Classifications- Main technical requirement and trends Units and standards- Calibration methods- Classification of errors- Error analysis- Limiting error- Probable error- Propagation of error- Odds and uncertainty- principle of transduction-Classification. Static characteristics- mathematical model of transducers- Zero, First and Second order transducers- Dynamic characteristics of first and second order transducers for standard test inputs.

### UNIT II VARIABLE RESISTANCE AND INDUTANCE SENSORS

**9**

Principle of operation- Construction details- Characteristics and applications of resistive potentiometer- Strain gauges- Resistive thermometers- Thermistors- Piezoresistive sensors Inductive potentiometer- Variable reluctance transducers:- EI pick up and LVDT

### UNIT III VARIABLE AND OTHER SPECIAL SENSORS

**9**

Variable air gap type, variable area type and variable permittivity type- capacitor microphone Piezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor- digital transducers-Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor.

### UNIT IV AUTOMOTIVE ACTUATORS

**9**

Electromechanical actuators- Fluid-mechanical actuators- Electrical machines- Direct-current machines- Three-phase machines- Single-phase alternating-current Machines - Duty-type ratings

for electrical machines. Working principles, construction and location of actuators viz. Solenoid, relay, stepper motor etc.

**UNIT V AUTOMATIC TEMPERATURE CONTROL ACTUATORS 9**

Different types of actuators used in automatic temperature control- Fixed and variable displacement temperature control- Semi Automatic- Controller design for Fixed and variable displacement type air conditioning system.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the student will be able to

**CO1:**List common types of sensor and actuators used in vehicles.

**CO2:**Design measuring equipment's for the measurement of pressure force, temperature and flow.

**CO3:**Generate new ideas in designing the sensors and actuators for automotive application

**CO4:**Understand the operation of the sensors, actuators and electronic control.

**CO5:**Design temperature control actuators for vehicles.

**TEXT BOOKS:**

1. Doebelin's Measurement Systems: 7th Edition (SIE), Ernest O. Doebelin Dhanesh N. Manik McGraw Hill Publishers, 2019.
2. Robert Brandy, "Automotive Electronics and Computer System", Prentice Hall, 2001
3. William Kimberley, "Bosch Automotive Handbook", 6th Edition, Robert Bosch GmbH, 2004.
4. Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th Edition, 2007, ISBN No: 978-3-658-01783-5.

**REFERENCES:**

1. James D Halderman, "Automotive Electrical and Electronics", Prentice Hall, USA, 2013
2. Tom Denton, "Automotive Electrical and Electronics Systems," Third Edition, 2004, SAE International.
3. Patranabis.D, "Sensors and Transducers", 2nd Edition, Prentice Hall India Ltd, 2003
4. William Ribbens, "Understanding Automotive Electronics -An Engineering Perspective," 7th Edition, Elsevier Butterworth-Heinemann Publishers, 2012.

<b>OAS353</b>	<b>SPACE VEHICLES</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

- To interpret the missile space stations, space vs earth environment.
- To explain the life support systems, mission logistics and planning.
- To deploy the skills effectively in the understanding of space vehicle configuration design.
- To explain Engine system and support of space vehicle
- To interpret nose cone configuration of space vehicle

**UNIT I FUNDAMENTAL ASPECTS 9**

Energy and Efficiencies of power plants for space vehicles – Typical Performance Values – Mission design – Structural design aspects during launch - role of launch environment on launch vehicle integrity.

**UNIT II SELECTION OF ROCKET PROPULSION SYSTEMS 9**

Ascent flight mechanics – Launch vehicle selection process – Criteria for Selection for different missions – selection of subsystems – types of staging – Interfaces – selection and criteria for stages and their role in launch vehicle configuration design.

**UNIT III ENGINE SYSTEMS, CONTROLS, AND INTEGRATION 9**

Propellant Budget – Performance of Complete or Multiple Rocket Propulsion Systems – Engine Design – Engine Controls – Engine System Calibration – System Integration and Engine Optimization.

**UNIT IV THRUST VECTOR CONTROL 9**

TVC Mechanisms with a Single Nozzle – TVC with Multiple Thrust Chambers or Nozzles – Testing – Integration with Vehicle – SITVC method – other jet control methods - exhaust plume problems in space environment

**UNIT V NOSE CONE CONFIGURATION 9**

Aerodynamic aspects on the selection of nose shape of a launch vehicle - design factors in the finalization of nose configuration with respect to payload - nose cone thermal protection system - separation of fairings - payload injection mechanism

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

- CO1:** Explain exotic space propulsion concepts, such as nuclear, solar sail, and antimatter.
- CO2:** Apply knowledge in selecting the appropriate rocket propulsion systems.
- CO3:** Interpret the air-breathing propulsion suitable for initial stages and fly-back boosters.
- CO4:** Analyze aerodynamics aspect, including boost-phase lift and drag, hypersonic, and re-entry.
- CO5:** Adapt from aircraft engineers moving into launch vehicle, spacecraft, and hypersonic vehicle design.

**OIM352**

**MANAGEMENT SCIENCE**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

Of this course are

- To introduce fundamental concepts of management and organization to students.
- To impart knowledge to students on various aspects of marketing, quality control and marketing strategies.
- To make students familiarize with the concepts of human resources management.
- To acquaint students with the concepts of project management and cost analysis.
- To make students familiarize with the concepts of planning process and business strategies.

**UNIT I INTRODUCTION TO MANAGEMENT AND ORGANISATION 9**

Concepts of Management and organization- nature, importance and Functions of Management, Systems Approach to Management - Taylor's Scientific Management Theory- Fayal's Principles of Management- Maslow's theory of Hierarchy of Human Needs- Douglas McGregor's Theory X and Theory Y- Herzberg Two Factor Theory of Motivation- Leadership Styles, Social responsibilities of Management, Designing Organisational Structures: Basic

concepts related to Organisation -Departmentation and Decentralisation.

**UNIT II OPERATIONS AND MARKETING MANAGEMENT 9**

Principles and Types of Plant Layout-Methods of Production(Job, batch and Mass Production),Work Study - Basic procedure involved in Method Study and Work Measurement - BusinessProcessReengineering(BPR)- StatisticalQualityControl:controlchartsforVariablesandAttributes (simple Problems) and Acceptance Sampling, Objectives of Inventory control, EOQ,ABC Analysis, Purchase Procedure, Stores Management and Store Records - JIT System,Supply Chain Management, Functions of Marketing, Marketing Mix, and Marketing Strategies based on ProductLifeCycle.

**UNIT III HUMAN RESOURCES MANAGEMENT 9**

Concepts of HRM, HRD and Personnel Management and Industrial Relations (PMIR), HRM vs PMIR, Basic functions of HR Manager:Manpower planning, Recruitment, Selection, TrainingandDevelopment,WageandSalaryAdministration,Promotion,Transfer,PerformanceAppraisal, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating –Capability Maturity Model (CMM)Levels.

**UNIT IV PROJECT MANAGEMENT 9**

Network Analysis, Programme Evaluation and Review Technique (PERT), Critical Path Method(CPM), identifying critical path, Probability of Completing the project within given time, Project Cost Analysis,Project Crashing (simple problems).

**UNIT V STRATEGIC MANAGEMENT AND CONTEMPORARY STRATEGIC ISSUES 9**

Mission, Goals, Objectives, Policy, Strategy, Programmes, Elements of Corporate Planning Process, Environmental Scanning, Value Chain Analysis, SWOT Analysis, Steps in Strategy Formulation and Implementation, Generic Strategy alternatives. Bench Marking and Balanced Score Cards as Contemporary Business Strategies.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, Students will be able to

**CO1:**Plan an organizational structure for a given context in the organisation to carry out production operations through Work-study.

**CO2:**Survey the markets, customers and competition better and price the given products appropriately

**CO3:**Ensure quality for a given product or service.

**CO4:**Plan, schedule and control projects through PERT and CPM.

**CO5:**Evaluate strategy for a business or service organisation.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3			3	3	3		3	3	2			2	3	
2	3			2	3	3		2	3	2				2	
3	3			3	2	2		3	2	2					2
4	3			3	3	2		3	2	3					3
5	3			2	3	3		2	3	3			2	1	
<b>AVg.</b>	3			2.6	2.8	2.6		2.6	2.6	2.4			2	2	2.5

1 - low, 2 - medium, 3 - high, "--" - no correlation

## TEXTBOOKS:

1. Kanishka Bedi, Production and Operations Management, Oxford University Press, 2007.
2. Stoner, Freeman, Gilbert, Management, 6<sup>th</sup> Ed, Pearson Education, New Delhi, 2004.
3. Thomas N. Duening & John M. Ivancevich Management Principles and Guidelines, Biztantra, 2007.
4. P. Vijay Kumar, N. Appa Rao and Ashnab, Chnalill, Cengage Learning India, 2012.

## REFERECES:

1. Kotler Philip and Keller Kevin Lane: Marketing Management, Pearson, 2012.
2. Koontz and Weihrich: Essentials of Management, McGraw Hill, 2012.
3. Lawrence R. Jauch, R. Gupta and William F. Glueck: Business Policy and Strategic Management Science, McGraw Hill, 2012.
4. Samuel C. Certo: Modern Management, 2012.

OIM353

PRODUCTION PLANNING AND CONTROL

L T P C  
3 0 0 3

## COURSE OBJECTIVES:

- To understand the concept of production planning and control act work study,
- To apply the concept of product planning,
- To analyze the production scheduling,
- To apply the Inventory Control concepts.
- To prepare the manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

## UNIT I INTRODUCTION

9

Objectives and benefits of planning and control-Functions of production control-Types of production-job- batch and continuous-Product development and design-Marketing aspect - Functional aspects-Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration-Standardization, Simplification & specialization- Break even analysis-Economics of a new design.

## UNIT II WORK STUDY

9

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

## UNIT III PRODUCT PLANNING AND PROCESS PLANNING

9

Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning- Steps in process planning-Quantity determination in batch production-Machine capacity, balancing- Analysis of process capabilities in a multi product system.

## UNIT IV PRODUCTION SCHEDULING

9

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance – Flow production scheduling-Batch production scheduling-Product sequencing – Production Control systems- Periodic batch



control-Material requirement planning kanban – Dispatching-Progress reporting and expediting- Manufacturing lead time-Techniques for aligning completion times and due dates.

**UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC**

**9**

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size- ABC analysis - Recorder procedure-Introduction to computer integrated production planning systems- elements of JUST IN TIME SYSTEMS-Fundamentals of MRP II and ERP.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course,

- CO1:**The students can able to prepare production planning and control act work study,
- CO2:**The students can able to prepare product planning,
- CO3:**The students can able to prepare production scheduling,
- CO4:**The students can able to prepare Inventory Control.
- CO5:**They can plan manufacturing requirements manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

**TEXT BOOKS:**

1. James. B. Dilworth, "Operations management – Design, Planning and Control for manufacturing and services" Mcgraw Hill International edition 1992.
2. Martand Telsang, "Industrial Engineering and Production Management", First edition, S. Chand and Company, 2000.

**REFERENCES**

1. Chary. S.N., "Theory and Problems in Production & Operations Management", Tata McGraw Hill, 1995.
2. Elwood S.Buffa, and Rakesh K.Sarin, "Modern Production / Operations Management", 8th Edition John Wiley and Sons, 2000
3. Jain. K.C. & Aggarwal. L.N., "Production Planning Control and Industrial Management", Khanna Publishers, 1990
4. Kanishka Bedi, "Production and Operations management", 2nd Edition, Oxford university press, 2007.
5. Melynk, Denzler, " Operations management – A value driven approach" Irwin Mcgraw hill.
6. Norman Gaither, G. Frazier, "Operations Management" 9th Edition, Thomson learning IE, 2007
7. Samson Eilon, "Elements of Production Planning and Control", Universal Book Corpn.1984
8. Upendra Kachru, " Production and Operations Management – Text and cases" 1st Edition, Excel books 2007

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3			3		1				1		3		
2	3	2			3									2	
3		2			3									2	
4		2	2												
5	3	3	2											1	

<b>AVg.</b>	3	2.6	2		3		1				1		3	1.8	
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1 - low, 2 - medium, 3 - high, ‘-‘- no correlation

**OIE353**

**OPERATIONS MANAGEMENT**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVE:**

- Recognize and appreciate the concept of Production and Operations Management in creating and enhancing a firm’s competitive advantages.
- Describe the concept and contribution of various constituents of Production and Operations Management (both manufacturing and service).
- Relate the interdependence of the operations function with the other key functional areas of a firm.
- Teach analytical skills and problem-solving tools to the analysis of the operations problems.
- Apply scheduling and Lean Concepts for improving System Performance.

**UNIT I INTRODUCTION TO OPERATIONS MANAGEMENT 9**

Operations Management – Nature, Importance, historical development, transformation processes, differences between services and goods, a system perspective, functions, challenges, current priorities, recent trends; Operations Strategy - Strategic fit , framework; Supply Chain Management

**UNIT II FORECASTING, CAPACITY AND FACILITY DESIGN 9**

Demand Forecasting - Need, Types, COURSE OBJECTIVES and Steps. Overview of Qualitative and Quantitative methods. Capacity Planning - Long range, Types, Developing capacity alternatives. Overview of sales and operations planning. Overview of MRP, MRP II and ERP. Facility Location – Theories, Steps in Selection, Location Models. Facility Layout – Principles, Types, Planning tools and techniques.

**UNIT III DESIGN OF PRODUCT, PROCESS AND WORK SYSTEMS 9**

Product Design – Influencing factors, Approaches, Legal, Ethical and Environmental issues. Process – Planning, Selection, Strategy, Major Decisions. Work Study – COURSE OBJECTIVES, Procedure. Method Study and Motion Study. Work Measurement and Productivity – Measuring Productivity and Methods to improve productivity.

**UNIT IV MATERIALS MANAGEMENT 9**

Materials Management – COURSE OBJECTIVES, Planning, Budgeting and Control. Purchasing – COURSE OBJECTIVES, Functions, Policies, Vendor rating and Value Analysis. Stores Management – Nature, Layout, Classification and Coding. Inventory – COURSE OBJECTIVES, Costs and control techniques. Overview of JIT.

**UNIT V SCHEDULING AND PROJECT MANAGEMENT 9**

Project Management – Scheduling Techniques, PERT, CPM; Scheduling - work centers – nature, importance; Priority rules and techniques, shopfloor control; Flow shop scheduling – Johnson’s Algorithm – Gantt charts; personnel scheduling in services.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1:** The students will appreciate the role of Production and Operations management in enabling and enhancing a firm’s competitive advantages in the dynamic business

environment.

**CO2:** The students will obtain sufficient knowledge and skills to forecast demand for Production and Service Systems.

**CO3:** The students will be able to Formulate and Assess Aggregate Planning strategies and Material Requirement Plan.

**CO4:** The students will be able to develop analytical skills to calculate capacity requirements and developing capacity alternatives.

**CO5:** The students will be able to apply scheduling and Lean Concepts for improving System Performance.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3											2			
2		3	3											3	3
3		2	3	3									2	3	
4		3	3	3									2	3	
5			3	2											
<b>AVg.</b>	3	2.6	3	2.6								2	2	3	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

**TEXT BOOKS**

1. Richard B. Chase, Ravi Shankar, F. Robert Jacobs, Nicholas J. Aquilano, Operations and Supply Management, Tata McGraw Hill, 12<sup>th</sup> Edition, 2010.
2. Norman Gaither and Gregory Frazier, Operations Management, South Western Cengage Learning, 2002.

**REFERENCES**

1. William J Stevenson, Operations Management, Tata McGraw Hill, 9<sup>th</sup> Edition, 2009.
2. Russel and Taylor, Operations Management, Wiley, Fifth Edition, 2006.
3. Kanishka Bedi, Production and Operations Management, Oxford University Press, 2004.
4. Chary S. N, Production and Operations Management, Tata McGraw Hill, Third Edition, 2008.
5. Aswathappa K and Shridhara Bhat K, Production and Operations Management, Himalaya Publishing House, Revised Second Edition, 2008.
6. Mahadevan B, Operations Management Theory and practice, Pearson Education, 2007.
7. Pannerselvam R, Production and Operations Management, Prentice Hall India, Second Edition, 2008.

**OSF352**

**INDUSTRIAL HYGIENE**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- Demonstrate an understanding of how occupational hygiene standards are set and used in work health and safety.
- Compare and contrast the roles of environmental and biological monitoring in work health and safety
- Outline strategies for identifying, assessing and controlling risks associated with airborne gases, vapours and particulates

- Discuss how personal protective equipment can be used to reduce risks associated with workplace exposures
- Provide high-level advice on managing and controlling noise and noise-related hazards

**UNIT I INTRODUCTION AND SCOPE 9**

Occupational Health and Environmental Safety Management - Principles practices. Common Occupational diseases: Occupational Health Management Services at the work place. Pre-employment, periodic medical examination of workers, medical surveillance for control of occupational diseases and health records.

**UNIT II MONITORING FOR SAFETY, HEALTH & ENVIRONMENT 9**

Occupational Health and Environment Safety Management System, ILO and EPA Standards Industrial Hygiene: Definition of Industrial Hygiene, Industrial Hygiene: Control Methods, Substitution, Changing the process, Local Exhaust Ventilation, Isolation, Wet method, Personal hygiene, housekeeping and maintenance, waste disposal, special control measures.

**UNIT III OCCUPATIONAL HEALTH AND ENVIRONMENTAL SAFETY EDUCATION 9**

Element of training cycle, Assessment of needs. Techniques of training, design and development of training programs. Training methods and strategies types of training. Evaluation and review of training programs. Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety, Exposure Limit .

**UNIT IV OCCUPATIONAL SAFETY, HEALTH AND ENVIRONMENT MANAGEMENT 9**

Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000, OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards, Performance measurements to determine effectiveness of PSM. Importance of Industrial safety, role of safety department,

**UNIT V INDUSTRIAL HAZARDS 9**

i. Radiation: Types and effects of radiation on human body, Measurement and detection of radiation intensity. Effects of radiation on human body, Measurement – disposal of radioactive waste, Control of radiation ii. Noise and Vibration: Sources, and its control, Effects of noise on the auditory system and health, Measurement of noise , Different air pollutants in industries, Effect of different gases and particulate matter ,acid fumes ,smoke, fog on human health, Vibration: effects.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Students able to

**CO1:** Explain and apply human factors engineering concepts in both evaluation of existing systems and design of new systems

**CO2:** Specify designs that avoid occupation related injuries

**CO3:** Define and apply the principles of work design, motion economy, and work environment design.

**CO4:** Identify the basic human sensory, cognitive, and physical capabilities and limitations with respect to human-machine system performance.

**CO5:** Acknowledge the impact of workplace design and environment on productivity

**TEXT BOOKS:**

1. R. K. Jain and Sunil S. Rao , Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006)
2. Slote. L, Handbook of Occupational Safety and Health, John Willey and Sons, New York .

**REFERENCES:**

1. Jeanne MagerStellman, Encyclopedia of Occupational Health and Safety (ILO) Ms. Irma Jourdan publication
2. Frank P Lees - Loss of prevention in Process Industries, Vol. 1 and 2,
3. ButterworthHeinemann Ltd., London (1991). 2. Industrial Safety - National Safety Council of India
4. Frank P Lees – Loss of prevention in Process Industries , Vol. 1 and 2, Butterworth- Heinemann Ltd., London
5. R. K. Jain and Sunil S. Rao, Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006).

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2		2		2	-	-	-	-	-	2	-	-	-	-
2	-		2		-	-	1	-	-	-	1	-	-	-	-
3	-		-		2	-	-	-	-	-	2	-	-	-	-
4	-		-		-	-	-	-	2	-	3	-	-	-	-
5	-		-		-	-	-	1	-	-	-	-	-	-	-
AVg.	2	-	2	-	-	-	1	1	2	-	2	-	-	-	-

1 - low, 2 - medium, 3 - high, "--" - no correlation

OSF353

CHEMICAL PROCESS SAFETY

L T P C  
3 0 0 3

**COURSE OBJECTIVES**

- Teach the principles of safety applicable to the design, and operation of chemical process plants.
- Ensure that potential hazards are identified and mitigation measures are in place to prevent unwanted release of energy.
- Learn about the hazardous chemicals into locations that could expose employees and others to serious harm.
- Focuses on preventing incidents and accidents during large scale manufacturing of chemicals and pharmaceuticals.
- Ensure that the general design of the plant is capable of complying with the dose limits in force and with the radioactive releases.

**UNIT I SAFETY IN THE STORAGE AND HANDLING OF CHEMICALS AND GASES 9**

Types of storage-general considerations for storage layouts- atmospheric venting, pressure and temperature relief - relief valve sizing calculations - storage and handling of hazardous chemicals and industrial gases, safe disposal methods, reaction with other chemicals, hazards during transportation - pipe line transport - safety in chemical laboratories.

**UNIT II CHEMICAL REACTION HAZARDS 9**

Hazardous inorganic and organic reactions and processes, Reactivity as a process hazard, Detonations, Deflagrations, and Runaways, Assessment and Testing strategies, Self - heating hazards of solids, Explosive potential of chemicals, Structural groups and instability of chemicals, Thermochemical screening,

**UNIT III SAFETY IN THE DESIGN OF CHEMICAL PROCESS PLANTS 9**

Design principles -Process design development -types of designs, feasibility survey, preliminary design, Flow diagrams, piping and instrumentation diagram, batch versus continuous operation, factors in equipment scale up and design, equipment specifications - reliability and safety in designing - inherent safety - engineered safety - safety during startup and shutdown - non destructive testing methods - pressure and leak testing - emergency safety devices - scrubbers and flares- new concepts in safety design and operation- Pressure vessel testing standards- Inspection techniques for boilers and reaction vessels.

**UNIT IV SAFETY IN THE OPERATION OF CHEMICAL PROCESS PLANTS 9**

Properties of chemicals - Material Safety Data Sheets - the various properties and formats used - methods available for property determination. Operational activities and hazards -standards operating procedures - safe operation of pumps, compressors, heaters, column, reactors, pressure vessels, storage vessels, piping systems - effects of pressure, temperature, Flow rate and humidity on operations - corrosion and control measures- condition monitoring - control valves - safety valves - pressure reducing valves, drains, bypass valves, inert gases. Chemical splashes, eye irrigation and automatic showers.

**UNIT V SAFETY AND ANALYSIS 9**

Safety vs reliability- quantification of basic events, system safety quantification, Human error analysis, Accident investigation and analysis, OSHAS 18001 and OSHMS.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**Students able to**

- CO1** Differentiate between inherent safety and engineered safety and recognize the importance of safety in the design of chemical process plants.
- CO2** Develop thorough knowledge about safety in the operation of chemical plants.
- CO3** Apply the principles of safety in the storage and handling of gases.
- CO4** Identify the conditions that lead to reaction hazards and adopt measures to prevent them.
- CO5** Develop thorough knowledge about

**TEXT BOOK**

- 1 David A Crowl & Joseph F Louvar, "Chemical Process safety", Pearson publication, 3<sup>rd</sup> Edition, 2014
- 2 Maurice Jones .A, "Fire Protection Systems, 2<sup>nd</sup> edition, Jones & Bartlett Publishers, 2015

**REFERENCES:**

1. Ralph King and Ron Hirst, "King's safety in the process industries", Arnold, London, 1998.
2. Industrial Environment and its Evolution and Control, NIOSH Publication, 1973.
3. National Safety Council, "Accident prevention manual for industrial operations". Chicago, 1982.
4. Lewis, Richard. J., Sr, "Sax's dangerous properties of materials". (Ninth edition). Van Nostrand Reinhold, New York, 1996.

5. Roy E Sanders, "Chemical Process Safety", 3<sup>rd</sup> Edition, Gulf professional publishing, 2006

### CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	-	-	-	1	-	-	1	-	-	-	2	-	-
2	-			2	-	-	-	-	1	-		-	-	2	-
3	-	3		1	-	-	-	2	-	-	1	-	-	-	-
4	-	2	-		-	1	-	-	1	-		-	-	-	2
5	-	2	3		-	-	-	1	-	-	1	-	-	-	-
AVg.	2	2.5	3	1.5	-	1	-	1.5	1	-	1		2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

OML352

**ELECTRICAL, ELECTRONIC AND MAGNETIC MATERIALS**

**L T P C**  
**3 0 0 3**

### COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Understanding the importance of various materials used in electrical, electronics and magnetic applications
- Acquiring knowledge on the properties of electrical, electronics and magnetic materials.
- Gaining knowledge on the selection of suitable materials for the given application
- Knowing the fundamental concepts in Semiconducting materials
- Getting equipped with the materials used in optical and optoelectronic applications.

### UNIT I DIELECTRIC MATERIALS

9

Dielectric as Electric Field Medium, leakage currents, dielectric loss, dielectric strength, breakdown voltage, breakdown in solid dielectrics, flashover, liquid dielectrics, electric conductivity in solid, liquid and gaseous dielectrics, Ferromagnetic materials, properties of ferromagnetic materials in static fields, spontaneous, polarization, curie point, anti-ferromagnetic materials, piezoelectric materials, pyroelectric materials.

### UNIT II MAGNETIC MATERIALS

9

Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials, magnetic Anisotropy, Magnetostriction, diamagnetism, magnetically soft and hard materials, special purpose materials, feebly magnetic materials, Ferrites, cast and cermet permanent magnets, ageing of magnets. Factors effecting permeability and Hysteresis

### UNIT III SEMICONDUCTOR MATERIALS

9

Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale Integration techniques. Concept of superconductivity; theories and examples for high temperature superconductivity; discussion on specific superconducting materials; comments on fabrication and engineering applications.

### UNIT IV MATERIALS FOR ELECTRICAL APPLICATIONS

9

Materials used for Resistors, rheostats, heaters, transmission line structures, stranded conductors, bimetals fuses, soft and hard solders, electric contact materials, electric carbon materials,

thermocouple materials. Solid, Liquid and Gaseous insulating materials, Effect of moisture on insulation.

**UNIT V OPTICAL AND OPTOELECTRONIC MATERIALS**

**9**

Principles of photoconductivity - effect of impurities - principles of luminescence-laser principles - He-Ne, injection lasers, LED materials - binary, ternary photoelectronic materials - LCD materials - photo detectors - applications of optoelectronic materials - optical fibres and materials - electro optic modulators - Kerr effect - Pockels effect.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the students will be able to

- CO1:** Understand various types of dielectric materials, their properties in various conditions.
- CO2:** Evaluate magnetic materials and their behavior.
- CO3:** Evaluate semiconductor materials and technologies.
- CO4:** Select suitable materials for electrical engineering applications.
- CO5:** Identify right material for optical and optoelectronic applications

**TEXT BOOKS:**

1. Pradeep Fulay, "Electronic, Magnetic and Optical materials", CRC Press, Taylor and Francis, 2nd illustrated edition, 2017.
2. "R K Rajput", "A course in Electrical Engineering Materials", Laxmi Publications, 2009.

**REFERENCE BOOKS:**

1. T K Basak, "A course in Electrical Engineering Materials", New Age Science Publications, 2009
2. TTTI Madras, "Electrical Engineering Materials", McGraw Hill Education, 2004.
3. Adrianus J. Dekker, "Electrical Engineering Materials", PHI Publication, 2006.
4. S. P. Seth, P. V. Gupta "A course in Electrical Engineering Materials", Dhanpat Rai & Sons, 2011.
5. C. Kittel, "Introduction to Solid State Physics", 7th Edition, John Wiley & Sons, Singapore, (2006).

**CO's-PO's & PSO's MAPPING**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C01	3	2	2	3								2	2	2	1
C02	3	1	2	2								2	2	2	1
C03	3	2	1	2								2	2	2	1
CO4	3	2	1	2								2	2	2	2
CO5	3	2	2	2								2	2	2	1
Avg	3	1.8	1.6	2.2								2	2	2	1.2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OML353**

**NANOMATERIALS AND APPLICATIONS**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:



- Understanding the evolution of nanomaterials in the scientific era and make them to understand different types of nanomaterials for the future engineering applications
- Gaining knowledge on dimensionality effects on different properties of nanomaterials
- Getting acquainted with the different processing techniques employed for fabricating nanomaterials
- Having knowledge on the different characterisation techniques employed to characterise the nanomaterials
- Acquiring knowledge on different applications of nanomaterials in different disciplines of engineering.

**UNIT I NANOMATERIALS 9**

Introduction, Classification: 0D, 1D, 2D, 3D nanomaterials and nano-composites, their mechanical, electrical, optical, magnetic properties; Nanomaterials versus bulk materials.

**UNIT II THERMODYNAMICS & KINETICS OF NANOSTRUCTURED MATERIALS 9**

Size and interface/interphase effects, interfacial thermodynamics, phase diagrams, diffusivity, grain growth, and thermal stability of nanomaterials.

**UNIT III PROCESSING 9**

Bottom-up and top-down approaches for the synthesis of nanomaterials, mechanical alloying, chemical routes, severe plastic deformation, and electrical wire explosion technique.

**UNIT IV STRUCTURAL CHARACTERISTICS 9**

Principles of emerging nanoscale X-ray techniques such as small angle X-ray scattering and X-ray absorption fine structure (XAFS), electron and neutron diffraction techniques and their application to nanomaterials; SPM, Nanoindentation, Grain size, phase formation, texture, stress analysis

**UNIT V APPLICATIONS 9**

Applications of nanoparticles, quantum dots, nanotubes, nanowires, nanocoatings; applications in electronic, electrical and medical industries

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the students will be able to

**CO1:**Evaluate nanomaterials and understand the different types of nanomaterials

**CO2:**Recognise the effects of dimensionality of materials on the properties

**CO3:**Process different nanomaterials and use them in engineering applications

**CO4:**Use appropriate techniques for characterising nanomaterials

**CO5:**Identify and use different nanomaterials for applications in different engineering fields.

**TEXT BOOKS:**

1. Bhusan, Bharat (Ed), "Springer Handbook of Nanotechnology", 2nd edition, 2007.
2. Carl C. Koch (ed.), NANOSTRUCTURED MATERIALS, Processing, Properties and Potential Applications, NOYES PUBLICATIONS, Norwich, New York, U.S.A.

**REFERENCES:**

1. Poole C.P, and Owens F.J., Introduction to Nanotechnology, John Wiley 2003

2. Nalwa H.S., Encyclopedia of Nanoscience and Nanotechnology, American Scientific Publishers 2004
3. Zehetbauer M.J. and Zhu Y.T., Bulk Nanostructured Materials, Wiley 2008
4. Wang Z.L., Characterization of Nanophase Materials, Wiley 2000
5. Gutkin Y., Ovid'ko I.A. and Gutkin M., Plastic Deformation in Nanocrystalline Materials, Springer 2004

#### CO's-PO's & PSO's MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
C01	2	2	2	3								2	1	2	
C02	3	1	2	2								2	2	2	1
C03	3	2	1	2								2	2	2	
CO4	3	1		2								2	2	2	2
CO5	3	2	2	2								2	2	2	1
Avg	2.8	1.6	1.7	2.2								2	1.8	2	1.3

1 - low, 2 - medium, 3 - high, "--" - no correlation

OMR352

### HYDRAULICS AND PNEUMATICS

L T P C  
3 0 0 3

#### COURSE OBJECTIVES:

- To knowledge on fluid power principles and working of hydraulic pumps
- To obtain the knowledge in hydraulic actuators and control components
- To understand the basics in hydraulic circuits and systems
- To obtain the knowledge in pneumatic and electro pneumatic systems
- To apply the concepts to solve the trouble shooting

#### UNIT I FLUID POWER PRINCIPLES AND HYDRAULIC PUMPS

9

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

#### UNIT II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS

9

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.

#### UNIT III HYDRAULIC CIRCUITS AND SYSTEMS

9

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

**UNIT IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9**

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits

**UNIT V TROUBLE SHOOTING AND APPLICATIONS 9**

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

- CO 1:** Analyze the methods in fluid power principles and working of hydraulic pumps
- CO 2:** Recognize the concepts in hydraulic actuators and control components
- CO 3:** Obtain the knowledge in basics of hydraulic circuits and systems
- CO 4:** Know about the basics concept in pneumatic and electro pneumatic systems
- CO 5:** Apply the concepts to solve the trouble shooting hydraulic and pneumatics

**CO's-PO's & PSO's MAPPING**

Mapping of COs with POs and PSOs															
COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1		2	2						1	2	2	1
CO2	3	2	1		2	2						1	2	2	1
CO3	3	2	1		2	2						1	2	2	1
CO4	3	2	1		2	2						1	2	2	1
CO5	3	2	1		2	2						1	2	2	1
CO/PO & PSO Average	3	2	1		2	2						1	2	2	1
<b>1 - low, 2 - medium, 3 - high, '-'- no correlation</b>															

**TEXT BOOKS**

1. Anthony Esposito, "Fluid Power with Applications", Prentice Hall, 2009.
2. James A. Sullivan, "Fluid Power Theory and Applications", Fourth Edition, Prentice Hall, 1997.

**REFERENCES**

1. Shanmugasundaram.K, "Hydraulic and Pneumatic Controls". Chand & Co, 2006.
2. Majumdar, S.R., "Oil Hydraulics Systems – Principles and Maintenance", Tata McG Raw Hill, 2001.
3. Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata McGRaw Hill, 2007.
4. Dudley, A. Pease and John J Pippenger, "Basic Fluid Power", Prentice Hall, 1987
5. Srinivasan. R, "Hydraulic and Pneumatic Controls", Vijay Nicole Imprints, 2008
6. Joshi.P, "Pneumatic Control", Wiley India, 2008.
7. Jagadeesha T, "Pneumatics Concepts, Design and Applications ", Universities Press, 2015.

**COURSE OBJECTIVES:**

- To learn the various types of sensors, transducers, sensor output signal types, calibration techniques, formulation of system equation and its characteristics.
- To understand basic working principle, construction, Application and characteristics of displacement, speed and ranging sensors.
- To understand and analyze the working principle, construction, application and characteristics of force, magnetic and heading sensors.
- To learn and analyze the working principle, construction, application and characteristics of optical, pressure, temperature and other sensors.
- To familiarize students with different signal conditioning circuits design and data acquisition system.

**UNIT I            SENSOR CLASSIFICATION, CHARACTERISTICS AND SIGNAL TYPES            9**

Basics of Measurement – Classification of Errors – Error Analysis – Static and Dynamic Characteristics of Transducers – Performance Measures of Sensors – Classification of Sensors – Sensor Calibration Techniques – Sensor Outputs - Signal Types - Analog and Digital Signals, PWM and PPM.

**UNIT II            DISPLACEMENT, PROXIMITY AND RANGING SENSORS            9**

Displacement Sensors – Brush Encoders - Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – Range Sensors - Ultrasonic Ranging - Reflective Beacons - Laser Range Sensor (LIDAR) – GPS - RF Beacons.

**UNIT III            FORCE, MAGNETIC AND HEADING SENSORS            9**

Strain Gage – Types, Working, Advantage, Limitation, and Applications: Load Measurement – Force and Torque Measurement - Magnetic Sensors – Types, Principle, Advantage, Limitation, and Applications - Magneto Resistive – Hall Effect, Eddy Current Sensor - Heading Sensors – Compass, Gyroscope and Inclinometers.

**UNIT IV            OPTICAL, PRESSURE, TEMPERATURE AND OTHER SENSORS            9**

Photo Conductive Cell, Photo Voltaic, Photo Resistive, LDR – Fiber Optic Sensors – Pressure – Diaphragm – Bellows - Piezoelectric - Piezo-resistive - Acoustic, Temperature – IC, Thermistor, RTD, Thermocouple – Non Contact Sensor - Chemical Sensors - MEMS Sensors - Smart Sensors.

**UNIT V            SIGNAL CONDITIONING            9**

Need for Signal Conditioning – Resistive, Inductive and Capacitive Bridges for Measurement - DC and AC Signal Conditioning - Voltage, Current, Power and Instrumentation Amplifiers – Filter and Isolation Circuits – Fundamentals of Data Acquisition System

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

CO1: Understand various sensor effects, sensor characteristics, signal types, calibration methods and obtain transfer function and empirical relation of sensors. They can also analyze the sensor response.

CO2: Analyze and select suitable sensor for displacement, proximity and range measurement.

CO3: Analyze and select suitable sensor for force, magnetic field, speed, position and direction measurement.

CO4: Analyze and Select suitable sensor for light detection, pressure and temperature measurement and also familiar with other miniaturized smart sensors.

CO5: Select and design suitable signal conditioning circuit with proper compensation and linearizing element based on sensor output signal.

**CO's-PO's & PSO's MAPPING**

Mapping of COs with POs and PSOs															
COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2								1	2	3	2	1
CO2	3	3	2	1	1	1					1	2	3	2	1
CO3	3	3	2	1	1	1					1	2	3	2	1
CO4	3	3	2	1	1	1					1	2	3	2	1
CO5	3	3	2	1	1	1					1	2	3	2	1
CO/PO & PSO Average	3	3	2	0.8	0.8	0.8					0.8	2	3	2	1
<b>1 - low, 2 - medium, 3 - high, '-'- no correlation</b>															

**TEXT BOOKS**

1. Bolton W., "Mechatronics", Pearson Education, 6th Edition, 2015.
2. Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Penram International Publishing Private Limited, 6th Edition, 2013.

**REFERENCES**

1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., "Mechatronics", Chapman and Hall, 1993.
2. Davis G. Alciatore and Michael B. Hstand, "Introduction to Mechatronics and Measurement systems", McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, "Mechatronics Principles, Concepts and Applications", McGraw Hill Education, 2015.
5. Smaili. A and Mrad. F, "Mechatronics Integrated Technologies for Intelligent Machines", Oxford University Press, 2007.

PROGRESS THROUGH KNOWLEDGE

<b>ORA352</b>	<b>CONCEPTS IN MOBILE ROBOTS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES**

- To introduce mobile robotic technology and its types in detail.
- To learn the kinematics of wheeled and legged robot.
- To familiarize the intelligence into the mobile robots using various sensors.
- To acquaint the localization strategies and mapping technique for mobile robot.
- To aware the collaborative mobile robotics in task planning, navigation and intelligence.

**UNIT I INTRODUCTION TO MOBILE ROBOTICS 9**

Introduction – Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Robots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles

**UNIT II KINEMATICS 9**

Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints – Degree of Mobility and Steerability – **Manoeuvrability** – Workspace – Degrees of Freedom – Path and Trajectory Considerations – Motion Controls - Holonomic Robots

**UNIT III PERCEPTION 9**

Sensor for Mobile Robots – Classification and Performance Characterization – Wheel/Motor Sensors – Heading Sensors - Ground-Based Beacons - Active Ranging - Motion/Speed Sensors – Camera - Visual Appearance based Feature Extraction.

**UNIT IV LOCALIZATION 9**

Localization Based Navigation Versus Programmed Solutions - Map Representation - Continuous Representations - Decomposition Strategies - Probabilistic Map-Based Localization - Landmark-Based Navigation - Globally Unique Localization - Positioning Beacon Systems - Route-Based Localization - Autonomous Map Building - Simultaneous Localization and Mapping (SLAM).

**UNIT V PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS 9**

Introduction - Competences for Navigation: Planning and Reacting - Path Planning - Obstacle Avoidance - Navigation Architectures - Control Localization - Techniques for Decomposition - Case Studies – Collaborative Robots – Swarm Robots.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

**CO1:** Evaluate the appropriate mobile robots for the desired application.

**CO2:** Create the kinematics for given wheeled and legged robot.

**CO3:** Analyse the sensors for the intelligence of mobile robotics.

**CO4:** Create the localization strategies and mapping technique for mobile robot.

**CO5:** Create the collaborative mobile robotics for planning, navigation and intelligence for desired applications.

**TEXTBOOK**

1. Roland Siegwart and IllahR.Nourbakish, "Introduction to Autonomous Mobile Robots" MIT Press, Cambridge, 2004.

**REFERENCES:**

1. Dragomir N. Nenchev, Atsushi Konno, TeppeiTsujiita, "Humanoid Robots: Modelling and Control", Butterworth-Heinemann, 2018
2. MohantaJagadish Chandra, "Introduction to Mobile Robots Navigation", LAP Lambert Academic Publishing, 2015.
3. Peter Corke, "Robotics, Vision and Control", Springer, 2017.
4. Ulrich Nehmzow, "Mobile Robotics: A Practical Introduction", Springer, 2003.

5. Xiao Qi Chen, Y.Q. Chen and J.G. Chase, "Mobile Robots - State of the Art in Land, Sea, Air, and Collaborative Missions", Intec Press, 2009.
6. Alonzo Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, 2013, ISBN: 978-1107031159.

**MV3501**

**MARINE PROPULSION**

**L T P C**

**3 0 0 3**

**COOURSE OBJECTIVES:**

- To impart knowledge on basics of propulsion system and ship dynamic movements
- To educate them on basic layout and propulsion equipment's
- To impart basic knowledge on performance of the ship
- To impart basic knowledge on Ship propeller and its types
- To impart knowledge on ship rudder and its types

**UNIT I                    BASICS SHIP PROPULSION SYSTEM AND EQUIPMENTS                    9**

law of floatation - Basics principle of propulsion- Earlier methods of propulsion- ship propulsion machinery- boiler, Marine steam engine, diesel engine, ship power transmission system, ship dynamic structure, Marine propulsion equipment - shaft tunnel, Intermediate shaft and bearing, stern tube, stern tube sealing etc. degree of freedom, Modern propelling methods- water jet propulsion , screw propulsion.

**UNIT II                    SHIPS MOVEMENTS AND SHIP STABILIZATION                    9**

Thrust augmented devices, Ship hull, modern ship propulsion design, bow thruster – Advantages, various methods to stabilize the ship- passive and active stabilizer, fin stabilizer, bilge keel - stabilizing and securing ship in port- effect of tides on ship – effect of river water and sea water sailing vessel, Load line and load line of marking- draught markings.

**UNIT III                    SHIPS SPEED AND ITS PERFORMANCE                    9**

Ship propulsion factors, factors affecting ships speed, various velocities of ship, hull drag, effects of fouling on ships hull, ship wake, relation between powers, Fuel consumption of ship, cavitations - effects of cavitation's, ship turning radius.

**UNIT IV                    BASICS OF PROPELLER                    9**

Propeller dimension, Propeller and its types – fixed propeller, control pitch propeller, kort nozzle, ducted propeller, voith schneider, Parts of propeller, 3 blade - 5 blade - 6 blade propellers and its advantages, propeller boss hub, crown nut, propeller skew, pitch of propeller - Thrust creation by propeller. Propeller Material – Propeller balancing- static and dynamic.

**UNIT V                    BASICS OF RUDDER                    9**

Rudder dimension, Area of rudder and its design, Rudder arrangements, Rudder fittings- Rudder pintle - Rudder types- Balanced rudder, semi balanced rudder, Spade rudder, merits and demerits of various types of rudders, Propeller and rudder interaction, Rudder stopper, movement of rudders, Basic construction of Rudder

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:

Upon successful completion of the course, students should be able to:

**CO1:** Explain the basics of propulsion system and ship dynamic movements

**CO2:** Familiarize with various components assisting ship stabilization.

**CO3:** Demonstrate the performance of the ship.

**CO4:** Classify the Propeller and its types, Materials etc.

**CO5:** Categories the Rudder and its types, design criteria of rudder.

### TEXT BOOKS:

1. GP. Ghose, "Basic Ship propulsion", 2015
2. E.A. Stokoe "Reeds Ship construction for marine engineers", Vol. 5, 2010
3. E.A. Stokoe, "Reeds Naval architecture for the marine engineers", 4<sup>th</sup> Edition, 2009

### REFERENCES BOOKS:

1. DJ Eyers and GJ Bruse, "Ship Construction", 7<sup>th</sup> Edition, 2006.
2. KJ Rawson and EC Tupper, "Basic Ship theory I" Vol. 1, 5<sup>th</sup> Edition, 2001.

### CO's-PO's & PSO's MAPPING

C O	PO												PSO			
	PO 1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
1	1	1	1	1	1						1	1		1		1
2	1	1	1											1		1
3	1			1	1				1	1	1		1	1		1
4	1		1	1										1		1
5	1		1	1										1		1
Av g	5/5 =1	2/2 =1	4/4 =1	4/4 =1	2/2 =1				1/1 =1	1/1 =1	2/2 =1	1/1 =1	1/1 =1	5/5 =1		5/5 =1

1 - low, 2 - medium, 3 - high, '-' - no correlation

OMV351

MARINE MERCHANT VESSELS

L T P C  
3 0 0 3

### COURSE OBJECTIVES:

**At the end of the course, students are expected to acquire**

- Knowledge on basics of Hydrostatics
- Familiarization on types of merchant ships
- Knowledge on Shipbuilding Materials
- Knowledge on marine propeller and rudder
- Awareness on governing bodies in shipping industry

### UNIT I INTRODUCTION TO HYDROSTATICS

9

Archimedes Principle- Laws of floatation– Meta centre – stability of floating and submerged bodies- Density, relative density - Displacement –Pressure –centre of pressure.

### UNIT II TYPES OF SHIP

10

General cargo ship - Refrigerated cargo ships - Container ships - Roll-on Roll-off ships – Oil tankers- Bulk carriers - Liquefied Natural Gas carriers - Liquefied Petroleum Gas carriers - Chemical tankers - Passenger ships



**UNIT III SHIPBUILDING MATERIALS 9**

Types of Steels used in Shipbuilding - High tensile steels, Corrosion resistant steels, Steel sandwich panels, Steel castings, Steel forgings - Other shipbuilding materials, Aluminium alloys, Aluminium alloy sandwich panels, Fire protection especially for Aluminium Alloys, Fiber Reinforced Composites

**UNIT IV MARINE PROPELLER AND RUDDER 8**

Types of rudder, construction of Rudder-Types of Propeller, Propeller material-Cavitations and its effects on propeller

**UNIT V GOVERNING BODIES FOR SHIPPING INDUSTRY 9**

Role of **IMO** (International Maritime Organization), **SOLAS** (International Convention for the Safety of Life at Sea), **MARPOL** (International Convention for the Prevention of Pollution from Ships) , **MLC** (Maritime Labour Convention), **STCW 2010** (International Convention on Standards of Training, Certification and Watch keeping for Seafarers), Classification societies Administration authorities

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**Upon completion of this course, students would**

**CO1:Acquire Knowledge on floatation of ships**

**CO2:Acquire Knowledge on features of various ships**

**CO3:Acquire Knowledge of Shipbuilding Materials**

**CO4:Acquire Knowledge to identify the different types of marine propeller and rudder**

**CO5:Understand the Roles and responsibilities of governing bodies**

**TEXT BOOKS:**

1. D.J.Eyres, "Ship Constructions", Seventh Edition, Butter Worth Heinemann Publishing, USA,2015
2. Dr.DA Taylor, "Merchant Ship Naval Architecture" I. Mar EST publications, 2006
3. EA Stokoe, E.A, "Naval Architecture for Marine Engineers", Vol.4, Reeds Publications,2000

**REFERENCES:**

1. Kemp & Young "Ship Construction Sketches & Notes", Butter Worth Heinemann Publishing,USA, 2011
2. MARPOL Consolidated Edition , Bhandakar Publications, 2018
3. SOLAS Consolidated Edition , Bhandakar Publications, 2016

**OMV352 ELEMENTS OF MARINE ENGINEERING**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

**At the end of the course, students are expected to**

- Understand the role of Marine machinery systems
- Be familiar with Marine propulsion machinery system
- Acquaint with Marine Auxiliary machinery system
- Have acquired basics of Marine Auxiliary boiler system
- Be aware of ship propellers and steering system

**UNIT I ELEMENTARY KNOWLEDGE ON MARINE MACHINERY SYSTEMS 9**

Marine Engineering Terminologies, Parts of Ship, Introduction to Machinery systems on board ships – Propulsion Machinery system, Electricity Generator system, Steering gear system, Air compressors & Air reservoirs, Fuel oil and Lubricating Oil Purifiers, Marine Boiler systems

**UNIT II MARINE PROPULSION MACHINERY SYSTEM 9**

Two stroke Large Marine slow speed Diesel Engine – General Construction, Basic knowledge of Air starting and reversing mechanism, Cylinder lubrication oil system, Main lubricating oil system and cooling water system

**UNIT III MARINE AUXILIARY MACHINERY SYSTEM 9**

Four stroke medium speed Diesel engine – General Construction, Inline, V-type arrangement of engine, Difference between slow speed and medium speed engines – advantages, limitations and applications

**UNIT IV MARINE BOILER SYSTEM 9**

Types of Boiler – Difference between Water tube boiler and Fire tube boiler, Need for boiler on board ships, Uses of steam, Advantages of using steam as working medium, Boiler mountings and accessories – importance of mountings, need for accessories

**UNIT V SHIP PROPELLERS AND STEERING MECHANISM 9**

Importance of Propellor and Steering gear, Types of propellers - Fixed pitch propellers, Controllable pitch propellers, Water jet propellers, Steering gear systems - 2-Ram and 4 Ram steering gear, Electric steering gear

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**At the end of the course, students should able to,**

**CO1:**Distinguish the role of various marine machinery systems

**CO2:**Relate the components of marine propulsion machinery system

**CO3:**Explain the importance of marine auxiliary machinery system

**CO4:**Acquire knowledge of marine boiler system

**CO5:**Understand the importance of ship propellers and steering system

**TEXT BOOKS:**

1. Taylor, "Introduction to Marine engineering", Revised Second Edition, Butterworth Heinemann, London, 2011
2. J.K.Dhar, "Basic Marine Engineering", Tenth Edition, G-Maritime Publications, Mumbai, 2011
3. K.Ramaraj, "Text book on Marine Engineering", Eswar Press, Chennai, 2018

**REFERENCES:**

1. Alan L.Rowen, "Introduction to Practical Marine Engineering, Volume 1&2, The Institute of Marine Engineers (India), Mumbai, 2006
2. A.S.Tambwekar, "Naval Architecture and Ship Construction", The Institute of Marine Engineers (India), Mumbai, 2015

**COURSE OBJECTIVES:**

- To understand the basics of drone concepts
- To learn and understand the fundamentals of design, fabrication and programming of drone
- To impart the knowledge of an flying and operation of drone
- To know about the various applications of drone
- To understand the safety risks and guidelines of fly safely

**UNIT I INTRODUCTION TO DRONE TECHNOLOGY 9**

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

**UNIT II DRONE DESIGN, FABRICATION AND PROGRAMMING 9**

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

**UNIT III DRONE FLYING AND OPERATION 9**

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone controls Flight operations –management tool –Sensors-Onboard storage capacity - Removable storage devices- Linked mobile devices and applications

**UNIT IV DRONE COMMERCIAL APPLICATIONS 9**

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

**UNIT V FUTURE DRONES AND SAFETY 9**

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

**CO1:** Know about a various type of drone technology, drone fabrication and programming.

**CO2:** Execute the suitable operating procedures for functioning a drone

**CO3:** Select appropriate sensors and actuators for Drones

**CO4:** Develop a drone mechanism for specific applications

**CO5:** Createthe programs for various drones

<b>CO's-PO's &amp; PSO's MAPPING</b>															
<b>COs/Pos&amp;P SOs</b>	<b>POs</b>												<b>PSOs</b>		
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>1</b>	<b>2</b>	<b>3</b>
CO1	1	2	3	1	3	2						1	2	1	3
CO2	1	2	3	1	3	2						1	2	1	3
CO3	1	2	3	1	3	2						1	2	1	3
CO4	1	2	3	1	3	2						1	2	1	3
CO5	1	2	3	1	3	2						1	2	1	3
CO/PO & PSO Average	1	2	3	1	3	2						1	2	1	3
<b>1 - low, 2 - medium, 3 - high, '-'- no correlation</b>															

### TEXT BOOKS

1. Daniel Tal and John Altschuld, "Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation", 2021 John Wiley & Sons, Inc.
2. Terry Kilby and Belinda Kilby, "Make: Getting Started with Drones", Maker Media, Inc, 2016

### REFERENCES

1. John Baichtal, "Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs", Que Publishing, 2016
2. Završnik, "Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance", Springer, 2018.

**OGI352**

**GEOGRAPHICAL INFORMATION SYSTEM**

**L T P C  
3 0 0 3**

### COURSE OBJECTIVES:

- To impart the knowledge on basic components, data preparation and implementation of Geographical Information System.

### UNIT I FUNDAMENTALS OF GIS

**9**

Introduction to GIS - Basic spatial concepts - Coordinate Systems - GIS and Information Systems – Definitions – History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Proprietary and open source Software - Types of data – Spatial, Attribute data- types of attributes – scales/ levels of measurements.

### UNIT II SPATIAL DATA MODELS

**9**

Database Structures – Relational, Object Oriented – Entities – ER diagram - data models - conceptual, logical and physical models - spatial data models – Raster Data Structures – Raster Data Compression - Vector Data Structures - Raster vs Vector Models- TIN and GRID data models.

### UNIT III DATA INPUT AND TOPOLOGY

**9**

Scanner - Raster Data Input – Raster Data File Formats – Georeferencing – Vector Data Input – Digitizer – Datum Projection and reprojection -Coordinate Transformation – Topology - Adjacency,

connectivity and containment – Topological Consistency – Non topological file formats - Attribute Data linking – Linking External Databases – GPS Data Integration

**UNIT IV DATA QUALITY AND STANDARDS**

**9**

Data quality - Basic aspects - completeness, logical consistency, positional accuracy, temporal accuracy, thematic accuracy and lineage – Metadata – GIS Standards –Interoperability - OGC - Spatial Data Infrastructure

**UNIT V DATA MANAGEMENT AND OUTPUT**

**9**

Import/Export – Data Management functions- Raster to Vector and Vector to Raster Conversion - Data Output - Map Compilation – Chart/Graphs – Multimedia – Enterprise Vs. Desktop GIS- distributed GIS.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the student is expected to

- CO1** Have basic idea about the fundamentals of GIS.
- CO2** Understand the types of data models.
- CO3** Get knowledge about data input and topology
- CO4** Gain knowledge on data quality and standards
- CO5** Understand data management functions and data output

**TEXTBOOKS:**

1. Kang - Tsung Chang, Introduction to Geographic Information Systems, McGraw Hill Publishing, 2nd Edition, 2011.
2. Ian Heywood, Sarah Cornelius, Steve Carver, Srinivasa Raju, “An Introduction Geographical Information Systems, Pearson Education, 2nd Edition,2007.

**REFERENCES:**

1. Lo. C. P., Albert K.W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice-Hall India Publishers, 2006

**CO’s-PO’s & PSO’s MAPPING: GEOGRAPHIC INFORMATION SYSTEM**

PO	Graduate Attribute	Course Outcome					Average
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering Knowledge	3	3	3	3	3	3
PO2	Problem Analysis				3	3	3
PO3	Design/Development of Solutions			3	3	3	3
PO4	Conduct Investigations of Complex Problems			3	3	3	3
PO5	Modern Tool Usage		3		3	3	3
PO6	The Engineer and Society						
PO 7	Environment and Sustainability						
PO 8	Ethics						
PO 9	Individual and Team Work						
PO 10	Communication						
PO 11	Project Management and Finance						
PO 12	Life-long Learning						

PSO 1	Knowledge of Geoinformatics discipline	3	3	3	3	3	3
PSO 2	Critical analysis of Geoinformatics Engineering problems and innovations	3	3	3	3	3	3
PSO 3	Conceptualization and evaluation of Design solutions	3	3	3	3	3	3

1 - low, 2 - medium, 3 - high, ‘-‘- no correlation

OAI352

**AGRICULTURE ENTREPRENEURSHIP DEVELOPMENT**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES**

- To introduce the importance of Agri-business management, its characteristics and principles
- To impart knowledge on the functional areas of Agri-business like Marketing management, Product pricing methods and Market potential assessment.

**UNIT I ENTREPRENEURIAL ENVIRONMENT IN INDIAN CONTEXT**

**9**

Entrepreneur Development(ED): Concept of entrepreneur and entrepreneurship assessing overall business environment in Indian economy- Entrepreneurial and managerial characteristics- Entrepreneurship development programmers (EDP)-Generation incubation and commercialization of ideas and innovations- Motivation and entrepreneurship development- Globalization and the emerging business entrepreneurial environment.

**UNIT II AGRIPRNEURSHIP IN GLOBAL ARENA: LEGAL PERSPECTIVE**

**9**

Importance of agribusiness in Indian economy - International trade-WTO agreements- Provisions related to agreements in agricultural and food commodities - Agreements on Agriculture (AOA)- Domestic supply, market access, export subsidies agreements on sanitary and phyto-sanitary (SPS) measures, Trade related intellectual property rights (TRIPS).

**UNIT III ENTREPRENEURSHIP MANAGEMENT: FINANCIAL PERSPECTIVE**

**9**

Entrepreneurship - Essence of managerial Knowledge -Management functions- Planning-organizing-Directing-Motivation-ordering-leading-supervision- communication and control- Understanding Financial Aspects of Business - Importance of financial statements-liquidity ratios-leverage ratios, coverage ratios-turnover ratios-Profitability ratios. Agro-based industries-Project-Project cycle-Project appraisal and evaluation techniques-undiscounted measures-Payback period-proceeds per rupee of outlay, Discounted measures-Net Present Value (NPV)-Benefit-Cost Ratio(BCR)-Internal Rate of Return(IRR)-Net benefit investment ratio(N/K ratio)-sensitivity analysis.

**UNIT IV ENTREPRENEURIAL OPPORTUNITIES: ECONOMIC GROWTH PERSPECTIVE**

**9**

Managing an enterprise: Importance of planning, budgeting, monitoring evaluation and follow-up managing competition. Role of ED in economic development of a country- Overview of Indian social, political system and their implications for decision making by individual entrepreneurs- Economic system and its implication for decision making by individual entrepreneurs.

**UNITV            ENTREPRENEURIAL PROMOTION MEASURES AND GOVERNMENT SUPPORT**

**9**

Social responsibility of business. Morals and ethics in enterprise management- SWOT analysis- Government schemes and incentives for promotions of entrepreneurship. Government policy on small and medium enterprises (SMEs)/SSIs/MSME sectors- Venture capital (VC), contract framing (CF) and Joint Venture (JV), public-private partnerships (PPP) - overview of agricultural engineering industry, characteristics of Indian farm machinery industry.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

- CO1:**Judge about agricultural finance, banking and cooperation
- CO2:**Evaluate basic concepts, principles and functions of financial management
- CO3:**Improve the skills on basic banking and insurance schemes available to customers
- CO4:**Analyze various financial data for efficient farm management
- CO5:**Identify the financial institutions

**TEXT BOOKS**

1. Joseph L. Massie, 1995, "Essentials of Management", prentice Hall of India Pvt limited, New Delhi
2. Khanka S, 1999, Entrepreneurial Development, S, Chand and Co, New Delhi
3. Mohanty S K, 2007, Fundamentals of Entrepreneurship, Prentice Hall India, New Delhi.

**REFERENCES**

1. Harih S B, Conner U J and Schwab G D, 1981, Management of the Farm Business, Prentice Hall Inc, New Jersey
2. Omri Ralins, N.1980, Introduction to Agricultural: Prentice Hall Inc, New Jersey
3. Gittenger Price, 1989, Economic Analysis of Agricultural project, John Hopkins University, Press, London.
4. Thomas W Zimmer and Norman M Scarborough, 1996, Entrepreneurship, Prentice Hall, New Jersey.
5. Mar J Dollinger, 1999, Entrepreneurship strategies and resources, Prentice –Hall, Upper Saddal Rover, New Jersey.

**CO's-PO's & PSO's MAPPING**

PO/PSO		CO1	CO2	CO3	CO4	CO5	Overall correlation of COs with POs
PO1	Engineering Knowledge	1	2	1	1	1	2
PO2	Problem Analysis	2	1	1	1	2	1
PO3	Design/ Development of Solutions	1	1	1	2	1	2
PO4	Conduct Investigations of Complex Problems	1	1	2	1	1	1
PO5	Modern Tool Usage	2	1	1	1	1	2
PO6	The Engineer and Society	1	2	1	2	1	1
PO7	Environment and sustainability	1	1	2	1	1	1
PO8	Ethics	1	2	1	1	1	1
PO9	Individual and team work:	1	1	1	2	1	1
PO10	Communication	1	1	1	1	2	1

PO11	Project management and finance	1	1	2	1	1	1
PO12	Life-long learning:	1	2	1	1	1	2
PSO1	To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	1	2	1	1	1	1
PSO2	To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.	1	1	2	1	1	1
PSO3	To inculcate entrepreneurial skills through strong Industry-Institution linkage.	1	2	1	1	2	1

1 - low, 2 - medium, 3 - high, ‘-‘- no correlation

OEN352

**BIODIVERSITY CONSERVATION**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVE:**

- The identification of different aspects of biological diversity and conservation techniques.

**UNIT I INTRODUCTION**

**9**

Concept of Species, Variation; Introduction to Major Plant Groups; Evolutionary relationships between Plant Groups; Nomenclature and History of plant taxonomy; Systems of Classification and their Application; Study of Plant Groups; Study of Identification Characters; Study of important families of Angiosperms; Plant Diversity Application.

**UNIT II INTRODUCTION TO ANIMAL DIVERSITY AND TAXONOMY**

**9**

Principles and Rules of Taxonomy; ICZN Rules, Animal Study Techniques; Concepts of Taxon, Categories, Holotype, Paratype, Topotype etc; Classification of Animal kingdom, Invertebrates, Vertebrates, Evolutionary relationships between Animal Groups.

**UNIT III MICROBIAL DIVERSITY**

**9**

Microbes and Earth History, Magnitude, Occurrence and Distribution. Concept of Species, Criteria for Classification, Outline Classification of Microorganisms (Bacteria, Viruses and Protozoa); Criteria for Classification and Identification of Fungi; Chemical and Biochemical Methods of Microbial Diversity Analysis

**UNIT IV MEGA DIVERSITY**

**9**

Biodiversity Hot-spots, Floristic and Faunal Regions in India and World; IUCN Red List; Factors affecting Diversity, Impact of Exotic Species and Human Disturbance on Diversity, Dispersal, Diversity-Stability Relationship; Socio- economic Issues of Biodiversity; Sustainable Utilization of Bioresources; National Movements and International Convention/Treaties on Biodiversity.



**UNIT V CONSERVATIONS OF BIODIVERSITY****9**

In-Situ Conservation- National parks, Wildlife sanctuaries, Biosphere reserves; Ex-situ conservation- Gene bank, Cryopreservation, Tissue culture bank; Long term captive breeding, Botanical gardens, Animal Translocation, Zoological Gardens; Concept of Keystone Species, Endangered Species, Threatened Species, Rare Species, Extinct Species

**TOTAL: 45 PERIODS****TEXT BOOKS:**

1. A textbook of Botany: Angiosperms- Taxonomy, Anatomy, Economic Botany & Embryology. S. Chand, Limited, Pandey, B. P. January 2001
2. Principles of Systematic Zoology, Mcgraw-Hill College, Ashlock, P.D., Latest Edition.
3. Microbiology, MacGraw Hill Companies Inc, Prescott, L.M., Harley, J.P., and Klein D.A. (2022).
4. Microbiology, Pearson Publisher, Gerard J. Tortora, Berdell R. Funke, Christine L. Case, 13<sup>th</sup> Edition 2019

**REFERENCES:**

1. Ecological Census Technique: A Handbook, Cambridge University Press, Sutherland, W.
2. Encyclopedia of Biodiversity, Academic Press, Simonson Asher Levin.

**COURSE OUTCOMES**

Upon successful completion of this course, students will:

**CO1:** An insight into the structure and function of diversity for ecosystem stability.

**CO2:** Understand the concept of animal diversity and taxonomy

**CO3:** Understand socio-economic issues pertaining to biodiversity

**CO4:** An understanding of biodiversity in community resource management.

**CO5:** Student can apply fundamental knowledge of biodiversity conservation to solve problems associated with infrastructure development.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		2						2		2			2	2	
2		2		2	2	2							3	2	
3				2		2							3	2	3
4	3	2			2			2	2	2	2		3	2	3
5		2	3	2			1					1		2	
<b>Avg.</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>3</b>

1.low, 2-medium, 3-high, '-'- no correlation

**Note:** The average value of this course to be used for program articulation matrix.

**OEE353****INTRODUCTION TO CONTROL SYSTEMS****L T P C****3 0 0 3****COURSE OBJECTIVES**

- To impart knowledge on various representations of systems.
- To familiarize time response analysis of LTI systems and steady state error.
- To analyze the frequency responses and stability of the systems
- To analyze the stability of linear systems in frequency domain and time domain

- To develop linear models mainly state variable model and transfer function model

**UNIT I MATHEMATICAL MODELS OF PHYSICAL SYSTEMS 9**

Definition & classification of system – terminology & structure of feedback control theory – Analogous systems - Physical system representation by Differential equations – Block diagram reduction–Signal flow graphs.

**UNIT II TIME RESPONSE ANALYSIS & ROOT LOCUS TECHNIQUE 9**

Standard test signals – Steady state error & error constants – Time Response of I and II order system–Root locus–Rules for sketching root loci.

**UNIT III FREQUENCY RESPONSE ANALYSIS 9**

Correlation between Time & Frequency response – Polar plots – Bode Plots – Determination of Transfer Function from Bode plot.

**UNIT IV STABILITY CONCEPTS & ANALYSIS 9**

Concept of stability – Necessary condition – RH criterion – Relative stability – Nyquist stability criterion – Stability from Bode plot – Relative stability from Nyquist & Bode – Closed loop frequency response.

**UNIT V STATE VARIABLE ANALYSIS 9**

Concept of state – State Variable & State Model – State models for linear & continuous time systems–Solution of state & output equation–controllability & observability.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Ability to

**CO1:** Design the basic mathematical model of physical System.

**CO2:** Analyze the time response analysis and techniques.

**CO3:** Analyze the transfer function from different plots.

**CO4:** Apply the stability concept in various criterion.

**CO5:** Assess the state models for linear and continuous Systems.

**TEXTBOOKS**

1. Farid Golnarghi, Benjamin C. Kuo, Automatic Control Systems Paper back McGraw Hill Education, 2018.
2. Katsuhiko Ogata, 'Modern Control Engineering', Pearson, 5<sup>th</sup> Edition 2015.
3. J. Nagrath and M. Gopal, Control Systems Engineering (Multi Colour Edition), New Age International, 2018.

**REFERENCES**

1. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, Pearson Education, 2010.
2. Control System Dynamics" by Robert Clark, Cambridge University Press, 1996 USA.
3. John J. D'Azzo, Constantine H. Houpis and Stuart N. Sheldon, Linear Control System Analysis and Design, 5<sup>th</sup> Edition, CRC PRESS, 2003.
4. S. Palani, Control System Engineering, McGraw-Hill Education Private Limited, 2009.
5. Yaduvir Singh and S. Janardhanan, Modern Control, Cengage Learning, First Impression 2010.

## CO's-PO's & PSO's MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
<b>CO1</b>	3	3	3	2	2							2	3	3	3
<b>CO2</b>	3	3	2	3	1								3	3	3
<b>CO3</b>	3	3	3	2	2								3	3	3
<b>CO4</b>	3	3	3	2	2							2	3	3	3
<b>CO5</b>	3	3	3	1	1							1	3	3	3
													3	3	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

### OEI354 INTRODUCTION TO INDUSTRIAL AUTOMATION SYSTEMS

**L T P C**  
**3 0 0 3**

#### COURSE OBJECTIVES:

- To educate on design of signal conditioning circuits for various applications.
- To Introduce signal transmission techniques and their design.
- Study of components used in data acquisition systems interface techniques
- To educate on the components used in distributed control systems
- To introduce the communication buses used in automation industries.

#### UNIT I INTRODUCTION

**9**

Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems : Modbus & Profibus

#### UNIT II AUTOMATION COMPONENTS

**9**

Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.

#### UNIT III COMPUTER AIDED MEASUREMENT AND CONTROL SYSTEMS

**9**

Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer aided process control software, Computer based data acquisition system, Internet of things (IoT) for plant automation.

#### UNIT IV PROGRAMMABLE LOGIC CONTROLLERS

**9**

Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.

#### UNIT V DISTRIBUTED CONTROL SYSTEM

**9**

Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 5**

1. Market survey of the recent PLCs and comparison of their features.
2. Summarize the PLC standards
3. Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)
4. Market survey of Industrial Data Networks.

**COURSE OUTCOMES:****Students able to**

- CO1** Design a signal conditioning circuits for various application (L3).
- CO2** Acquire a detail knowledge on data acquisition system interface and DCS system (L2).
- CO3** Understand the basics and Importance of communication buses in applied automation Engineering (L2).
- CO4** Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.(L3)
- CO5** Able to develop a PLC logic for a specific application on real world problem. (L5)

**TEXT BOOKS:**

1. S.K.Singh, "Industrial Instrumentation", Tata Mcgraw Hill, 2nd edition companies,2003.
2. C D Johnson, "Process Control Instrumentation Technology", Prentice Hall India,8th Edition, 2006.
3. E.A.Parr, Newnes ,NewDelhi,"Industrial Control Handbook",3rd Edition, 2000.

**REFERENCES:**

1. John W. Webb and Ronald A. Reis, "Programmable Logic Controllers: Principles and Applications", 5th Edition, Prentice Hall Inc., New Jersey, 2003.
2. Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, McGraw- Hill, New York, 2016.
3. Krishna Kant, "Computer - Based Industrial Control", 2nd Edition, Prentice Hall, New Delhi, 2011.
4. Gary Dunning, Thomson Delmar,"Programmable Logic Controller", CeneageLearning, 3 rd Edition,2005.

**List of Open Source Software/ Learning website:**

1. <https://archive.nptel.ac.in/courses/108/105/108105062/>
2. <https://nptel.ac.in/courses/108105063>
3. <https://www.electrical4u.com/industrial-automation/>
4. <https://realpars.com/what-is-industrial-automation/>
5. <https://automationforum.co/what-is-industrial-automation-2/>

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
<b>CO1</b>	3	2	2	2	1	1	-	1	-	1	-	1	1	-	1
<b>CO2</b>	3	1	1	-	1	-	-	1	-	1	-	-	1	-	1
<b>CO3</b>	3	-	1	-	1	-	-	1	-	1	-	-	1	-	1
<b>CO4</b>	3	3	3	3	1			1		1			1		1

<b>CO5</b>	3	3	3	3	1	1		1		1			1		1
<b>AVg.</b>	3	2.25	2	2.6	1	1	-	1	-	1	-	-	1	-	1

1 - low, 2 - medium, 3 - high, "--" - no correlation

**OCH353**

**ENERGY TECHNOLOGY**

**L T P C**

**3 0 0 3**

**UNIT I INTRODUCTION**

**8**

Units of energy, conversion factors, general classification of energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, Renewable and non-renewable energy sources and their availability. Prospects of Renewable energy sources

**UNIT II CONVENTIONAL ENERGY**

**8**

Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.

**UNIT III NON-CONVENTIONAL ENERGY**

**10**

Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.

**UNIT IV BIOMASS ENERGY**

**10**

Biomass energy resources, thermo-chemical and biochemical methods of biomass conversion, combustion, gasification, pyrolysis, biogas production, ethanol, fuel cells, alkaline fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, solid polymer electrolyte fuel cell, magneto hydrodynamic power generation, energy storage routes like thermal energy storage, chemical, mechanical storage and electrical storage.

**UNIT V ENERGY CONSERVATION**

**9**

Energy conservation in chemical process plants, energy audit, energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, steam economy in chemical plants, energy conservation.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the students will be able to

CO1: Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.

CO2: Students will excel as professionals in the various fields of energy engineering

CO3: Compare different renewable energy technologies and choose the most appropriate based on local conditions.

CO4: Explain the technological basis for harnessing renewable energy sources.

CO5: Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level.

### TEXT BOOKS

1. Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005.
2. Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi, 1984.
3. Bansal, N.K., Kleeman, M. and Meliss, M., Renewable Energy Sources and Conversion Technology, Tata McGraw Hill, 1990.
4. Nagpal, G.R., Power Plant Engineering, Khanna Publishers, 2008.

### REFERENCES

1. Nejat Vezirog, Alternate Energy Sources, IT, McGraw Hill, New York.
2. El. Wakil, Power Plant Technology, Tata McGraw Hill, New York, 2002.
3. Sukhatme. S.P., Solar Energy - Thermal Collection and Storage, Tata McGraw hill, New Delhi, 1981.

### CO's-PO's & PSO's MAPPING

Course Outcomes	Statements	Program Outcomes														
		P O 1	P O 2	P O 3	P O 4	P O 5	P O 6	P O 7	P O 8	P O 9	P O 10	P O 11	P O 12	P O 13	P O 14	PS O2
<b>CO1</b>	Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.	2	3	2	3	3	-	-	-	1	1	-	3	1	1	3
<b>CO2</b>	Students will excel as professionals in the various fields of energy engineering	2	3	1	3	3	-	-	-	1	1	-	3	2	1	3
<b>CO3</b>	Compare different renewable energy technologies and choose the most appropriate based on local conditions.	2	2	2	3	3	1	1	-	1	1	-	3	2	1	3
<b>CO4</b>	Explain the technological basis for harnessing renewable energy sources.	2	2	1	3	3	1	1	1	1	-	1	3	1	1	3
<b>CO5</b>	Identify and critically evaluate current	2	2	1	3	3	1	1	1	1	-	1	3	2	1	3

developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level																
<b>OVERALL CO</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>3</b>	

**1 - low, 2 - medium, 3 - high, ‘-‘- no correlation**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OCH354**

**SURFACE SCIENCE**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVE:**

- To enable the students to analyze properties of a surfaces and correlate them to structure, chemistry, and physics and surface modification technique.

**UNIT I SURFACE STRUCTURE AND EXPERIMENTAL PROBES 9**

Relevance of surface science to Chemical and Electrochemical Engineering, Heterogeneous Catalysis and Nanoscience; Surface structure and reconstructions, adsorbate structure, Band and Vibrational structure, Importance of UHV techniques, Electronic probes and molecular beams, Scanning probes and diffraction, Qualitative introduction to electronic and vibrational spectroscopy

**UNIT II ADSORPTION, DYNAMICS, THERMODYNAMICS AND KINETICS AT SURFACES 9**

Interactions at the surface, Physisorption, Chemisorption, Diffusion, dynamics and reactions of atoms/molecules on surfaces, Generic reaction mechanism on surfaces, Adsorption isotherms, Kinetics of adsorption, Use of temperature desorption methods

**UNIT III LIQUID INTERFACES 9**

Structure and Thermodynamics of liquid-solid interface, Self-assembled monolayers, Electrified interfaces, Charge transfer at the liquid-solid interfaces, Photoelectrochemical processes, Gratzel cells

**UNIT IV HETEROGENEOUS CATALYSIS 9**

Characterization of heterogeneous catalytic processes, Microscopic kinetics to catalysis, Overview of important heterogeneous catalytic processes: Haber-Bosch, Fishcher-Tropsch and Automotive catalysis, Role of promoters and poisons, Bimetallic surfaces, surface functionalization and clusters in catalysis, Role of Sabatier principle in catalyst design, Rate oscillations and spatiotemporal pattern formation

**UNIT V EPITAXIAL GROWTH AND NANO SURFACE-STRUCTURES 9**

Origin of surface forces, Role of stress and strain in epitaxial growth, Energetic and growth modes, Nucleation theory, Nonequilibrium growth modes, MBE, CVD and ablation techniques, Catalytic

growth of nanotubes, Etching of surfaces, Formation of nanopillars and nanorods and its application in photoelectrochemical processes, Polymer surfaces and biointerfaces.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

- Upon completion of this course, the students can understand, predict and design surface properties based on surface structure. Students would understand the physics and chemistry behind surface phenomena

**TEXT BOOK:**

1. K. W. Kolasinski, "Surface Science: Foundations of catalysis and nanoscience" II Edition, John Wiley & Sons, New York, 2008.

**REFERENCE:**

1. Gabor A. Somorjai and Yimin Li "Introduction to Surface Chemistry and catalysis", II Edition John Wiley & Sons, New York, 2010.

**OFD354**

**FUNDAMENTALS OF FOOD ENGINEERING**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES**

The course aims to

- acquaint and equip the students with different techniques of measurement of engineering properties.
- make the students understand the nature of food constituents in the design of processing equipment

**UNIT I**

**9**

Engineering properties of food materials: physical, thermal, aerodynamic, mechanical, optical and electromagnetic properties.

**UNIT II**

**9**

Drying and dehydration: Basic drying theory, heat and mass transfer in drying, drying rate curves, calculation of drying times, dryer efficiencies; classification and selection of dryers; tray, vacuum, osmotic, fluidized bed, pneumatic, rotary, tunnel, trough, bin, belt, microwave, IR, heat pump and freeze dryers; dryers for liquid: Drum or roller dryer, spray dryer and foammat dryers

**UNIT III**

**9**

Size reduction: Benefits, classification, determination and designation of the fineness of ground material, sieve/screen analysis, principle and mechanisms of comminution of food, Rittinger's, Kick's and Bond's equations, work index, energy utilization; Size reduction equipment: Principal types, crushers (jaw crushers, gyratory, smooth roll), hammer mills and impactors, attrition mills, buhr mill, tumbling mills, tumbling mills, ultra fine grinders, fluid jet pulverizer, colloid mill, cutting machines (slicing, dicing, shredding, pulping)

**UNIT IV**

**9**

Mixing: theory of solids mixing, criteria of mixer effectiveness and mixing indices, rate of mixing, theory of liquid mixing, power requirement for liquids mixing; Mixing equipment: Mixers for low- or medium-viscosity liquids (paddle agitators, impeller agitators, powder-liquid contacting devices,



other mixers), mixers for high viscosity liquids and pastes, mixers for dry powders and particulate solids.

## UNIT V

9

Mechanical Separations: Theory, centrifugation, liquid-liquid centrifugation, liquid-solid centrifugation, clarifiers, desludging and decanting machine, Filtration: Theory of filtration, rate of filtration, pressure drop during filtration, applications, constant-rate filtration and constant-pressure filtration, derivation of equation; Filtration equipment; plate and frame filter press, rotary filters, centrifugal filters and air filters, filter aids, Membrane separation: General considerations, materials for membrane construction, ultra-filtration, microfiltration, concentration, polarization, processing variables, membrane fouling, applications of ultra-filtration in food processing, reverse osmosis, mode of operation, and applications; Membrane separation methods, demineralization by electro-dialysis, gel filtration, ion exchange, per-evaporation and osmotic dehydration.

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:

At the end of the course the students will be able to

**CO1** understand the importance of food polymers

**CO2** understand the effect of various methods of processing on the structure and texture of food materials

**CO3** understand the interaction of food constituents with respect to thermal, electrical properties to develop new technologies for processing and preservation.

### TEXTBOOKS:

1. R.L. Earle. 2004. Unit Operations in Food Processing. The New Zealand Institute of Food Science & Technology, Nz. Warren L. McCabe, Julian Smith, Peter Harriott. 2004.
2. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA. Christie John Geankoplis. 2003.
3. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed. Prentice-Hall, NY, USA.
4. George D. Saravacos and Athanasios E. Kostaropoulos. 2002. Handbook of Food Processing Equipment. Springer Science+Business Media, New York, USA.
5. J. F. Richardson, J. H. Harker and J. R. Backhurst. 2002. Coulson & Richardson's Chemical Engineering, Vol. 2, Particle Technology and Separation Processes, 5th Ed.

**OFD355**

**FOOD SAFETY AND QUALITY REGULATIONS**

**L T P C**

**3 0 0 3**

### COURSE OBJECTIVES:

- To characterize different type of food hazards, physical, chemical and biological in the industry and food service establishments
- To help become skilled in systems for food safety surveillance
- To be aware of the regulatory and statutory bodies in India and the world
- To ensure processed food meets global standards

## UNIT I

10

Introduction to food safety and security: Hygienic design of food plants and equipments, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labeling. Sanitation in warehousing,

storage, shipping, receiving, containers and packaging materials. Control of rats, rodents, mice, birds, insects and microbes. Cleaning and Disinfection, ISO 22000 – Importance and Implementation

**UNIT II** **8**

Food quality: Various Quality attributes of food, Instrumental, chemical and microbial Quality control. Sensory evaluation of food and statistical analysis. Water quality and other utilities.

**UNIT III** **9**

Critical Quality control point in different stages of production including raw materials and processing materials. Food Quality and Quality control including the HACCP system. Food inspection and Food Law, Risk assessment – microbial risk assessment, dose response and exposure response modelling, risk management, implementation of food surveillance system to monitor food safety, risk communication

**UNIT IV** **9**

Indian and global regulations: FAO in India, Technical Cooperation programmes, Bio-security in Food and Agriculture, World Health Organization (WHO), World Animal Health Organization (OIE), International Plant Protection Convention (IPPC)

**UNIT V** **9**

Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1** Thorough Knowledge of food hazards, physical, chemical and biological in the industry and food service establishments

**CO2** Awareness on regulatory and statutory bodies in India and the world

**REFERENCES:**

1. Handbook of food toxicology by S. S. Deshpande, 2002
2. The food safety information handbook by Cynthia A. Robert, 2009
3. Nutritional and safety aspects of food processing by Tannenbaum SR, Marcel Dekker Inc., New York 1979
4. Microbiological safety of Food by Hobbs BC, 1973
5. Food Safety Handbook by Ronald H. Schmidt, Gary E. Rodrick, A John Wiley & Sons Publication, 2003

**OPY353**

**NUTRACEUTICALS**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the basic concepts of Nutraceuticals and functional food, their chemical nature and methods of extraction.
- To understand the role of Nutraceuticals and functional food in health and disease.

**UNIT I INTRODUCTION AND SIGNIFICANCE 6**

Introduction to Nutraceuticals and functional foods; importance, history, definition, classification, list of functional foods and their benefits, Phytochemicals, zoochemicals and microbes in food, plants, animals and microbes.

**UNIT II PHYTOCHEMICALS AS NUTRACEUTICALS 11**

Phytoestrogens in plants; isoflavones; flavonols, polyphenols, tannins, saponins, lignans, lycopene, chitin, carotenoids. Manufacturing practice of selected nutraceuticals such as lycopene, isoflavonoids, glucosamine, phytosterols. Formulation of functional foods containing nutraceuticals - stability, analytical and labelling issues.

**UNIT III ASSESSMENT OF ANTIOXIDANT ACTIVITY 11**

In vitro and in vivo methods for the assessment of antioxidant activity, Comparison of different *in vitro* methods to evaluate the antioxidant, antioxidant mechanism, Prediction of the antioxidant activity of natural phenolics from electrotopological state indices, Optimising phytochemical release by process technology; Variation of Antioxidant Activity during technological treatments, new food grade peptidases from plant sources.

**UNIT IV ROLE IN HEALTH AND DISEASE 11**

The health benefit of - Soy protein, Spirulina, Tea, Olive oil, plant sterols, Broccoli, omega3 fatty acid and eicosanoids. Nutraceuticals and Functional foods in Gastrointestinal disorder, Cancer, CVD, Diabetic Mellitus, HIV and Dental disease; Importance and function of probiotic, prebiotic and synbiotic and their applications, Functional foods and immune competence; role and use in obesity and nervous system disorders.

**UNIT V SAFETY ISSUES 6**

Health Claims, Adverse effects and toxicity of nutraceuticals, regulations and safety issues International and national.

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**

1. Bisset, Normal Grainger and Max Wich H "Herbal Drugs and Phytopharmaceuticals", 2<sup>nd</sup> Edition, CRC, 2001.
2. Handbook of Nutraceuticals and Functional Foods: Robert Wildman, CRC, Publications. 2006
3. WEBB, PP, Dietary Supplements and Functional Foods Blackwell Publishing Ltd (United Kingdom), 2006
4. Ikan, Raphael "Natural Products: A Laboratory Guide", 2nd Edition, Academic Press / Elsevier, 2005.

**REFERENCES:**

1. Asian Functional Foods (Nutraceutical Science and Technology) by John Shi (Editor), Fereidoon Shahidi (Editor), Chi-Tang Ho (Editor), CRC Publications, Taylor & Francis, 2007
2. Functional Foods and Nutraceuticals in Cancer Prevention by Ronald Ross Watson (Author), Blackwell Publishing, 2007
3. Marketing Nutrition: Soy, Functional Foods, Biotechnology, and Obesity by Brian Wansink.
4. Functional foods: Concept to Product: Edited by G R Gibson and C M Williams, Wood head Publ., 2000

5. Hanson, James R. "Natural Products: The Secondary Metabolites", Royal Society of Chemistry, 2003.

### COURSE OUTCOME - NUTRACEUTICALS

<b>CO 1</b>	acquire knowledge about the Nutraceuticals and functional foods, their classification and benefits.
<b>CO 2</b>	acquire knowledge of phytochemicals, zoochemicals and microbes in food, plants, animals and microbes
<b>CO 3</b>	attain the knowledge of the manufacturing practices of selected nutraceutical components and formulation considerations of functional foods.
<b>CO 4</b>	distinguish the various <i>In vitro</i> and <i>In vivo</i> assessment of Antioxidant activity of compounds from plant sources.
<b>CO 5</b>	gain information about the health benefits of various functional foods and nutraceuticals in the prevention and treatment of various lifestyle diseases.
<b>CO 6</b>	Attain the knowledge of the regulatory and safety issues of nutraceuticals at national and international level.

CO's-PO's & PSO's MAPPING												
NUTRACEUTICALS												
Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3											1
CO 2	3											1
CO 3	3					2						
CO 4	3											
CO 5	3					2						1
CO 6	3							2				1

1 - low, 2 - medium, 3 - high, '-' - no correlation

OTT354

**BASICS OF DYEING AND PRINTING**

**L T P C**  
**3 0 0 3**

#### COURSE OBJECTIVE:

- To enable the students to learn about the basics of Pretreatment, dyeing, printing and machinery in textile processing.

#### UNIT I INTRODUCTION

**9**

Impurities present in different fibres, Inspection of grey goods and lot preparation. Shearing,

#### UNIT II PRE TREATMENT

**9**

Desizing-Objective of Desizing- types of Desizing- Objective of Scouring- Mechanism of Scouring- Degumming of Silk, Scouring of wool - Bio Scouring. Bleaching -Objective of Bleaching: Bleaching mechanism of Hydrogen Peroxide, Hypo chlorites. Objective of Mercerizing - Physical and Chemical changes of Mercerizing.

**UNIT III DYEING** **9**  
 Dye - Affinity, Substantively, Reactivity, Exhaustion and Fixation. Classification of dyes. Direct dyes: General properties, principles and method of application on cellulosic materials. Reactive dyes – principles and method of application on cellulosic materials hot brand, cold brand.

**UNIT IV PRINTING** **9**  
 Definition of printing – Difference between printing and dying- Classification thickeners – Requirements to be good thickener, printing paste Preparation - different styles of printing.

**UNIT V MACHINERIES** **9**  
 Fabric Processing - winch, jigger and soft flow machines. Beam dyeing machines: Printing -flat bed screen - Rotary screen. Thermo transfer printing machinery. Garment dyeing machines.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to Understand the

- CO1:** Basics of grey fabric
- CO2:** Basics of pre treatment
- CO3:** Concept of Dyeing
- CO4:** Concept of Printing
- CO5:** Machinery in processing industry

**TEXT BOOKS:**

1. Trotman, E.R., Textile Scouring and Bleaching, Charless Griffins, Com. Ltd., London 1990.
2. Shenai V.A. "Technology of Textile Processing Vol. IV" 1998, Sevak Publications, Mumbai.

**REFERENCES:**

1. Trotman E. R., "Dyeing and Chemical Technology of Textile Fibres", Charles Griffin & Co. Ltd., U.K., 1984, ISBN : 0 85264 165 6.
2. Dr. N N Mahapatra., "Textile dyeing", Wood head publishing India, 2018
3. Mathews Kolanjikombil., "Dyeing of Textile substrates III –Fibres, Yarns and Knitted fabrics", Wood head publishing India , 2021
4. Bleaching & Mercerizing – BTRA Silver Jubilee Monograph series
5. Chakraborty, J.N, "Fundamentals and Practices in colouration of Textiles", Wood head Publishing India, 2009, ISBN-13:978-81-908001-4-3.

**CO's-PO's & PSO's MAPPING:**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Course Outcomes	Statement	Program Outcome															
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	
<b>CO1</b>	Classification of fibres and production of	-	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-

	natural fibres															
<b>CO2</b>	Regenerated and synthetic fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>CO3</b>	Yarn spinning	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>CO4</b>	Weaving	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>CO5</b>	Knitting and nonwoven	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>Overall CO</b>		-	-	-	-	-	-	-	2	1	-	1	1	-	1	-

1 - low, 2 - medium, 3 - high, ‘-’ - no correlation

FT3201

FIBRE SCIENCE

L T P C  
3 0 0 3

### COURSE OBJECTIVES

- To enable the students to learn about the types of fibre and its properties

#### UNIT I INTRODUCTION TO TEXTILE FIBRES

9

Definition of various forms of textile fibres - staple fibre, filament, bicomponent fibres. Classification of Natural and Man-made fibres, essential and desirable properties of Fibres. Production and cultivation of Natural Fibers: Cotton, Silk, Wool -Physical and chemical structure of the above fibres.

#### UNIT II REGENERATED FIBRES

9

Production Sequence of Regenerated Cellulosic fibres: Viscose Rayon, Acetate rayon – High wet modulus fibres: Modal and Lyocel ,Tencel

#### UNIT III SYNTHETIC FIBRES

9

Production Sequence of Synthetic Fibers: polymer-Polyester, Nylon, Acrylic and polypropylene. Mineral fibres: fibre glass ,carbon .Introduction to spin finishes and texturization

#### UNIT IV SPECIALITY FIBRES

9

Properties and end uses of high tenacity and high modulus fibres, high temperature and flame retardant fibres, Chemical resistant fibres

#### UNIT V FUNCTIONAL SPECIALITY FIBRES

9

**Properties and end uses** : Fibres for medical application – Biodegradable fibres based on PLA ,Super absorbent fibres elastomeric fibres, ultra-fine fibres, electrospun nano fibres, metallic fibres – Gold and Silver coated.

**TOTAL : 45 PERIODS**

### COURSE OUTCOMES

Upon completion of this course, the student would be able to

**CO1:**Understand the process sequence of various fibres

**CO2:** Understand the properties of various fibres

**TEXT BOOKS:**

1. Morton W. E., and Hearle J. W. S., "Physical Properties of Textile Fibres", The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95
2. Meredith R., and Hearle J. W. S., "Physical Methods of Investigation of Textiles", Wiley Publication, New York, 1989, ISBN: B00JCV6ZWU | ISBN-13:
3. Mukhopadhyay S. K., "Advances in Fibre Science", The Textile Institute, 1992, ISBN: 1870812379

**REFERENCES:**

1. Meredith R., "Mechanical Properties of Textile Fibres", North Holland, Amsterdam, 1986, ISBN: 1114790699, ISBN-13: 9781114790698
2. Hearle J. W. S., Lomas B., and Cooke W. D., "Atlas of Fibre Fracture and Damage to Textiles", The Textile Institute, 2<sup>nd</sup> Edition, 1998, ISBN: 1855733196.
3. Raheel M. (ed.), "Modern Textile Characterization Methods", Marcel Dekker, 1995, ISBN:0824794737
4. Mukhopadhyay. S. K., "The Structure and Properties of Typical Melt Spun Fibres", Textile Progress, Vol. 18, No. 4, Textile Institute, 1989, ISBN: 1870812115
5. Hearle J.W.S., "Polymers and Their Properties: Fundamentals of Structures and Mechanics Vol 1", Ellis Horwood, England, 1982, ISBN: 047027302X | ISBN-13: 9780470273029 36

**OTT355**

**GARMENT MANUFACTURING TECHNOLOGY**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVE:**

- To enable the students to understand the basics of pattern making, cutting and sewing.
- To expose the students to various problems & remedies during garment manufacturing

**UNIT I PATTERN MAKING, MARKER PLANNING, CUTTING**

**9**

Anthropometry, specification sheet, pattern making – principles, basic pattern set drafting, grading, marker planning, spreading & cutting

**UNIT II TYPES OF SEAMS, STITCHES AND FUNCTIONS OF NEEDLES**

**9**

Different types of seams and stitches; single needle lock stitch machine – mechanism and accessories; needle – functions, special needles, needlepoint

**UNIT III COMPONENTS AND TRIMS USED IN GARMENT**

**9**

Sewing thread-construction, material, thread size, packages, accessories – labels, linings, interlinings, wadding, lace, braid, elastic, hook and loop fastening, shoulder pads, eyelets and laces, zip fasteners, buttons

**UNIT IV GARMENT INSPECTION AND DIMENSIONAL CHANGES**

**9**

Raw material, in process and final inspection; needle cutting; sewability of fabrics; strength properties of apparel; dimensional changes in apparel due to laundering, dry-cleaning, steaming and pressing.

**UNIT V GARMENT PRESSING, PACKING AND CARE LABELING**

9

Garment pressing – categories and equipment, packing; care 356labelling of apparels

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

Upon completion of the course, the students will be able to Understand

- CO1:** Pattern making, marker planning, cutting
- CO2:** Types of seams, stitches and functions of needles
- CO3:** Components and trims used in garment
- CO4:** Garment inspection and dimensional changes
- CO5:** Garment pressing, packing and carelabelling

**TEXT BOOKS:**

1. Carr H., and Latham B., "The Technology of Clothing Manufacture", Blackwell Science Ltd., Oxford, 1994.
2. Gerry Cooklin, "Introduction to Clothing Manufacture" Blackwell Science Ltd., 1995. 64
3. Harrison.P.W Garment Dyeing, The Textile Institute Publication, Textile Progress, Vol .19 No.2,1988.

**REFERENCES:**

1. Winifred Aldrich., "Metric Pattern Cutting", Blackwell Science Ltd., Oxford, 1994
2. Peggal H., "The Complete Dress Maker", Marshall Caverdish, London, 1985
3. Jai Prakash and Gaur R.K., "Sewing Thread", NITRA, 1994
4. Ruth Glock, Grace I. Kunz, "Apparel Manufacturing", Dorling Kindersley Publishing Inc., New Jersey, 1995.
5. Pradip V.Mehta, "An Introduction to Quality Control for the Apparel Industry", J.S.N. Internationals, 1992.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	1	1	1	-	2	-	1	1	-	2	3	1	2	3	1	3
2	2	2	1	1	1	-	1	1	-	2	2	1	2	2	1	2
3	1	1	1	1	1	1	1	1	-	1	2	1	1	3	1	3
4	2	1	1	1	2	2	2	1	1	2	3	1	2	3	1	3
5	2	2	1	1	1	1	2	1	-	2	2	1	2	2	1	2
<b>Avg</b>	1.6	1.2	1	0.8	1.4	0.8	1.4	1	0.2	1.8	2.4	1	1.8	2.6	1	2.6

1 - low, 2 - medium, 3 - high, '-'- no correlation

OPE353

INDUSTRIAL SAFETY

L T P C

3 0 0 3

**COURSE OBJECTIVES:**

- To educate about the health hazards and the safety measures to be followed in the industrial environment.



- Describe industrial legislations (Factories Acts, Workmen's Compensation and other laws) enacted for the protection of employees health at work settings
- Describe methods of prevention and control of Occupational Health diseases, accidents / emergencies and other hazards

**UNIT I INTRODUCTION 9**

Need for developing Environment, Health and Safety systems in work places - Accident Case Studies - Status and relationship of Acts - Regulations and Codes of Practice - Role of trade union safety representatives. International initiatives - Ergonomics and work place.

**UNIT II OCCUPATIONAL HEALTH AND HYGIENE 9**

Definition of the term occupational health and hygiene - Categories of health hazards - Exposure pathways and human responses to hazardous and toxic substances - Advantages and limitations of environmental monitoring and occupational exposure limits - Hierarchy of control measures for occupational health risks - Role of personal protective equipment and the selection criteria - Effects on humans - control methods and reduction strategies for noise, radiation and excessive stress.

**UNIT III WORKPLACE SAFETY AND SAFETY SYSTEMS 9**

Features of Satisfactory and Safe design of work premises – good housekeeping - lighting and colour, Ventilation and Heat Control – Electrical Safety – Fire Safety – Safe Systems of work for manual handling operations – Machine guarding – Working at different levels – Process and System Safety.

**UNIT IV HAZARDS AND RISK MANAGEMENT 9**

Safety appraisal - analysis and control techniques – plant safety inspection – Accident investigation - Analysis and Reporting – Hazard and Risk Management Techniques – major accident hazard control – Onsite and Offsite emergency Plans.

**UNIT V ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT 9**

Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and methods of its effective implementation and review – Elements of Management Principles – Education and Training – Employee Participation.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the student is expected to be able to:

**CO1:** Describe, with example, the common work-related diseases and accidents in occupational setting

**CO2:** Name essential members of the Occupational Health team

**CO3:** What roles can a community health practitioners play in an Occupational setting to ensure the protection, promotion and maintenance of the health of the employee

**OPE354 UNIT OPERATIONS IN PETRO CHEMICAL INDUSTRIES L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- To impart to the student basic knowledge on fluid mechanics, mechanical operations, heat transfer operations and mass transfer operations.

## **UNIT I FLUID MECHANICS CONCEPTS**

Fluid definition and classification of fluids, types of fluids, Rheological behaviour of fluids & Newton's Law of viscosity. Fluid statics-Pascal's law, Hydrostatic equilibrium, Barometric equation and pressure measurement(problems),Basic equations of fluid flow - Continuity equation, Euler's equation and Bernoulli equation; Types of flow - laminar and turbulent; Reynolds experiment; Flow through circular and non-circular conduits - Hagen Poiseuille equation (no derivation). Flow through stagnant fluids – theory of Settling and Sedimentation – Equipment (cyclones, thickeners) Conceptual numericals.

## **UNIT II FLOW MEASUREMENTS & MECHANICAL OPERATIONS**

Different types of flow measuring devices (Orifice meter, Venturimeter, Rotameter) with derivations, flow measurements –. Pumps – types of pumps (Centrifugal & Reciprocating pumps), Energy calculations and characteristics of pumps. Size reduction–characteristics of comminute products, sieve analysis, Properties and handling of particulate solids – characterization of solid particles, average particle size, screen analysis- Conceptual numerical of differential and cumulative analysis. Size reduction, crushing laws, working principle of ball mill. Filtration & types, filtration equipments (plate and frame, rotary drum). Conceptual numericals.

## **UNIT III CONDUCTIVE & CONVECTIVE HEAT TRANSFER**

Modes of heat transfer; Conduction – steady state heat conduction through unilayer and multilayer walls, cylinders; Insulation, critical thickness of insulation. Convection- Forced and Natural convection, principles of heat transfer co-efficient, log mean temperature difference, individual and overall heat transfer co-efficient, fouling factor; Condensation – film wise and drop wise (no derivation). Heat transfer equipments – double pipe heat exchanger, shell and tube heat exchanger (with working principle and construction with applications).

## **UNIT IV BASICS OF MASS TRANSFER**

Diffusion-Fick's law of diffusion. Types of diffusion. Steady state molecular diffusion in fluids at rest and laminar flow (stagnant / unidirection and bi direction). Measurement of diffusivity, Mass transfer coefficients and their correlations. Conceptual numerical.

## **UNIT V MASS TRANSFER OPERATIONS**

Basic concepts of Liquid-liquid extraction – equilibrium, stage type extractors (belt extraction and basket extraction).Distillation – Methods of distillation, distillation of binary mixtures using McCabe Thiele method.Drying- drying operations, batch and continuous drying. Conceptual numerical.

**TOTAL: 45 PERIODS**

### **COURSE OUTCOMES:**

At the end of the course the student will be able to:

**CO1:**State and describe the nature and properties of the fluids.

**CO2:**Study the different flow measuring instruments, the principles of various size reductions, conveying equipment's, sedimentation and mixing tanks.

**CO3:**Comprehend the laws governing the heat and mass transfer operations to solve the problems.

**CO4:**Design the heat transfer equipment suitable for specific requirement.

### **TEXTBOOK(S)**

1. Unit operations in Chemical Engineering Warren L. McCabe, Julian C. Smith & Peter Harriot McGraw-Hill Education (India) Edition 2014

2. Fluid Mechanics K L Kumar S Chand & Company Ltd 2008
3. Introduction to Chemical Engineering Badger W.I. and Banchemo, J.T., Tata McGraw Hill New York 1997

### REFERENCE BOOKS

1. Principles of Unit Operations Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B. Anderson John Wiley & Sons 2nd edition 2008
2. Unit Operations of Chemical Engineering, Vol I &II Chattopadhyaya Khanna Publishers, Delhi-6 1996
3. Heat Transfer J P Holman McGraw Hill International Ed

**OPT352**

**PLASTIC MATERIALS FOR ENGINEERS**

**L T P C**

**3 0 0 3**

### COURSE OBJECTIVES

- Understand the advantages, disadvantages and general classification of plastic materials
- To know the manufacturing, sources, and applications of engineering thermoplastics
- Understand the basics as well as the advanced applications of various plastic materials in the industry
- To understand the preparation methods of thermosetting materials
- Select suitable specialty plastics for different end applications

#### **UNIT I INTRODUCTION TO PLASTIC MATERIALS 9**

Introduction to Plastics – Brief history of plastics, advantages and disadvantages, thermoplastic and thermosetting behavior, amorphous polymers, crystalline polymers and cross-linked structures. General purpose thermoplastics/ Commodity plastics: manufacture, structure, properties and applications of polyethylene (PE), cross-linked PE, chlorinated PE, polypropylene, polyvinyl chloride-compounding, formulation, polypropylene (PP)

#### **UNIT II ENGINEERING THERMOPLASTICS AND APPLICATIONS 9**

Engineering thermoplastics – Aliphatic polyamides: structure, properties, manufacture and applications of Nylon 6, Nylon 66. Polyesters: manufacture, structure, properties and uses of PET, PBT. Manufacture, structure, properties and uses of Polycarbonates, acetal resins, polyimides, PMMA, polyphenylene oxide, thermoplastic polyurethane (PU)

#### **UNIT III THERMOSETTING PLASTICS 9**

Thermosetting Plastics – Manufacture, curing, moulding powder, laminates, properties and uses of phenol formaldehyde resins, urea formaldehyde, melamine formaldehyde, unsaturated polyester resin, epoxy resin, silicone resins, polyurethane resins.

#### **UNIT IV MISCELLANEOUS PLASTICS FOR END APPLICATIONS 9**

Miscellaneous plastics- Manufacture, properties and uses of polystyrene, HIPS, ABS, SAN, poly(tetrafluoroethylene) (PTFE), TFE and copolymers, PVDF, PVA, poly (vinyl acetate), poly (vinyl carbazole), cellulose acetate, PEEK, High energy absorbing polymers, super absorbent polymers-their synthesis, properties and applications

**UNIT V PLASTICS MATERIALS FOR BIOMEDICAL APPLICATIONS 9**

Sources, raw materials, methods of manufacturing, properties and applications of bio-based polymers- poly lactic acid (PLA), poly hydroxy alkanooates (PHA), PBAT, bioplastics- bio-PE, bio-PP, bio-PET, polymers for biomedical applications

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

**CO1:**To study the importance, advantages and classification of plastic materials

**CO2:**Summarize the raw materials, sources, production, properties and applications of various engineering thermoplastics

**CO3:**To understand the application of polyamides, polyesters and other engineering thermoplastics, thermosetting resins

**CO4:**Know the manufacture, properties and uses of thermosetting resins based on polyester, epoxy, silicone and PU

**CO5:**To understand the engineering applications of various polymers in miscellaneous areas and applications of different biopolymers

**REFERENCES**

1. Marianne Gilbert (Ed.), Brydson's Plastics Materials, 8<sup>th</sup> Edn., Elsevier (2017).
2. J.A.Brydson, Plastics Materials, 7<sup>th</sup> Edn., Butterworth Heinemann (1999).
3. Manas Chanda, Salil K. Roy, Plastics Technology Handbook, 4<sup>th</sup> Edn., CRC press (2006).
4. A. Brent Strong, Plastics: Materials and Processing, 3<sup>rd</sup> Edn., Pearson Prentice Hall (2006).
5. Olagoke Olabisi, Kolapo Adewale (Eds.), Handbook of Thermoplastics 2<sup>nd</sup> Edn., CRC press(2016).
6. Charles A. Harper, Modern Plastics Handbook, McGraw-Hill, New York, 1999.
7. H. Dominighaus, Plastics for Engineers, Hanser Publishers, Munich, 1988.

**OPT353 PROPERTIES AND TESTING OF PLASTICS**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES**

- To understand the relevance of standards and specifications as well as the specimen preparation for polymer testing.
- To study the mechanical properties and testing of polymer materials and their structural property relationships.
- To understand the thermal properties of polymers and their testing methods.
- To gain knowledge on the electrical and optical properties of polymers and their testing methods.
- To study about the environmental effects and prevent polymer degradation.

**UNIT I INTRODUCTION TO CHARACTERIZATION AND TESTING OF POLYMERS 9**

Introduction- Standard organizations: BIS, ASTM, ISO, BS, DIN etc. Standards and specifications. Importance of standards in the quality control of polymers and polymer products. Preparation of test pieces, conditioning and test atmospheres. Tests on elastomers: processability parameters of rubbers – plasticity, Mooney viscosity, scorch time, cure time, cure rate index, Processability tests carried out on thermoplastics and thermosets: MFI, cup flow index, gel time, bulk density, bulk factor.

**UNIT II MECHANICAL PROPERTIES 9**

Mechanical properties: Tensile, compression, flexural, shear, tear strength, hardness, impact strength, resilience, abrasion resistance, creep and stress relaxation, compression set, dynamic fatigue, ageing properties, Basic concepts of stress and strain, short term tests: Viscoelastic behavior (simple models: Kelvin model for creep and stress relaxation, Maxwell-Voigt model, strain recovery and dynamic response), Effect of structure and composition on mechanical properties, Behavior of reinforced polymers

**UNIT III THERMAL RHEOLOGICAL PROPERTIES 9**

Thermal properties: Transition temperatures, specific heat, thermal conductivity, co-efficient of thermal expansion, heat deflection temperature, Vicat softening point, shrinkage, brittleness temperature, thermal stability and flammability. Product testing: Plastic films, sheeting, pipes, laminates, foams, containers, cables and tubes.

**UNIT IV ELECTRICAL AND OPTICAL PROPERTIES 9**

Electrical properties: volume and surface resistivity, dielectric strength, dielectric constant and power factor, arc resistance, tracking resistance, dielectric behavior of polymers (dielectric co-efficient, dielectric polarization), dissipation factor and its importance. Optical properties: transparency, refractive index, haze, gloss, clarity, birefringence.

**UNIT V ENVIRONMENTAL AND CHEMICAL RESISTANCE 9**

Environmental stress crack resistance (ESCR), water absorption, weathering, aging, ozone resistance, permeability and adhesion. Tests for chemical resistance. Acids, alkalies, Flammability tests- oxygen index test.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES**

- CO1:** Understand the relevance of standards and specifications.
- CO2:** Summarize the various test methods for evaluating the mechanical properties of the polymers.
- CO3:** To know the thermal, electrical & optical properties of polymers.
- CO4:** Identify various techniques used for characterizing polymers.
- CO5:** Distinguish the processability tests used for thermoplastics, thermosets and elastomers.

**REFERENCES**

1. F.Majewska, H.Zowall, Handbook of analysis of synthetic polymers and plastics, Ellis Horwood Limited Publisher 1977.
2. J.F.Rabek, Experimental Methods in Polymer Chemistry, John Wiley and Sons 1980.
3. R.P.Brown, Plastic test methods, 2<sup>nd</sup> Edn., Harlond, Longman Scientific, 1981.
4. A. B. Mathur, I. S. Bharadwaj, Testing and Evaluation of Plastcis, Allied Publishers Pvt. Ltd., New Delhi, 2003.
5. Vishu Shah, Handbook of Plastic Testing Technology, 3<sup>rd</sup> Edn., John Wiley & Sons 2007.
6. S. K. Nayak, S. N. Yadav, S. Mohanty, Fundamentals of Plastic Testing, Springer, 2010.

**OEC353**

**VLSI DESIGN**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- Understand the fundamentals of IC technology components and their characteristics.
- Understand combinational logic circuits and design principles.

- Understand sequential logic circuits and clocking strategies.
- Understand Interconnects and Memory Architecture.
- Understand the design of arithmetic building blocks

<b>UNIT I</b>	<b>MOS TRANSISTOR PRINCIPLES</b>	<b>9</b>
MOS logic families (NMOS and CMOS), Ideal and Non Ideal IV Characteristics, CMOS devices. MOS(FET) Transistor DC transfer Characteristics ,small signal analysis of MOSFET.		
<b>UNIT II</b>	<b>COMBINATIONAL LOGIC CIRCUITS</b>	<b>9</b>
Propagation Delays, stick diagram, Layout diagrams, Examples of combinational logic design, Elmore’s constant, Static Logic Gates, Dynamic Logic Gates, Pass Transistor Logic, Power Dissipation.		
<b>UNIT III</b>	<b>SEQUENTIAL LOGIC CIRCUITS AND CLOCKING STRATEGIES</b>	<b>9</b>
Static Latches and Registers, Dynamic Latches and Registers, Pipelines, Timing classification of Digital Systems, Synchronous Design, Self-Timed Circuit Design .		
<b>UNIT IV</b>	<b>INTERCONNECT, MEMORY ARCHITECTURE</b>	<b>9</b>
Interconnect Parameters – Capacitance, Resistance, and Inductance, Logic Implementation using Programmable Devices (ROM, PLA, FPGA), Memory Architecture and Building Blocks.		
<b>UNIT V</b>	<b>DESIGN OF ARITHMETIC BUILDING BLOCKS</b>	<b>9</b>
Arithmetic Building Blocks: Data Paths, Adders-Ripple Carry Adder, Carry-Bypass Adder, Carry Select Adder, Carry-Look Ahead Adder, Multipliers, Barrel Shifter, power and speed tradeoffs.		

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**Upon successful completion of the course the student will be able to**

- CO1:** Understand the working principle and characteristics of MOSFET
- CO2:** Design Combinational Logic Circuits
- CO3:** Design Sequential Logic Circuits and Clocking systems
- CO4:** Understand Memory architecture and interconnects
- CO5:** Design of arithmetic building blocks.

**TEXTBOOKS**

1. Jan D Rabaey, Anantha Chandrakasan, “Digital Integrated Circuits: A Design Perspective”, PHI, 2016.(Units II, III IV and V).
2. Neil H E Weste, Kamran Eshraghian, “Principles of CMOS VLSI Design: A System Perspective,” Addison Wesley, 2009.( Units - I).

**REFERENCES**

1. D.A. Hodges and H.G. Jackson, Analysis and Design of Digital Integrated Circuits, International Student Edition, McGraw Hill 1983
2. P. Rashinkar, Paterson and L. Singh, "System-on-a-Chip Verification-Methodology and Techniques", Kluwer Academic Publishers,2001
3. Samiha Mourad and Yervant Zorian, “Principles of Testing Electronic Systems”, Wiley 2000
4. M. Bushnell and V. D. Agarwal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers,2000

### CO's-PO's & PSO's MAPPING

C	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1	PSO	PSO	PSO
1	3	3	2	2	1	3	-	-	-	-	2	3	3	3	3
2	3	3	2	2	1	-	-	-	-	-	-	2	3	3	3
3	3	-	3	2	1	2	-	-	-	-	3	2	3	2	3
4	3	3	2	2	2	-	-	-	-	-	-	1	3	3	2
5	2	-	3	2	2	1	-	-	-	-	1	1	3	2	2
C	3	3	2	2	1	2	-	-	-	-	2	2	3	3	3

1 - low, 2 - medium, 3 - high, '-'- no correlation

CBM370

WEARABLE DEVICES

L T P C

3 0 0 3

#### COURSE OBJECTIVES:

The student should be made to:

- To know the hardware requirement of wearable systems
- To understand the communication and security aspects in the wearable devices
- To know the applications of wearable devices in the field of medicine

#### UNIT I INTRODUCTION TO WEARABLE SYSTEMS AND SENSORS 9

Wearable Systems- Introduction, Need for Wearable Systems, Drawbacks of Conventional Systems for Wearable Monitoring, Applications of Wearable Systems, Types of Wearable Systems, Components of wearable Systems. Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Impedance plethysmography, Wearable ground reaction force sensor.

#### UNIT II SIGNAL PROCESSING AND ENERGY HARVESTING FOR WEARABLE DEVICES 9

Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, sampling frequency for reduced energy consumption, Rejection of irrelevant information. Power Requirements- Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.

#### UNIT III WIRELESS HEALTH SYSTEMS 9

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication Techniques.

#### UNIT IV SMART TEXTILE 9

Introduction to smart textile- Passive smart textile, active smart textile. Fabrication Techniques- Conductive Fibres, Treated Conductive Fibres, Conductive Fabrics, Conductive Inks. Case study- smart fabric for monitoring biological parameters - ECG, respiration.

#### UNIT V APPLICATIONS OF WEARABLE SYSTEMS 9

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, neural recording, Gait analysis, Sports Medicine.

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

- CO1:** Describe the concepts of wearable system.  
**CO2:** Explain the energy harvestings in wearable device.  
**CO3:** Use the concepts of BAN in health care.  
**CO4:** Illustrate the concept of smart textile  
**CO5:** Compare the various wearable devices in healthcare system

**TOTAL:45 PERIODS**

**TEXT BOOKS**

1. Annalisa Bonfiglio and Danilo De Rossi, Wearable Monitoring Systems, Springer, 2011
2. Zhang and Yuan-Ting, Wearable Medical Sensors and Systems, Springer, 2013
3. Edward Sazonov and Micheal R Neuman, Wearable Sensors: Fundamentals, Implementation and Applications, Elsevier, 2014
4. Mehmet R. Yuce and JamilY.Khan, Wireless Body Area Networks Technology, Implementation applications, Pan Stanford Publishing Pte.Ltd, Singapore, 2012

**REFERENCES**

1. Sandeep K.S, Gupta, Tridib Mukherjee and Krishna Kumar Venkatasubramanian, Body Area Networks Safety, Security, and Sustainability, Cambridge University Press, 2013.
2. Guang-Zhong Yang, Body Sensor Networks, Springer, 2006.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	2			1					1		1
2	3	2	1	1	2			1					1		1
3	3	2	1	1	2			1					1		1
4	3	2	1	1	2			1					1		1
5	3	2	1	1	2			1					1		1
AVg.	3	2	1	1	2			1					1		1

1 - low, 2 - medium, 3 - high, "--" - no correlation

**CBM356**

**MEDICAL INFORMATICS**

**L T P C**

**3 0 0 3**

**Preamble:**

1. To study the applications of information technology in health care management.
2. This course provides knowledge on resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine.

**UNIT I INTRODUCTION TO MEDICAL INFORMATICS**

**9**

Introduction - Structure of Medical Informatics –Internet and Medicine -Security issues , Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, Health Informatics – Medical Informatics, Bioinformatics



**UNIT II COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING 9**

Automated clinical laboratories-Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System - Computer assisted medical imaging- nuclear medicine, ultrasound imaging, computed X-ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance.

**UNIT III COMPUTERISED PATIENT RECORD 9**

Introduction - conventional patient record, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for patients.

**UNIT IV COMPUTER ASSISTED MEDICAL DECISION-MAKING 9**

Neuro computers and Artificial Neural Networks application, Expert system-General model of CMD, Computer-assisted decision support system-production rule system cognitive model, semantic networks, decisions analysis inclinical medicine-computers in the care of critically ill patients, Computer aids for the handicapped.

**UNIT V RECENT TRENDS IN MEDICAL INFORMATICS 9**

Virtual reality applications in medicine, Virtual endoscopy, Computer assisted surgery, Surgical simulation, Telemedicine - Tele surgery, Computer assisted patient education and health- Medical education and healthcare information, computer assisted instruction in medicine.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

**Upon completion of the course, students will be able to:**

- CO1:** Explain the structure and functional capabilities of Hospital Information System.
- CO2:** Describe the need of computers in medical imaging and automated clinical laboratory.
- CO3:** Articulate the functioning of information storage and retrieval in computerized patient record system.
- CO4:** Apply the suitable decision support system for automated clinical diagnosis.
- CO5:** Discuss the application of virtual reality and telehealth technology in medical industry.

**TEXT BOOKS:**

1. Mohan Bansal, "Medical informatics", Tata McGraw Hill Publishing Ltd, 2003.
2. R.D.Lele, "Computers in medicine progress in medical informatics", Tata Mcgraw Hill, 2005

**REFERENCES:**

1. Kathryn J. Hannah, Marion J Ball, "Health Informatics", 3<sup>rd</sup> Edition, Springer, 2006.

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	2			1					1	1	1
2	3	2	1	1	2			1					1	1	1
3	3	2	1	1	2			1					1	1	1
4	3	2	1	1	2			1					1	1	1
5	3	2	1	1	2			1					1	1	1
<b>AVg.</b>	3	2	1	1	2			1					1	1	1

1 - low, 2 - medium, 3 - high, '-'- no correlation

**COURSE OBJECTIVES**

- To introduce the interdisciplinary approach of water management.
- To develop knowledge base and capacity building on IWRM.

**UNIT I OVERVIEW OF IWRM****9**

Facts about water - Definition – Key challenges - Paradigm shift - Water management Principles - Social equity - Ecological sustainability – Economic efficiency - SDGs - World Water Forums.

**UNIT II WATER USE SECTORS: IMPACTS AND SOLUTION****9**

Water users: People, Agriculture, ecosystem and others - Impacts of the water use sectors on water resources - Securing water for people, food production, ecosystems and other uses - IWRM relevance in water resources management.

**UNIT III WATER ECONOMICS****9**

Economic characteristics of water good and services – Economic instruments – Private sector involvement in water resources management - PPP experiences through case studies.

**UNIT IV RECENT TREANDS IN WATER MANAGEMENT****9**

River basin management - Ecosystem Regeneration – 5 Rs - WASH - Sustainable livelihood - Water management in the context of climate change.

**UNIT V IMPLEMENTATION OF IWRM****9**

Barriers to implementing IWRM - Policy and legal framework - Bureaucratic reforms and inclusive development - Institutional Transformation - Capacity building - Case studies on conceptual framework of IWRM.

**TOTAL: 45 PERIODS****COURSEOUTCOMES**

On completion of the course, the student will be able to apply appropriate management techniques towards managing the water resources.

**CO1** Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.

**CO2** Discuss on the different water uses; how it is impacted and ways to tackle these impacts.

**CO3** Explain the economic aspects of water and choose the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.

**CO4** Illustrate the recent trends in water management.

**CO5** Understand the implementation hitches and the institutional frameworks.

**TEXT BOOKS**

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2. Mollinga P. *et al.* “ Integrated Water Resources Management”, Water in South Asia Volume I, Sage Publications, 2006.

**REFERENCES**

1. Technical Advisory Committee, Background Papers No: 1, 4 and 7, Stockholm, Sweden. 2002.

2. IWRM Guidelines at River Basin Level (UNESCO, 2008).
3. Tutorial on Basic Principles of Integrated Water Resources Management ,CAP-NET. [http://www.pacificwater.org/userfiles/file/IWRM/Toolboxes/introduction%20to%20iwrM/Tutorial\\_text .pdf](http://www.pacificwater.org/userfiles/file/IWRM/Toolboxes/introduction%20to%20iwrM/Tutorial_text.pdf)
4. Pramod R. Bhave, 2011, Water Resources Systems, Narosa Publishers.
5. The 17 Goals, United Nations, <https://sdgs.un.org/goals>.

**OBT355**

**BIOTECHNOLOGY FOR WASTE MANAGEMENT**

**L T P C**

**3 0 0 3**

**UNIT I                      BIOLOGICAL TREATMENT PROCESS                      9**

Fundamentals of biological process - Anaerobic process – Pretreatment methods in anaerobic process – Aerobic process, Anoxic process, Aerobic and anaerobic digestion of organic wastes - Factors affecting process efficiency - Solid state fermentation – Submerged fermentation – Batch and continuous fermentation

**UNIT II                      WASTE BIOMASS AND ITS VALUE ADDITION                      9**

Types of waste biomass – Solid waste management - Nature of biomass feedstock – Biobased economy/process – Value addition of waste biomass – Biotransformation of biomass – Biotransformation of marine processing wastes – Direct extraction of biochemicals from biomass – Plant biomass for industrial application

**UNIT III                      BIOCONVERSION OF WASTES TO ENERGY                      9**

Perspective of biofuels from wastes - Bioethanol production – Biohydrogen Production – dark and photofermentative process - Biobutanol production – Biogas and Biomethane production - Single stage anaerobic digestion, Two stage anaerobic digestion - Biodiesel production - Enzymatic hydrolysis technologies

**UNIT IV                      CHEMICALS AND ENZYME PRODUCTION FROM WASTES                      9**

Production of lactic acid, succinic acid, citric acid – Biopolymer synthesis – Production of Amylases - Lignocellulolytic enzymes - Pectinolytic enzymes - Proteases – Lipases

**UNIT V                      BIOCUMPOSTING OF ORGANIC WASTES                      9**

Overview of composting process - Benefits of composting, Role of microorganisms in composting - Factors affecting the composting process - Waste Materials for Composting, Fundamentals of composting process - Composting technologies, Composting systems – Nonreactor Composting, Reactor composting - Compost Quality

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

After completion of this course, the students should be able

- CO1:**To learn the various methods biological treatment
- CO2:**To know the details of waste biomass and its value addition
- CO3:**To develop the bioconversion processes to convert wastes to energy
- CO4:**To synthesize the chemicals and enzyme from wastes
- CO5:**To produce the biocompost from wastes
- CO6:**To apply the theoretical knowledge for the development of value added products

## TEXT BOOKS

1. Antoine P. T., (2017) "Biofuels from Food Waste Applications of Saccharification Using Fungal Solid State Fermentation", CRC press
2. Joseph C A., (2019) "Anaerobic Waste-Wastewater Treatment and Biogas Plants-A Practical Handbook", CRC Press,

## REFERENCE BOOKS

1. Palmiro P. and Oscar F.D'Urso, (2016) 'Biotransformation of Agricultural Waste and By-Products', The Food, Feed, Fibre, Fuel (4F) Economy, Elsevier
2. Kaur Brar S., Gurpreet Singh D. and Carlos R.S., (Eds), (2014) 'Biotransformation of Waste Biomass into High Value Biochemicals', Springer.
3. Keikhosro K, Editor, (2015) 'Lignocellulose-Based Bioproducts', Springer.
4. John P, (2014) 'Waste Management Practices-Municipal, Hazardous, and Industrial', Second Edition, CRC Press, 2014

OBT356	LIFESTYLE DISEASES	L	T	P	C
		3	0	0	3
<b>UNIT I</b>	<b>INTRODUCTION</b>				<b>9</b>
Lifestyle diseases – Definition ; Risk factors – Eating, smoking, drinking, stress, physical activity, illicit drug use ; Obesity, diabetes, cardiovascular diseases, respiratory diseases, cancer; Prevention – Diet and exercise.					
<b>UNIT II</b>	<b>CANCER</b>				<b>9</b>
Types - Lung cancer, Mouth cancer, Skin cancer, Cervical cancer, Carcinoma oesophagus; Causes Tobacco usage, Diagnosis – Biomarkers, Treatment					
<b>UNIT III</b>	<b>CARDIOVASCULAR DISEASES</b>				<b>9</b>
Coronary atherosclerosis – Coronary artery disease; Causes -Fat and lipids, Alcohol abuse – Diagnosis - Electrocardiograph, echocardiograph, Treatment, Exercise and Cardiac rehabilitation					
<b>UNIT IV</b>	<b>DIABETES AND OBESITY</b>				<b>9</b>
Types of Diabetes mellitus; Blood glucose regulation; Complications of diabetes – Paediatric and adolescent obesity – Weight control and BMI					
<b>UNIT V</b>	<b>RESPIRATORY DISEASES</b>				<b>9</b>
Chronic lung disease, Asthma, COPD; Causes - Breathing pattern (Nasal vs mouth), Smoking – Diagnosis - Pulmonary function testing					

**TOTAL: 45 PERIODS**

## TEXT BOOKS:

1. R.Kumar&Meenal Kumar, "Guide to Prevention of Lifestyle Diseases", Deep & Deep Publications, 2003
2. Gary Eggar et al, "Lifestyle Medicine", 3rd Edition, Academic Press, 2017

## REFERENCES:

1. James M.R, "Lifestyle Medicine", 2nd Edition, CRC Press, 2013
2. Akira Miyazaki et al, "New Frontiers in Lifestyle-Related Disease", Springer, 2008

**COURSE OBJECTIVES**

The aim of this course is to

- Create higher standard of knowledge on healthcare system and services
- Prioritize advanced technologies for the diagnosis and treatment of various diseases

**UNIT I PUBLIC HEALTH****9**

Definition and Concept of Public Health, Historical aspects of Public Health, Changing Concepts of Public Health, Public Health versus Medical Care, Unique Features of Public Health, Determinants of Health (Social, Economic, Cultural, Environmental, Education, Genetics, Food and Nutrition). Indicators of health, Burden of disease, Role of different disciplines in Public Health.

**UNIT II CLINICAL DISEASES****9**

Communicable diseases: Chickenpox / Shingles, COVID-19, Tuberculosis, Hepatitis B, Hepatitis C, HIV / AIDS, Influenza, Swine flu. Non Communicable diseases: Diabetes mellitus, atherosclerosis, fatty liver, Obesity, Cancer

**UNIT III VACCINOLOGY****9**

History of Vaccinology, conventional approaches to vaccine development, live attenuated and killed vaccines, adjuvants, quality control, preservation and monitoring of microorganisms in seed lot systems. Instruments related to monitoring of temperature, sterilization, environment.

**UNIT IV OUTPATIENT & IN PATIENT SERVICES****9**

Radiotherapy, Nuclear medicine, surgical units, OT Medical units, G & Obs. units Pediatric, neonatal units, Critical care units, Physical medicine & Rehabilitation, Neurology, Gastroenterology, Endoscopy, Pulmonology, Cardiology.

**UNIT V BASICS OF IMAGING MODALITIES****9**

Diagnostic X-rays - Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography – Different types of biotelemetry systems.

**TOTAL: 45 PERIODS****TEXT BOOKS**

1. Joseph J.carr and John M. Brown, Introduction to Biomedical Equipment Technology, John Wiley and sons, New York, 4th Edition, 2012.
2. Thomas M. Devlin.Textbook of Biochemistry with clinical correlations. Wiley Liss Publishers
3. The Vaccine Book (2nd Ed.), Rafi Ahmed, Roy M. Anderson et. al.Editor(s): Barry R. Bloom, PaulHenri Lambert, Academic Press, 2016, Pages xxi-xxiv.

**REFERENCE BOOKS**

1. Suh, Sang, Gurupur, Varadraj P., Tanik, Murat M., Health Care Systems, Technology and Techniques, Springer, 1st Edition, 2011
2. Burtis & Ashwood W.B. Tietz Textbook of Clinical chemistry. Saunders Company
3. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker

## VERTICAL 1: FINTECH AND BLOCK CHAIN

CMG331

FINANCIAL MANAGEMENT

LT P C

3 0 0 3

### LEARNING OBJECTIVES

1. To acquire the knowledge of the decision areas in finance.
2. To learn the various sources of Finance
3. To describe about capital budgeting and cost of capital.
4. To discuss on how to construct a robust capital structure and dividend policy
5. To develop an understanding of tools on Working Capital Management.

### UNIT I INTRODUCTION TO FINANCIAL MANGEMENT 9

Definition and Scope of Finance Functions - Objectives of Financial Management - Profit Maximization and Wealth Maximization- Time Value of money- Risk and return concepts.

### UNIT II SOURCES OF FINANCE 9

Long term sources of Finance -Equity Shares – Debentures - Preferred Stock – Features – Merits and Demerits. Short term sources - Bank Sources, Trade Credit, Overdrafts, Commercial Papers, Certificate of Deposits, Money market mutual funds etc

### UNIT III INVESTMENT DECISIONS: 9

Investment Decisions: capital budgeting – Need and Importance – Techniques of Capital Budgeting – Payback -ARR – NPV – IRR –Profitability Index.

Cost of Capital - Cost of Specific Sources of Capital - Equity -Preferred Stock- Debt - Reserves - Concept and measurement of cost of capital - Weighted Average Cost of Capital.

### UNIT IV FINANCING AND DIVIDEND DECISION 9

Operating Leverage and Financial Leverage- EBIT-EPS analysis. Capital Structure – determinants of Capital structure- Designing an Optimum capital structure .

Dividend policy - Aspects of dividend policy - practical consideration - forms of dividend policy - - Determinants of Dividend Policy

### UNIT V WORKING CAPITAL DECISION 9

Working Capital Management: Working Capital Management - concepts - importance -Determinants of Working capital. Cash Management: Motives for holding cash – Objectives and Strategies of Cash Management. Receivables Management: Objectives - Credit policies.

**TOTAL : 45 PERIODS**

### TEXT BOOKS

1. M.Y. Khan and P.K.Jain Financial management, Text, Tata McGraw Hill
2. M. Pandey Financial Management, Vikas Publishing House Pvt. Ltd

### REFERENCES .

1. James C. Vanhorne –Fundamentals of Financial Management– PHI Learning,.
2. Prasanna Chandra, Financial Management,
3. Srivatsava, Mishra, Financial Management, Oxford University Press, 2011

**COURSE OBJECTIVES:**

- Describe the investment environment in which investment decisions are taken.
- Explain how to Value bonds and equities
- Explain the various approaches to value securities
- Describe how to create efficient portfolios through diversification
- Discuss the mechanism of investor protection in India.

**UNIT I THE INVESTMENT ENVIRONMENT 9**

The investment decision process, Types of Investments – Commodities, Real Estate and Financial Assets, the Indian securities market, the market participants and trading of securities, security market indices, sources of financial information, Concept of return and risk, Impact of Taxes and Inflation on return.

**UNIT II FIXED INCOME SECURITIES 9**

Bond features, types of bonds, estimating bond yields, Bond Valuation types of bond risks, default risk and credit rating.

**UNIT III APPROACHES TO EQUITY ANALYSIS 9**

Introduction to Fundamental Analysis, Technical Analysis and Efficient Market Hypothesis, dividend capitalisation models, and price-earnings multiple approach to equity valuation.

**UNIT IV PORTFOLIO ANALYSIS AND FINANCIAL DERIVATIVES 9**

Portfolio and Diversification, Portfolio Risk and Return; Mutual Funds; Introduction to Financial Derivatives; Financial Derivatives Markets in India

**UNIT V INVESTOR PROTECTION** Role of SEBI and stock exchanges in investor protection; Investor grievances and their redressal system, insider trading, investors' awareness and activism**TOTAL : 45 PERIODS****REFERENCES**

1. Charles P. Jones, Gerald R. Jensen. Investments: analysis and management. Wiley, 14<sup>TH</sup> Edition, 2019.
2. Chandra, Prasanna. Investment analysis and portfolio management. McGraw-hill education, 5<sup>th</sup>, Edition, 2017.
3. Rustagi, R. P. Investment Management Theory and Practice. Sultan Chand & Sons, 2021.
4. Zvi Bodie, Alex Kane, Alan J Marcus, Pitab Mohanty, Investments, McGraw Hill Education (India), 11 Edition (SIE), 2019

**COURSE OBJECTIVES**

- Understand the Banking system in India
- Grasp how banks raise their sources and how they deploy it
- Understand the development in banking technology
- Understand the financial services in India
- Understand the insurance Industry in India

**UNIT I INTRODUCTION TO INDIAN BANKING SYSTEM 9**

Overview of Banking system – Structure – Functions –Banking system in India - Key Regulations in Indian Banking sector –RBI. Relationship between Banker and Customer - Retail & Wholesale Banking – types of Accounts - Opening and operation of Accounts.

**UNIT II MANAGING BANK FUNDS/ PRODUCTS 9**

Liquid Assets - Investment in securities - Advances - Loans.Negotiable Instruments – Cheques, Bills of Exchange & Promissory Notes.Designing deposit schemes– Asset and Liability Management – NPA’s – Current issues on NPA’s – M&A’s of banks into securities market

**UNIT III DEVELOPMENT IN BANKING TECHNOLOGY 9**

Payment system in India – paper based – e payment –electronic banking –plastic money – e-money –forecasting of cash demand at ATM’s –The Information Technology Act, 2000 in India – RBI’s Financial Sector Technology vision document – security threats in e-banking & RBI’s Initiative.

**UNIT IV FINANCIAL SERVICES 9**

Introduction – Need for Financial Services – Financial Services Market in India – NBFC — Leasing and Hire Purchase — mutual funds. Venture Capital Financing –Bill discounting –factoring – Merchant Banking

**UNIT V INSURANCE 9**

Insurance –Concept - Need - History of Insurance industry in India. Insurance Act, 1938 –IRDA – Regulations – Life Insurance - Annuities and Unit Linked Policies - Lapse of the Policy – revival – settlement of claim

**TOTAL : 45 PERIODS**

**REFERENCES :**

1. Padmalatha Suresh and Justin Paul, “Management of Banking and Financial Services, Pearson, Delhi, 2017.
2. Meera Sharma, “Management of Financial Institutions – with emphasis on Bank and Risk Management”, PHI Learning Pvt. Ltd., New Delhi 2010
3. Peter S. Rose and Sylvia C. and Hudgins, “Bank Management and Financial Services”, Tata McGraw Hill, New Delhi, 2017

**CMG334 INTRODUCTION TO BLOCKCHAIN AND ITS APPLICATIONS L T P C  
3 0 0 3**

**UNIT I INTRODUCTION TO BLOCKCHAIN 9**

Blockchain: The growth of blockchain technology - Distributed systems - The history of blockchain and Bitcoin - Features of a blockchain - Types of blockchain, Consensus: Consensus mechanism - Types of consensus mechanisms - Consensus in blockchain. Decentralization: Decentralization using blockchain - Methods of decentralization - Routes to decentralization- Blockchain and full ecosystem decentralization - Smart contracts - Decentralized Organizations- Platforms for decentralization.



**UNIT II INTRODUCTION TO CRYPTOCURRENCY 9**

Bitcoin – Digital Keys and Addresses – Transactions – Mining – Bitcoin Networks and Payments – Wallets – Alternative Coins – Theoretical Limitations – Bitcoin limitations – Name coin – Prime coin – Zcash – Smart Contracts – Ricardian Contracts- Deploying smart contracts on a blockchain

**UNIT III ETHEREUM 9**

Introduction - The Ethereum network - Components of the Ethereum ecosystem - Transactions and messages - Ether cryptocurrency / tokens (ETC and ETH) - The Ethereum Virtual Machine (EVM), Ethereum Development Environment: Test networks - Setting up a private net - Starting up the private network

**UNIT IV WEB3 AND HYPERLEDGE 9**

Introduction to Web3 – Contract Deployment – POST Requests – Development Frameworks – Hyperledger as a Protocol – The Reference Architecture – Hyperledger Fabric – Distributed Ledger – Corda.

**UNIT V EMERGING TRENDS 9**

Kadena – Ripple – Rootstock – Quorum – Tendermint – Scalability – Privacy – Other Challenges – Blockchain Research – Notable Projects – Miscellaneous Tools.

**TOTAL : 45 PERIODS**

**REFERENCE**

1. Imran. Bashir. Mastering block chain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained. Packt Publishing, 2<sup>nd</sup> Edition, 2018
2. Peter Borovykh , Blockchain Application in Finance, Blockchain Driven, 2nd Edition, 2018
3. ArshdeepBahga, Vijay Madiseti, “Blockchain Applications: A Hands On Approach”, VPT, 2017.

**CMG335 FINTECH PERSONAL FINANCE AND PAYMENTS L T P C  
3 0 0 3**

**UNIT I CURRENCY EXCHANGE AND PAYMENT 9**

Understand the concept of Crypto currency- Bitcoin and Applications -Cryptocurrencies and Digital Crypto Wallets -Types of Cryptocurrencies - Cryptocurrencies and Applications, block chain, Artificial Intelligence, machine learning. Fintech users, Individual Payments, RTGS Systems, Immediate Page 54 of 90 Payment Service (IMPS), Unified Payments Interface (UPI).Legal and Regulatory Implications of Crypto currencies, Payment systems and their regulations.Digital Payments Smart Cards, Stored-Value Cards, EC Micropayments, Payment Gateways, Mobile Payments, Digital and Virtual Currencies, Security, Ethical, Legal, Privacy, and Technology Issues

**UNIT II DIGITAL FINANCE AND ALTERNATIVE FINANCE 9**

A Brief History of Financial Innovation, Digitization of Financial Services, Crowd funding, Charity and Equity,. Introduction to the concept of Initial Coin Offering

**UNIT III INSURETECH 9**

InsurTech Introduction , Business model disruption AI/ML in InsurTech • IoT and InsurTech ,Risk Modeling ,Fraud Detection Processing claims and Underwriting Innovations in Insurance Services

**UNIT IV PEER TO PEER LENDING 9**  
P2P and Marketplace Lending, New Models and New Products in market place lending P2P Infrastructure and technologies , Concept of Crowdfunding Crowdfunding Architecture and Technology ,P2P and Crowdfunding unicorns and business models , SME/MSME Lending: Unique opportunities and Challenges, Solutions and Innovations

**UNIT V REGULATORY ISSUES 9**  
FinTech Regulations: Global Regulations and Domestic Regulations, Evolution of RegTech, RegTech Ecosystem: Financial Institutions, RegTech Ecosystem: StartupsRegTech, Startups: Challenges, RegTech Ecosystem: Regulators, Use of AI in regulation and Fraud detection

**TOTAL : 45 PERIODS**

**REFERENCE**

1. Swanson Seth, Fintech for Beginners: Understanding and Utilizing the power of technology, Createspace Independent Publishing Platform,2016.
2. Models AuTanda, Fintech Bigtech And Banks Digitalization and Its Impact On Banking Business, Springer, 2019
3. Henning Diedrich, Ethereum: Blockchains, Digital Assets, Smart Contracts, Decentralized Autonomous Organizations, Wildfire Publishing, 2016
4. Jacob William, FinTech:TheBeginner's Guide to Financial Technology, Createspace Independent Publishing Platform, 2016
5. IIBF, Digital Banking, Taxmann Publication, 2016
6. Jacob William, Financial Technology, Create space Independent Pub, 2016
7. Luke Sutton, Financial Technology: Bitcoin & Blockchain, Createspace Independent Pub, 2016

**CMG336**

**INTRODUCTION TO FINTECH**

**LT P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- To learn about history, importance and evolution of Fintech
- To acquire the knowledge of Fintech in payment industry
- To acquire the knowledge of Fintech in insurance industry
- To learn the Fintech developments around the world
- To know about the future of Fintech

**UNIT I INTRODUCTION 9**  
Fintech - Definition, History, concept, meaning, architecture, significance, Goals, key areas in Fintech, Importance of Fintech, role of Fintech in economic development, opportunities and challenges in Fintech, Evolution of Fintech in different sectors of the industry - Infrastructure, Banking Industry, Startups and Emerging Markets, recent developments in FinTech, future prospects and potential issues with Fintech.

**UNIT II PAYMENT INDUSTRY 9**  
FinTech in Payment Industry-Multichannel digital wallets, applications supporting wallets, onboarding and KYC application, FinTech in Lending Industry- Formal lending, Informal lending, P2P lending, POS lending, Online lending, Payday lending, Microfinance, Crowdfunding.

**UNIT III INSURANCE INDUSTRY 9**

FinTech in Wealth Management Industry-Financial Advice, Automated investing, Socially responsible investing, Fractional Investing, Social Investing. FinTech in Insurance Industry- P2P insurance, On-Demand Insurance, On-Demand Consultation, Customer engagement through Quote to sell, policy servicing, Claims Management, Investment linked health insurance.

**UNIT IV FINTECH AROUND THE GLOBE 9**

FinTech developments - US, Europe and UK, Germany, Sweden, France, China, India, Africa, Australia, New Zealand, Brazil and Middle East, Regulatory and Policy Assessment for Growth of FinTech. FinTech as disruptors, Financial institutions collaborating with FinTech companies, The new financial world.

**UNIT V FUTURE OF FINTECH 9**

How emerging technologies will change financial services, the future of financial services, banking on innovation through data, why FinTech banks will rule the world, The FinTech Supermarket, Banks partnering with FinTech start-ups, The rise of BankTech, Fintech impact on Retail Banking, A future without money, Ethics in Fintech.

**TOTAL : 45 PERIODS**

**REFERENCES**

1. Arner D., Barbers J., Buckley R, The evolution of FinTech: a new post crisis paradigm, University of New South Wales Research Series, 2015
2. Susanne Chishti, Janos Barberis, The FINTECH Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries, Wiley Publications, 2016
3. Richard Hayen, FinTech: The Impact and Influence of Financial Technology on Banking and the Finance Industry, 2016
4. Parag Y Arjunwadkar, FinTech: The Technology Driving Disruption in the financial service industry CRC Press, 2018
5. Sanjay Phadke, Fintech Future : The Digital DNA of Finance Paperback .Sage Publications, 2020
6. Pranay Gupta, T. Mandy Tham, Fintech: The New DNA of Financial Services Paperback, 2018

**VERTICAL 2: ENTREPRENEURSHIP**

PROGRESS THROUGH KNOWLEDGE

**CMG337**

**FOUNDATIONS OF ENTREPRENEURSHIP**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES**

- To develop and strengthen the entrepreneurial quality and motivation of learners.
- To impart the entrepreneurial skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of entrepreneurship and management in Technology oriented businesses.
- To empower the learners to run a Technology driven business efficiently and effectively

**UNIT I INTRODUCTION TO ENTREPRENEURSHIP 9**

Entrepreneurship- Definition, Need, Scope - Entrepreneurial Skill & Traits - Entrepreneur vs. Intrapreneur; Classification of entrepreneurs, Types of entrepreneurs -Factors affecting

entrepreneurial development – Achievement Motivation – Contributions of Entrepreneurship to Economic Development.

**UNIT II BUSINESS OWNERSHIP & ENVIRONMENT 9**

Types of Business Ownership – Business Environmental Factors – Political-Economic-Sociological-Technological-Environmental-Legal aspects – Human Resources Mobilisation-Basics of Managing Finance- Essentials of Marketing Management - Production and Operations Planning – Systems Management and Administration

**UNIT III FUNDAMENTALS OF TECHNOPRENEURSHIP 9**

Introduction to Technopreneurship - Definition, Need, Scope- Emerging Concepts- Principles - Characteristics of a technopreneur - Impacts of Technopreneurship on Society – Economy- Job Opportunities in Technopreneurship - Recent trends

**UNIT IV APPLICATIONS OF TECHNOPRENEURSHIP 9**

Technology Entrepreneurship - Local, National and Global practices - Intrapreneurship and Technology interactions, Networking of entrepreneurial activities – Launching - Managing Technology based Product / Service entrepreneurship – Success Stories of Technopreneurs - Case Studies

**UNIT V EMERGING TRENDS IN ENTREPRENEURSHIP 9**

Effective Business Management Strategies For Franchising - Sub-Contracting- Leasing- Technopreneurs – Agripreneurs - Netpreneurs- Portfolio entrepreneurship - NGO Entrepreneurship – Recent Entrepreneurial Developments - Local – National – Global perspectives.

**TOTAL 45 : PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the student should be able to:

- CO 1** Learn the basics of Entrepreneurship
- CO 2** Understand the business ownership patterns and environment
- CO 3** Understand the Job opportunities in Industries relating to Technopreneurship
- CO 4** Learn about applications of technopreneurship and successful technopreneurs
- CO 5** Acquaint with the recent and emerging trends in entrepreneurship

**TEXT BOOKS:**

- 1 S.S.Khanka, "Entrepreneurial Development" S.Chand & Co. Ltd. Ram Nagar New Delhi, 2021.
- 2 Donal F Kuratko Entrepreneurship (11th Edition) Theory, Process, Practice by Published 2019 by Cengage Learning,

**REFERENCES :**

- 1 Daniel Mankani. 2003. Technopreneurship: The successful Entrepreneur in the new Economy. Prentice Hall
- 2 Edward Elgar. 2007. Entrepreneurship, Cooperation and the Firm: The Emergence and Survival of High-Technology Ventures in Europe. Edi: Jan Ulijn, Dominique Drillon, and Frank Lasch. Wiley Pub.
- 3 Lang, J. 2002, The High Tech Entrepreneur's Handbook, Ft.com.
- 4 David Sheff 2002, China Dawn: The Story of a Technology and Business Revolution,
- 5 HarperBusiness, <https://fanny.staff.uns.ac.id/files/2013/12/Technopreneur-BASED-EDUCATION-REVOLUTION.pdf>

- 6 JumpStart: A Technopreneuership Fable, Dennis Posadas, (Singapore: Pearson Prentice Hall, 2009
- 7 Basics of Technopreneuership: Module 1.1-1.2, Frederico Gonzales, President-PESO Inc; M. Barcelon, UP
- 8 Journal articles pertaining to Entrepreneurship

**CMG338 TEAM BUILDING & LEADERSHIP MANAGEMENT FOR BUSINESS L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- To develop and strengthen the Leadership qualities and motivation of learners.
- To impart the Leadership skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of Team Building in managing Technology oriented businesses.
- To empower the learners to build robust teams for running and leading a business efficiently and effectively

**UNIT I INTRODUCTION TO MANAGING TEAMS 9**  
 Introduction to Team - Team Dynamics - Team Formation – Stages of Team Development - Enhancing teamwork within a group - Team Coaching - Team Decision Making - Virtual Teams - Self Directed Work Teams (SDWTs) -Multicultural Teams.

**UNIT II MANAGING AND DEVELOPING EFFECTIVE TEAMS 9**  
 Team-based Organisations- Leadership roles in team-based organisations - Offsite training and team development - Experiential Learning - Coaching and Mentoring in team building - Building High-Performance Teams - Building Credibility and Trust - Skills for Developing Others - Team Building at the Top - Leadership in Teamwork Effectiveness.

**UNIT III INTRODUCTION TO LEADERSHIP 9**  
 Introduction to Leadership - Leadership Myths – Characteristics of Leader, Follower and Situation - Leadership Attributes - Personality Traits and Leadership- Intelligence Types and Leadership - Power and Leadership - Delegation and Empowerment .

**UNIT IV LEADERSHIP IN ORGANISATIONS 9**  
 Leadership Styles – LMX Theory- Leadership Theory and Normative Decision Model - Situational Leadership Model - Contingency Model and Path Goal Theory – Transactional and Transformational Leadership - Charismatic Leadership - Role of Ethics and Values in Organisational Leadership.

**UNIT V LEADERSHIP EFFECTIVENESS 9**  
 Leadership Behaviour - Assessment of Leadership Behaviors - Destructive Leadership - Motivation and Leadership - Managerial Incompetence and Derailment Conflict Management - Negotiation and Leadership - Culture and Leadership - Global Leadership – Recent Trends in Leadership.

**TOTAL 45 : PERIODS**

**COURSE OUTCOMES**

Upon completion of this course, the student should be able to:

- CO 1** Learn the basics of managing teams for business.
- CO 2** Understand developing effective teams for business management.
- CO 3** Understand the fundamentals of leadership for running a business.

- CO 4** Learn about the importance of leadership for business development.  
**CO 5** Acquaint with emerging trends in leadership effectiveness for entrepreneurs.”

**REFERENCES :**

- Hughes, R.L., Ginnett, R.C., & Curphy, G.J., Leadership: Enhancing the lessons of experience ,9th Ed, McGraw Hill Education, Chennai, India. (2019).
- Katzenback, J.R., Smith, D.K., The Wisdom of Teams: Creating the High Performance Organisations, Harvard Business Review Press, (2015).
- Haldar, U.K., Leadership and Team Building, Oxford University Press, (2010).
- Daft, R.L., The Leadership Experience, Cengage, (2015).
- Daniel Levi, Group Dynamics for Teams ,4th Ed, (2014), Sage Publications.
- Dyer, W. G., Dyer, W. G., Jr., & Dyer, J. H..Team building: Proven strategies for improving team performance, 5thed, Jossey-Bass, (2013).

**CMG339 CREATIVITY & INNOVATION IN ENTREPRENEURSHIP**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- To develop the creativity skills among the learners
- To impart the knowledge of creative intelligence essential for entrepreneurs
- To know the applications of innovation in entrepreneurship.
- To develop innovative business models for business.

**UNIT I CREATIVITY**

**9**

Creativity: Definition- Forms of Creativity-Essence, Elaborative and Expressive Creativities- Quality of Creativity-Existential, Entrepreneurial and Empowerment Creativities – Creative Environment-Creative Technology- - Creative Personality and Motivation.

**UNIT II CREATIVE INTELLIGENCE**

**9**

Creative Intelligence: Convergent thinking ability – Traits Congenial to creativity – Creativity Training- -Criteria for evaluating Creativity-Credible Evaluation- Improving the quality of our creativity – Creative Tools and Techniques - Blocks to creativity- fears and Disabilities- Strategies for Unblocking- Designing Creativity Enabling Environment.

**UNIT III INNOVATION**

**9**

Innovation: Definition- Levels of Innovation- Incremental Vs Radical Innovation-Product Innovation and Process- Technological, Organizational Innovation – Indicators- Characteristics of Innovation in Different Sectors. Theories in Innovation and Creativity- Design Thinking and Innovation- Innovation as Collective Change-Innovation as a system

**UNIT IV INNOVATION AND ENTREPRENEURSHIP**

**9**

Innovation and Entrepreneurship: Entrepreneurial Mindset , Motivations and Behaviours- Opportunity Analysis and Decision Making- Industry Understanding - Entrepreneurial Opportunities- Entrepreneurial Strategies – Technology Pull/Market Push – Product -Market fit

**UNIT V INNOVATIVE BUSINESS MODELS**

**9**

Innovative Business Models: Customer Discovery-Customer Segments-Prospect Theory and Developing Value Propositions- Developing Business Models: Elements of Business Models –

Innovative Business Models: Elements, Designing Innovative Business Models- Responsible Innovation and Creativity.

**TOTAL 45 : PERIODS**

### **COURSE OUTCOMES**

Upon completion of this course, the student should be able to:

**CO 1** Learn the basics of creativity for developing Entrepreneurship

**CO 2** Understand the importance of creative intelligence for business growth

**CO 3** Understand the advances through Innovation in Industries

**CO 4** Learn about applications of innovation in building successful ventures

**CO 5** Acquaint with developing innovative business models to run the business efficiently and effectively

### **Suggested Readings:**

Creativity and Innovation in Entrepreneurship, Kankha, Sultan Chand

Pradip N Khandwalla, Lifelong Creativity, An Unending Quest, Tata Mc Graw Hill, 2004.

Paul Trott, Innovation Management and New Product Development, 4e, Pearson, 2018.

Vinnie Jauhari, Sudanshu Bhushan, Innovation Management, Oxford Higher Education, 2014.

Innovation Management, C.S.G. Krishnamacharyulu, R. Lalitha, Himalaya Publishing House, 2010.

A. Dale Timpe, Creativity, Jaico Publishing House, 2003.

Brian Clegg, Paul Birch, Creativity, Kogan Page, 2009.

Strategic Innovation: Building and Sustaining Innovative Organizations- Course Era, Raj Echambadi.

<b>CMG340</b>	<b>PRINCIPLES OF MARKETING MANAGEMENT FOR BUSINESS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

### **COURSE OBJECTIVES:**

- To provide basic knowledge of concepts, principles, tools and techniques of marketing for entrepreneurs
- To provide an exposure to the students pertaining to the nature and Scope of marketing, which they are expected to possess when they enter the industry as practitioners.
- To give them an understanding of fundamental premise underlying market driven strategies and the basic philosophies and tools of marketing management for business owners.

<b>UNIT I</b>	<b>INTRODUCTION TO MARKETING MANAGEMENT</b>	<b>9</b>
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Introduction - Market and Marketing – Concepts- Functions of Marketing - Importance of Marketing - Marketing Orientations - Marketing Mix-The Traditional 4Ps - The Modern Components of the Mix - The Additional 3Ps - Developing an Effective Marketing Mix.

<b>UNIT II</b>	<b>MARKETING ENVIRONMENT</b>	<b>9</b>
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Introduction - Environmental Scanning - Analysing the Organisation's Micro Environment and Macro Environment - Differences between Micro and Macro Environment – Techniques of Environment Scanning - Marketing organization - Marketing Research and the Marketing Information System, Types and Components.

<b>UNIT III</b>	<b>PRODUCT AND PRICING MANAGEMENT</b>	<b>9</b>
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Product- Meaning, Classification, Levels of Products – Product Life Cycle (PLC) - Product Strategies - Product Mix - Packaging and Labelling - New Product Development - Brand and Branding - Advantages and disadvantages of branding Pricing - Factors Affecting Price Decisions - Cost Based

Pricing - Value Based and Competition Based Pricing - Pricing Strategies - National and Global Pricing.

**UNIT IV PROMOTION AND DISTRIBUTION MANAGEMENT 9**

Introduction to Promotion – Marketing Channels- Integrated Marketing Communications (IMC) - Introduction to Advertising and Sales Promotion – Basics of Public Relations and Publicity - Personal Selling - Process - Direct Marketing - Segmentation, Targeting and Positioning (STP)-Logistics Management- Introduction to Retailing and Wholesaling.

**UNIT V CONTEMPORARY ISSUES IN MARKETING MANAGEMENT 9**

Introduction - Relationship Marketing Vs. Relationship Management - Customer Relationship Management (CRM) - Forms of Relationship Management - CRM practices - Managing Customer Loyalty and Development – Buyer-Seller Relationships- Buying Situations in Industrial / Business Market - Buying Roles in Industrial Marketing - Factors that Influence Business - Services Marketing - E-Marketing or Online Marketing.

**TOTAL 45 : PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the students will be able to :

- CO1** Have the awareness of marketing management process
- CO 2** Understand the marketing environment
- CO 3** Acquaint about product and pricing strategies
- CO 4** Knowledge of promotion and distribution in marketing management.
- CO 5** Comprehend the contemporary marketing scenarios and offer solutions to marketing issues.

**REFERENCES:**

1. Marketing Management, Sherlekar S.A, Himalaya Publishing House, 2016.
2. Marketing Management , Philip Kotler and Kevin Lane Keller, PHI 15th Ed, 2015.
- 3 Marketing Management- An Indian perspective, Vijay Prakash Anand, Biztantra, Second edition, 2016.
4. Marketing Management Global Perspective, Indian Context, V.S.Ramaswamy & S.Namakumari, Macmillan Publishers India,5th edition, 2015.
5. Marketing Management, S.H.H. Kazmi, 2013, Excel Books India.
6. Marketing Management- text and Cases, Dr. C.B.Gupta & Dr. N.Rajan Nair, 17th edition, 2016.

<b>CMG341</b>	<b>HUMAN RESOURCE MANAGEMENT FOR ENTREPRENEURS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

- To introduce the basic concepts, structure and functions of human resource management for entrepreneurs.
- To create an awareness of the roles, functions and functioning of human resource department.
- To understand the methods and techniques followed by Human Resource Management practitioners.



<b>UNIT I INTRODUCTION TO HRM</b>	<b>9</b>
Concept, Definition, Objectives- Nature and Scope of HRM - Evolution of HRM - HR Manager Roles- Skills - Personnel Management Vs. HRM - Human Resource Policies - HR Accounting - HR Audit - Challenges in HRM.	
<b>UNIT II HUMAN RESOURCE PLANNING</b>	<b>9</b>
HR Planning - Definition - Factors- Tools - Methods and Techniques - Job analysis- Job rotation- Job Description - Career Planning - Succession Planning - HRIS - Computer Applications in HR - Recent Trends	
<b>UNIT III RECRUITMENT AND SELECTION</b>	<b>9</b>
Sources of recruitment- Internal Vs. External - Domestic Vs. Global Sources -eRecruitment - Selection Process- Selection techniques -eSelection- Interview Types- Employee Engagement.	
<b>UNIT IV TRAINING AND EMPLOYEE DEVELOPMENT</b>	<b>9</b>
Types of Training - On-The-Job, Off-The-Job - Training Needs Analysis – Induction and Socialisation Process - Employee Compensation - Wages and Salary Administration – Health and Social Security Measures- Green HRM Practices	
<b>UNIT V CONTROLLING HUMAN RESOURCES</b>	<b>9</b>
Performance Appraisal – Types - Methods - Collective Bargaining - Grievances Redressal Methods – Employee Discipline – Promotion – Demotion - Transfer – Dismissal - Retrenchment - Union Management Relationship - Recent Trends	

**TOTAL 45 : PERIODS**

### **COURSE OUTCOMES**

Upon completion of this course the learners will be able:

- CO 1** To understand the Evolution of HRM and Challenges faced by HR Managers
- CO 2** To learn about the HR Planning Methods and practices.
- CO 3** To acquaint about the Recruitment and Selection Techniques followed in Industries.
- CO 4** To know about the methods of Training and Employee Development.
- CO 5** To comprehend the techniques of controlling human resources in organisations.

### **REFERENCES**

- 1) Gary Dessler and Biju Varkkey, Human Resource Management, 14e , Pearson, 2015.
- 2) Mathis and Jackson, Human Resource Management, Cengage Learning 15e, 2017.
- 3) David A. Decenzo, Stephen.P.Robbins, and Susan L. Verhulst, Human Resource Management, Wiley, International Student Edition, 11th Edition, 2014
- 4) R. Wayne Mondy, Human Resource Management, Pearson , 2015.
- 5) Luis R.Gomez-Mejia, David B.Balkin, Robert L Cardy. Managing Human Resource. PHI Learning. 2012
- 6) John M. Ivancevich, Human Resource Management,12e, McGraw Hill Irwin,2013.
- 7) K. Aswathappa, Sadhna Dash , Human Resource Management - Text and Cases , 9th Edition, McGraw Hill, 2021.
- 8) Uday Kumar Haldar, Juthika Sarkar. Human Resource management. Oxford. 2012

**COURSE OBJECTIVES**

- To develop the basics of business venture financing.
- To impart the knowledge essential for entrepreneurs for financing new ventures.
- To acquaint the learners with the sources of debt and equity financing.
- To empower the learners towards fund raising for new ventures effectively.

**UNIT I ESSENTIALS OF NEW BUSINESS VENTURE 9**

Setting up new Business Ventures – Need - Scope - Franchising - Location Strategy, Registration Process - State Directorate of Industries- Financing for New Ventures - Central and State Government Agencies - Types of loans – Financial Institutions - SFC, IDBI, NSIC and SIDCO.

**UNIT II INTRODUCTION TO VENTURE FINANCING 9**

Venture Finance – Definition – Historic Background - Funding New Ventures- Need – Scope – Types - Cost of Project - Means of Financing - Estimation of Working Capital - Requirement of funds – Mix of Debt and Equity - Challenges and Opportunities.

**UNIT III SOURCES OF DEBT FINANCING 9**

Fund for Capital Assets - Term Loans - Leasing and Hire-Purchase - Money Market instruments – Bonds, Corporate Papers – Preference Capital- Working Capital Management- Fund based Credit Facilities - Cash Credit - Over Draft.

**UNIT IV SOURCES OF EQUITY FINANCING 9**

Own Capital, Unsecured Loan - Government Subsidies , Margin Money- Equity Funding - Private Equity Fund- Schemes of Commercial banks - Angel Funding – Crowdfunding- Venture Capital.

**UNIT V METHODS OF FUND RAISING FOR NEW VENTURES 9**

Investor Decision Process - Identifying the appropriate investors- Targeting investors- Developing Relationships with investors - Investor Selection Criteria- Company Creation- Raising Funds - Seed Funding- VC Selection Criteria – Process- Methods- Recent Trends

**TOTAL 45 : PERIODS****COURSE OUTCOMES:**

Upon completion of this course, the students should be able to:

- CO 1** Learn the basics of starting a new business venture.
- CO 2** Understand the basics of venture financing.
- CO 3** Understand the sources of debt financing.
- CO 4** Understand the sources of equity financing.
- CO 5** Acquaint with the methods of fund raising for new business ventures.

**REFERENCES :**

- 1) Principles of Corporate Finance by Brealey and Myers et al., 12<sup>TH</sup> ed, McGraw Hill Education (India) Private Limited, 2018
- 2) Prasanna Chandra, Projects : Planning ,Analysis, Selection ,Financing, Implementation and Review, McGraw Hill Education India Pvt Ltd ,New Delhi , 2019.
- 3) Introduction to Project Finance. Andrew Fight, Butterworth-Heinemann, 2006.

- 4) Metrick, Andrew; Yasuda, Ayako. Venture Capital And The Finance Of Innovation. Venture Capital And The Finance Of Innovation, 2nd Edition, Andrew Metrick And Ayako Yasuda, Eds., John Wiley And Sons, Inc, 2010.
- 5) Feld, Brad; Mendelson, Jason. Venture Deals. Wiley, 2011.
- 6) May, John; Simons, Cal. Every Business Needs An Angel: Getting The Money You Need To Make Your Business Grow. Crown Business, 2001.
- 7) Gompers, Paul Alan; Lerner, Joshua. The Money Of Invention: How Venture Capital Creates New Wealth. Harvard Business Press, 2001.
- 8) Camp, Justin J. Venture Capital Due Diligence: A Guide To Making Smart Investment Choices And Increasing Your Portfolio Returns. John Wiley & Sons, 2002.
- 9) Byers, Thomas. Technology Ventures: From Idea To Enterprise. Mcgraw-Hill Higher Education, 2014.
- 10) Lerner, Josh; Leamon, Ann; Hardyman, Felda. Venture Capital, Private Equity, And The Financing Of Entrepreneurship. 2012.

### **VERTICAL 3: PUBLIC ADMINISTRATION**

**CMG343**

**PRINCIPLES OF PUBLIC ADMINISTRATION**

**L T P C**  
**3 0 0 3**

**UNIT I**

**(9)**

1. Meaning, Nature and Scope of Public Administration
2. Importance of Public Administration
3. Evolution of Public Administration

**UNIT II**

**(9)**

1. New Public Administration
2. New Public Management
3. Public and Private Administration

**UNIT III**

**(9)**

1. Relationships with Political Science, History and Sociology
2. Classical Approach
3. Scientific Management Approach

**UNIT IV**

**(9)**

1. Bureaucratic Approach: Max Weber
2. Human Relations Approach : Elton Mayo
3. Ecological Approach : Riggs

**UNIT V**

**(9)**

1. Leadership: Leadership - Styles - Approaches
2. Communication: Communication Types - Process - Barriers
3. Decision Making: Decision Making - Types, Techniques and Processes.

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Avasthi and Maheswari: Public Administration in India, Agra:Lakshmi Narain Agarwal,2013.
2. Ramesh K Arora: Indian Public Administration, New Delhi: Wishwa Prakashan, 2012.
3. R.B. Jain: Public Administration in India,21st Century Challenges for Good Governance, New Delhi: Deep and Deep, 2002.
4. Rumki Basu: Public Administration:Concept and Theories, New Delhi:Sterling, 2013.
5. R. Tyagi, Public Administration, Atma Ram & Sons, New Delhi, 1983.

**CMG344****CONSTITUTION OF INDIA****L T P C  
3 0 0 3****UNIT I****(9)**

1. Constitutional Development Since 1909 to 1947
2. Making of the Constitution.
3. Constituent Assembly

**UNIT II****(9)**

1. Fundamental Rights
2. Fundamental Duties
3. Directive Principles of State Policy

**UNIT III****(9)**

1. President
2. Parliament
3. Supreme Court

**UNIT IV****(9)**

1. Governor
2. State Legislature
3. High Court

**UNIT V****(9)**

1. Secularism
2. Social Justice
3. Minority Safeguards

**TOTAL: 45 PERIODS****REFERENCES:**

1. Basu. D.D.: Introduction to Indian Constitution ; Prentice Hall; New Delhi.
2. Kapur. A.C: Indian Government and Political System; S.Chand and Company Ltd., New Delhi.
3. Johari J.C.: Indian Politics, Vishal Publications Ltd, New Delhi
4. Agarwal R.C: Indian Political System; S.Chand & Co., New Delhi

**CMG345**

**PUBLIC PERSONNEL ADMINISTRATION**

**L T P C**

**3 0 0 3**

**UNIT I**

**(9)**

1. Meaning, Scope and Importance of Personnel Administration
2. Types of Personnel Systems: Bureaucratic, Democratic and Representative systems

**UNIT II**

**(9)**

1. Generalist Vs Specialist
2. Civil Servants' Relationship with Political Executive
3. Integrity in Administration.

**UNIT III**

**(9)**

1. Recruitment: Direct Recruitment and Recruitment from Within
2. Training: Kinds of Training
3. Promotion

**UNIT IV**

**(9)**

1. All India Services
2. Service Conditions
3. State Public Service Commission

**UNIT V**

**(9)**

1. Employer Employee Relations
2. Wage and Salary Administration
3. Allowances and Benefits

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Stahl Glean O: Public Personnel Administration
2. Parnandikar Pai V.A: Personnel System for Development Administration.
3. Bhambhiru . P: Bureaucracy and Policy in India.
4. Dwivedi O.P and Jain R.B: India's Administrative state.
5. Muttalis M.A: Union Public Service Commission.
6. Bhakara Rao .V: Employer Employee Relations in India.
7. Davar R.S. Personnel Management & Industrial Relations

**CMG346**

**ADMINISTRATIVE THEORIES**

**L T P C**

**3 0 0 3**

**UNIT I**

**(9)**

Meaning, Scope and significance of Public Administration, Evolution of Public Administration as a discipline and Identity of Public Administration

**UNIT II** (9)  
Theories of Organization: Scientific Management Theory, Classical Model,  
Human Relations Theory

**UNIT III** (9)  
Organization goals and Behaviour, Groups in organization and group dynamics, Organizational  
Design.

**UNIT IV** (9)  
Motivation Theories, content, process and contemporary; Theories of Leadership: Traditional and  
Modern: Process and techniques of decision-making

**UNIT V** (9)  
Administrative thinkers: Kautilya, Woodrow Willson, C.I. Barnard . Peter Drucker

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Crozier M : The Bureaucratic phenomenon (Chand)
2. Blau. P.M and Scott. W : Formal Organizations (RKP)
3. Presthus. R : The Organizational Society (MAC)
4. Alvi, Shum Sun Nisa : Eminent Administrative Thinkers.
5. Keith Davis : Organization Theory (MAC)

**CMG347**

**INDIAN ADMINISTRATIVE SYSTEM**

**L T P C**

**3 0 0 3**

**UNIT I** (9)  
Evolution and Constitutional Context of Indian Administration, Constitutional Authorities: Finance  
Commission, Union Public Services Commission, Election Commission, Comptroller and Auditor  
General of India, Attorney General of India

**UNIT II** (9)  
Role & Functions of the District Collector, Relationship between the District  
Collector and Superintendent of Police, Role of Block Development Officer in development  
programmes, Local Government

**UNIT III** (9)  
Main Features of 73rd Constitutional Amendment Act 1992, Salient Features of 74th Constitutional  
Amendment Act 1992

**UNIT IV** (9)  
Coalition politics in India, Integrity and Vigilance in Indian Administration

**UNIT V** (9)  
Corruption – Ombudsman, Lok Pal & Lok Ayuktha

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. S.R. Maheswari : Indian Administration
2. Khera. S.S : Administration in India
3. Ramesh K. Arora : Indian Public Administration
4. T.N. Chaturvedi : State administration in India
5. Basu, D.D : Introduction to the Constitution of India

**CMG348****PUBLIC POLICY ADMINISTRATION****L T P C**  
**3 0 0 3****UNIT I****(9)**

Meaning and Definition of Public Policy - Nature, Scope and Importance of public policy – Public policy relationship with social sciences especially with political science and Public Administration.

**UNIT II****(9)**

Approaches in Policy Analysis - Institutional Approach – Incremental Approach and System's Approach – Dror's Optimal Model

**UNIT III****(9)**

Major stages involved in Policy making Process – Policy Formulation – Policy Implementation – Policy Evaluation.

**UNIT IV****(9)**

Institutional Framework of Policy making – Role of Bureaucracy – Role of Interest Groups and Role of Political Parties.

**UNIT V****(9)**

Introduction to the following Public Policies – New Economic Policy – Population Policy – Agriculture policy - Information Technology Policy.

**TOTAL: 45 PERIODS****REFERENCES:**

1. Rajesh Chakrabarti & Kaushik Sanyal : Public Policy in India, Oxford University Press, 2016.
2. Kuldeep Mathur : Public Policy and Politics in India, Oxford University Press, 2016.
3. Bidyutv Chakrabarty: Public Policy: Concept, Theory and Practice, 2015.
4. Pradeep Saxena : Public Policy Administration and Development
5. Sapru R.K. : Public Policy: Formulation, Implementation and Evaluation, Sterling Publishers, 2016.

**VERTICAL 4: BUSINESS DATA ANALYTICS****CMG349****STATISTICS FOR MANAGEMENT****L T P C**  
**3 0 0 3****COURSE OBJECTIVE:**

- To learn the applications of statistics in business decision making.

**UNIT I INTRODUCTION 9**  
Basic definitions and rules for probability, Baye's theorem and random variables, Probability distributions: Binomial, Poisson, Uniform and Normal distributions.

**UNIT II SAMPLING DISTRIBUTION AND ESTIMATION 9**  
Introduction to sampling distributions, Central limit theorem and applications, sampling techniques, Point and Interval estimates of population parameters.

**UNIT III TESTING OF HYPOTHESIS - PARAMETIRC TESTS 9**  
Hypothesis testing: one sample and two sample tests for means of large samples (z-test), one sample and two sample tests for means of small samples (t-test), ANOVA one way.

**UNIT IV NON-PARAMETRIC TESTS 9**  
Chi-square tests for independence of attributes and goodness of fit, Kolmogorov-Smirnov – test for goodness of fit, Mann – Whitney U test and Kruskal Wallis test.

**UNIT V CORRELATION AND REGRESSION 9**  
Correlation –Rank Correlation – Regression – Estimation of Regression line – Method of Least Squares – Standard Error of estimate.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

**CO1:**To facilitate objective solutions in business decision making.

**CO2:**To understand and solve business problems

**CO3:**To apply statistical techniques to data sets, and correctly interpret the results.

**CO4:**To develop skill-set that is in demand in both the research and business environments

**CO5:**To enable the students to apply the statistical techniques in a work setting.

**REFERENCES:**

1. Richard I. Levin, David S. Rubin, Masood H.Siddiqui, Sanjay Rastogi, Statistics for Management, Pearson Education, 8th Edition, 2017.
2. Prem. S. Mann, Introductory Statistics, Wiley Publications, 9th Edition, 2015.
3. T N Srivastava and Shailaja Rego, Statistics for Management, Tata McGraw Hill, 3rd Edition 2017.
4. Ken Black, Applied Business Statistics, 7th Edition, Wiley India Edition, 2012.
5. David R. Anderson, Dennis J. Sweeney, Thomas A.Williams, Jeffrey D.Camm, James J.Cochran, Statistics for business and economics, 13th edition, Thomson (South – Western) Asia, Singapore, 2016.
6. N. D. Vohra, Business Statistics, Tata McGraw Hill, 2017.

**CMG350 DATAMINING FOR BUSINESS INTELLIGENCE L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES :**

- To know how to derive meaning form huge volume of data and information.
- To understand how knowledge discovering process is used in business decision making.

**UNIT I INTRODUCTION 9**  
Data mining, Text mining, Web mining, Data ware house.



<b>UNIT II</b>	<b>DATA MINING PROCESS</b>	<b>9</b>
Datamining process – KDD, CRISP-DM, SEMMA Prediction performance measures		
<b>UNIT III</b>	<b>PREDICTION TECHNIQUES</b>	<b>9</b>
Data visualization, Time series – ARIMA, Winter Holts,		
<b>UNIT IV</b>	<b>CLASSIFICATION AND CLUSTERING TECHNIQUES</b>	<b>9</b>
Classification, Association, Clustering.		
<b>UNIT V</b>	<b>MACHINE LEARNING AND AI</b>	<b>9</b>
Genetic algorithms, Neural network, Fuzzy logic, Ant Colony optimization, Particle Swarm optimization		
		<b>TOTAL: 45 PERIODS</b>

**COURSE OUTCOMES:**

- CO1:** Learn to apply various data mining techniques into various areas of different domains.
- CO2:** Be able to interact competently on the topic of data mining for business intelligence.
- CO3:** Apply various prediction techniques.
- CO4:** Learn about supervised and unsupervised learning technique.
- CO5:** Develop and implement machine learning algorithms

**REFERENCES :**

1. Jaiwei Ham and Micheline Kamber, Data Mining concepts and techniques, Kauffmann Publishers 2006
2. Efraim Turban, Ramesh Sharda, Jay E. Aronson and David King, Business Intelligence, Prentice Hall, 2008.
3. W.H.Inmon, Building the Data Warehouse, fourth edition Wiley India pvt. Ltd. 2005.
4. Ralph Kimball and Richard Merz, The data warehouse toolkit, John Wiley, 3rd edition, 2013.
5. Michel Berry and Gordon Linoff, Mastering Data mining, John Wiley and Sons Inc, 2nd Edition, 2011
6. Michel Berry and Gordon Linoff, Data mining techniques for Marketing, Sales and Customer support, John Wiley, 2011
7. G. K. Gupta, Introduction to Data mining with Case Studies, Prentice hall of India, 2011
8. Giudici, Applied Data mining – Statistical Methods for Business and Industry, John Wiley. 2009
9. Elizabeth Vitt, Michael Luckevich Stacia Misner, Business Intelligence, Microsoft, 2011
10. Michalewicz Z., Schmidt M. Michalewicz M and Chiriach C, Adaptive Business Intelligence, Springer – Verlag, 2007
11. Galit Shmueli, Nitin R. Patel and Peter C. Bruce, Data Mining for Business Intelligence – Concepts, Techniques and Applications Wiley, India, 2010.

<b>CMG351</b>	<b>HUMAN RESOURCE ANALYTICS</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

**COURSE OBJECTIVE:**

- To develop the ability of the learners to define and implement HR metrics that are aligned with the overall business strategy.

- To know the different types of HR metrics and understand their respective impact and application.
- To understand the impact and use of HR metrics and their connection with HR analytics.
- To understand common workforce issues and resolving them using people analytics.

**UNIT I INTRODUCTION TO HR ANALYTICS 9**

People Analytics - stages of maturity - Human Capital in the Value Chain : impact on business – HR metrics and KPIs.

**UNIT II HR ANALYTICS I: RECRUITMENT 9**

Recruitment Metrics : Fill-up ratio - Time to hire - Cost per hire - Early turnover - Employee referral hires - Agency hires - Lateral hires - Fulfillment ratio- Quality of hire.

**UNIT III HR ANALYTICS - TRAINING AND DEVELOPMENT 9**

Training & Development Metrics : Percentage of employees trained- Internally and externally trained -Training hours and cost per employee - ROI.

**UNIT IV HR ANALYTICS EMPLOYEE ENGAGEMENT AND CAREER PROGRESSION 9**

Employee Engagement Metrics :Talent Retention index - Voluntary and involuntary turnover- grades, performance, and service tenure - Internal hired index Career Progression Metrics: Promotion index - Rotation index - Career path index.

**UNIT V HR ANALYTICS IV: WORKFORCE DIVERSITY AND DEVELOPMENT 9**

Workforce Diversity and Development Metrics : Employees per manager – Workforce age profiling - Workforce service profiling - Churnover index - Workforce diversity index - Gender mix

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

**CO1:**The learners will be conversant about HR metrics and ready to apply at work settings.

**CO2:**The learners will be able to resolve HR issues using people analytics.

**REFERENCES:**

1. JacFitzenz , The New HR Analytics, AMACOM , 2010.
2. Edwards M. R., & Edwards K, Predictive HR Analytics: Mastering the HR Metric.London: Kogan Page.2016.
3. Human Resources kit for Dummies – 3 rd edition – Max Messmer, 2003
4. Dipak Kumar Bhattacharyya, HR Analytics ,Understanding Theories and Applications, SAGE Publications India ,2017.
5. Sesil, J. C. , Applying advanced analytics to HR management decisions: Methods fo selection, developing incentives, and improving collaboration. Upper Saddle River,New Jersey: Pearson Education,2014.
6. Pease, G., & Beresford, B, Developing Human Capital: Using Analytics to Plan and Optimize Your Learning and Development Investments. Wiley ,2014.
7. Phillips, J., & Phillips, P.P, Making Human Capital Analytics Work: Measuring the ROI of Human Capital Processes and OUTCOME. McGraw-Hill,2014.
8. HR Scorecard and Metrics, HBR, 2001.

**CMG352**

**MARKETING AND SOCIAL MEDIA WEB ANALYTICS**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVE:**

- To showcase the opportunities that exist today to leverage the power of the web and social media

**UNIT I MARKETING ANALYTICS**

**9**

Marketing Budget and Marketing Performance Measure, Marketing - Geographical Mapping, Data Exploration, Market Basket Analysis

**UNIT II COMMUNITY BUILDING AND MANAGEMENT**

**9**

History and Evolution of Social Media-Understanding Science of Social Media –Goals for using Social Media- Social Media Audience and Influencers - Digital PR- Promoting Social Media Pages- Linking Social Media Accounts-The Viral Impact of Social Media.

**UNIT III SOCIAL MEDIA POLICIES AND MEASUREMENTS**

**9**

Social Media Policies-Etiquette, Privacy- ethical problems posed by emerging social media technologies - The Basics of Tracking Social Media.

**UNIT IV WEB ANALYTICS**

**9**

Data Collection, Overview of Qualitative Analysis, Business Analysis, KPI and Planning, Critical Components of a Successful Web Analytics Strategy, Proposals & Reports, Web Data Analysis.

**UNIT V SEARCH ANALYTICS**

**9**

Search engine optimization (SEO), user engagement, user-generated content, web traffic analysis, online security, online ethics, data visualization.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

- The Learners will understand social media, web and social media analytics and their potential impact.

**REFERENCES:**

1. K. M. Shrivastava, Social Media in Business and Governance, Sterling Publishers Private Limited, 2013
2. Christian Fuchs, Social Media a critical introduction, SAGE Publications Ltd, 2014
3. Bittu Kumar, Social Networking, V & S Publishers, 2013
4. Avinash Kaushik, Web Analytics - An Hour a Day, Wiley Publishing, 2007
5. Ric T. Peterson, Web Analytics Demystified, Celilo Group Media and CafePress 2004
6. Takeshi Moriguchi, Web Analytics Consultant Official Textbook, 7th Edition, 2016

**CMG353**

**OPERATION AND SUPPLY CHAIN ANALYTICS**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVE:**

- To treat the subject in depth by emphasizing on the advanced quantitative models and methods in operations and supply chain management and its practical aspects and the latest developments in the field.

<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>9</b>
Descriptive, predictive and prescriptive analytics, Data Driven Supply Chains – Basics, transforming supply chains.		
<b>UNIT II</b>	<b>WAREHOUSING DECISIONS</b>	<b>9</b>
P-Median Methods - Guided LP Approach, Greedy Drop Heuristics, Dynamic Location Models, Space Determination and Layout Methods.		
<b>UNIT III</b>	<b>INVENTORY MANAGEMENT</b>	<b>9</b>
Dynamic Lot sizing Methods, Multi-Echelon Inventory models, Aggregate Inventory system and LIMIT, Risk Analysis in Supply Chain, Risk pooling strategies.		
<b>UNIT IV</b>	<b>TRANSPORTATION NETWORK MODELS</b>	<b>9</b>
Minimal Spanning Tree, Shortest Path Algorithms, Maximal Flow Problems, Transportation Problems, Set covering and Set Partitioning Problems, Travelling Salesman Problem, Scheduling Algorithms.		
<b>UNIT V</b>	<b>MCDM MODELS</b>	<b>9</b>
Analytic Hierarchy Process(AHP), Data Envelopment Analysis (DEA), Fuzzy Logic an Techniques, the analytical network process (ANP), TOPSIS.		

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

- To enable quantitative solutions in business decision making under conditions of certainty, risk and uncertainty.

**REFERENCES:**

1. Nada R. Sanders, Big data driven supply chain management: A framework for implementing analytics and turning information into intelligence, Pearson Education, 2014.
2. Michael Watson, Sara Lewis, Peter Cacioppi, Jay Jayaraman, Supply Chain Network Design: Applying Optimization and Analytics to the Global Supply Chain, Pearson Education, 2013.
3. Anna Nagurney, Min Yu, Amir H. Masoumi, Ladimer S. Nagurney, Networks Against Time: Supply Chain Analytics for Perishable Products, Springer, 2013.
4. Muthu Mathirajan, Chandrasekharan Rajendran, Sowmyanarayanan Sadagopan, Arunachalam Ravindran, Parasuram Balasubramanian, Analytics in Operations/Supply Chain Management , I.K. International Publishing House Pvt. Ltd., 2016.
5. Gerhard J. Plenert, Supply Chain Optimization through Segmentation and Analytics, CRC Press, Taylor & Francis Group, 2014.

<b>CMG354</b>	<b>FINANCIAL ANALYTICS</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

**COURSE OBJECTIVE:**

- This course introduces a core set of modern analytical tools that specifically target finance applications.

<b>UNIT I</b>	<b>CORPORATE FINANCE ANALYSIS</b>	<b>9</b>
Basic corporate financial predictive modelling- Project analysis- cash flow analysis- cost of capital, Financial Break even modelling, Capital Budget model-Payback, NPV, IRR.		

**UNIT II FINANCIAL MARKET ANALYSIS 9**  
Estimation and prediction of risk and return ( bond investment and stock investment) –Time series-  
examining nature of data, Value at risk, ARMA, ARCH and GARCH.

**UNIT III PORTFOLIO ANALYSIS 9**  
Portfolio Analysis – capital asset pricing model, Sharpe ratio, Option pricing models- binomial model  
for options, Black Scholes model and Option implied volatility.

**UNIT IV TECHNICAL ANALYSIS 9**  
Prediction using charts and fundamentals – RSI, ROC, MACD, moving average and candle charts,  
simulating trading strategies. Prediction of share prices.

**UNIT V CREDIT RISK ANALYSIS 9**  
Credit Risk analysis- Data processing, Decision trees, logistic regression and evaluating credit risk  
model.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME**

- The learners should be able to perform financial analysis for decision making using excel, Python and R.

**REFERENCES:**

1. Financial analytics with R by Mark J. Bennett, Dirk L. Hugen, Cambridge university press.
2. Haskell Financial Data Modeling and Predictive Analytics Paperback – Import, 25 Oct 2013 by Pavel Ryzhov.
3. Quantitative Financial Analytics: The Path To Investment Profits Paperback – Import, 11 Sep 2017 by Edward E Williams (Author), John A Dobelman.
4. Python for Finance - Paperback – Import, 30 Jun 2017 by Yuxing Yan (Author).
5. Mastering Python for Finance Paperback – Import, 29 Apr 2015 by James Ma Weiming.

**VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY**

**CES331 SUSTAINABLE INFRASTRUCTURE DEVELOPMENT L T P C**  
**3 0 0 3**

**COURSE OBJECTIVE:**

- To impart knowledge about sustainable Infrastructure development goals, practices and to understand the concepts of sustainable planning, design, construction, maintenance and decommissioning of infrastructure projects.

**UNIT I SUSTAINABLE DEVELOPMENT GOALS 9**  
Definitions, principles and history of Sustainable Development - Sustainable development goals (SDG): global and Indian – Infrastructure Demand and Supply - Environment and Development linkages - societal and cultural demands – Sustainability indicators - Performance indicators of sustainability and Assessment mechanism - Policy frameworks and practices: global and Indian – Infrastructure Project finance – Infrastructure project life cycle - Constraints and barriers for sustainable development - future directions.

## **UNIT II SUSTAINABLE INFRASTRUCTURE PLANNING 9**

Overview of Infrastructure projects: Housing sector, Power sector, Water supply, road, rail and port transportation sector, rural and urban infrastructure. Environmental Impact Assessment (EIA), Land acquisition -Legal aspects, Resettlement & Rehabilitation and Development - Cost effectiveness Analysis - Risk Management Framework for Infrastructure Projects, Economic, demand, political, socio-environmental and cultural risks. Shaping the Planning Phase of Infrastructure Projects to mitigate risks, Designing Sustainable Contracts, Negotiating with multiple Stakeholders on Infrastructure Projects. Use of ICT tools in planning – Integrated planning - Clash detection in construction - BIM (Building Information Modelling).

## **UNIT III SUSTAINABLE CONSTRUCTION PRACTICES AND TECHNIQUES 9**

Sustainability through lean construction approach - Enabling lean through information technology – Lean in planning and design - IPD (Integrated Project Delivery) - Location Based Management System - Geospatial Technologies for machine control, site management, precision control and real time progress monitoring - Role of logistics in achieving sustainable construction – Data management for integrated supply chains in construction - Resource efficiency benefits of effective logistics - Sustainability in geotechnical practice – Design considerations, Design Parameters and Procedures – Quality control and Assurance - Use of sustainable construction techniques: Precast concrete technology, Pre-engineered buildings.

## **UNIT IV SUSTAINABLE CONSTRUCTION MATERIALS 9**

Construction materials: Concrete, steel, glass, aluminium, timber and FRP - No/Low cement concrete - Recycled and manufactured aggregate - Role of QC and durability - Sustainable consumption – Eco-efficiency - green consumerism - product stewardship and green engineering - Extended producer responsibility – Design for Environment Strategies, Practices, Guidelines, Methods, And Tools. Eco-design strategies –Design for Disassembly - Dematerialization, rematerialization, transmaterialization – Green procurement and green distribution - Analysis framework for reuse and recycling – Typical constraints on reuse and recycling - Communication of Life Cycle Information - Indian Eco mark scheme - Environmental product declarations – Environmental marketing- Life cycle Analysis (LCA), Advances in LCA: Hybrid LCA, Thermodynamic LCA - Extending LCA - economic dimension, social dimension - Life cycle costing (LCC) - Combining LCA and LCC – Case studies

## **UNIT V SUSTAINABLE MAINTENANCE OF INFRASTRUCTURE PROJECTS 9**

Case Studies - Sustainable projects in developed countries and developing nations - An Integrated Framework for Successful Infrastructure Planning and Management - Information Technology and Systems for Successful Infrastructure Management, - Structural Health Monitoring for Infrastructure projects - Innovative Design and Maintenance of Infrastructure Facilities - Capacity Building and Improving the Governments Role in Infrastructure Implementation, Infrastructure Management Systems and Future Directions. – Use of Emerging Technologies – IoT, Big Data Analytics and Cloud Computing, Artificial Intelligences, Machine and Deep Learning, Fifth Generation (5G) Network services for maintenance .

**TOTAL: 45 PERIODS**

### **COURSE OUTCOME:**

On completion of the course, the student is expected to be able to

**CO1** Understand the environment sustainability goals at global and Indian scenario.

**CO2** Understand risks in development of projects and suggest mitigation measures.

**CO3** Apply lean techniques, LBMS and new construction techniques to achieve sustainability in infrastructure construction projects.

**CO4** Explain Life Cycle Analysis and life cycle cost of construction materials.

**CO5** Explain the new technologies for maintenance of infrastructure projects.

**REFERENCES:**

1. Charles J Kibert, Sustainable Construction : Green Building Design & Delivery, 4th Edition , Wiley Publishers 2016.
2. Steve Goodhew, Sustainable Construction Process, Wiley Blackwell,UK, 2016.
3. Craig A. Langston & Grace K.C. Ding, Sustainable Practices in the Built Environment, Butterworth Heinemann Publishers, 2011.
4. William P Spence, Construction Materials, Methods & Techniques (3e), Yesdee Publication Pvt. Ltd, 2016.
6. New Building Materials and Construction World magazine
7. Kerry Turner. R, "Sustainable Environmental Management", Principles and Practice Publisher:Belhaven Press,ISBN:1852930039.
8. Munier N, "Introduction to Sustainability", Springer2005
9. Sharma, "Sustainable Smart Cities In India: Challenges And Future Perspectives", SPRINGER, 2022.
10. Ralph Horne, Tim Grant, KarliVerghese, Life Cycle Assessment: Principles, Practice and Prospects, Csiro Publishing,2009
11. European Commission - Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. Luxembourg. European Union;2010
12. Hudson, Haas, Uddin, Infrastructure management: integrating design, construction, maintenance, rehabilitation, and renovation, McGraw Hill, (1997).
13. GregerLundesjö, Supply Chain Management and Logistics in Construction: Delivering Tomorrow's Built Environment, Kogan Page Publishers, 2015.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2		1	1		2	3	1	1		2	1	1	2	1
2	3	1	3	2	1	2	2		1	1	1	2	2	2	2
3	2	2	3	1	1	1	1				1	1	1	3	1
4	3	1	3	2	2	1	3	1	1	1	1	2	2	2	2
5	3	1	2	2	2	2	3	1		1	1	2	2	3	2
<b>Avg.</b>	3	1	3	2	2	2	3	1	1	1	1	2	2	3	2

1 - low, 2 - medium, 3 - high, '-'- no correlation

**CES332 SUSTAINABLE AGRICULTURE AND ENVIRONMENTAL MANAGEMENT**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To educate the students about the issues of sustainability in agroecosystems, introduce the concepts and principles of agroecology as applied to the design and management of sustainable agricultural systems for a changing world.

## **UNIT I AGROECOLOGY, AGROECOSYSTEM AND SUSTAINABLE AGRICULTURE CONCEPTS** **9**

Ecosystem definition - Biotic Vs. abiotic factors in an ecosystem - Ecosystem processes - Ecological services and agriculture - Problems associated with industrial agriculture/food systems - Defining sustainability - Characteristics of sustainable agriculture - Difference between regenerative and sustainable agriculture systems

## **UNIT II SOIL HEALTH, NUTRIENT AND PEST MANAGEMENT** **9**

Soil health definition - Factors to consider (physical, chemical and biological) - Composition of healthy soils - Soil erosion and possible control measures - Techniques to build healthy soil - Management practices for improving soil nutrient - Ecologically sustainable strategies for pest and disease control

## **UNIT III WATER MANAGEMENT** **9**

Soil water storage and availability - Plant yield response to water - Reducing evaporation in agriculture - Earthworks and tanks for rainwater harvesting - Options for improving the productivity of water - Localized irrigation - Irrigation scheduling - Fertigation - Advanced irrigation systems and agricultural practices for sustainable water use

## **UNIT IV ENERGY AND WASTE MANAGEMENT** **9**

Types and sources of agricultural wastes - Composition of agricultural wastes - Sustainable technologies for the management of agricultural wastes - Useful and high value materials produced using different processes from agricultural wastes - Renewable energy for sustainable agriculture

## **UNIT V EVALUATING SUSTAINABILITY IN AGROECOSYSTEMS** **9**

Indicators of sustainability in agriculture - On-farm evaluation of agroecosystem sustainability - Alternative agriculture approaches/ farming techniques for sustainable food production - Goals and components of a community food system - Case studies

**TOTAL: 45 PERIODS**

### **COURSE OUTCOME**

On completion of the course, the student is expected to be able to

**CO1** Have an in-depth knowledge about the concepts, principles and advantages of sustainable agriculture

**CO2** Discuss the sustainable ways in managing soil health, nutrients, pests and diseases

**CO3** Suggest the ways to optimize the use of water in agriculture to promote an ecological use of resources

**CO4** Develop energy and waste management plans for promoting sustainable agriculture in non-sustainable farming areas

**CO5** Assess an ecosystem for its level of sustainability and prescribe ways of converting to a sustainable system through the redesign of a conventional agroecosystem

### **REFERENCES:**

1. Approaches to Sustainable Agriculture – Exploring the Pathways Towards the Future of Farming, Oberc, B.P. & Arroyo Schnell, A., IUCN, Belgium, 2020
2. Natural bioactive products in sustainable agriculture, Singh, J. & Yadav, A.N., Springer, 2020
3. Organic Farming for Sustainable Agriculture, Nandwani, D., Springer, 2016
4. Principles of Agronomy for Sustainable Agriculture, Villalobos, F.J. & Fereres, E., Springer, 2016



5. Sustainable Agriculture for Food Security: A Global Perspective, Balkrishna, A., CRC Press, 2021
6. Sustainable Energy Solutions in Agriculture, Bundschuh, J. & Chen, G., CRC Press, 2014

### CO's-PO's & PSO's MAPPING - SUSTAINABLE AGRICULTURE PRACTICES

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		2						2		2			2	2	
2		2		2	2	2							3	2	
3				2		2							3	2	3
4	3	2			2			2	2	2	2		3	2	3
5		2	3	2			1					1		2	
Avg.	3	2	3	2	2	2	1	2	2	2	2	1	3	2	3

1 – Low; 2 – Medium; 3 – High; ‘- ‘– No correlation

CES333

SUSTAINABLE BIOMATERIALS

LT P C  
3 0 0 3

#### COURSE OBJECTIVES

- To Impart knowledge of biomaterials and their properties
- To learn about Fundamentals aspects of Biopolymers and their applications
- To learn about bioceramics and biopolymers
- To introduce the students about metals as biomaterials and their usage as implants
- To make the students understand the significance of bionanomaterials and its applications.

#### UNIT I INTRODUCTION TO BIOMATERIALS

9

Introduction: Definition of biomaterials, requirements & classification of biomaterials- Types of Biomaterials- Degradable and resorbable biomaterials- engineered natural materials- Biocompatibility-Hydrogels-pyrolitic carbon for long term medical implants-textured and porous materials-Bonding types- crystal structure-imperfection in crystalline structure-surface properties and adhesion of materials –strength of biological tissues-performance of implants-tissue response to implants- Impact and Future of Biomaterials

#### UNIT II BIO POLYMERS

9

Molecular structure of polymers -Molecular weight - Types of polymerization techniques–Types of polymerization reactions- Physical states of polymers- Common polymeric biomaterials - Polyethylene -Polymethylmethacrylate (PMMA-Polylactic acid (PLA) and polyglycolic acid (PGA) - Polycaprolactone (PCL) - Other biodegradable polymers –Polyurethan- reactions polymers for medical purposes - Collagens- Elastin- Cellulose and derivatives-Synthetic polymeric membranes and their biological applications

#### UNIT III BIO CERAMICS AND BIOCOMPOSITES

9

General properties- Bio ceramics -Silicate glass - Alumina (Al<sub>2</sub>O<sub>3</sub>) -Zirconia (ZrO<sub>2</sub>)-Carbon- Calcium phosphates (CaP)- Resorbable Ceramics- surface reactive ceramics- Biomedical Composites- Polymer Matrix Composite(PMC)-Ceramic Matrix Composite(CMC)-Metal Matrix Composite (MMC)– glass ceramics - Orthopedic implants-Tissue engineering scaffolds

#### **UNIT IV METALS AS BIOMATERIALS**

**9**

Biomedical metals-types and properties-stainless steel-Cobalt chromium alloys-Titanium alloys-Tantalum-Nickel titanium alloy (Nitinol)- magnesium-based biodegradable alloys-surface properties of metal implants for osteointegration-medical application-corrosion of metallic implants – biological tolerance of implant metals

#### **UNIT V NANOBIMATERIALS**

**9**

Meatlllicnanobiomaterials–Nanopolymers-Nanoceramics- Nanocomposites -Carbon based nanobiomaterials - transport of nanoparticles- release rate-positive and negative effect of nanosize-nanofibres-Nano and micro features and their importance in implant performance-Nanosurface and coats-Applications nanoantibiotics-Nanomedicines- Biochips – Biomimetics- BioNEMs -Biosensor-Bioimaging/Molecular Imaging- challenges and future perspective.

**TOTAL : 45 PERIODS**

#### **COURSE OUTCOMES**

**CO1:**Students will gain familiarity with Biomaterials and they will understand their importance.

**CO2:**Students will get an overview of different biopolymers and their properties

**CO3:**Students gain knowledge on some of the important Bioceramics and Biocomposite materials

**CO4:**Students gain knowledge on metals as biomaterials

**CO5:**Student gains knowledge on the importance of nanobiomaterials in biomedical applications.

#### **REFERENCES**

1. C. Mauli Agrawal, Joo L. Ong, Mark R. Appleford, Gopinath Mani “Introduction to Biomaterials Basic Theory with Engineering Applications” Cambridge University Press, 2014.
2. Donglu shi “Introduction to Biomaterials” Tsinghua University press, 2006.
3. Joon Park, R.S.Lakes “Biomaterials An Introduction” third edition, Springer 2007.
4. M.Jaffe,W.Hammond, P.Tolias and T.Arinzeh “Characterization of Biomaterials” Wood head publishing, 2013.
5. Buddy D.Ratner and Allan S.Hoffman Biomaterials Science “An Introduction to Material in Medicine” Third Edition, 2013.
6. VasifHasirci, NesrinHasirci “Fundamentals of Biomaterials” Springer, 2018
7. Leopido Javier Rios Gonzalez. “Handbook of Research on Bioenergy and Biomaterials: Consolidated and green process” Apple academic press, 2021.
8. Devarajan Thangadurai, Jeyabalan Sangeetha, Ram Prasad “Functional Bionanomaterials” springer, 2020.
9. Sujata.V.Bhat Biomaterials; Narosa Publishing house, 2002.

**CES334**

**MATERIALS FOR ENERGY SUSTAINABILITY**

**L T P C  
3 0 0 3**

#### **COURSE OBJECTIVES**

- To familiarize the students about the challenges and demands of energy sustainability
- To provide fundamental knowledge about electrochemical devices and the materials used.
- To introduce the students to various types of fuel cell
- To enable students to appreciate novel materials and their usage in photovoltaic application
- To introduce students to the basic principles of various types Supercapacitors and the materials used.

**UNIT I SUSTAINABLE ENERGY SOURCES 9**

Introduction to energy demand and challenges ahead – sustainable source of energy (wind, solar etc.) – electrochemical energy systems for energy harvesting and storage – materials for sustainable electrochemical systems building – India centric solutions based on locally available materials – Economics of wind and solar power generators vs. conventional coal plants – Nuclear energy

**UNIT II ELECTROCHEMICAL DEVICES 9**

Electrochemical Energy – Difference between primary and secondary batteries – Secondary battery (Li-ion battery, Sodium-ion battery, Li-S battery, Li-O<sub>2</sub> battery, Nickel Cadmium, Nickel Metal Hydride) – Primary battery (Alkaline battery, Zinc-Carbon battery) – Materials for battery (Anode materials – Lithiated graphite, Sodiated hard carbon, Silicon doped graphene, Lithium Titanate) (Cathode Materials – S, LiCoO<sub>2</sub>, LiFePO<sub>4</sub>, LiMn<sub>2</sub>O<sub>4</sub>) – Electrolytes for Lithium-ion battery (ethylene carbonate and propylene carbonate based)

**UNIT III FUEL CELLS 9**

Principle of operation of fuel cells – types of fuel cells (Proton exchange membrane fuel cells, alkaline fuel cell, direct methanol fuel cells, direct borohydride fuel cells, phosphoric acid fuel cells, solid oxide fuel cells, and molten carbonate fuel cells) – Thermodynamics of fuel cell – Fuel utilization – electrolyte membrane (proton conducting and anion conducting) – Catalysts (Platinum, Platinum alloys, carbon supported platinum systems and metal oxide supported platinum catalysts) – Anatomy of fuel cells (gas diffusion layer, catalyst layer, flow field plate, current conductors, bipolar plates and monopolar plates).

**UNIT IV PHOTOVOLTAICS 9**

Physics of the solar cell – Theoretical limits of photovoltaic conversion – bulk crystal growth of Si and wafering for photovoltaic application - Crystalline silicon solar cells – thin film silicon solar cells – multijunction solar cells – amorphous silicon based solar cells – photovoltaic concentrators – Cu(InGa)Se<sub>2</sub> solar cells – Cadmium Telluride solar cells – dye sensitized solar cells – Perovskite solar cells – Measurement and characterization of solar cells - Materials used in solar cells (metallic oxides, CNT films, graphene, OD fullerenes, single-multi walled carbon nanotubes, two-dimensional Graphene, organic or Small molecule-based solar cells materials - copper-phthalocyanine and perylenetetra-carboxylic bis - benzene – fullerenes - boron subphthalocyanine- tin (II) phthalocyanine)

**UNIT V SUPERCAPACITORS 9**

Supercapacitor –types of supercapacitors (electrostatic double-layer capacitors, pseudo capacitors and hybrid capacitors) - design of supercapacitor-three and two electrode cell-parameters of supercapacitor- Faradaic and non - Faradaic capacitance – electrode materials (transition metal oxides (MO), mixed metal oxides, conducting polymers (CP), Mxenes, nanocarbons, non-noble metal, chalcogenides, hydroxides and 1D-3D metal-organic frame work (MOF), activated carbon fibres (ACF)- Hydroxides-Based Materials - Polyaniline (PANI), a ternary hybrid composite-conductive polypyrrole hydrogels – Different types of nanocomposites for the SC electrodes (carbon-carbon composites, carbon-MOs composites, carbon-CPs composites and MOs-CPs composites) - Two-Dimensional (2D) Electrode Materials - 2D transition metal carbides, carbonitrides, and nitrides.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES**

**CO1:**Students will acquire knowledge about energy sustainability.

**CO2:**Students understand the principles of different electrochemical devices.

**CO3:**Students learn about the working of fuel cells and their application.

**CO4:**Students will learn about various Photovoltaic applications and the materials used.

**CO5:**The students gain knowledge on different types of supercapacitors and the performance of various materials

## REFERENCES

1. Functional materials for sustainable energy applications; John A. Kilner, Stephen J. Skinner, Stuart J. C. Irvine and Peter P. Edwards.
2. Hand Book of Fuel Cells: Fuel Cell Technology and Applications, Wolf Vielstich, Arnold Lamm, Hubert Andreas Gasteiger, Harumi Yokokawa, Wiley, London 2003.
3. B.E. Conway, Electrochemical supercapacitors: scientific fundamentals and technological applications, Kluwer Academic / Plenum publishers, New York, 1999.
4. T.R. Crompton, Batteries reference book, Newners, 3rd Edition, 2002.
5. Materials for Supercapacitor applications; B.Viswanathan. M.Aulice Scibioh
6. Electrode Materials for Supercapacitors: A Review of Recent Advances, Parnia Forouzandeh, Vignesh Kumaravel and Suresh C. Pillai, catalysts 2020.
7. Recent advances, practical challenges, and perspectives of intermediate temperature solid oxide fuel cell cathodes Amanda Ndubuisi, Sara Abouali, Kalpana Singh and VenkataramanThangadurai, J. Mater. Chem. A, 2022.
8. Review of next generation photovoltaic solar cell technology and comparative materialistic development Neeraj Kant, Pushendra Singh, Materials Today: Proceedings, 2022.

**CES335**

**GREEN TECHNOLOGY**

**L T P C**  
**3 0 0 3**

### COURSE OBJECTIVE:

- To acquire knowledge on green systems and the environment, energy technology and efficiency, and sustainability.
- To provide green engineering solutions to energy demand, reduced energy footprint.

### UNIT I PRINCIPLES OF GREEN CHEMISTRY

**9**

Historical Perspectives and Basic Concepts. The twelve Principles of Green Chemistry and green engineering. Green chemistry metrics- atom economy, E factor, reaction mass efficiency, and other green chemistry metrics, application of green metrics analysis to synthetic plans.

### UNIT II POLLUTION TYPES

**9**

Pollution – types, causes, effects, and abatement. Waste – sources of waste, different types of waste, chemical, physical and biochemical methods of waste minimization and recycling.

### UNIT III GREEN REAGENTS AND GREEN SYNTHESIS

**9**

Environmentally benign processes- alternate solvents- supercritical solvents, ionic liquids, water as a reaction medium, energy-efficient design of processes- photo, electro and sono chemical methods, microwave-assisted reactions

### UNIT IV DESIGNING GREEN PROCESSES

**9**

Safe design, process intensification, in process monitoring. Safe product and process design – Design for degradation, Real-time Analysis for pollution prevention, inherently safer chemistry for accident prevention

**UNIT V GREEN NANOTECHNOLOGY****9**

Nanomaterials for water treatment, nanotechnology for renewable energy, nanotechnology for environmental remediation and waste management, nanotechnology products as potential substitutes for harmful chemicals, environmental concerns with nanotechnology

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

**CO1:** To understand the principles of green engineering and technology

**CO2:** To learn about pollution using hazardous chemicals and solvents

**CO3:** To modify processes and products to make them green and safe.

**CO4:** To design processes and products using green technology

**CO5:** To understand advanced technology in green synthesis

**TEXT BOOKS**

1. Green technology and design for the environment, Samir B. Billatos, Nadia A. Basaly, Taylor & Francis, Washington, DC, ©1997
2. Green Chemistry – An introductory text - M. Lancaster, RSC, 2016.
3. Green chemistry metrics - Alexi Lapkin and David Constable (Eds) , Wiley publications, 2008

**REFERENCE BOOKS**

1. Environmental chemistry, Stanley E Manahan, Taylor and Francis, 2017

**CES336 ENVIRONMENTAL QUALITY MONITORING AND ANALYSIS****L T P C**  
**3 0 0 3****COURSE OBJECTIVES:**

- to understand and study the complexity of the environment in relation to pollutants generated due to industrial activity.
- To analyze the quality of the environmental parameters and monitor the same for the purpose of environmental risk assessment.

**UNIT I ENVIRONMENTAL MONITORING AND STANDARDS****9**

Introduction- Environmental Standards- Classification of Environmental Standards- Global Environmental Standards- Environmental Standards in India- Ambient air quality standards- water quality standard- Environmental Monitoring-Need for environmental monitoring- Concepts of environmental monitoring- Techniques of Environmental Monitoring.

**UNIT II MONITORING OF ENVIRONMENTAL PARAMETERS****9**

Current Environmental Issues- Global Environmental monitoring programme-International conventions- Application of Environmental Monitoring- Atmospheric Monitoring - screening parameters – Significance of environmental sampling- sampling methods – water sampling - sampling of ambient air-sampling of flue gas.

**UNIT III ANALYTICAL METHODS FOR ENVIRONMENTAL MONITORING****9**

Classification of Instrumental Method- Analysis of Organic Pollutants by Spectrophotometric methods -Determination of nitrogen, phosphorus and, chemical oxygen demand (COD) in sewage; Biochemical oxygen demand (BOD)- Sampling techniques for air pollution measurements; analysis

of particulates and air pollutants like oxides of nitrogen, oxides of sulfur, carbon monoxide, hydrocarbon; Introduction to advanced instruments for environmental analysis

#### UNIT IV ENVIRONMENTAL MONITORING PROGRAMME (EMP) & RISKASSESSMENT 9

Water quality monitoring programme- national water quality monitoring- Parameters for National Water Quality Monitoring- monitoring protocol; Process of risk assessment- hazard identification- exposure assessment- dose-response assessment; risk characterization.

#### UNIT V AUTOMATED DATA ACQUISITION AND PROCESSING 9

Data Acquisition for Process Monitoring and Control - The Data Acquisition System - Online Data Acquisition, Monitoring, and Control - Implementation of a Data Management System - Review of Observational Networks -Sensors and transducers- classification of transducers- data acquisition system- types of data acquisition systems- data management and quality control; regulatory overview.

**TOTAL: 45 PERIODS**

#### COURSE OUTCOMES

After completion of this course, the students will know

CO1	Basic concepts of environmental standards and monitoring.
CO2	the ambient air quality and water quality standards;
CO3	the various instrumental methods and their principles for environmental monitoring
CO4	The significance of environmental standards in monitoring quality and sustainability of the environment.
CO5	the various ways of raising environmental awareness among the people.
CO6	Know the standard research methods that are used worldwide for monitoring the environment.

#### TEXTBOOKS

1. Environmental monitoring Handbook, Frank R. Burden, © 2002 by The McGraw-Hill Companies, Inc.
2. Handbook of environmental analysis: chemical pollutants in the air, water, soil, and solid wastes / Pradyot Patnaik, © 1997 by CRC Press, Inc

#### REFERENCES

1. Environmental monitoring / edited by G. Bruce Wiersma, © 2004 by CRC Press LLC.
2. H. H. Willard, L. L. Merit, J. A. Dean and F. A. Settle, Instrumental Methods of Analysis, CBP Publishers and Distributors, New Delhi, 1988.
3. Heaslip, G. (1975) Environmental Data Handling. John Wiley & Sons. New York.

#### CO's-PO's & PSO's MAPPING

Course Outcomes	Program Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	1	1	1	-	-	-	-	-	-	-	-	-	3	-	-
CO2	1	1	1	1	1	-	-	-	1	-	2	2	2	1	1
CO3	1	1	2	1	1	-	-	-	2	-	1	1	1	-	-
CO4	1	2	3	3	1	-	-	-	2	-	3	3	1	-	-
CO5	1	1	3	2	1	-	-	-	3	-	3	1	2	-	-

CO6	3	2	3	3	2	-	-	-	3	-	3	3	3	1	1
Over all	3	2	3	3	2	-	-	-	3	-	3	3	3	1	1

1 - low, 2 - medium, 3 - high, "--" - no correlation

## CES337 INTEGRATED ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT

L T P C  
3 0 0 3

### COURSE OBJECTIVES:

- To create awareness on the energy scenario of India with respect to world
- To understand the fundamentals of energy sources, energy efficiency and resulting environmental implications of energy utilisation
- Familiarisation on the concept of sustainable development and its benefits
- Recognize the potential of renewable energy sources and its conversion technologies for attaining sustainable development
- Acquainting with energy policies and energy planning for sustainable development

### UNIT I ENERGY SCENARIO 9

Comparison of energy scenario – India and World (energy sources, generation mix, consumption pattern, T&D losses, energy demand, per capita energy consumption) – energy pricing – Energy security

### UNIT II ENERGY AND ENVIRONMENT 9

Conventional Energy Sources - Emissions from fuels – Air, Water and Land pollution – Environmental standards - measurement and controls

### UNIT III SUSTAINABLE DEVELOPMENT 9

Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG) - Social development: Poverty, conceptual issues and measures, impact of poverty. Globalization and Economic growth - Economic development: Economic inequalities, Income and growth.

### UNIT IV RENEWABLE ENERGY TECHNOLOGY 9

Renewable Energy – Sources and Potential – Technologies for harnessing from Solar, Wind, Hydro, Biomass and Oceans – Principle of operation, relative merits and demerits

### UNIT V ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT 9

National & State Energy Policy - National solar mission - Framework of Central Electricity Authority - National Hydrogen Mission - Energy and climate policy - State Energy Action Plan, RE integration, Road map for ethanol blending, Energy Efficiency and Energy Mix

### COURSE OUTCOMES:

Upon completion of this course, the students will be able to

**CO1:** Understand the world and Indian energy scenario

**CO2:** Analyse energy projects, its impact on environment and suggest control strategies

**CO3:** Recognise the need of Sustainable development and its impact on human resource development

**CO4:** Apply renewable energy technologies for sustainable development

**CO5:** Fathom Energy policies and planning for sustainable development.

## REFERENCES:

1. Energy Manager Training Manual (4Volumes) available at [http://www.em-  
ea.org/gbook1.asp](http://www.em-<br/>ea.org/gbook1.asp), a website administered by Bureau of Energy Efficiency (BEE), a statutory  
body under Ministry of Power, Government of India.2004
2. Robert Ristirer and Jack P. Kraushaar, "Energy and the environment", Willey, 2005.
3. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University  
Press, U.K., 2012
4. Twidell, J.W. & Weir A., "Renewable Energy Resources", EFNSpon Ltd., UK, 2015.
5. Dhandapani Alagiri, Energy Security in India Current Scenario, The ICFAI University Press,  
2006.
6. M.H. Fulekar, Bhawana Pathak, R K Kale, "Environment and Sustainable Development"  
Springer, 2016
7. <https://www.niti.gov.in/verticals/energy>

**CES338 ENERGY EFFICIENCY FOR SUSTAINABLE DEVELOPMENT L T P C**  
**3 0 0 3**

## COURSE OBJECTIVES:

- To understand the types of energy sources, energy efficiency and environmental implications of energy utilisation
- To create awareness on energy audit and its impacts
- To acquaint the techniques adopted for performance evaluation of thermal utilities
- To familiarise on the procedures adopted for performance evaluation of electrical utilities
- To learn the concept of sustainable development and the implication of energy usage

### **UNIT I ENERGY AND ENVIRONMENT 9**

Primary energy sources - Coal, Oil, Gas – India Vs World with respect to energy production and consumption, Climate Change, Global Warming, Ozone Depletion, UNFCCC, COP

### **UNIT II ENERGY AUDITING 9**

Need and types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments

### **UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES 9**

Energy conservation avenues in steam generation and utilisation, furnaces, Thermic Fluid Heaters. Insulation and Refractories - Commercial waste heat recovery devices: recuperator, regenerator, heat pipe, heat exchangers (Plate, Shell & Tube), heat pumps, and thermocompression

### **UNIT IV ENERGY CONSERVTION IN ELECTRICAL UTILITIES 9**

Demand side management - Power factor improvement – Energy efficient transformers - Energy conservation avenues in Motors, HVAC, fans, blowers, pumps, air compressors, illumination systems and cooling towers



## UNIT V SUSTAINABLE DEVELOPMENT

9

Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG). Globalization and Economic growth. Economic development: Economic inequalities, Income and growth. Social development: Poverty, conceptual issues and measures, impact of poverty,

### COURSE OUTCOMES:

Upon completion of this course, the students will be able to

**CO1:** Understand the prevailing energy scenario

**CO2:** Familiarise on energy audits and its relevance

**CO3:** Apply the concept of energy audit on thermal utilities

**CO4:** Employ relevant techniques for energy improvement in electrical utilities

**CO5:** Understand Sustainable development and its impact on human resource development

**TOTAL:45 PERIODS**

### REFERENCES:

1. Energy Manager Training Manual (4Volumes) available at [http://www.em-  
ea.org/gbook1.asp](http://www.em-<br/>ea.org/gbook1.asp), a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004
2. Eastop.T.D& Croft D.R, "Energy Efficiency for Engineers and Technologists", Logman Scientific & Technical, ISBN-0-582-03184, 1990
3. W.R. Murphy and G. McKay "Energy Management" Butterworths, London 1987
4. Pratap Bhattacharyya, "Climate Change and Greenhouse Gas Emission", New India Publishing Agency- Nipa,2020
5. Matthew John Franchetti , Defne Apul "Carbon Footprint Analysis: Concepts, Methods, Implementation, and Case Studies" CRC Press,2012
6. Robert A. Ristinen, Jack J. Kraushaar, Jeffrey T. Brack, "Energy and the Environment", 4th Edition,Wiley,2022
7. M.H. Fulekar,Bhawana Pathak, R K Kale,"Environment and Sustainable Development" Springer,2016
8. Sustainable development in India: Stocktaking in the run up to Rio+20: Report prepared by TERI for MoEF, 2011.

PROGRESS THROUGH KNOWLEDGE





**ANNA UNIVERSITY, CHENNAI  
NON-AUTONOMOUS AFFILIATED COLLEGES  
REGULATIONS 2021  
CHOICE BASED CREDIT SYSTEM**

**B.E. ELECTRICAL AND ELECTRONICS ENGINEERING**

**1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):**

- I. Find employment in Core Electrical and Electronics Engineering and service sectors.
- II. Get elevated to technical lead position and lead the organization competitively.
- III. Enter into higher studies leading to post-graduate and research degrees.  
Become consultant and provide solutions to the practical problems of core organization.
- IV. Become an entrepreneur and be part of electrical and electronics product and service industries.

**2. PROGRAMME OUTCOMES (POs):**

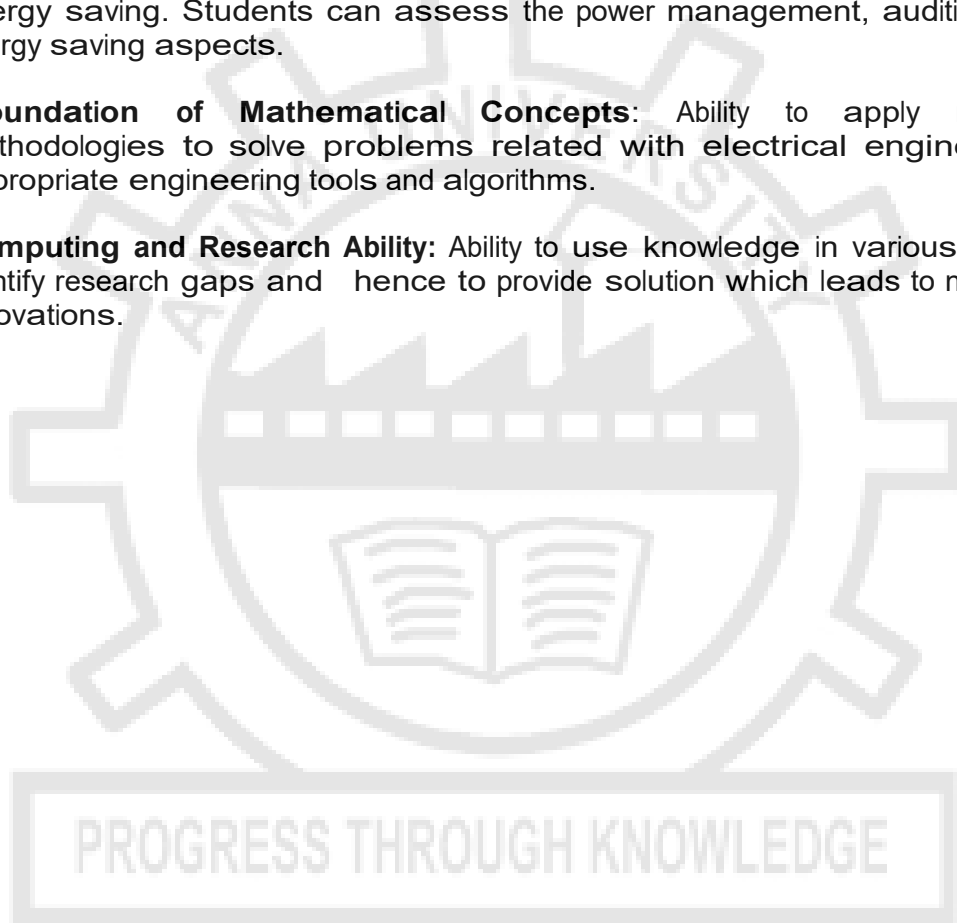
After going through the four years of study, our Electrical and Electronics Engineering Graduates will exhibit ability to:

PO#	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply knowledge of mathematics, basic science and engineering science.
2	Problem analysis	Identify, formulate and solve engineering problems.
3	Design/development of solutions	Design an electrical system or process to improve its performance, satisfying its constraints.
4	Conduct investigations of complex problems	Conduct experiments in electrical and electronics systems and interpret the data.
5	Modern tool usage	Apply various tools and techniques to improve the efficiency of the system.
6	The Engineer and society	Conduct themselves to uphold the professional and social obligations.
7	Environment and sustainability	Design the system with environment consciousness and sustainable development.
8	Ethics	Interacting industry, business and society in a professional and ethical manner.
9	Individual and team work	Function in a multidisciplinary team.
10	Communication	Proficiency in oral and written Communication.
11	Project management and finance	Implement Cost effective and improved system.
12	Life-long learning	Continue professional development and learning as a life-long activity.

### 3. PROGRAM SPECIFIC OUTCOMES (PSOs):

On completion of Electrical and Electronics Engineering program, the student will have the following Program Specific Outcomes.

1. **Foundation of Electrical Engineering:** Ability to understand the principles and working of electrical components, circuits, systems and control that are forming a part of power generation, transmission, distribution, utilization, conservation and energy saving. Students can assess the power management, auditing, crisis and energy saving aspects.
2. **Foundation of Mathematical Concepts:** Ability to apply mathematical methodologies to solve problems related with electrical engineering using appropriate engineering tools and algorithms.
3. **Computing and Research Ability:** Ability to use knowledge in various domains to identify research gaps and hence to provide solution which leads to new ideas and innovations.



EMESTER	COURSE CODE	PROGRAM OUTCOMES												PROGRAM SPECIFIC OUTCOMES		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
I	Induction Programme															
	Professional English - I	1.6	2.2	1.8	2.2	1.5	3	3	3	1.6	3	3	3	-	-	-
	Matrices and Calculus	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
	Engineering Physics	3	3	1.6	1.2	1.8	1	-	-	-	-	-	1	-	-	-
	Engineering Chemistry	2.8	1.3	1.6	1	-	1.5	1.8	-	-	-	-	1.5	-	-	-
	Problem Solving and Python Programming	2	3	3	3	2	c	-	-	-	-	2	2	3	3	
	தமிழர் மரபு / Heritage of Tamils	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Problem Solving and Python Programming Laboratory	2	3	3	3	2	-	-	-	-	-	2	2	3	3	
	Physics and Chemistry Laboratory	3	2.4	2.6	1	1	-	-	-	-	-	-	-	-	-	-
		2.6	1.3	1.6	1	1	1.4	1.8	-	-	-	-	1.3	-	-	-
English Laboratory <sup>s</sup>	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-	
II	Professional English - II	3	3	3	3	2.75	3	3	3	2.2	3	3	3	-	-	-
	Statistics and Numerical Methods	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
	Physics for Electrical Engineering	3	2	1			1	-	-	-	-	-	-	-	-	-
	Basic Civil and Mechanical Engineering	2	-	-	0.2	-	-	1	2	1.2	2	-	-	-	-	-
	Engineering Graphics	3	1	2		2	-	-	-	-	3		2	2	2	
	Electric Circuit Analysis	3	3	3	2.8	2		2	1				3	3	3	3
	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Engineering Practices Laboratory	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1
	Electric Circuits Laboratory	3	3	3	3	3		2	1.5	3			3	3	3	2
	Communication Laboratory / Foreign Language <sup>s</sup>	2.4	2.8	3	3	1.8	3	3	3	3	3	3	3	-	-	-
III	Probability and Complex Functions	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
	Electromagnetic Fields	3	2	1	2	-	-	1.4	1	-	-	-	1	3	2	1
	Digital Logic Circuits	3	3	3	1	3	-	-	1	-	-	-	1	3		1
	Electron Devices and Circuits	2	2	3	2	2	-	-	1	-	-	-	1	3		1

	Electrical Machines - I	3	3	1	1	1	-	-	1	-	-	-	1	3	3	3
	C Programming and Data Structures	2	2	1	2	2	1	1	-	1	1	1	2	2	2	2
	Electronic Devices and Circuits Laboratory	-	3	2.7	3	3	-	-	1.5	-	-	3	-	-	3	
	Electrical Machines Laboratory – I	3	3	1	1		-	-		1				2.5	2.6	1.6
	C Programming and Data Structures Laboratory	2	2	1	2	2	1	1	-	1	1	1	2	2	2	2
	Professional Development <sup>s</sup>															
IV	Environmental Sciences and Sustainability	2.8	1.8	1	1	-	2.2	2.4	-	-	-	-	1.8	-	-	-
	Transmission and Distribution	2.8	1.8	1	1		1	-	1.8	-	-	-		3	2.4	1
	Linear Integrated Circuits	2	2	3	2	2			1	-	-	-	1	3	2	1
	Measurements and Instrumentation	3	2	3	2	3	2		2	-	3	-	3	3	3	3
	Microprocessor and Microcontroller	2	1	2	3		-		1	-	-	-	3	3	1	3
	Electrical Machines - II	3	3	1.6	2.3	2.6	-		1	-	-	-		3	3	2
	Electrical Machines Laboratory - II	3	3	1	1		-		1.5	1	-	-	2.8	3	3	1.6
	Linear and Digital Circuits Laboratory		3	1.6	3	3	-		1.5		-	3	3	2	1	2
	Microprocessor and Microcontroller laboratory	2	1	2	3		-		1.5		-		3	3	1	3
V	Power System Analysis	3	2.6	2.4	1.8	1.4	-			1	-		1	1	1	1.4
	Power Electronics	3	3	3	3		-	1.5	1	-	-	2.25	3	3	3	3
	Control Systems	3	3	3	3	3	-		1		-		3	3	3	3
	Power Electronics Laboratory	3	3	3	3	3	-		1.5		-		3	3	3	3
	Control and Instrumentation Laboratory	3	3	3	3	3	-		1.5		-		2	3	3	3
VI	Protection and Switchgear	3	1	1	2	1.2	2	1	1	1	1	2		3	1.4	1
	Power System Operation and Control	2	1.6	1	1		1		1.6		2		2	3	2.2	2.86
	Power System Laboratory	3	3	2	2	3	-		2	1	2		3	3	3	3
VII	High Voltage Engineering	2	2	2.33	1		2		1	1		2	3	3	2	2
	Human Values and Ethics															
VIII	Project Work / Internship	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

1-low, 2-medium, 3-high, ‘-‘- no correlation

**ANNA UNIVERSITY, CHENNAI**  
**NON-AUTONOMOUS AFFILIATED COLLEGES**  
**REGULATIONS 2021**  
**CHOICE BASED CREDIT SYSTEM**  
**B.E. ELECTRICAL AND ELECTRONICS ENGINEERING**  
**CURRICULUM AND SYLLABI FOR SEMESTERS I TO VIII**  
**SEMESTER – I**

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IP3151	Induction Programme	-	-	-	-	-	0
<b>THEORY</b>								
2.	HS3152	Professional English - I	HSMC	3	0	0	3	3
3.	MA3151	Matrices and Calculus	BSC	3	1	0	4	4
4.	PH3151	Engineering Physics	BSC	3	0	0	3	3
5.	CY3151	Engineering Chemistry	BSC	3	0	0	3	3
6.	GE3151	Problem Solving and Python Programming	ESC	3	0	0	3	3
7.	GE3152	தமிழர் மரபு / Heritage of Tamils	HSMC	1	0	0	1	1
<b>PRACTICALS</b>								
8.	GE3171	Problem Solving and Python Programming Laboratory	ESC	0	0	4	4	2
9.	BS3171	Physics and Chemistry Laboratory	BSC	0	0	4	4	2
10.	GE3172	English Laboratory <sup>§</sup>	EEC	0	0	2	2	1
<b>TOTAL</b>				<b>16</b>	<b>1</b>	<b>10</b>	<b>27</b>	<b>22</b>

<sup>§</sup> Skill Based Course

**SEMESTER – II**

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	HS3252	Professional English - II	HSMC	2	0	0	2	2
2.	MA3251	Statistics and Numerical Methods	BSC	3	1	0	4	4
3.	PH3202	Physics for Electrical Engineering	BSC	3	0	0	3	3
4.	BE3255	Basic Civil and Mechanical Engineering	ESC	3	0	0	3	3
5.	GE3251	Engineering Graphics	ESC	2	0	4	6	4
6.	EE3251	Electric Circuit Analysis	PCC	3	1	0	4	4
7.		NCC Credit Course Level1 <sup>#</sup>	-	2	0	0	2	2 <sup>#</sup>
8.	GE3252	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	HSMC	1	0	0	1	1
<b>PRACTICALS</b>								
8.	GE3271	Engineering Practices Laboratory	ESC	0	0	4	4	2
9.	EE3271	Electric Circuits Laboratory	PCC	0	0	4	4	2
	GE3272	Communication Laboratory / Foreign Language <sup>§</sup>	EEC	0	0	4	4	2
<b>TOTAL</b>				<b>17</b>	<b>2</b>	<b>16</b>	<b>35</b>	<b>27</b>

<sup>#</sup> NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

<sup>§</sup> Skill Based Course

**SEMESTER III**

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	MA3303	Probability and Complex Functions	BSC	3	1	0	4	4
2.	EE3301	Electromagnetic Fields	PCC	3	1	0	4	4
3.	EE3302	Digital Logic Circuits	PCC	3	0	0	3	3
4.	EC3301	Electron Devices and Circuits	PCC	3	0	0	3	3
5.	EE3303	Electrical Machines - I	PCC	3	0	0	3	3
6.	CS3353	C Programming and Data Structures	PCC	3	0	0	3	3
<b>PRACTICALS</b>								
7.	EC3311	Electronic Devices and Circuits Laboratory	PCC	0	0	3	3	1.5
8.	EE3311	Electrical Machines Laboratory – I	PCC	0	0	3	3	1.5
9.	CS3362	C Programming and Data Structures Laboratory	PCC	0	0	3	3	1.5
10.	GE3361	Professional Development <sup>\$</sup>	EEC	0	0	2	2	1
<b>TOTAL</b>				<b>18</b>	<b>2</b>	<b>11</b>	<b>31</b>	<b>25.5</b>

**\$ Skill Based Course**

**SEMESTER IV**

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	GE3451	Environmental Sciences and Sustainability	BSC	2	0	0	2	2
2.	EE3401	Transmission and Distribution	PCC	3	0	0	3	3
3.	EE3402	Linear Integrated Circuits	PCC	3	0	0	3	3
4.	EE3403	Measurements and Instrumentation	PCC	3	0	0	3	3
5.	EE3404	Microprocessor and Microcontroller	PCC	3	0	0	3	3
6.	EE3405	Electrical Machines - II	PCC	3	0	0	3	3
7.		NCC Credit Course Level 2 <sup>#</sup>		3	0	0	3	3 <sup>#</sup>
<b>PRACTICALS</b>								
8.	EE3411	Electrical Machines Laboratory - II	PCC	0	0	3	3	1.5
9.	EE3412	Linear and Digital Circuits Laboratory	PCC	0	0	3	3	1.5
10.	EE3413	Microprocessor and Microcontroller laboratory	PCC	0	0	3	3	1.5
<b>TOTAL</b>				<b>17</b>	<b>0</b>	<b>9</b>	<b>26</b>	<b>21.5</b>

**# NCC Credit Course level 2 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.**



### SEMESTER V

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	EE3501	Power System Analysis	PCC	3	0	0	3	3
2.	EE3591	Power Electronics	PCC	3	0	0	3	3
3.	EE3503	Control Systems	PCC	3	0	0	3	3
4.		Professional Elective I	PEC	3	0	0	3	3
5.		Professional Elective II	PEC	3	0	0	3	3
6.		Professional Elective III	PEC	3	0	0	3	3
7.		Mandatory Course-I <sup>&amp;</sup>	MC	3	0	0	3	0
<b>PRACTICALS</b>								
8.	EE3511	Power Electronics Laboratory	PCC	0	0	3	3	1.5
9.	EE3512	Control and Instrumentation Laboratory	PCC	0	0	4	4	2
<b>TOTAL</b>				<b>21</b>	<b>0</b>	<b>7</b>	<b>28</b>	<b>21.5</b>

<sup>&</sup> Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under MC-I)

### SEMESTER VI

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	EE3601	Protection and Switchgear	PCC	3	0	0	3	3
2.	EE3602	Power System Operation and Control	PCC	3	0	0	3	3
3.		Open Elective – I*	OEC	3	0	0	3	3
4.		Professional Elective IV	PEC	3	0	0	3	3
5.		Professional Elective V	PEC	3	0	0	3	3
6.		Professional Elective VI	PEC	3	0	0	3	3
7.		Mandatory Course-II <sup>&amp;</sup>	MC	3	0	0	3	0
8.		NCC Credit Course Level 3 <sup>#</sup>		3	0	0	3	3 <sup>#</sup>
<b>PRACTICALS</b>								
9.	EE3611	Power System Laboratory	PCC	0	0	3	3	1.5
<b>TOTAL</b>				<b>21</b>	<b>0</b>	<b>3</b>	<b>24</b>	<b>19.5</b>

\* Open Elective – I shall be chosen from the emerging technologies

<sup>&</sup> Mandatory Course-II is a Non-credit Course (Student Shall select one course from the list given under MC-II)

<sup>#</sup> NCC Credit Course level 3 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA

**SEMESTER VII/VIII \***

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	EE3701	High Voltage Engineering	PCC	3	0	0	3	3
2.	GE3791	Human Values and Ethics	HSMC	2	0	0	2	2
3.		Elective – Management <sup>#</sup>	HSMC	3	0	0	3	3
4.		Open Elective – II <sup>**</sup>	OEC	3	0	0	3	3
5.		Open Elective – III <sup>***</sup>	OEC	3	0	0	3	3
6.		Open Elective – IV <sup>***</sup>	OEC	3	0	0	3	3
7.		Professional Elective VII	PEC	3	0	0	3	3
<b>TOTAL</b>				<b>20</b>	<b>0</b>	<b>0</b>	<b>20</b>	<b>20</b>

\*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

# Elective - Management shall be chosen from the Elective Management Courses

\*\*Open Elective – II shall be chosen from the emerging technologies

\*\*\*Open Elective III and IV (shall be chosen from the list of open electives offered by other Programmes).

**SEMESTER VIII/VII\***

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>PRACTICALS</b>								
1.	EE3811	Project Work / Internship	EEC	0	0	20	20	10
<b>TOTAL</b>				<b>0</b>	<b>0</b>	<b>20</b>	<b>20</b>	<b>10</b>

\*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

**TOTAL CREDITS: 167**

PROGRESS THROUGH KNOWLEDGE

### MANDATORY COURSES I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3081	Introduction to Women and Gender Studies	MC	3	0	0	3	0
2.	MX3082	Elements of Literature	MC	3	0	0	3	0
3.	MX3083	Film Appreciation	MC	3	0	0	3	0
4.	MX3084	Disaster Risk Reduction and Management	MC	3	0	0	3	0

### MANDATORY COURSES II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3085	Well Being with Traditional Practices - Yoga, Ayurveda and Siddha	MC	3	0	0	3	0
2.	MX3086	History of Science and Technology in India	MC	3	0	0	3	0
3.	MX3087	Political and Economic Thought for a Humane Society	MC	3	0	0	3	0
4.	MX3088	State, Nation Building and Politics in India	MC	3	0	0	3	0
5.	MX3089	Industrial Safety	MC	3	0	0	3	0

### ELECTIVE - MANAGEMENT COURSES

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	GE3751	Principles of Management	HSMC	3	0	0	3	3
2.	GE3752	Total Quality Management	HSMC	3	0	0	3	3
3.	GE3753	Engineering Economics and Financial Accounting	HSMC	3	0	0	3	3
4.	GE3754	Human Resource Management	HSMC	3	0	0	3	3
5.	GE3755	Knowledge Management	HSMC	3	0	0	3	3
6.	GE3792	Industrial Management	HSMC	3	0	0	3	3

**PROFESSIONAL ELECTIVE COURSES : VERTICALS**

Professional Elective	Vertical I Power Engineering	Vertical II Converters and Drives	Vertical III Embedded Systems	Vertical IV Electric Vehicle Technology	Vertical V Advanced Control	Vertical VI Diversified Courses
1.	Utilization and Conservation of Electrical Energy	Special Electrical Machines	Embedded System Design	Electric Vehicle Architecture	Process Modeling and Simulation	Energy Storage Systems
2.	Under Ground Cable Engineering	Analysis of Electrical Machines	Embedded C-Programming	Design of Motor and Power Converters for Electric Vehicles	Computer Control of Processes	Hybrid Energy Technology
3.	Substation Engineering and Automation	Multilevel Power Converters	Embedded Processors	Electric Vehicle Design, Mechanics and Control	System Identification	Design and Modelling of Renewable Energy Systems
4.	HVDC and FACTS	Electrical Drives	Embedded Control for Electric Drives	Design of Electric Vehicle Charging System	Model Based Control	Grid integrating Techniques and Challenges
5.	Energy Management and Auditing	SMPS and UPS	Smart System Automation	Testing of Electric Vehicles	Non Linear Control	Sustainable and Environmental Friendly HV Insulation System
6.	Power Quality	Power Electronics for Renewable Energy Systems	Embedded System for Automotive Applications.	Grid Integration of Electric Vehicles	Optimal Control	Power System Transients
7.	Smart Grids	Control of Power Electronics Circuits	VLSI Design	Intelligent control of Electric Vehicles.	Adaptive Control	PLC Programming
8.	Restructured Power Market	-	MEMS and NEMS	-	Machine Monitoring System	Big Data Analytics
9.	-	-	Digital Signal Processing System Design	-	-	-

**Registration of Professional Elective Courses from Verticals:**

Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E./B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to the Regulations 2021, Clause 4.10. (Amendments)

Total number of courses per vertical may change in the each programme of study as 6 or 7 or 8. If there is shortage of courses in a vertical the same may be chosen from another vertical of the same programme.

## PROFESSIONAL ELECTIVE COURSES : VERTICALS

### VERTICAL I : POWER ENGINEERING

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EE3001	Utilization and Conservation of Electrical Energy	PEC	3	0	0	3	3
2.	EE3002	Under Ground Cable Engineering	PEC	3	0	0	3	3
3.	EE3003	Substation Engineering and Automation	PEC	3	0	0	3	3
4.	EE3004	HVDC and FACTS	PEC	3	0	0	3	3
5.	EE3005	Energy Management and Auditing	PEC	3	0	0	3	3
6.	EE3006	Power Quality	PEC	3	0	0	3	3
7.	EE3007	Smart Grid	PEC	3	0	0	3	3
8.	EE3008	Restructured Power Market	PEC	3	0	0	3	3

### VERTICAL II : CONVERTERS AND DRIVES

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EE3009	Special Electrical Machines	PEC	2	0	2	4	3
2.	EE3010	Analysis of Electrical Machines	PEC	2	0	2	4	3
3.	EE3011	Multilevel Power Converters	PEC	2	0	2	4	3
4.	EE3012	Electrical Drives	PEC	2	0	2	4	3
5.	EE3013	SMPS and UPS	PEC	2	0	2	4	3
6.	EE3014	Power Electronics for Renewable Energy Systems	PEC	2	0	2	4	3
7.	EE3015	Control of Power Electronics Circuits	PEC	2	0	2	4	3

**VERTICAL III : EMBEDDED SYSTEMS**

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EE3016	Embedded System Design	PEC	2	0	2	4	3
2.	EE3017	Embedded C-programming	PEC	2	0	2	4	3
3.	EE3018	Embedded Processors	PEC	2	0	2	4	3
4.	EE3019	Embedded Control for Electric Drives	PEC	2	0	2	4	3
5.	EE3020	Smart System Automation	PEC	2	0	2	4	3
6.	EE3021	Embedded System for Automotive Applications	PEC	2	0	2	4	3
7.	EE3022	VLSI Design	PEC	2	0	2	4	3
8.	EE3023	MEMS and NEMS	PEC	2	0	2	4	3
9.	EE3024	Digital Signal Processing System Design	PEC	2	0	2	4	3

**VERTICAL IV : ELECTRIC VEHICLE TECHNOLOGY**

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EE3025	Electric Vehicle Architecture	PEC	3	0	0	3	3
2.	EE3026	Design of Motor and Power Converters for Electric Vehicles	PEC	2	0	2	4	3
3.	EE3027	Electric Vehicle Design, Mechanics and Control	PEC	2	0	2	4	3
4.	EE3028	Design of Electric Vehicle Charging System	PEC	2	0	2	4	3
5.	EE3029	Testing of Electric Vehicles	PEC	2	0	2	4	3
6.	EE3030	Grid Integration of Electric Vehicles	PEC	3	0	0	3	3
7.	EE3031	Intelligent Control of Electric Vehicles	PEC	2	0	2	4	3

**VERTICAL V : ADVANCED CONTROL**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CIC331	Process Modeling and Simulation	PEC	3	0	0	3	3
2.	CIC332	Computer Control of Processes	PEC	3	0	0	3	3
3.	CIC333	System Identification	PEC	3	0	0	3	3
4.	CIC336	Model Based Control	PEC	3	0	0	3	3
5.	CIC334	Non Linear Control	PEC	3	0	0	3	3
6.	CIC337	Optimal Control	PEC	3	0	0	3	3
7.	CIC335	Adaptive Control	PEC	3	0	0	3	3
8.	CIC338	Machine Monitoring System	PEC	3	0	0	3	3

**VERTICAL VI - DIVERSIFIED COURSES**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EE3032	Energy Storage Systems	PEC	3	0	0	3	3
2.	EE3033	Hybrid Energy Technology	PEC	3	0	0	3	3
3.	EE3034	Design and Modeling of Renewable Energy Systems	PEC	3	0	0	3	3
4.	EE3035	Grid integrating Techniques and Challenges	PEC	2	0	2	4	3
5.	EE3036	Sustainable and Environmental Friendly HV Insulation System	PEC	3	0	0	3	3
6.	EE3037	Power System Transients	PEC	3	0	0	3	3
7.	CEI331	PLC Programming	PEC	3	0	0	3	3
8.	CCS334	Big Data Analytics	PEC	2	0	2	4	3

### **OPEN ELECTIVES**

(Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories).

#### **OPEN ELECTIVE I AND II (EMERGING TECHNOLOGIES)**

To be offered other than Faculty of Information and Communication Engineering

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OCS351	Artificial Intelligence and Machine Learning Fundamentals	OEC	2	0	2	4	3
2.	OCS352	IoT Concepts and Applications	OEC	2	0	2	4	3
3.	OCS353	Data Science Fundamentals	OEC	2	0	2	4	3
4.	CCS333	Augmented Reality /Virtual Reality	OEC	2	0	2	4	3

#### **OPEN ELECTIVES – III**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS351	English for Competitive Examinations	OEC	3	0	0	3	3
2.	OMG352	NGOs and Sustainable Development	OEC	3	0	0	3	3
3.	OMG353	Democracy and Good Governance	OEC	3	0	0	3	3
4.	CME365	Renewable Energy Technologies	OEC	3	0	0	3	3
5.	OME354	Applied Design Thinking	OEC	3	0	0	3	3
6.	MF3003	Reverse Engineering	OEC	3	0	0	3	3
7.	OPR351	Sustainable Manufacturing	OEC	3	0	0	3	3
8.	AU3791	Electric and Hybrid Vehicles	OEC	3	0	0	3	3
9.	OAS352	Space Engineering	OEC	3	0	0	3	3
10.	OIM351	Industrial Management	OEC	3	0	0	3	3
11.	OIE354	Quality Engineering	OEC	3	0	0	3	3
12.	OSF351	Fire Safety Engineering	OEC	3	0	0	3	3
13.	OML351	Introduction to Non-Destructive Testing	OEC	3	0	0	3	3
14.	OMR351	Mechatronics	OEC	3	0	0	3	3
15.	ORA351	Foundation of Robotics	OEC	3	0	0	3	3
16.	OAE352	Fundamentals of Aeronautical Engineering	OEC	3	0	0	3	3
17.	OGI351	Remote Sensing Concepts	OEC	3	0	0	3	3
18.	OAI351	Urban Agriculture	OEC	3	0	0	3	3
19.	OEN351	Drinking Water Supply and Treatment	OEC	3	0	0	3	3



20.	OCE353	Lean Concepts, Tools And Practices	OEC	3	0	0	3	3
21.	OEI353	Introduction to PLC Programming	OEC	3	0	0	3	3
22.	OCH351	Nano Technology	OEC	3	0	0	3	3
23.	OCH352	Functional Materials	OEC	3	0	0	3	3
24.	OFD352	Traditional Indian Foods	OEC	3	0	0	3	3
25.	OFD353	Introduction to food processing	OEC	3	0	0	3	3
26.	OPY352	IPR for Pharma Industry	OEC	3	0	0	3	3
27.	OTT351	Basics of Textile Finishing	OEC	3	0	0	3	3
28.	OTT352	Industrial Engineering for Garment Industry	OEC	3	0	0	3	3
29.	OTT353	Basics of Textile Manufacture	OEC	3	0	0	3	3
30.	OPE351	Introduction to Petroleum Refining and Petrochemicals	OEC	3	0	0	3	3
31.	CPE334	Energy Conservation and Management	OEC	3	0	0	3	3
32.	OPT351	Basics of Plastics Processing	OEC	3	0	0	3	3
33.	OEC351	Signals and Systems	OEC	3	0	0	3	3
34.	OEC352	Fundamentals of Electronic Devices and Circuits	OEC	3	0	0	3	3
35.	CBM348	Foundation Skills in Integrated Product Development	OEC	3	0	0	3	3
36.	CBM333	Assistive Technology	OEC	3	0	0	3	3
37.	OMA352	Operations Research	OEC	3	0	0	3	3
38.	OMA353	Algebra and Number Theory	OEC	3	0	0	3	3
39.	OMA354	Linear Algebra	OEC	3	0	0	3	3
40.	OBT352	Basics of Microbial Technology	OEC	3	0	0	3	3
41.	OBT353	Basics of Biomolecules	OEC	3	0	0	3	3
42.	OBT354	Fundamentals of Cell and Molecular Biology	OEC	3	0	0	3	3

#### OPEN ELECTIVES – IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS352	Project Report Writing	OEC	3	0	0	3	3
2.	OMA355	Advanced Numerical Methods	OEC	3	0	0	3	3
3.	OMA356	Random Processes	OEC	3	0	0	3	3
4.	OMA357	Queuing and Reliability Modelling	OEC	3	0	0	3	3
5.	OMG354	Production and Operations Management for Entrepreneurs	OEC	3	0	0	3	3

6.	OMG355	Multivariate Data Analysis	OEC	3	0	0	3	3
7.	OME352	Additive Manufacturing	OEC	3	0	0	3	3
8.	CME343	New Product Development	OEC	3	0	0	3	3
9.	OME355	Industrial Design & Rapid Prototyping Techniques	OEC	3	0	0	3	3
10.	MF3010	Micro and Precision Engineering	OEC	3	0	0	3	3
11.	OMF354	Cost Management of Engineering Projects	OEC	3	0	0	3	3
12.	AU3002	Batteries and Management System	OEC	3	0	0	3	3
13.	AU3008	Sensors and Actuators	OEC	3	0	0	3	3
14.	OAS353	Space Vehicles	OEC	3	0	0	3	3
15.	OIM352	Management Science	OEC	3	0	0	3	3
16.	OIM353	Production Planning and Control	OEC	3	0	0	3	3
17.	OIE353	Operations Management	OEC	3	0	0	3	3
18.	OSF352	Industrial Hygiene	OEC	3	0	0	3	3
19.	OSF353	Chemical Process Safety	OEC	3	0	0	3	3
20.	OML352	Electrical, Electronic and Magnetic Materials	OEC	3	0	0	3	3
21.	OML353	Nanomaterials and Applications	OEC	3	0	0	3	3
22.	OMR352	Hydraulics and Pneumatics	OEC	3	0	0	3	3
23.	OMR353	Sensors	OEC	3	0	0	3	3
24.	ORA352	Concepts in Mobile Robots	OEC	3	0	0	3	3
25.	MV3501	Marine Propulsion	OEC	3	0	0	3	3
26.	OMV351	Marine Merchant Vessels	OEC	3	0	0	3	3
27.	OMV352	Elements of Marine Engineering	OEC	3	0	0	3	3
28.	CRA332	Drone Technologies	OEC	3	0	0	3	3
29.	OGI352	Geographical Information System	OEC	3	0	0	3	3
30.	OAI352	Agriculture Entrepreneurship Development	OEC	3	0	0	3	3
31.	OEN352	Biodiversity Conservation	OEC	3	0	0	3	3
32.	OCE354	Basics of Integrated Water Resources Management	OEC	3	0	0	3	3
33.	OEI354	Introduction to Industrial Automation Systems	OEC	3	0	0	3	3
34.	OCH353	Energy Technology	OEC	3	0	0	3	3
35.	OCH354	Surface Science	OEC	3	0	0	3	3
36.	OFD354	Fundamentals of Food Engineering	OEC	3	0	0	3	3
37.	OFD355	Food Safety and Quality Regulations	OEC	3	0	0	3	3
38.	OPY353	Nutraceuticals	OEC	3	0	0	3	3

39.	OTT354	Basics of Dyeing and Printing	OEC	3	0	0	3	3
40.	FT3201	Fibre Science	OEC	3	0	0	3	3
41.	OTT355	Garment Manufacturing Technology	OEC	3	0	0	3	3
42.	OPE353	Industrial Safety	OEC	3	0	0	3	3
43.	OPE354	Unit Operations in Petro Chemical Industries	OEC	3	0	0	3	3
44.	OPT352	Plastic Materials for Engineers	OEC	3	0	0	3	3
45.	OPT353	Properties and Testing of Plastics	OEC	3	0	0	3	3
46.	OEC353	VLSI Design	OEC	3	0	0	3	3
47.	CBM370	Wearable Devices	OEC	3	0	0	3	3
48.	CBM356	Medical Informatics	OEC	3	0	0	3	3
49.	OBT355	Biotechnology for Waste Management	OEC	3	0	0	3	3
50.	OBT356	Lifestyle Diseases	OEC	3	0	0	3	3
51.	OBT357	Biotechnology in Health Care	OEC	3	0	0	3	3

### SUMMARY

SL. NO.	SUBJECT AREA	CREDITS PER SEMESTER								CREDITS TOTAL
		I	II	III	IV	V	VI	VII/VIII	VIII/VII	
1.	HSMC	4	3	-	-	-	-	5	-	12
2.	BSC	12	7	4	2	-	-	-	-	25
3.	ESC	5	9	-	-	-	-	-	-	14
4.	PCC	-	6	20.5	19.5	12.5	7.5	3	-	69
5.	PEC	-	-	-	-	9	9	3	-	21
6.	OEC	-	-	-	-	-	3	9	-	12
7.	EEC	1	2	1	-	-	-	-	10	14
	<b>Total</b>	<b>22</b>	<b>27</b>	<b>25.5</b>	<b>21.5</b>	<b>21.5</b>	<b>19.5</b>	<b>20</b>	<b>10</b>	<b>167</b>
8.	<b>Mandatory Course (Non credit)</b>					✓	✓			

### **Enrollment for B.E. / B. Tech. (Honours) / Minor degree (Optional)**

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E./B.Tech. (Honours) Minor degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes, Moreover, for minor degree the student can register for courses from any one of the following verticals also.

Complete details are available in clause 4.10 (Amendments) of Regulations 2021.



**VERTICALS FOR MINOR DEGREE (In addition to all the verticals of other degree programmes)**

<b>Vertical I</b>	<b>Vertical II</b>	<b>Vertical III</b>	<b>Vertical IV</b>	<b>Vertical V</b>
<b>Fintech and Block Chain</b>	<b>Entrepreneurship</b>	<b>Public Administration</b>	<b>Business Data Analytics</b>	<b>Environment and Sustainability</b>
Financial Management	Foundations of Entrepreneurship	Principles of Public Administration	Statistics for Management	Sustainable infrastructure Development
Fundamentals of Investment	Team Building and Leadership Management for Business	Constitution of India	Data mining for Business Intelligence	Sustainable Agriculture and Environmental Management
Banking, Financial Services and Insurance	Creativity and Innovation in Entrepreneurship	Public Personnel Administration	Human Resource Analytics	Sustainable Bio Materials
Introduction to Blockchain and its Applications	Principles of Marketing Management for Business	Administrative Theories	Marketing and Social Media Web Analytics	Materials for Energy Sustainability
Fintech Personal Finance and Payments	Human Resource Management for Entrepreneurship	Indian Administrative System	Operation and Supply Chain Analytics	Green Technology
Introduction to Fintech	Financing New Business Ventures	Public Policy Administration	Financial Analytics	Environmental Quality Monitoring and Analysis
-	-	-	-	Integrated Energy Planning for Sustainable Development
-	-	-	-	Energy Efficiency for Sustainable Development

### VERTICALS FOR MINOR DEGREE

(Choice of courses for Minor degree is to be made from any one vertical of other programmes or from anyone of the following verticals)

#### VERTICAL I : FINTECH AND BLOCK CHAIN

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG331	Financial Management	PEC	3	0	0	3	3
2.	CMG332	Fundamentals of Investment	PEC	3	0	0	3	3
3.	CMG333	Banking, Financial Services and Insurance	PEC	3	0	0	3	3
4.	CMG334	Introduction to Blockchain and its Applications	PEC	3	0	0	3	3
5.	CMG335	Fintech Personal Finance and Payments	PEC	3	0	0	3	3
6.	CMG336	Introduction to Fintech	PEC	3	0	0	3	3

#### VERTICAL II : ENTREPRENEURSHIP

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG337	Foundations of Entrepreneurship	PEC	3	0	0	3	3
2.	CMG338	Team Building & Leadership Management for Business	PEC	3	0	0	3	3
3.	CMG339	Creativity & Innovation in Entrepreneurship	PEC	3	0	0	3	3
4.	CMG340	Principles of Marketing Management For Business	PEC	3	0	0	3	3
5.	CMG341	Human Resource Management for Entrepreneurs	PEC	3	0	0	3	3
6.	CMG342	Financing New Business Ventures	PEC	3	0	0	3	3

### VERTICAL III: PUBLIC ADMINISTRATION

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG343	Principles of Public Administration	PEC	3	0	0	3	3
2.	CMG344	Constitution of India	PEC	3	0	0	3	3
3.	CMG345	Public Personnel Administration	PEC	3	0	0	3	3
4.	CMG346	Administrative Theories	PEC	3	0	0	3	3
5.	CMG347	Indian Administrative System	PEC	3	0	0	3	3
6.	CMG348	Public Policy Administration	PEC	3	0	0	3	3

### VERTICAL IV : BUSINESS DATA ANALYTICS

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG349	Statistics For Management	PEC	3	0	0	3	3
2.	CMG350	Datamining For Business Intelligence	PEC	3	0	0	3	3
3.	CMG351	Human Resource Analytics	PEC	3	0	0	3	3
4.	CMG352	Marketing And Social Media Web Analytics	PEC	3	0	0	3	3
5.	CMG353	Operation And Supply Chain Analytics	PEC	3	0	0	3	3
6.	CMG354	Financial Analytics	PEC	3	0	0	3	3

**VERTICAL V : ENVIRONMENT AND SUSTAINABILITY**

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CES331	Sustainable infrastructure Development	PEC	3	0	0	3	3
2.	CES332	Sustainable Agriculture and Environmental Management	PEC	3	0	0	3	3
3.	CES333	Sustainable Bio Materials	PEC	3	0	0	3	3
4.	CES334	Materials for Energy Sustainability	PEC	3	0	0	3	3
5.	CES335	Green Technology	PEC	3	0	0	3	3
6.	CES336	Environmental Quality Monitoring and Analysis	PEC	3	0	0	3	3
7.	CES337	Integrated Energy Planning for Sustainable Development	PEC	3	0	0	3	3
8.	CES338	Energy Efficiency for Sustainable Development	PEC	3	0	0	3	3

PROGRESS THROUGH KNOWLEDGE



## IP3151

## INDUCTION PROGRAMME

This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

“Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed.”

“One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. “

Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

(i) Physical Activity

This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

(ii) Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

(iii) Universal Human Values

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and don'ts, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing.

Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

(iv) Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

(v) Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

(vi) Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

(vii) Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

(viii) Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix) Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering/Technology/Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

**Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.**

References:

Guide to Induction program from AICTE

**COURSE OBJECTIVES :**

- To improve the communicative competence of learners
- To learn to use basic grammatic structures in suitable contexts
- To acquire lexical competence and use them appropriately in a sentence and understand their meaning in a text
- To help learners use language effectively in professional contexts
- To develop learners' ability to read and write complex texts, summaries, articles, blogs, definitions, essays and user manuals.

**UNIT I INTRODUCTION TO EFFECTIVE COMMUNICATION 1**

What is effective communication? (Explain using activities) Why is communication critical for excellence during study, research and work? What are the seven C's of effective communication? What are key language skills? What is effective listening? What does it involve? What is effective speaking? What does it mean to be an excellent reader? What should you be able to do? What is effective writing? How does one develop language and communication skills? What does the course focus on? How are communication and language skills going to be enhanced during this course? What do you as a learner need to do to enhance your English language and communication skills to get the best out of this course?

**INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 8**

Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails. Writing - Writing emails / letters introducing oneself. Grammar - Present Tense (simple and progressive); Question types: Wh/ Yes or No/ and Tags. Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).

**UNIT II NARRATION AND SUMMATION 9**

Reading - Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel & technical blogs. Writing - Guided writing-- Paragraph writing Short Report on an event (field trip etc.) Grammar - Past tense (simple); Subject-Verb Agreement; and Prepositions. Vocabulary - Word forms (prefixes & suffixes); Synonyms and Antonyms. Phrasal verbs.

**UNIT III DESCRIPTION OF A PROCESS / PRODUCT 9**

Reading - Reading advertisements, gadget reviews; user manuals. Writing - Writing definitions; instructions; and Product /Process description. Grammar - Imperatives; Adjectives; Degrees of comparison; Present & Past Perfect Tenses. Vocabulary - Compound Nouns, Homonyms; and Homophones, discourse markers (connectives & sequence words).

**UNIT IV CLASSIFICATION AND RECOMMENDATIONS 9**

Reading - Newspaper articles; Journal reports -and Non Verbal Communication ( tables, pie charts etc.,). Writing - Note-making / Note-taking (\*Study skills to be taught, not tested); Writing recommendations; Transferring information from non verbal ( chart , graph etc, to verbal mode) Grammar - Articles; Pronouns - Possessive & Relative pronouns. Vocabulary - Collocations; Fixed / Semi fixed expressions.

**UNIT V EXPRESSION****9**

Reading – Reading editorials; and Opinion Blogs; Writing – Essay Writing (Descriptive or narrative). Grammar – Future Tenses, Punctuation; Negation (Statements & Questions); and Simple, Compound & Complex Sentences. Vocabulary - Cause & Effect Expressions – Content vs Function words.

**TOTAL : 45 PERIODS****LEARNING OUTCOMES :**

At the end of the course, learners will be able

**CO1:**To use appropriate words in a professional context

**CO2:**To gain understanding of basic grammatic structures and use them in right context.

**CO3:**To read and infer the denotative and connotative meanings of technical texts

**CO4:**To write definitions, descriptions, narrations and essays on various topics

**TEXT BOOKS :**

1. English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition)
2. English for Science & Technology Cambridge University Press, 2021.  
Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

**REFERENCE BOOKS:**

1. Technical Communication – Principles And Practices By Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2. A Course Book On Technical English By Lakshminarayanan, Scitech Publications (India) Pvt. Ltd.
3. English For Technical Communication (With CD) By Aysha Viswamohan, Mcgraw Hill Education, ISBN : 0070264244.
4. Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.
5. Learning to Communicate – Dr. V. Chellammal, Allied Publishing House, New Delhi, 2003.

**ASSESSMENT PATTERN**

Two internal assessments and an end semester examination to test students' reading and writing skills along with their grammatical and lexical competence.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1	1	1	1	3	3	3	1	3	-	3	-	-	-
2	1	1	1	1	1	3	3	3	1	3	-	3	-	-	-
3	2	3	2	3	2	3	3	3	2	3	3	3	-	-	-
4	2	3	2	3	2	3	3	3	2	3	3	3	-	-	-
5	2	3	3	3	-	3	3	3	2	3	-	3	-	-	-
Avg.	1.6	2.2	1.8	2.2	1.5	3	3	3	1.6	3	3	3	-	-	-

**COURSE OBJECTIVES :**

- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To familiarize the students with differential calculus.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To make the students understand various techniques of integration.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

**UNIT I MATRICES****9 + 3**

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley - Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms – Applications : Stretching of an elastic membrane.

**UNIT II DIFFERENTIAL CALCULUS****9 + 3**

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum, product, quotient, chain rules) - Implicit differentiation - Logarithmic differentiation - Applications : Maxima and Minima of functions of one variable.

**UNIT III FUNCTIONS OF SEVERAL VARIABLES****9 + 3**

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Applications : Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.

**UNIT IV INTEGRAL CALCULUS****9 + 3**

Definite and Indefinite integrals - Substitution rule - Techniques of Integration : Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals - Applications : Hydrostatic force and pressure, moments and centres of mass.

**UNIT V MULTIPLE INTEGRALS****9 + 3**

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals – Applications : Moments and centres of mass, moment of inertia.

**TOTAL : 60 PERIODS****COURSE OUTCOMES:**

At the end of the course the students will be able to

**CO1:**Use the matrix algebra methods for solving practical problems.

**CO2:**Apply differential calculus tools in solving various application problems.

**CO3:**Able to use differential calculus ideas on several variable functions.

**CO4:**Apply different methods of integration in solving practical problems.

**CO5:**Apply multiple integral ideas in solving areas, volumes and other practical problems.

**TEXT BOOKS :**

1. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10<sup>th</sup> Edition, New Delhi, 2016.
2. Grewal.B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44<sup>th</sup> Edition , 2018.
3. James Stewart, " Calculus : Early Transcendentals ", Cengage Learning, 8<sup>th</sup> Edition, New Delhi, 2015. [For Units II & IV - Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8 ].

**REFERENCES :**

1. Anton. H, Bivens. I and Davis. S, " Calculus ", Wiley, 10<sup>th</sup> Edition, 2016
2. Bali. N., Goyal. M. and Watkins. C., " Advanced Engineering Mathematics ", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.), New Delhi, 7<sup>th</sup> Edition, 2009.
3. Jain .R.K. and Iyengar. S.R.K., " Advanced Engineering Mathematics ", Narosa Publications, New Delhi, 5<sup>th</sup> Edition, 2016.
4. Narayanan. S. and Manicavachagom Pillai. T. K., " Calculus " Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6. Srimantha Pal and Bhunia. S.C, " Engineering Mathematics " Oxford University Press, 2015.
7. Thomas. G. B., Hass. J, and Weir. M.D, " Thomas Calculus ", 14<sup>th</sup> Edition, Pearson India, 2018.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
2	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
3	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
4	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
5	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
Avg.	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-

**COURSE OBJECTIVES:**

- To make the students effectively to achieve an understanding of mechanics.
- To enable the students to gain knowledge of electromagnetic waves and its applications.
- To introduce the basics of oscillations, optics and lasers.
- Equipping the students to be successfully understand the importance of quantum physics.
- To motivate the students towards the applications of quantum mechanics.

**UNIT I MECHANICS****9**

Multiparticle dynamics: Center of mass (CM) – CM of continuous bodies – motion of the CM – kinetic energy of system of particles. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy and moment of inertia - theorems of M .I –moment of inertia of continuous bodies – M.I of a diatomic molecule - torque – rotational dynamics of rigid bodies – conservation of angular momentum – rotational energy state of a rigid diatomic molecule - gyroscope - torsional pendulum – double pendulum –Introduction to nonlinear oscillations.

**UNIT II ELECTROMAGNETIC WAVES****9**

The Maxwell's equations - wave equation; Plane electromagnetic waves in vacuum, Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

**UNIT III OSCILLATIONS, OPTICS AND LASERS****9**

Simple harmonic motion - resonance –analogy between electrical and mechanical oscillating systems - waves on a string - standing waves - traveling waves - Energy transfer of a wave - sound waves - Doppler effect. Reflection and refraction of light waves - total internal reflection - interference – Michelson interferometer –Theory of air wedge and experiment. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients - population inversion - Nd-YAG laser, CO<sub>2</sub> laser, semiconductor laser –Basic applications of lasers in industry.

**UNIT IV BASIC QUANTUM MECHANICS****9**

Photons and light waves - Electrons and matter waves –Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization –Free particle - particle in a infinite potential well: 1D,2D and 3D Boxes- Normalization, probabilities and the correspondence principle.

**UNIT V APPLIED QUANTUM MECHANICS****9**

The harmonic oscillator(qualitative)- Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope - Resonant diode - Finite potential wells (qualitative)- Bloch's theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.

**TOTAL : 45 PERIODS****COURSE OUTCOMES:**

After completion of this course, the students should be able to

**CO1:**Understand the importance of mechanics.

**CO2:**Express their knowledge in electromagnetic waves.

**CO3:**Demonstrate a strong foundational knowledge in oscillations, optics and lasers.

**CO4:**Understand the importance of quantum physics.

**CO5:**Comprehend and apply quantum mechanical principles towards the formation of energy bands.

**TEXT BOOKS:**

1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017.
2. E.M.Purcell and D.J.Morin, Electricity and Magnetism, Cambridge Univ.Press, 2013.
3. Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGraw-Hill (Indian Edition), 2017.

**REFERENCES:**

1. R.Wolfson. Essential University Physics. Volume 1 & 2. Pearson Education (Indian Edition), 2009.
2. Paul A. Tipler, Physic – Volume 1 & 2, CBS, (Indian Edition), 2004.
3. K.Thyagarajan and A.Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications, (Indian Edition), 2019.
4. D.Halliday, R.Resnick and J.Walker. Principles of Physics, Wiley (Indian Edition), 2015.
5. N.Garcia, A.Damask and S.Schwarz. Physics for Computer Science Students. Springer-Verlag, 2012.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	1	1	1	-	-	-	-	-	-	-	-	-
2	3	3	2	1	2	1	-	-	-	-	-	-	-	-	-
3	3	3	2	2	2	1	-	-	-	-	-	1	-	-	-
4	3	3	1	1	2	1	-	-	-	-	-	-	-	-	-
5	3	3	1	1	2	1	-	-	-	-	-	-	-	-	-
Avg.	3	3	1.6	1.2	1.8	1	-	-	-	-	-	1	-	-	-



PROGRESS THROUGH KNOWLEDGE



**COURSE OBJECTIVES:**

- To inculcate sound understanding of water quality parameters and water treatment techniques.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To introduce the basic concepts and applications of phase rule and composites.
- To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
- To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

**UNIT I WATER AND ITS TREATMENT 9**

**Water:** Sources and impurities, **Water quality parameters:** Definition and significance of-colour, odour, turbidity, pH, hardness, alkalinity, TDS, COD and BOD, flouride and arsenic. **Municipal water treatment:** primary treatment and disinfection (UV, Ozonation, break-point chlorination). **Desalination of brackish water:** Reverse Osmosis. **Boiler troubles:** Scale and sludge, Boiler corrosion, Caustic embrittlement, Priming & foaming. **Treatment of boiler feed water:** Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralisation and zeolite process.

**UNIT II NANO CHEMISTRY 9**

**Basics:** Distinction between molecules, nanomaterials and bulk materials; **Size-dependent properties** (optical, electrical, mechanical and magnetic); **Types of nanomaterials:** Definition, properties and uses of – nanoparticle, nanocluster, nanorod, nanowire and nanotube. **Preparation of nanomaterials:** sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro spinning. **Applications** of nanomaterials in medicine, agriculture, energy, electronics and catalysis.

**UNIT III PHASE RULE AND COMPOSITES 9**

**Phase rule:** Introduction, definition of terms with examples. One component system - water system; Reduced phase rule; Construction of a simple eutectic phase diagram - Thermal analysis; Two component system: lead-silver system - Pattinson process.

**Composites: Introduction:** Definition & Need for composites; **Constitution:** Matrix materials (Polymer matrix, metal matrix and ceramic matrix) and Reinforcement (fiber, particulates, flakes and whiskers). **Properties and applications of:** Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. **Hybrid composites** - definition and examples.

**UNIT IV FUELS AND COMBUSTION 9**

**Fuels: Introduction:** Classification of fuels; **Coal and coke:** Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). **Petroleum and Diesel:** Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; **Power alcohol and biodiesel.**

**Combustion of fuels: Introduction:** Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; **Ignition temperature:** spontaneous ignition temperature, Explosive range; **Flue gas analysis** - ORSAT Method. **CO<sub>2</sub> emission and carbon foot print.**

**UNIT V ENERGY SOURCES AND STORAGE DEVICES 9**

**Stability of nucleus: mass defect (problems), binding energy; Nuclear energy:** light water nuclear power plant, breeder reactor. **Solar energy conversion:** Principle, working and applications of solar cells; **Recent developments in solar cell materials. Wind energy; Geothermal energy; Batteries:** Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion-

battery; **Electric vehicles-working principles; Fuel cells:** H<sub>2</sub>-O<sub>2</sub> fuel cell, microbial fuel cell; **Supercapacitors:** Storage principle, types and examples.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the students will be able:

- CO1:** To infer the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.
- CO2:** To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.
- CO3:** To apply the knowledge of phase rule and composites for material selection requirements.
- CO4:** To recommend suitable fuels for engineering processes and applications.
- CO5:** To recognize different forms of energy resources and apply them for suitable applications in energy sectors.

**TEXT BOOKS:**

1. P. C. Jain and Monica Jain, "Engineering Chemistry", 17<sup>th</sup> Edition, DhanpatRai Publishing Company (P) Ltd, New Delhi, 2018.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3. S.S. Dara, "A text book of Engineering Chemistry", S. Chand Publishing, 12<sup>th</sup> Edition, 2018.

**REFERENCES:**

1. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, "Text book of nanoscience and nanotechnology", Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2. O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2<sup>nd</sup> Edition, 2017.
3. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.
4. ShikhaAgarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, Second Edition, 2019.
5. O.V. Roussak and H.D. Gesser, Applied Chemistry-A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	1	-	1	1	-	-	-	-	1	-	-	-
2	2	-	-	1	-	2	2	-	-	-	-	-	-	-	-
3	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
4	3	1	1	-	-	1	2	-	-	-	-	-	-	-	-
5	3	1	2	1	-	2	2	-	-	-	-	2	-	-	-
Avg.	2.8	1.3	1.6	1	-	1.5	1.8	-	-	-	-	1.5	-	-	-

**COURSE OBJECTIVES:**

- To understand the basics of algorithmic problem solving.
- To learn to solve problems using Python conditionals and loops.
- To define Python functions and use function calls to solve problems.
- To use Python data structures - lists, tuples, dictionaries to represent complex data.
- To do input/output with files in Python.

<b>UNIT I</b>	<b>COMPUTATIONAL THINKING AND PROBLEM SOLVING</b>	<b>9</b>
Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.		
<b>UNIT II</b>	<b>DATA TYPES, EXPRESSIONS, STATEMENTS</b>	<b>9</b>
Python interpreter and interactive mode,debugging; values and types: int, float, boolean, string, a nd list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.		
<b>UNIT III</b>	<b>CONTROL FLOW, FUNCTIONS, STRINGS</b>	<b>9</b>
Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.		
<b>UNIT IV</b>	<b>LISTS, TUPLES, DICTIONARIES</b>	<b>9</b>
Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.		
<b>UNIT V</b>	<b>FILES, MODULES, PACKAGES</b>	<b>9</b>
Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).		

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, students will be able to

- CO1:** Develop algorithmic solutions to simple computational problems.
- CO2:** Develop and execute simple Python programs.
- CO3:** Write simple Python programs using conditionals and loops for solving problems.
- CO4:** Decompose a Python program into functions.
- CO5:** Represent compound data using Python lists, tuples, dictionaries etc.
- CO6:** Read and write data from/to files in Python programs.

**TEXT BOOKS:**

1. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.

**REFERENCES:**

1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1<sup>st</sup> Edition, 2021.
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1<sup>st</sup> Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press, 2021
4. Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2<sup>nd</sup> Edition, No Starch Press, 2019.
5. <https://www.python.org/>
6. Martin C. Brown, "Python: The Complete Reference", 4<sup>th</sup> Edition, Mc-Graw Hill, 2018.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	2	-	-	-	-	-	2	2	3	3	-
2	3	3	3	3	2	-	-	-	-	-	2	2	3	-	-
3	3	3	3	3	2	-	-	-	-	-	2	-	3	-	-
4	2	2	-	2	2	-	-	-	-	-	1	-	3	-	-
5	1	2	-	-	1	-	-	-	-	-	1	-	2	-	-
6	2	2	-	-	2	-	-	-	-	-	1	-	2	-	-
Avg.	2	3	3	3	2	-	-	-	-	-	2	2	3	3	-

**UNIT I LANGUAGE AND LITERATURE****3**

Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

**UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE****3**

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

**UNIT III FOLK AND MARTIAL ARTS****3**

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyilattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

**UNIT IV THINAI CONCEPT OF TAMILS****3**

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

**UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE****3**

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

**TOTAL : 15 PERIODS****TEXT-CUM-REFERENCE BOOKS**

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருளுத – ஆற்றுங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

**அலகு I மொழி மற்றும் இலக்கியம்:****3**

இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை - சங்க இலக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துக்கள் - தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் - சிற்றிலக்கியங்கள் - தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி - தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

**அலகு II மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக் கலை:****3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை - ஐம்பொன் சிலைகள்- பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளூர் சிலை - இசைக் கருவிகள் - மிருதங்கம், பறை, வீணை, யாழ், நாதல்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

**அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்:****3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஓயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

**அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள்:****3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் - தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு - சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் - சங்ககால நகரங்களும் துறை முகங்களும் - சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

**அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு:****3**

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு - கல்வெட்டுகள், கையெழுத்துப்படிக்கள் - தமிழ்ப் புத்தகங்களின் அச்ச வரலாறு.

**TOTAL : 15 PERIODS****TEXT-CUM-REFERENCE BOOKS**

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் - முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருளை - ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL - (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
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11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) - Reference Book.

**COURSE OBJECTIVES:**

- To understand the problem solving approaches.
- To learn the basic programming constructs in Python.
- To practice various computing strategies for Python-based solutions to real world problems.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

**EXPERIMENTS:**

**Note: The examples suggested in each experiment are only indicative. The lab instructor is expected to design other problems on similar lines. The Examination shall not be restricted to the sample experiments listed here.**

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).
3. Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6. Implementing programs using Functions. (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings. (reverse, palindrome, character count, replacing characters)
8. Implementing programs using written modules and Python Standard Libraries (pandas, numpy. Matplotlib, scipy)
9. Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word)
10. Implementing real-time/technical applications using Exception handling. (divide by zero error, voter's age validity, student mark range validation)
11. Exploring Pygame tool.
12. Developing a game activity using Pygame like bouncing ball, car race etc.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, students will be able to:

**CO1:** Develop algorithmic solutions to simple computational problems

**CO2:** Develop and execute simple Python programs.

**CO3:** Implement programs in Python using conditionals and loops for solving problems..

**CO4:** Deploy functions to decompose a Python program.

**CO5:** Process compound data using Python data structures.

**CO6:** Utilize Python packages in developing software applications.

**TEXT BOOKS:**

1. Allen B. Downey, "Think Python : How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.

**REFERENCES:**

1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press , 2021
4. Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.
5. <https://www.python.org/>
6. Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	3	-	-	-	-	-	3	2	3	3	-
2	3	3	3	3	3	-	-	-	-	-	3	2	3	-	-
3	3	3	3	3	2	-	-	-	-	-	2	-	3	-	-
4	3	2	-	2	2	-	-	-	-	-	1	-	3	-	-
5	1	2	-	-	1	-	-	-	-	-	1	-	2	-	-
6	2	-	-	-	2	-	-	-	-	-	1	-	2	-	-
Avg.	2	3	3	3	2	-	-	-	-	-	2	2	3	3	-



**PHYSICS LABORATORY : (Any Seven Experiments)****COURSE OBJECTIVES:**

- To learn the proper use of various kinds of physics laboratory equipment.
  - To learn how data can be collected, presented and interpreted in a clear and concise manner.
  - To learn problem solving skills related to physics principles and interpretation of experimental data.
  - To determine error in experimental measurements and techniques used to minimize such error.
  - To make the student as an active participant in each part of all lab exercises.
1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular and irregular objects.
  2. Simple harmonic oscillations of cantilever.
  3. Non-uniform bending - Determination of Young's modulus
  4. Uniform bending – Determination of Young's modulus
  5. Laser- Determination of the wave length of the laser using grating
  6. Air wedge - Determination of thickness of a thin sheet/wire
  7. a) Optical fibre -Determination of Numerical Aperture and acceptance angle  
b) Compact disc- Determination of width of the groove using laser.
  8. Acoustic grating- Determination of velocity of ultrasonic waves in liquids.
  9. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids
  10. Post office box -Determination of Band gap of a semiconductor.
  11. Photoelectric effect
  12. Michelson Interferometer.
  13. Melde's string experiment
  14. Experiment with lattice dynamics kit.

**TOTAL: 30 PERIODS****COURSE OUTCOMES:**

Upon completion of the course, the students should be able to

**CO1:** Understand the functioning of various physics laboratory equipment.

**CO2:** Use graphical models to analyze laboratory data.

**CO3:** Use mathematical models as a medium for quantitative reasoning and describing physical reality.

**CO4:** Access, process and analyze scientific information.

**CO5:** Solve problems individually and collaboratively.

### MAPPING OF COs WITH POs AND PSOs

CO's	PO's												PSO's		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-
2	3	3	2	1	1	-	-	-	-	-	-	-	-	-	-
3	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-
4	3	3	2	1	1	-	-	-	-	-	-	-	-	-	-
5	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-
Avg.	3	2.4	2.6	1	1	-	-	-	-	-	-	-	-	-	-

#### CHEMISTRY LABORATORY: (Any seven experiments to be conducted)

##### COURSE OBJECTIVES:

- To inculcate experimental skills to test basic understanding of water quality parameters, such as, acidity, alkalinity, hardness, DO, chloride and copper.
  - To induce the students to familiarize with electroanalytical techniques such as, pH metry, potentiometry and conductometry in the determination of impurities in aqueous solutions.
  - To demonstrate the analysis of metals and alloys.
  - To demonstrate the synthesis of nanoparticles
1. Preparation of  $\text{Na}_2\text{CO}_3$  as a primary standard and estimation of acidity of a water sample using the primary standard
  2. Determination of types and amount of alkalinity in water sample.
    - Split the first experiment into two
  3. Determination of total, temporary & permanent hardness of water by EDTA method.
  4. Determination of DO content of water sample by Winkler's method.
  5. Determination of chloride content of water sample by Argentometric method.
  6. Estimation of copper content of the given solution by Iodometry.
  7. Estimation of TDS of a water sample by gravimetry.
  8. Determination of strength of given hydrochloric acid using pH meter.
  9. Determination of strength of acids in a mixture of acids using conductivity meter.
  10. Conductometric titration of barium chloride against sodium sulphate (precipitation titration)
  11. Estimation of iron content of the given solution using potentiometer.
  12. Estimation of sodium /potassium present in water using flame photometer.
  13. Preparation of nanoparticles ( $\text{TiO}_2/\text{ZnO}/\text{CuO}$ ) by Sol-Gel method.
  14. Estimation of Nickel in steel
  15. Proximate analysis of Coal

**TOTAL : 30 PERIODS**

##### COURSE OUTCOMES :

- CO1:** To analyse the quality of water samples with respect to their acidity, alkalinity, hardness and DO.
- CO2:** To determine the amount of metal ions through volumetric and spectroscopic techniques
- CO3:** To analyse and determine the composition of alloys.
- CO4:** To learn simple method of synthesis of nanoparticles
- CO5:** To quantitatively analyse the impurities in solution by electroanalytical techniques

**TEXT BOOKS :**

1. J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas and B. Sivasankar, Vogel's Textbook of Quantitative Chemical Analysis (2009).

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	1	-	-	2	2	-	-	-	-	2	-	-	-
2	3	1	2	-	-	1	2	-	-	-	-	1	-	-	-
3	3	2	1	1	-	-	1	-	-	-	-	-	-	-	-
4	2	1	2	-	-	2	2	-	-	-	-	-	-	-	-
5	2	1	2	-	1	2	2	-	-	-	-	1	-	-	-
Avg.	2.6	1.3	1.6	1	1	1.4	1.8	-	-	-	-	1.3	-	-	-

**GE3172****ENGLISH LABORATORY****L T P C  
0 0 2 1****COURSE OBJECTIVES:**

- To improve the communicative competence of learners
- To help learners use language effectively in academic /work contexts
- To develop various listening strategies to comprehend various types of audio materials like lectures, discussions, videos etc.
- To build on students' English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
- To use language efficiently in expressing their opinions via various media.

**UNIT I INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION****6**

Listening for general information-specific details- conversation: Introduction to classmates - Audio / video (formal & informal); Telephone conversation; Listening to voicemail & messages; Listening and filling a form. Speaking - making telephone calls-Self Introduction; Introducing a friend; - politeness strategies- making polite requests, making polite offers, replying to polite requests and offers-understanding basic instructions( filling out a bank application for example).

**UNIT II NARRATION AND SUMMATION****6**

Listening - Listening to podcasts, anecdotes / stories / event narration; documentaries and interviews with celebrities. Speaking - Narrating personal experiences / events-Talking about current and temporary situations & permanent and regular situations\* - describing experiences and feelings-engaging in small talk- describing requirements and abilities.

**UNIT III DESCRIPTION OF A PROCESS / PRODUCT****6**

Listening - Listen to product and process descriptions; a classroom lecture; and advertisements about products. Speaking – Picture description- describing locations in workplaces- Giving instruction to use the product- explaining uses and purposes- Presenting a product- describing shapes and sizes and weights- talking about quantities(large & small)-talking about precautions.

**UNIT IV CLASSIFICATION AND RECOMMENDATIONS****6**

Listening – Listening to TED Talks; Listening to lectures - and educational videos. Speaking – Small Talk; discussing and making plans-talking about tasks-talking about progress- talking about positions and directions of movement-talking about travel preparations- talking about transportation-

**UNIT V EXPRESSION****6**

Listening – Listening to debates/ discussions; different viewpoints on an issue; and panel discussions. Speaking –making predictions- talking about a given topic-giving opinions- understanding a website-describing processes

**TOTAL : 30 PERIODS****LEARNING OUTCOMES:**

At the end of the course, learners will be able

**CO1:** To listen to and comprehend general as well as complex academic information

**CO2:** To listen to and understand different points of view in a discussion

**CO3:** To speak fluently and accurately in formal and informal communicative contexts

**CO4:** To describe products and processes and explain their uses and purposes clearly and accurately

**CO5:** To express their opinions effectively in both formal and informal discussions

**ASSESSMENT PATTERN**

- One online / app based assessment to test listening /speaking
- End Semester **ONLY** listening and speaking will be conducted online.
- Proficiency certification is given on successful completion of listening and speaking internal test and end semester exam.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
2	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
3	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
4	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
5	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
Avg.	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-

## SEMESTER II

HS3252

PROFESSIONAL ENGLISH - II

L T P C  
2 0 0 2

### **COURSE OBJECTIVES:**

- To engage learners in meaningful language activities to improve their reading and writing skills
- To learn various reading strategies and apply in comprehending documents in professional context.
- To help learners understand the purpose, audience, contexts of different types of writing
- To develop analytical thinking skills for problem solving in communicative contexts
- To demonstrate an understanding of job applications and interviews for internship and placements

### **UNIT I MAKING COMPARISONS**

**6**

Reading - Reading advertisements, user manuals, brochures; Writing – Professional emails, Email etiquette - Compare and Contrast Essay; Grammar – Mixed Tenses, Prepositional phrases

### **UNIT II EXPRESSING CAUSAL RELATIONS IN SPEAKING AND WRITING**

**6**

Reading - Reading longer technical texts– Cause and Effect Essays, and Letters / emails of complaint, Writing - Writing responses to complaints. Grammar - Active Passive Voice transformations, Infinitive and Gerunds

### **UNIT III PROBLEM SOLVING**

**6**

Reading - Case Studies, excerpts from literary texts, news reports etc. Writing – Letter to the Editor, Checklists, Problem solution essay / Argumentative Essay. Grammar – Error correction; If conditional sentences

### **UNIT IV REPORTING OF EVENTS AND RESEARCH**

**6**

Reading –Newspaper articles; Writing – Recommendations, Transcoding, Accident Report, Survey Report Grammar – Reported Speech, Modals Vocabulary – Conjunctions- use of prepositions

### **UNIT V THE ABILITY TO PUT IDEAS OR INFORMATION COGENTLY**

**6**

Reading – Company profiles, Statement of Purpose, (SOP), an excerpt of interview with professionals; Writing – Job / Internship application – Cover letter & Resume; Grammar – Numerical adjectives, Relative Clauses.

**TOTAL : 30 PERIODS**

### **COURSE OUTCOMES:**

At the end of the course, learners will be able

**CO1:**To compare and contrast products and ideas in technical texts.

**CO2:**To identify and report cause and effects in events, industrial processes through technical texts

**CO3:**To analyse problems in order to arrive at feasible solutions and communicate them in the written format.

**CO4:**To present their ideas and opinions in a planned and logical manner

**CO5:**To draft effective resumes in the context of job search.

### **TEXT BOOKS :**

1. English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.
2. English for Science & Technology Cambridge University Press 2021.

3. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

**REFERENCE BOOKS:**

1. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.
2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, NewDelhi.
3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.

**ASSESSMENT PATTERN**

Two internal assessments and an end semester examination to test students’ reading and writing skills along with their grammatical and lexical competence.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	3	3	3	3	2	3	3	3	-	-	-
2	3	3	3	3	3	3	3	3	2	3	3	3	-	-	-
3	3	3	3	3	3	3	3	3	2	3	3	3	-	-	-
4	3	3	3	3	2	3	3	3	2	3	3	3	-	-	-
5	-	-	-	-	-	-	-	-	3	3	3	3	-	-	-
Avg.	3	3	3	3	2.75	3	3	3	2.2	3	3	3	-	-	-

**MA3251**

**STATISTICS AND NUMERICAL METHODS**

**L T P C**  
**3 1 0 4**

**COURSE OBJECTIVES:**

- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

**UNIT I TESTING OF HYPOTHESIS****9 + 3**

Sampling distributions - Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.

**UNIT II DESIGN OF EXPERIMENTS****9 + 3**

One way and two way classifications - Completely randomized design – Randomized block design – Latin square design -  $2^2$  factorial design.

**UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS****9 + 3**

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.

**UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION****9 + 3**

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

**UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS****9 + 3**

Single step methods: Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first order differential equations - Multi step methods: Milne's and Adams - Bash forth predictor corrector methods for solving first order differential equations.

**TOTAL: 60 PERIODS****COURSE OUTCOMES:**

Upon successful completion of the course, students will be able to:

**CO1:**Apply the concept of testing of hypothesis for small and large samples in real life problems.

**CO2:**Apply the basic concepts of classifications of design of experiments in the field of agriculture.

**CO3:**Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.

**CO4:**Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.

**CO5:**Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

**TEXT BOOKS:**

1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10<sup>th</sup> Edition, New Delhi, 2015.
2. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8<sup>th</sup> Edition, 2015.

**REFERENCES:**

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9<sup>th</sup> Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8<sup>th</sup> Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7<sup>th</sup> Edition, 2007.
4. Gupta S.C. and Kapoor V. K., " Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 12<sup>th</sup> Edition, 2020.

5. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics ", Tata McGraw Hill Edition, 4<sup>th</sup> Edition, 2012.
6. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", 9<sup>th</sup> Edition, Pearson Education, Asia, 2010.

### MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
2	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
3	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
4	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
5	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
Avg.	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-

**PH3202**

**PHYSICS FOR ELECTRICAL ENGINEERING**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

- To make the students to understand the basics of dielectric materials and insulation.
- To understand the electrical properties of materials including free electron theory, applications of quantum mechanics and magnetic materials.
- To instil knowledge on physics of semiconductors, determination of charge carriers and device applications
- To establish a sound grasp of knowledge on different optical properties of materials, optical displays and applications
- To inculcate an idea of significance of nano structures, quantum confinement and ensuing nano device applications.

**UNIT I DIELECTRIC MATERIALS AND INSULATION**

**9**

Matter polarization and relative permittivity: definition – dipole moment and polarization vector P- polarization mechanisms: electronic, ionic, orientational, interfacial and total polarization – frequency dependence – local field and Clausius-Mossetti equation – dielectric constant and dielectric loss – Gauss's law and boundary conditions – dielectric strength, introduction to insulation breakdown in gases, liquids and solids – capacitor materials – typical capacitor constructions – piezoelectricity, ferroelectricity and pyroelectricity – quartz oscillators and filters – piezo and pyroelectric crystals.

**UNIT II ELECTRICAL AND MAGNETIC PROPERTIES OF MATERIALS**

**9**

Classical free electron theory - Expression for electrical conductivity – Thermal conductivity, expression - Quantum free electron theory :Tunneling – degenerate states – Fermi- Dirac statistics – Density of energy states – Electron in periodic potential – Energy bands in solids – tight binding approximation - Electron effective mass – concept of hole. Magnetic materials: Dia, para and ferromagnetic effects – paramagnetism in the conduction electrons in metals – exchange interaction and ferromagnetism – quantum interference devices – GMR devices.



**UNIT III SEMICONDUCTORS AND TRANSPORT PHYSICS 9**

Intrinsic Semiconductors – Energy band diagram – direct and indirect band gap semiconductors – Carrier concentration in intrinsic semiconductors – extrinsic semiconductors - Carrier concentration in N-type & P-type semiconductors – Variation of carrier concentration with temperature – Carrier transport in Semiconductors: Drift, mobility and diffusion – Hall effect and devices – Ohmic contacts – Schottky diode.

**UNIT IV OPTICAL PROPERTIES OF MATERIALS 9**

Classification of optical materials – Optical processes in semiconductors: optical absorption and emission, charge injection and recombination, optical absorption, loss and gain. Optical processes in quantum wells – Optoelectronic devices: light detectors and solar cells – light emitting diode – laser diode - optical processes in organic semiconductor devices –excitonic state – Electro-optics and nonlinear optics: Modulators and switching devices – plasmonics.

**UNIT V NANO DEVICES 9**

Density of states for solids - Significance between Fermi energy and volume of the material – Quantum confinement – Quantum structures – Density of states for quantum wells, wires and dots – Band gap of nanomaterials –Tunneling – Single electron phenomena – Single electron Transistor. Conductivity of metallic nanowires – Ballistic transport – Quantum resistance and conductance –

Carbon nanotubes: Properties and applications - Spintronic devices and applications – Optics in quantum structures – quantum well laser.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

At the end of the course, the students should be able to

**CO1:** know basics of dielectric materials and insulation.

**CO2:** gain knowledge on the electrical and magnetic properties of materials and their applications

**CO3:** understand clearly of semiconductor physics and functioning of semiconductor devices

**CO4:** understand the optical properties of materials and working principles of various optical devices

**CO5:** appreciate the importance of nanotechnology and nanodevices.

**TEXT BOOKS:**

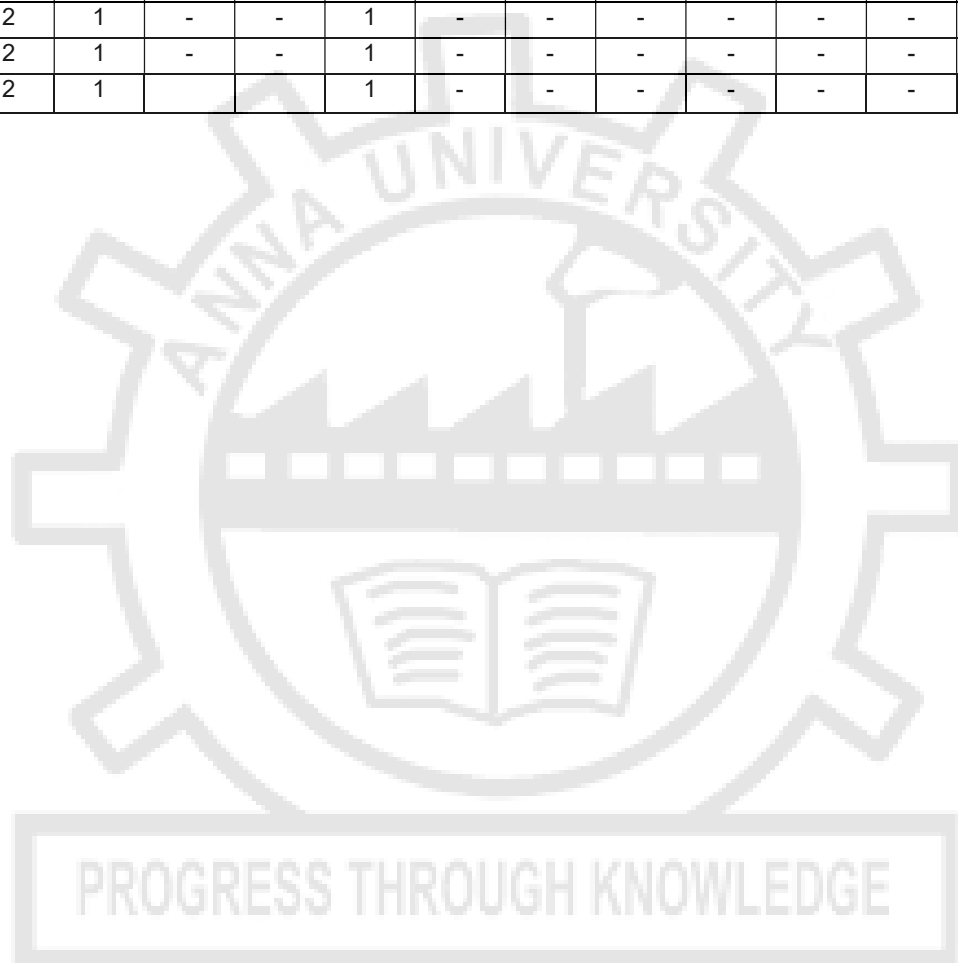
1. S.O. Kasap. Principles of Electronic Materials and Devices, McGraw Hill Education (Indian Edition), 2020.
2. R.F.Pierret. Semiconductor Device Fundamentals. Pearson (Indian Edition), 2006.
3. G.W.Hanson. Fundamentals of Nanoelectronics. Pearson Education (Indian Edition), 2009.

**REFERENCES:**

1. Laszlo Solymar, Walsh, Donald, Syms and Richard R.A., Electrical Properties of Materials, Oxford Univ. Press (Indian Edition) 2015.
2. Jasprit Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Education (Indian Edition), 2019.
3. Charles Kittel, Introduction to Solid State Physics, Wiley India Edition, 2019.
4. Mark Fox, Optical Properties of Solids, Oxford Univ.Press, 2001.
5. Parag K. Lala, Quantum Computing: A Beginner's Introduction, McGraw-Hill Education (Indian Edition), 2020.

### MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1	-	-	1	-	-	-	-	-	-	-	-	-
2	3	2	1	-	-	1	-	-	-	-	-	-	-	-	-
3	3	2	1	-	-	1	-	-	-	-	-	-	-	-	-
4	3	2	1	-	-	1	-	-	-	-	-	-	-	-	-
5	3	2	1	-	-	1	-	-	-	-	-	-	-	-	-
Avg.	3	2	1			1	-	-	-	-	-	-	-	-	-



**COURSE OBJECTIVES:**

- To provide the students an illustration of the significance of the Civil and Mechanical Engineering Profession in satisfying the societal needs.
- To help students acquire knowledge in the basics of surveying and the materials used for construction.
- To provide an insight to the essentials of components of a building and the infrastructure facilities.
- To explain the component of power plant units and detailed explanation to IC engines their working principles.
- To explain the Refrigeration & Air-conditioning system.

**UNIT I PART A: OVERVIEW OF CIVIL ENGINEERING 5**

Civil Engineering contributions to the welfare of Society - Specialized sub disciplines in Civil Engineering – Structural, Construction, Geotechnical, Environmental, Transportation and Water Resources Engineering – National building code – terminologists: Plinth area, Carpet area, Floor area, Buildup area, Floor space index - Types of buildings: Residential buildings, Industrial buildings.

**UNIT I PART B: OVERVIEW OF MECHANICAL ENGINEERING 4**

Overview of Mechanical Engineering - Mechanical Engineering Contributions to the welfare of Society –Specialized sub disciplines in Mechanical Engineering – Manufacturing, Automation, Automobile and Energy Engineering - Interdisciplinary concepts in Mechanical Engineering.

**UNIT II SURVEYING AND CIVIL ENGINEERING MATERIALS 9**

**Surveying:** Objects – Classification – Principles – Measurements of Distances and angles – Leveling – Determination of areas– Contours.

Civil Engineering Materials: Bricks – Stones – Sand – Cement – Concrete – Steel - Timber - Modern Materials, Thermal and Acoustic Insulating Materials, Decorative Panels, Water Proofing Materials. Modern uses of Gypsum, Pre-fabricated Building component (brief discussion only)

**UNIT III BUILDING COMPONENTS AND INFRASTRUCTURE 9**

Building plans – Setting out of a Building - Foundations: Types of foundations - Bearing capacity and settlement – Brick masonry – Stone Masonry – Beams – Columns – Lintels – Roofing – Flooring – Plastering.

Types of Bridges and Dams – Water Supply Network - Rain Water Harvesting – Solid Waste Management - Introduction to Highways and Railways - Introduction to Green Buildings.

**UNIT IV INTERNAL COMBUSTION ENGINES AND POWER PLANTS 9**

Classification of Power Plants- Working principle of steam, Gas, Diesel, Hydro -electric and Nuclear Power plants- Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines. Working principle of Boilers-Turbines, Reciprocating Pumps (single acting and double acting) and Centrifugal Pumps, Concept of hybrid engines. Industrial safety practices and protective devices

**UNIT V REFRIGERATION AND AIR CONDITIONING SYSTEM****9**

Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system–Layout of typical domestic refrigerator–Window and Split type room Air conditioner. Properties of air - water mixture, concepts of psychometric and its process.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

- CO1:** Understanding profession of Civil and Mechanical engineering.
- CO2:** Summarise the planning of building, infrastructure and working of Machineries.
- CO3:** Apply the knowledge gained in respective discipline
- CO4:** Illustrate the ideas of Civil and Mechanical Engineering applications.
- CO5:** Appraise the material, Structures, machines and energy.

**TEXT BOOKS:**

1. G Shanmugam, M S Palanichamy, Basic Civil and Mechanical Engineering, McGraw Hill Education; First edition, 2018

**REFERENCES:**

- 1.Palanikumar, K. Basic Mechanical Engineering, ARS Publications, 2018.
- 2.Ramamrutham S., “Basic Civil Engineering”, Dhanpat Rai Publishing Co.(P) Ltd, 2013.
- 3.Seetharaman S., “Basic Civil Engineering”, Anuradha Agencies, 2005.
- 4.Shantha Kumar SRJ., “Basic Mechanical Engineering”, Hi-tech Publications, Mayiladuthurai, 2000.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	-	-	1	-	-	1	2	1	2	-	1	-	-	-
2	2	-	-	-	-	-	1	2	1	2	-	2	-	-	-
3	2	-	-	-	-	-	1	2	2	2	-	2	-	-	-
4	2	-	-	-	-	-	1	2	1	2	-	2	-	-	-
5	2	-	-	-	-	-	1	2	1	2	-	2	-	-	-
Avg.	2	-	-	0.2	-	-	1	2	1.2	2	-	1.8	-	-	-

PROGRESS THROUGH KNOWLEDGE

**GE3251****ENGINEERING GRAPHICS****L T P C****2 0 4 4****COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

1. Drawing engineering curves.
2. Drawing freehand sketch of simple objects.
3. Drawing orthographic projection of solids and section of solids.
4. Drawing development of solids
5. Drawing isometric and perspective projections of simple solids.

## **CONCEPTS AND CONVENTIONS (Not for Examination)**

Importance of graphics in engineering applications — Use of drafting instruments — BIS conventions and specifications — Size, layout and folding of drawing sheets — Lettering and dimensioning.

### **UNIT I PLANE CURVES**

**6+12**

Basic Geometrical constructions, Curves used in engineering practices: Conics — Construction of ellipse, parabola and hyperbola by eccentricity method — Construction of cycloid — construction of involutes of square and circle — Drawing of tangents and normal to the above curves.

### **UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE**

**6+12**

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

### **UNIT III PROJECTION OF SOLIDS AND FREEHAND SKETCHING**

**6+12**

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method. Visualization concepts and Free Hand sketching: Visualization principles —Representation of Three Dimensional objects — Layout of views- Freehand sketching of multiple views from pictorial views of objects.

Practicing three dimensional modeling of simple objects by CAD Software(Not for examination)

### **UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES**

**6 +12**

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other — obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids — Prisms, pyramids cylinders and cones.

Practicing three dimensional modeling of simple objects by CAD Software(Not for examination)

### **UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS**

**6+12**

Principles of isometric projection — isometric scale —Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

Practicing three dimensional modeling of isometric projection of simple objects by CAD Software(Not for examination)

**TOTAL: (L=30+P=60) 90 PERIODS**

### **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1:**Use BIS conventions and specifications for engineering drawing.

**CO2:**Construct the conic curves, involutes and cycloid.

**CO3:**Solve practical problems involving projection of lines.

**CO4:**Draw the orthographic, isometric and perspective projections of simple solids.

**CO5:**Draw the development of simple solids.

### **TEXT BOOK:**

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 53<sup>rd</sup> Edition, 2019.
2. Natrajan K.V., "A Text Book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2018.
3. Parthasarathy, N. S. and Vela Murali, "Engineering Drawing", Oxford University Press, 2015

## REFERENCES:

1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill, 2<sup>nd</sup> Edition, 2019.
2. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Publications, Bangalore, 27<sup>th</sup> Edition, 2017.
3. Luzzader, Warren.J. and Duff, John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4. Parthasarathy N. S. and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.
5. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson Education India, 2<sup>nd</sup> Edition, 2009.
6. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.

## Publication of Bureau of Indian Standards:

1. IS 10711 — 2001: Technical products Documentation — Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) — 2001: Technical products Documentation — Lettering.
3. IS 10714 (Part 20) — 2001 & SP 46 — 2003: Lines for technical drawings.
4. IS 11669 — 1986 & SP 46 — 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) — 2001: Technical drawings — Projection Methods.

## Special points applicable to University Examinations on Engineering Graphics:

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

## MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
2	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
3	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
4	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
5	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
Avg.	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-

PROGRESS THROUGH KNOWLEDGE

**COURSE OBJECTIVES:**

- To introduce electric circuits and its analysis
- To provide key concepts to analyze and understand electrical circuits
- To impart knowledge on solving circuit equations using network theorems
- To educate on obtaining the transient response of circuits.
- To introduce the phenomenon of resonance in coupled circuits.
- To introduce Phasor diagrams and analysis of single & three phase circuits

**UNIT I BASIC CIRCUITS ANALYSIS****9+3**

Fundamentals concepts of R, L and C elements-Energy Sources- Ohm's Law -Kirchhoff 's Laws – DC Circuits – Resistors in series and parallel circuits - A.C Circuits – Average and RMS Value – Complex Impedance – Phasor diagram - Real and Reactive Power, Power Factor, Energy -Mesh current and node voltage methods of analysis D.C and A.C Circuits.

**UNIT II NETWORK REDUCTION AND THEOREMS FOR DC AND AC CIRCUITS****9+3**

Network reduction: voltage and current division, source transformation – star delta conversion. Theorems – Superposition, Thevenin's and Norton's Theorem – Maximum power transfer theorem – Reciprocity Theorem – Millman's theorem- Tellegen's Theorem-Statement, application to DC and AC Circuits.

**UNIT III TRANSIENT RESPONSE ANALYSIS****9+3**

Introduction – Laplace transforms and inverse Laplace transforms- standard test signals -Transient response of RL, RC and RLC circuits using Laplace transform for Source free, Step input and Sinusoidal input.

**UNIT IV RESONANCE AND COUPLED CIRCUITS****9+3**

Series and parallel resonance –frequency response – Quality factor and Bandwidth – Self and mutual inductance – Coefficient of coupling – Dot rule-Analysis of coupled circuits– Single Tuned circuits.

**UNIT V THREE PHASE CIRCUITS****9+3**

Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced and unbalanced – phasor diagram of voltages and currents – power measurement in three phase circuits– Power Factor Calculations.

**TOTAL: 60 PERIODS****COURSE OUTCOMES:**

After completing this course, the students will be able to:

- CO1: Explain circuit's behavior using circuit laws.
- CO2: Apply mesh analysis/ nodal analysis / network theorems to determine behavior of the given DC and AC circuit
- CO3: Compute the transient response of first order and second order systems to step and sinusoidal input
- CO4: Compute power, line/ phase voltage and currents of the given three phase circuit
- CO5: Explain the frequency response of series and parallel RLC circuits
- CO6: Explain the behavior of magnetically coupled circuits.

**TEXT BOOKS:**

1. William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", McGraw Hill publishers, 9<sup>th</sup> edition, New Delhi, 2020.

2. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", Second Edition, McGraw Hill, 2019.
3. Allan H. Robbins, Wilhelm C. Miller, "Circuit Analysis Theory and Practice", Cengage Learning India, 2013.

### REFERENCES

1. Chakrabarti A, "Circuits Theory (Analysis and synthesis), Dhanpat Rai& Sons, New Delhi, 2020.
- 2 Joseph A. Edminister, Mahmood Nahvi, "Electric circuits", Schaum's series, McGraw-Hill, First Edition, 2019.
4. M E Van Valkenburg, "Network Analysis", Prentice-Hall of India Pvt Ltd, New Delhi, 2015.
5. Richard C. Dorf and James A. Svoboda, "Introduction to Electric Circuits", 7th Edition, John Wiley Sons, Inc. 2018.
6. Sudhakar A and Shyam Mohan SP, "Circuits and Networks Analysis and Synthesis", McGraHill, 2015.

### MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	3	2	2	-	2	1	-	-	-	3	3	3	3
CO2	3	3	3	3	2	-	2	1	-	-	-	3	3	3	3
CO3	3	3	3	3	2	-	2	1	-	-	-	3	3	3	3
CO4	3	3	3	3	2	-	2	1	-	-	-	3	3	3	3
CO5	3	3	3	3	2	-	2	1	-	-	-	3	3	3	3
CO6	3	3	3	3	2	-	2	1	-	-	-	3	3	3	3
Avg.	3	3	3	2.8	2	-	2	1	-	-	-	3	3	3	3

PROGRESS THROUGH KNOWLEDGE



## NCC Credit Course Level 1\*

NX3251	(ARMY WING) NCC Credit Course Level - I	L	T	P	C
		2	0	0	2
<b>NCC GENERAL</b>					<b>6</b>
NCC 1	Aims, Objectives & Organization of NCC				1
NCC 2	Incentives				2
NCC 3	Duties of NCC Cadet				1
NCC 4	NCC Camps: Types & Conduct				2
<b>NATIONAL INTEGRATION AND AWARENESS</b>					<b>4</b>
NI 1	National Integration: Importance & Necessity				1
NI 2	Factors Affecting National Integration				1
NI 3	Unity in Diversity & Role of NCC in Nation Building				1
NI 4	Threats to National Security				1
<b>PERSONALITY DEVELOPMENT</b>					<b>7</b>
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving				2
PD 2	Communication Skills				3
PD 3	Group Discussion: Stress & Emotions				2
<b>LEADERSHIP</b>					<b>5</b>
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code				3
L 2	Case Studies: Shivaji, Jhasi Ki Rani				2
<b>SOCIAL SERVICE AND COMMUNITY DEVELOPMENT</b>					<b>8</b>
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth				3
SS 4	Protection of Children and Women Safety				1
SS 5	Road / Rail Travel Safety				1
SS 6	New Initiatives				2
SS 7	Cyber and Mobile Security Awareness				1

**TOTAL : 30 PERIODS**

## NCC Credit Course Level 1\*

NX3252		(NAVAL WING) NCC Credit Course Level - I	L	T	P	C
			2	0	0	2
<b>NCC GENERAL</b>						<b>6</b>
NCC 1	Aims, Objectives & Organization of NCC					1
NCC 2	Incentives					2
NCC 3	Duties of NCC Cadet					1
NCC 4	NCC Camps: Types & Conduct					2
<b>NATIONAL INTEGRATION AND AWARENESS</b>						<b>4</b>
NI 1	National Integration: Importance & Necessity					1
NI 2	Factors Affecting National Integration					1
NI 3	Unity in Diversity & Role of NCC in Nation Building					1
NI 4	Threats to National Security					1
<b>PERSONALITY DEVELOPMENT</b>						<b>7</b>
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving					2
PD 2	Communication Skills					3
PD 3	Group Discussion: Stress & Emotions					2
<b>LEADERSHIP</b>						<b>5</b>
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code					3
L 2	Case Studies: Shivaji, Jhasi Ki Rani					2
<b>SOCIAL SERVICE AND COMMUNITY DEVELOPMENT</b>						<b>8</b>
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth					3
SS 4	Protection of Children and Women Safety					1
SS 5	Road / Rail Travel Safety					1
SS 6	New Initiatives					2
SS 7	Cyber and Mobile Security Awareness					1

**TOTAL : 30 PERIODS**

## NCC Credit Course Level 1\*

NX3253	(AIR FORCE WING) NCC Credit Course Level - I	L	T	P	C
		2	0	0	2
<b>NCC GENERAL</b>					<b>6</b>
NCC 1	Aims, Objectives & Organization of NCC				1
NCC 2	Incentives				2
NCC 3	Duties of NCC Cadet				1
NCC 4	NCC Camps: Types & Conduct				2
<b>NATIONAL INTEGRATION AND AWARENESS</b>					<b>4</b>
NI 1	National Integration: Importance & Necessity				1
NI 2	Factors Affecting National Integration				1
NI 3	Unity in Diversity & Role of NCC in Nation Building				1
NI 4	Threats to National Security				1
<b>PERSONALITY DEVELOPMENT</b>					<b>7</b>
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving				2
PD 2	Communication Skills				3
PD 3	Group Discussion: Stress & Emotions				2
<b>LEADERSHIP</b>					<b>5</b>
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code				3
L 2	Case Studies: Shivaji, Jhasi Ki Rani				2
<b>SOCIAL SERVICE AND COMMUNITY DEVELOPMENT</b>					<b>8</b>
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth				3
SS 4	Protection of Children and Women Safety				1
SS 5	Road / Rail Travel Safety				1
SS 6	New Initiatives				2
SS 7	Cyber and Mobile Security Awareness				1
<b>TOTAL : 30 PERIODS</b>					

GE3252

TAMILS AND TECHNOLOGY

LT P C

1 0 0 1

**UNIT I WEAVING AND CERAMIC TECHNOLOGY**

**3**

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

**UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY**

**3**

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

**UNIT III MANUFACTURING TECHNOLOGY**

**3**

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beads - Archeological evidences - Gem stone types described in Silappathikaram.

**UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY**

**3**

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thooppu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

**UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING**

**3**

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

**அலகு I நெசவு மற்றும் பாணைத் தொழில்நுட்பம்:**

சங்க காலத்தில் நெசவுத் தொழில் - பாணைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் - பாண்டங்களில் கீறல் குறியீடுகள்.

**அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்:**

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் - சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் - சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் - நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் - செட்டிநாட்டு வீடுகள் - பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

**அலகு III உற்பத்தித் தொழில் நுட்பம்:**

கப்பல் கட்டும் கலை - உலோகவியல் - இரும்புத் தொழிற்சாலை - இரும்பை உருக்குதல், எஃகு - வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் - நாணயங்கள் அச்சடித்தல் - மணி உருவாக்கும் தொழிற்சாலைகள் - கல்மணிகள், கண்ணாடி மணிகள் - சுடுமண் மணிகள் - சங்கு மணிகள் - எலும்புத்துண்டுகள் - தொல்லியல் சான்றுகள் - சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

**அலகு IV வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்:**

அணை, ஏரி, குளங்கள், மதகு - சோழர்காலக் குழுழித் தூம்பின் முக்கியத்துவம் - கால்நடை பராமரிப்பு - கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் - வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் - கடல்சார் அறிவு - மீன்வளம் - முத்து மற்றும் முத்துக்குளித்தல் - பெருங்கடல் குறித்த பண்டைய அறிவு - அறிவுசார் சமூகம்.

**அலகு V அறிவியல் தமிழ் மற்றும் கணித்தமிழ்:**

அறிவியல் தமிழின் வளர்ச்சி - கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் - தமிழ் மென்பொருட்கள் உருவாக்கம் - தமிழ் இணையக் கல்விக்கழகம் - தமிழ் மின் நூலகம் - இணையத்தில் தமிழ் அகராதிகள் - சொற்குவைத் திட்டம்.

**TOTAL : 15 PERIODS****TEXT-CUM-REFERENCE BOOKS**

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் - முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL - (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies).
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) - Reference Book.

**COURSE OBJECTIVES:**

The main learning objective of this course is to provide hands on training to the students in:

1. Drawing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planing; making joints in wood materials used in common household wood work.
2. Wiring various electrical joints in common household electrical wire work.
3. Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts; Assembling simple mechanical assembly of common household equipments; Making a tray out of metal sheet using sheet metal work.
4. Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.

**GROUP – A (CIVIL & ELECTRICAL)****PART I CIVIL ENGINEERING PRACTICES 15****PLUMBING WORK:**

- a) Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
- b) Preparing plumbing line sketches.
- c) Laying pipe connection to the suction side of a pump
- d) Laying pipe connection to the delivery side of a pump.
- e) Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.

**WOOD WORK:**

- a) Sawing,
- b) Planing and
- c) Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.

## Wood Work Study:

- a) Studying joints in door panels and wooden furniture
- b) Studying common industrial trusses using models.

**PART II ELECTRICAL ENGINEERING PRACTICES 15**

- a) Introduction to switches, fuses, indicators and lamps - Basic switch board wiring with lamp, fan and three pin socket
- b) Staircase wiring
- c) Fluorescent Lamp wiring with introduction to CFL and LED types.
- d) Energy meter wiring and related calculations/ calibration
- e) Study of Iron Box wiring and assembly
- f) Study of Fan Regulator (Resistor type and Electronic type using Diac/Triac/quadrac)
- g) Study of emergency lamp wiring/Water heater

## GROUP – B (MECHANICAL AND ELECTRONICS)

### PART III MECHANICAL ENGINEERING PRACTICES 15

#### WELDING WORK:

- a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
- b) Practicing gas welding.

#### BASIC MACHINING WORK:

- a) (simple)Turning.
- b) (simple)Drilling.
- c) (simple)Tapping.

#### ASSEMBLY WORK:

- a) Assembling a centrifugal pump.
- b) Assembling a household mixer.
- c) Assembling an airconditioner.

#### SHEET METAL WORK:

- a) Making of a square tray

#### FOUNDRY WORK:

- a) Demonstrating basic foundry operations.

### PART IV ELECTRONIC ENGINEERING PRACTICES 15

#### SOLDERING WORK:

- a) Soldering simple electronic circuits and checking continuity.

#### ELECTRONIC ASSEMBLY AND TESTING WORK:

- a) Assembling and testing electronic components on a small PCB.

#### ELECTRONIC EQUIPMENT STUDY:

- a) Study an elements of smart phone.
- b) Assembly and dismantle of LED TV.
- c) Assembly and dismantle of computer/ laptop

**TOTAL : 60 PERIODS**

#### COURSE OUTCOMES:

**Upon completion of this course, the students will be able to:**

**CO1:**Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.

**CO2:**Wire various electrical joints in common household electrical wire work.

**CO3:**Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical assembly of common household equipments; Make a tray out of metal sheet using sheet metal work.

**CO4:**Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

## MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
1	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1
2	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1
3	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1
Avg.	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1

**EE3271**

**ELECTRIC CIRCUITS LABORATORY**

**L T P C**  
**0 0 4 2**

**COURSE OBJECTIVES:**

- To simulate various electric circuits using Pspice/ Matlab/e-Sim / Scilab
- To gain practical experience on electric circuits and verification of theorems

**LIST OF EXPERIMENTS**

**Familiarization of various electrical components, sources and measuring instruments**

1. Simulation and experimental verification of series and parallel electrical circuit using fundamental laws.
2. Simulation and experimental verification of electrical circuit problems using Thevenin's theorem.
3. Simulation and experimental verification of electrical circuit problems using Norton's theorem.
4. Simulation and experimental verification of electrical circuit problems using Superposition theorem.
5. Simulation and experimental verification of Maximum Power transfer theorem.
6. Simulation and Experimental validation of R-C,R-L and RLC electric circuit transients
7. Simulation and Experimental validation of frequency response of RLC electric circuit.
8. Design and implementation of series and parallel resonance circuit.
9. Simulation and experimental verification of three phase balanced and unbalanced star, delta networks circuit (Power and Power factor calculations).

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

- CO1: Use simulation and experimental methods to verify the fundamental electrical laws for the given DC/AC circuit (Ex 1)
- CO2: Use simulation and experimental methods to verify the various electrical theorems (Superposition, Thevenin, Norton and maximum power transfer) for the given DC/AC circuit (Ex 2-5)
- CO3: Analyze transient behavior of the given RL/RC/RLC circuit using simulation and experimental methods (Ex 6)
- CO4: Analyze frequency response of the given series and parallel RLC circuit using simulation and experimentation methods (Ex 7-8)



CO5: Analyze the performance of the given three-phase circuit using simulation and experimental methods (Ex 9)

### MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
1	3	3	3	3	3	-	2	1.5	3	-	-	3	3	3	2
2	3	3	3	3	3	-	2	1.5	3	-	-	3	3	3	2
3	3	3	3	3	3	-	2	1.5	3	-	-	3	3	3	2
4	3	3	3	3	3	-	2	1.5	3	-	-	3	3	3	2
5	3	3	3	3	3	-	2	1.5	3	-	-	3	3	3	2
Avg.	3	3	3	3	3	-	2	1.5	3	-	-	3	3	3	2

**GE3272**

**COMMUNICATION LABORATORY**

**L T P C**  
**0 0 4 2**

#### COURSE OBJECTIVES

- To identify varied group discussion skills and apply them to take part in effective discussions in a professional context.
- To analyse concepts and problems and make effective presentations explaining them clearly and precisely.
- To be able to communicate effectively through formal and informal writing.
- To be able to use appropriate language structures to write emails, reports and essays
- To give instructions and recommendations that are clear and relevant to the context

#### UNIT I

**12**

Speaking-Role Play Exercises Based on Workplace Contexts, - talking about competition- discussing progress toward goals-talking about experiences- talking about events in life- discussing past events- Writing: writing emails ( formal & semi-formal).

#### UNIT II

**12**

Speaking: discussing news stories-talking about frequency-talking about travel problems- discussing travel procedures- talking about travel problems- making arrangements-describing arrangements-discussing plans and decisions- discussing purposes and reasons- understanding common technology terms-Writing: - writing different types of emails.

#### UNIT III

**12**

Speaking: discussing predictions-describing the climate-discussing forecasts and scenarios- talking about purchasing-discussing advantages and disadvantages- making comparisons- discussing likes and dislikes- discussing feelings about experiences-discussing imaginary scenarios Writing: short essays and reports-formal/semi-formal letters.

**UNIT IV****12**

Speaking: discussing the natural environment-describing systems-describing position and movement-explaining rules-( example- discussing rental arrangements)- understanding technical instructions- Writing: writing instructions-writing a short article.

**UNIT V****12**

Speaking: describing things relatively-describing clothing-discussing safety issues( making recommendations) talking about electrical devices-describing controlling actions- Writing: job application( Cover letter + Curriculum vitae)-writing recommendations.

**TOTAL: 60 PERIODS****LEARNING OUTCOMES**

At the end of the course, learners will be able

- Speak effectively in group discussions held in formal/semi formal contexts.
- Discuss, analyse and present concepts and problems from various perspectives to arrive at suitable solutions
- Write emails, letters and effective job applications.
- Write critical reports to convey data and information with clarity and precision
- Give appropriate instructions and recommendations for safe execution of tasks

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
1	2	3	3	3	1	3	3	3	3	3	3	3	-	-	-
2	2	3	3	3	1	3	3	3	3	3	3	3	-	-	-
3	2	2	3	3	1	3	3	3	3	3	3	3	-	-	-
4	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
5	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
Avg.	2.4	2.8	3	3	1.8	3	3	3	3	3	3	3	-	-	-

**Assessment Pattern**

- One online / app based assessment to test speaking and writing skills
- Proficiency certification is given on successful completion of speaking and writing.

PROGRESS THROUGH KNOWLEDGE

**MA3303****PROBABILITY AND COMPLEX FUNCTIONS**

**L T P C**  
**3 1 0 4**

**COURSE OBJECTIVES:**

- This course aims at providing the required skill to apply the statistical tools in engineering problems.
- To introduce the basic concepts of probability and random variables.
- To introduce the basic concepts of two dimensional random variables.
- To develop an understanding of the standard techniques of complex variable theory in particular analytic function and its mapping property.

- To familiarize the students with complex integration techniques and contour integration techniques which can be used in real integrals.
- To acquaint the students with Differential Equations which are significantly used in engineering problems.

#### **UNIT I PROBABILITY AND RANDOM VARIABLES**

**9 + 3**

Axioms of probability – Conditional probability – Baye’s theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions – Functions of a random variable.

#### **UNIT II TWO-DIMENSIONAL RANDOM VARIABLES**

**9 + 3**

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

#### **UNIT III ANALYTIC FUNCTIONS**

**9 + 3**

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions  $w = z + c, cz, \frac{1}{z}, z^2$  - Bilinear transformation.

#### **UNIT IV COMPLEX INTEGRATION**

**9 + 3**

Line integral - Cauchy’s integral theorem – Cauchy’s integral formula – Taylor’s and Laurent’s series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Applications of circular contour and semicircular contour (with poles NOT on real axis).

#### **UNIT V ORDINARY DIFFERENTIAL EQUATIONS**

**9 + 3**

Higher order linear differential equations with constant coefficients - Method of variation of parameters – Homogenous equation of Euler’s and Legendre’s type – System of simultaneous linear first order differential equations with constant coefficients - Method of undetermined coefficients.

**TOTAL: 60 PERIODS**

#### **COURSE OUTCOMES:**

Upon successful completion of the course, students will be able to:

- CO1: Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon.
- CO2: Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
- CO3: To develop an understanding of the standard techniques of complex variable theory in particular analytic function and its mapping property.
- CO4: To familiarize the students with complex integration techniques and contour integration techniques which can be used in real integrals.
- CO5: To acquaint the students with Differential Equations which are significantly used in engineering problems.

#### **TEXT BOOKS**

1. Johnson. R.A., Miller. I and Freund. J., "Miller and Freund’s Probability and Statistics for Engineers", Pearson Education, Asia, 9<sup>th</sup> Edition, 2016.
2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4<sup>th</sup> Edition, 2007.
3. Grewal.B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44<sup>th</sup> Edition, 2018.

## REFERENCES

1. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8<sup>th</sup> Edition, 2014.
2. Papoulis. A. and Unnikrishnapillai . S., "Probability, Random Variables and Stochastic Processes", McGraw Hill Education India, 4<sup>th</sup> Edition, New Delhi, 2010.
3. Ross . S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 5<sup>th</sup> Edition, Elsevier, 2014.
4. Spiegel. M.R., Schiller. J. and Srinivasan . R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 4<sup>th</sup> Edition, 2012.
5. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 9<sup>th</sup> Edition, 2010.
6. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10<sup>th</sup> Edition, New Delhi, 2016.

## MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
2	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
3	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
4	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
5	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
Avg.	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-

EE3301

**ELECTROMAGNETIC FIELDS**

**L T P C**

**3 1 0 4**

### COURSE OBJECTIVES:

- To introduce the basic mathematical concepts related to electromagnetic vector fields
- To impart knowledge on the concepts of
  - ✓ Electrostatic fields, electric potential, energy density and their applications.
  - ✓ Magneto static fields, magnetic flux density, vector potential and its applications.
  - ✓ Different methods of emf generation and Maxwell's equations
  - ✓ Electromagnetic waves and characterizing parameters

### UNIT I ELECTROSTATICS – I

**12**

Sources and effects of electromagnetic fields – Coordinate Systems – Vector fields – Gradient, Divergence, Curl – theorems and applications - Coulomb's Law – Electric field intensity – Field due to discrete and continuous charges – Gauss's law and applications.

**UNIT II ELECTROSTATICS – II****12**

Electric potential – Electric field and equipotential plots, Uniform and Non-Uniform field, Utilization factor – Electric field in free space, conductors, dielectrics - Dielectric polarization –Dielectric strength - Electric field in multiple dielectrics – Boundary conditions, Poisson’s and Laplace’s equations, Capacitance, Energy density, Applications.

**UNIT III MAGNETOSTATICS****12**

Lorentz force, magnetic field intensity (H) – Biot–Savart’s Law - Ampere’s Circuit Law – H due to straight conductors, circular loop, infinite sheet of current, Magnetic flux density (B) – B in free space, conductor, magnetic materials – Magnetization, Magnetic field in multiple media –Boundary conditions, scalar and vector potential, Poisson’s Equation, Magnetic force, Torque, Inductance, Energy density, Applications.

**UNIT IV ELECTRODYNAMIC FIELDS****12**

Magnetic Circuits - Faraday’s law – Transformer and motional EMF – Displacement current -Maxwell’s equations (differential and integral form) – Relation between field theory and circuit theory – Applications.

**UNIT V ELECTROMAGNETIC WAVES****12**

Electromagnetic wave generation and equations – Wave parameters; velocity, intrinsic impedance, propagation constant – Waves in free space, lossy and lossless dielectrics, conductors- skin depth - Poynting vector – Plane wave reflection and refraction.

**TOTAL: 60 PERIODS****COURSE OUTCOMES:**

Upon the successful completion of the course, students will be able to:

- CO1: Visualize and explain Gradient, Divergence, and Curl operations on electromagnetic vector fields and identify the electromagnetic sources and their effects.
- CO2: Compute and analyse electrostatic fields, electric potential, energy density along with their applications.
- CO3: Compute and analyse magneto static fields, magnetic flux density, vector potential along with their applications.
- CO4: Explain different methods of emf generation and Maxwell’s equations
- CO5: Explain the concept of electromagnetic waves and characterizing parameters

**TEXT BOOKS:**

1. Mathew N. O. Sadiku, S.V. Kulkarni ‘Principles of Electromagnetics’, 6th Edition, Oxford University Press Inc. Asian edition, 2015.
2. William H. Hayt and John A. Buck, ‘Engineering Electromagnetics’, McGraw Hill Special Indian edition, 2014.
3. Kraus and Fleish, ‘Electromagnetics with Applications’, McGraw Hill International Editions, Fifth Edition, 2010.

**REFERENCES**

1. V.V.Sarwate, ‘Electromagnetic fields and waves’, Second Edition, Newage Publishers, 2018.
2. J.P.Tewari, ‘Engineering Electromagnetics - Theory, Problems and Applications’,

Second Edition, Khanna Publishers 2013.

3. Joseph. A.Edminister, 'Schaum's Outline of Electromagnetics, Fifth Edition (Schaum's Outline Series), McGraw Hill, 2018.
4. S.P.Ghosh, Lipika Datta, 'Electromagnetic Field Theory', First Edition, McGraw Hill Education(India) Private Limited, 2017.
5. K A Gangadhar, 'Electromagnetic Field Theory', Khanna Publishers; Sixteenth Edition Eighth Reprint :2015

### MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	-	-	-	-	3	1	-	-	-	1	3	2	1
CO2	3	2	1	2	-	-	1	1	-	-	-	1	3	2	1
CO3	3	2	1	2	-	-	1	1	-	-	-	1	3	2	1
CO4	3	2	1	2	-	-	1	1	-	-	-	1	3	2	1
CO5	3	2	1	2	-	-	1	1	-	-	-	1	3	2	1
Avg.	3	2	1	2	-	-	1.4	1	-	-	-	1	3	2	1

**EE3302**

**DIGITAL LOGIC CIRCUITS**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce the fundamentals of combinational and sequential digital circuits.
- To study various number systems and to simplify the mathematical expressions using Boolean functions word problems
- To study implementation of combinational circuits using Gates` and MSI Devices.
- To study the design of various synchronous and asynchronous circuits
- To introduce digital simulation techniques for development of application oriented logic circuit

**UNIT I NUMBER SYSTEMS AND DIGITAL LOGIC FAMILIES 9**  
 Number system, error detection, corrections & codes conversions, Boolean algebra: De-Morgan's theorem, switching functions and minimization using K-maps & Quine McCluskey method - Digital Logic Families -comparison of RTL, DTL, TTL, ECL and MOS families - operation, characteristics of digital logic family.

**UNIT II COMBINATIONAL CIRCUITS 9**  
 Combinational logic - representation of logic functions-SOP and POS forms, K-map representations - minimization using K maps - simplification and implementation of combinational logic – multiplexers and de multiplexers - code converters, adders, subtractors, Encoders and Decoders.

**UNIT III SYNCHRONOUS SEQUENTIAL CIRCUITS 9**

Sequential logic- SR, JK, D and T flip flops - level triggering and edge triggering - counters - asynchronous and synchronous type - Modulo counters - Shift registers - design of synchronous sequential circuits – Moore and Mealy models- Counters, state diagram; state reduction; state assignment.

**UNIT IV ASYNCHRONOUS SEQUENTIAL CIRCUITS AND PROGRAMMABILITY LOGIC DEVICES 9**

Asynchronous sequential logic Circuits-Transition stability, flow stability-race conditions, hazards & errors in digital circuits; analysis of asynchronous sequential logic circuits-introduction to Programmability Logic Devices: PROM – PLA –PAL, CPLD-FPGA.

**UNIT V VHDL 9**

RTL Design – combinational logic – Sequential circuit – Operators – Introduction to Packages – Subprograms – Test bench. (Simulation /Tutorial Examples: adders, counters, flip flops, Multiplexers & De multiplexers).

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon the successful completion of the course, students will be able to:

- CO1: Explain various number systems and characteristics of digital logic families
- CO2: Apply K-maps and Quine McCluskey methods to simplify the given Boolean expressions
- CO3: Explain the implementation of combinational circuit such as multiplexers and de multiplexers - code converters, adders, subtractors, Encoders and Decoders
- CO4: Design various synchronous and asynchronous circuits using Flip Flops
- CO5: Explain asynchronous sequential circuits and programmable logic devices
- CO6: Use VHDL for simulating and testing RTL, combinatorial and sequential circuits

**TEXTBOOKS:**

1. Morris Mano.M, 'Digital Logic and Computer Design', Prentice Hall of India, 3<sup>rd</sup>Edition, 2005.
2. Donald D.Givone, 'Digital Principles and Design', Tata McGraw Hill, 1<sup>st</sup> Edition, 2003
3. Thomas L Floyd, 'Digital fundamentals', Pearson Education Limited, 11<sup>th</sup> Edition, 2018

**REFERENCES:**

1. Tocci R.J., Neal S. Widmer, 'Digital Systems: Principles and Applications', Pearson Education Asia, 12<sup>th</sup> Edition, 2017.
2. Donald P Leach, Albert Paul Malvino, Goutam Sha, 'Digital Principles and Applications', Tata McGraw Hill, 7<sup>th</sup> Edition, 2010.

## MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	3	1	3	-	-	1	-	-	-	1	3	-	1
CO2	3	3	3	1	3	-	-	1	-	-	-	1	3	-	1
CO3	3	3	3	1	3	-	-	1	-	-	-	1	3	-	1
CO4	3	3	3	1	3	-	-	1	-	-	-	1	3	-	1
CO5	3	3	3	1	3	-	-	1	-	-	-	1	3	-	1
Avg	3	3	3	1	3	-	-	1	-	-	-	1	3	-	1

**EC3301**

**ELECTRON DEVICES AND CIRCUITS**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the structure of basic electronic devices.
- To be exposed to active and passive circuit elements.
- To familiarize the operation and applications of transistor like BJT and FET.
- To explore the characteristics of amplifier gain and frequency response.
- To learn the required functionality of positive and negative feedback systems.

**UNIT I PN JUNCTION DEVICES**

**9**

PN junction diode –structure, operation and V-I characteristics, diffusion and transition capacitance – Clipping & Clamping circuits - Rectifiers – Half Wave and Full Wave Rectifier– Display devices- LED, Laser diodes, Zener diode characteristics- Zener diode Reverse characteristics – Zener diode as regulator.

**UNIT II TRANSISTORS AND THYRISTORS**

**9**

BJT, JFET, MOSFET- structure, operation, characteristics and Biasing UJT, Thyristors and IGBT - Structure and characteristics.

**UNIT III AMPLIFIERS**

**9**

BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response –MOSFET small signal model– Analysis of CS and Source follower – Gain and frequency response- High frequency analysis.

**UNIT IV MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER**

**9**

BIMOS cascade amplifier, Differential amplifier – Common mode and Difference mode analysis – FET input stages – Single tuned amplifiers – Gain and frequency response – Neutralization methods, power amplifiers –Types (Qualitative analysis).

**UNIT V FEEDBACK AMPLIFIERS AND OSCILLATORS**

**9**

Advantages of negative feedback – voltage / current, series, Shunt feedback –positive feedback – Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.

**TOTAL: 45 PERIODS**



**COURSE OUTCOMES:**

Upon successful completion of the course, the students will be able to:

- CO1: Explain the structure and operation of PN junction devices (diode, Zener diode, LED and Laser diode)
- CO2: Design clipper, clamper, half wave and full wave rectifier, regulator circuits using PN junction diodes
- CO3: Analyze the structure and characteristics BJT, FET, MOSFET, UJT, Thyristor and IGBT
- CO4: Analyze the performance of various configurations of BJT and MOSFET based amplifier
- CO5: Explain the characteristics of MOS based cascade and differential amplifier
- CO6: Explain the operation of various feedback amplifiers and oscillators

**TEXT BOOKS:**

- David A. Bell , "Electronic devices and circuits", Oxford University higher education, 5<sup>th</sup> edition 2008.
- Sedra and smith, "Microelectronic circuits",7<sup>th</sup> Edition., Oxford University Press, 2017

**REFERENCES:**

- Balbir Kumar, Shail.B.Jain, "Electronic devices and circuits" PHI learning private limited, 2<sup>nd</sup> edition 2014.
- Thomas L.Floyd, "Electronic devices" Conventional current version, Pearson prentice hall, 10<sup>th</sup> Edition, 2017.
- Donald A Neamen, "Electronic Circuit Analysis and Design" Tata McGraw Hill, 3rd Edition, 2003.
- Robert L.Boylestad, "Electronic devices and circuit theory", 11<sup>th</sup> edition, Pearson prentice Hall 2013.
- Robert B. Northrop, "Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation", CRC Press, Second edition, 2012.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	2	2	3	2	2	-	-	1	-	-	-	1	3	-	1
CO2	2	2	3	2	2	-	-	1	-	-	-	1	3	-	1
CO3	2	2	3	2	2	-	-	1	-	-	-	1	3	-	1
CO4	2	2	3	2	2	-	-	1	-	-	-	1	3	-	1
CO5	2	2	3	2	2	-	-	1	-	-	-	1	3	-	1
Avg.	2	2	3	2	2	-	-	1	-	-	-	1	3	-	1

**COURSE OBJECTIVES:**

- To understand the concept of electromechanical energy conversion system.
- To identify the appropriate machine for a given application based on its characteristics.
- To identify the appropriate test to determine the performance parameters of a given machine.
- To familiarize with the procedure for parallel operation of generators and transformers.
- To deliberate the working of auto transformer and three phase transformers.

**UNIT I ELECTROMECHANICAL ENERGY CONVERSION****9**

Fundamentals of Magnetic circuits- Statically and dynamically induced EMF - Principle of electromechanical energy conversion forces and torque in magnetic field systems- energy balance in magnetic circuits- magnetic force- co-energy in singly excited and multi excited magnetic field system mmf of distributed windings – Winding Inductances-, magnetic fields in rotating machines- magnetic saturation and leakage fluxes. Introduction to Indian Standard Specifications (ISS) - Role and significance in testing.

**UNIT II DC GENERATORS****9**

Principle of operation, constructional details, armature windings and its types, EMF equation, wave shape of induced emf, armature reaction, demagnetizing and cross magnetizing Ampere turns, compensating winding, commutation, methods of improving commutation, interpoles, OCC and load characteristics of different types of DC Generators. Parallel operation of DC Generators, equalizing connections- applications of DC Generators.

**UNIT III DC MOTORS****9**

Principle of operation, significance of back emf, torque equations and power developed by armature, speed control of DC motors, starting methods of DC motors, load characteristics of DC motors, losses and efficiency in DC machine, condition for maximum efficiency. Testing of DC Machines: Brake test, Swinburne's test, Hopkinson's test, Field test, Retardation test, Separation of core losses-applications of DC motors.

**UNIT IV SINGLE PHASE TRANSFORMER****9**

Construction and principle of operation, equivalent circuit, phasor diagrams, testing - polarity test, open circuit and short circuit tests, voltage regulation, losses and efficiency, all day efficiency, back-to-back test, separation of core losses, parallel operation of single-phase transformers, applications of single-phase transformer.

**UNIT V AUTOTRANSFORMER AND THREE PHASE TRANSFORMER****9**

Construction and working of auto transformer, comparison with two winding transformers, applications of autotransformer. Three Phase Transformer- Construction, types of connections and their comparative features, Scott connection, applications of Scott connection.

**TOTAL : 45 PERIODS**

## TEXT BOOKS

1. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 5<sup>th</sup> Edition, 2017.
2. P. S. Bimbhra, "Electric Machinery", Khanna Publishers, 2<sup>nd</sup> Edition, 2021.

## REFERENCES

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 6<sup>th</sup> Edition 2017.
2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2018.
3. M. G. Say, "Performance and design of AC machines", CBS Publishers, First Edition 2008.
4. Sahdev S. K. "Electrical Machines", Cambridge University Press, 2018.

## COURSE OUTCOMES:

At the end of the course students will be able to:

- CO1: Apply the laws governing the electromechanical energy conversion for singly and multiple excited systems.
- CO2: Explain the construction and working principle of DC machines.
- CO3: Interpret various characteristics of DC machines.
- CO4: Compute various performance parameters of the machine, by conducting suitable tests.
- CO5: Draw the equivalent circuit of transformer and predetermine the efficiency and regulation.
- CO6: Describe the working principle of auto transformer, three phase transformer with different types of connections.

## MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	1	1	1	-	-	1	-	-	-	1	3	2	2
CO2	3	3	1	1	1	-	-	1	-	-	-	1	3	1	1
CO3	3	3	1	1	1	-	-	1	-	-	-	1	3	1	1
CO4	3	3	1	1	1	-	-	1	-	-	-	1	3	3	2
CO5	3	3	1	1	1	-	-	1	-	-	-	1	3	3	2
CO6	3	3	1	1	1	-	-	1	-	-	-	1	3	3	2
Avg	3	3	1	1	1	-	-	1	-	-	-	1	3	3	3

CS3353

**C PROGRAMMING AND DATA STRUCTURES**

L	T	P	C
3	0	0	3

**COURSE OBJECTIVES:**

- To introduce the basics of C programming language.
- To learn the concepts of advanced features of C.
- To understand the concepts of ADTs and linear data structures.
- To know the concepts of non-linear data structure and hashing.
- To familiarize the concepts of sorting and searching techniques.

**UNIT I C PROGRAMMING FUNDAMENTALS (8+1 SKILL)**

**9**

Data Types – Variables – Operations – Expressions and Statements – Conditional Statements – Functions – Recursive Functions – Arrays – Single and Multi-Dimensional Arrays.

**UNIT II C PROGRAMMING - ADVANCED FEATURES (8+1 SKILL)**

**9**

Structures – Union – Enumerated Data Types – Pointers: Pointers to Variables, Arrays and Functions – File Handling – Preprocessor Directives.

**UNIT III LINEAR DATA STRUCTURES (8+1 SKILL)**

**9**

Abstract Data Types (ADTs) – List ADT – Array-Based Implementation – Linked List – Doubly- Linked Lists – Circular Linked List – Stack ADT – Implementation of Stack – Applications – Queue ADT – Priority Queues – Queue Implementation – Applications.

**UNIT IV NON-LINEAR DATA STRUCTURES (8+1 SKILL)**

**9**

Trees – Binary Trees – Tree Traversals – Expression Trees – Binary Search Tree – Hashing - Hash Functions – Separate Chaining – Open Addressing – Linear Probing– Quadratic Probing – Double Hashing – Rehashing.

**UNIT V SORTING AND SEARCHING TECHNIQUES (8+1 SKILL)**

**9**

Insertion Sort – Quick Sort – Heap Sort – Merge Sort –Linear Search – Binary Search.

**TOTAL: 45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)**

**5**

**COURSE OUTCOMES:**

- CO1 Develop C programs for any real world/technical application.
- CO2 Apply advanced features of C in solving problems.
- CO3 Write functions to implement linear and non-linear data structure operations.
- CO4 Suggest and use appropriate linear/non-linear data structure operations for solving a given problem.
- CO5 Appropriately use sort and search algorithms for a given application.
- CO6 Apply appropriate hash functions that result in a collision free scenario for data storage and retrieval.

**TEXT BOOKS:**

1. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", Second Edition, Pearson Education, 1997.
2. ReemaThareja, "Programming in C", Second Edition, Oxford University Press, 2016.

## REFERENCES:

1. Brian W. Kernighan, Rob Pike, "The Practice of Programming", Pearson Education, 1999.
2. Paul J. Deitel, Harvey Deitel, "C How to Program", Seventh Edition, Pearson Education, 2013.
3. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, 1983.
4. Ellis Horowitz, SartajSahni and Susan Anderson, "Fundamentals of Data Structures", Galgotia, 2008.

### List of Open Source Software/ Learning website:

<https://www.coursera.org/specializations/data-structures-algorithms>

<https://nptel.ac.in/courses/112107243>

<https://nptel.ac.in/courses/112105598>

## MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	1	2	2	1	1	-	1	2	1	3	2	1	3
2	1	2	1	2	2	-	-	-	1	1	1	2	2	2	2
3	2	3	1	2	3	-	-	-	1	1	1	2	2	1	2
4	2	1	-	1	1	-	-	-	2	1	1	2	2	3	1
5	1	2	1	2	2	1	1	-	1	2	1	3	2	2	3
Avg.	2	2	1	2	2	1	1	-	1	1	1	2	2	2	2

EC3311

ELECTRONIC DEVICES AND CIRCUITS LABORATORY

L T P C  
0 0 3 1.5

### COURSE OBJECTIVES:

- To enable the students to understand the behavior of semiconductor device based on experimentation.
- Be exposed to active and passive circuit elements.
- Familiarize the operation and characteristics of transistor like BJT and FET.
- Explore the characteristics of amplifier gain and frequency response.
- Learn the required functionality of positive and negative feedback systems.

### LIST OF EXPERIMENTS

1. Characteristics of Semiconductor diode, Zener diode , photo diode , and photo transistor,
2. Characteristics of NPN Transistor under common emitter , common collector and common base configurations
3. Characteristics of JFET and draw the equivalent circuit
4. Characteristics of UJT and generation of saw tooth waveforms
5. Design and frequency response characteristics of a Common Emitter amplifier
6. Characteristics of light activated relay circuit

7. Design and testing of RC phase shift and LC oscillators
8. Characteristics of Single Phase half-wave and full wave rectifiers with inductive and capacitive filters
9. Design of Differential amplifiers using FET
10. Measurement of frequency and phase angle using CRO
11. Realization of passive filters

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon successful completion of the course, the students will be able to:

- CO1: Analyze the characteristics of PN, Zener diode and BJT in CE,CC,CB configurations experimentally
- CO2: Analyze the characteristics of JFET and UJT experimentally
- CO3: Analyze frequency response characteristics of a Common Emitter amplifier experimentally
- CO4: Analyze the characteristics of RC phase shift and LC oscillators experimentally
- CO5: Analyze the characteristics of half-wave and full-wave rectifier with and without filters experimentally
- CO6: Analyze the characteristics of FET based differential amplifier experimentally
- CO7: Calculate the frequency and phase angle using CRO experimentally
- CO8: Analyze the frequency response characteristics of passive filters experimentally

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	-	-	-	3	3	-	-	1.5	-	-	3	-	-	3	3
CO2	-	-	3	3	3	-	-	1.5	-	-	3	-	-	3	3
CO3	-	3	2	3	-	-	-	1.5	-	-	3	-	-	3	3
CO4	-	3	3	3	-	-	-	1.5	-	-	3	-	-	3	3
CO5	-	-	-	-	3	-	-	1.5	-	-	-	-	-	3	3
CO6	-	-	-	-	3	-	-	1.5	-	-	-	-	-	3	3
CO7	-	-	-	-	3	-	-	1.5	-	-	3	-	-	3	3
CO8	-	-	-	-	3	-	-	1.5	-	-	3	-	-	3	3
Avg	-	3	2.7	3	3	-	-	1.5	-	-	3	-	-	3	3

**EE3311**

**ELECTRICAL MACHINES LABORATORY - I**

**L T P C  
0 0 3 1.5**

**COURSE OBJECTIVES:**

- To expose the students to determine the characteristics of DC machines and transformers by performing experiments on these machines.
- To provide hands on experience to evaluate the performance parameters of DC machines and transformer by conducting suitable tests.

**LIST OF EXPERIMENTS:**

1. Open circuit and load characteristics of DC shunt generator- calculation of critical resistance and critical speed.
2. Load characteristics of DC compound generator with differential and cumulative connections.
3. Load test on DC shunt motor.
4. Load test on DC compound motor.
5. Load test on DC series motor.
6. Swinburne's test and speed control of DC shunt motor.
7. Hopkinson's test on DC motor – generator set.
8. Load test on single-phase transformer and three phase transformers.
9. Open circuit and short circuit tests on single phase transformer.
10. Sumpner's test on single phase transformers.
11. Separation of no-load losses in single phase transformer.
12. Study of starters and 3-phase transformers connections.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

At the end of the course students will be able to:

CO1: Construct the circuit with appropriate connections for the given DC machine/transformer.

CO2: Experimentally determine the characteristics of different types of DC machines.

CO3: Demonstrate the speed control techniques for a DC motor for industrial applications.

CO4: Identify suitable methods for testing of transformer and DC machines.

CO5: Predetermine the performance parameters of transformers and DC motor.

CO6: Understand DC motor starters and 3-phase transformer connections.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	1	1	-	-	-	-	1	-	-	-	3	1	1
CO2	3	3	1	1	-	-	-	-	1	-	-	-	3	3	2
CO3	3	3	1	1	-	-	-	-	1	-	-	-	3	3	2
CO4	3	3	1	1	-	-	-	-	1	-	-	-	2	3	2
CO5	3	3	1	1	-	-	-	-	1	-	-	-	2	3	2
CO6	3	3	1	1	-	-	-	-	1	-	-	-	2	3	1
Avg	3	3	1	1	-	-	-	-	1	-	-	-	2.5	2.6	1.6

**COURSE OBJECTIVES:**

- To develop applications in C
- To implement linear and non-linear data structures
- To understand the different operations of search trees
- To get familiarized to sorting and searching algorithms

**LIST OF EXPERIMENTS**

1. Practice of C programming using statements, expressions, decision making and iterative statements
2. Practice of C programming using Functions and Arrays
3. Implement C programs using Pointers and Structures
4. Implement C programs using Files
5. Development of real time C applications
6. Array implementation of List ADT
7. Array implementation of Stack and Queue ADTs
8. Linked list implementation of List, Stack and Queue ADTs
9. Applications of List, Stack and Queue ADTs
10. Implementation of Binary Trees and operations of Binary Trees
11. Implementation of Binary Search Trees
12. Implementation of searching techniques
13. Implementation of Sorting algorithms : Insertion Sort, Quick Sort, Merge Sort
14. Implementation of Hashing – any two collision techniques

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

At the end of the course, the students will be able to:

- CO1 Use different constructs of C and develop applications
- CO2 Write functions to implement linear and non-linear data structure operations
- CO3 Suggest and use the appropriate linear / non-linear data structure operations for a given problem
- CO4 Apply appropriate hash functions that result in a collision free scenario for data storage and Retrieval
- CO5 Implement Sorting and searching algorithms for a given application

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	1	2	2	1	1	-	1	2	1	3	2	1	3
2	1	2	1	2	2	-	-	-	1	1	1	2	2	2	2
3	2	3	1	2	3	-	-	-	1	1	1	2	2	1	2
4	2	1	-	1	1	-	-	-	2	1	1	2	2	3	1
5	1	2	1	2	2	1	1	-	1	2	1	3	2	2	3
Avg.	2	2	1	2	2	1	1	-	1	1	1	2	2	2	2



**COURSE OBJECTIVES:**

- To be proficient in important Microsoft Office tools: MS WORD, EXCEL, POWERPOINT.
- To be proficient in using MS WORD to create quality technical documents, by using standard templates, widely acceptable styles and formats, variety of features to enhance the presentability and overall utility value of content.
- To be proficient in using MS EXCEL for all data manipulation tasks including the common statistical, logical, mathematical etc., operations, conversion, analytics, search and explore, visualize, interlink, and utilizing many more critical features offered
- To be able to create and share quality presentations by using the features of MS PowerPoint, including: organization of content, presentability, aesthetics, using media elements and enhance the overall quality of presentations.

**MS WORD:****10 Hours**

Create and format a document  
 Working with tables  
 Working with Bullets and Lists  
 Working with styles, shapes, smart art, charts  
 Inserting objects, charts and importing objects from other office tools  
 Creating and Using document templates  
 Inserting equations, symbols and special characters  
 Working with Table of contents and References, citations  
 Insert and review comments  
 Create bookmarks, hyperlinks, endnotes footnote  
 Viewing document in different modes  
 Working with document protection and security  
 Inspect document for accessibility

**MS EXCEL:****10 Hours**

Create worksheets, insert and format data  
 Work with different types of data: text, currency, date, numeric etc.  
 Split, validate, consolidate, Convert data  
 Sort and filter data  
 Perform calculations and use functions: (Statistical, Logical, Mathematical, date, Time etc.,)  
 Work with Lookup and reference formulae  
 Create and Work with different types of charts  
 Use pivot tables to summarize and analyse data  
 Perform data analysis using own formulae and functions  
 Combine data from multiple worksheets using own formulae and built-in functions to generate results  
 Export data and sheets to other file formats  
 Working with macros  
 Protecting data and Securing the workbook

**MS POWERPOINT:****10 Hours**

- Select slide templates, layout and themes
- Formatting slide content and using bullets and numbering
- Insert and format images, smart art, tables, charts
- Using Slide master, notes and handout master
- Working with animation and transitions
- Organize and Group slides
- Import or create and use media objects: audio, video, animation
- Perform slideshow recording and Record narration and create presentable videos

**TOTAL: 30 PERIODS****COURSE OUTCOMES:**

On successful completion the students will be able to

- Use MS Word to create quality documents, by structuring and organizing content for their day to day technical and academic requirements
- Use MS EXCEL to perform data operations and analytics, record, retrieve data as per requirements and visualize data for ease of understanding
- Use MS PowerPoint to create high quality academic presentations by including common tables, charts, graphs, interlinking other elements, and using media objects.

**GE3451****ENVIRONMENTAL SCIENCES AND SUSTAINABILITY**

L	T	P	C
2	0	0	2

**COURSE OBJECTIVES:**

- To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation.
- To impart knowledge on the causes, effects and control or prevention measures of environmental pollution and natural disasters.
- To facilitate the understanding of global and Indian scenario of renewable and nonrenewable resources, causes of their degradation and measures to preserve them.
- To familiarize the concept of sustainable development goals and appreciate the interdependence of economic and social aspects of sustainability, recognize and analyze climate changes, concept of carbon credit and the challenges of environmental management.
- To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles and analyze the role of sustainable urbanization.

**UNIT I ENVIRONMENT AND BIODIVERSITY****6**

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

**UNIT II ENVIRONMENTAL POLLUTION****6**

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions.

Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts .

### **UNIT III RENEWABLE SOURCES OF ENERGY**

**6**

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

### **UNIT IV SUSTAINABILITY AND MANAGEMENT**

**6**

Development, GDP, Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols - Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

### **UNIT V SUSTAINABILITY PRACTICES**

**6**

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economical and technological change.

**TOTAL: 30 PERIODS**

### **COURSE OUTCOMES:**

- To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.
- To identify the causes, effects of environmental pollution and natural disasters and contribute to the preventive measures in the society.
- To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.
- To recognize the different goals of sustainable development and apply them for suitable technological advancement and societal development.
- To demonstrate the knowledge of sustainability practices and identify green materials, energy cycles and the role of sustainable urbanization.

### **TEXT BOOKS:**

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

## REFERENCES

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

## MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
1	2	1	-	-	-	2	3	-	-	-	-	2	-	-	-
2	3	2	-	-	-	3	3	-	-	-	-	2	-	-	-
3	3	-	1	-	-	2	2	-	-	-	-	2	-	-	-
4	3	2	1	1	-	2	2	-	-	-	-	2	-	-	-
5	3	2	1	-	-	2	2	-	-	-	-	1	-	-	-
Avg.	2.8	1.8	1	1	-	2.2	2.4	-	-	-	-	1.8	-	-	-

EE3401

## TRANSMISSION AND DISTRIBUTION

L T P C  
3 0 0 3

### COURSE OBJECTIVES:

- To impart knowledge about the configuration of the electrical power systems.
- To study the line parameters and interference with neighboring circuits.
- To understand the mechanical design and performance analysis of transmission lines.
- To learn about different insulators and underground cables.
- To understand and analyze the distribution system.

### UNIT I TRANSMISSION LINE PARAMETERS

9

Structure of electric power system - Parameters of single and three phase transmission lines with single and double circuits -Resistance, inductance, and capacitance of solid, stranded, and bundled conductors - Typical configuration, conductor types - Symmetrical and unsymmetrical spacing and transposition – application of self and mutual GMD; skin and proximity effects - Effects of earth on the capacitance of the transmission line - interference with neighboring communication circuits.

### UNIT II MODELLING AND PERFORMANCE OF TRANSMISSION LINES

9

Performance of Transmission lines – short line, medium line and long line – equivalent circuits, phasor diagram, attenuation constant, phase constant, surge impedance – transmission efficiency and voltage regulation, real and reactive power flow in lines – Power Circle diagrams – Ferranti effect – Formation of Corona – Critical Voltages – Effect on line Performance.

**UNIT III SAG CALCULATION AND LINE SUPPORTS 9**

Mechanical design of overhead lines – Line Supports –Types of towers – Tension and Sag Calculation for different weather conditions – Methods of grounding - Insulators: Types, voltage distribution in insulator string, improvement of string efficiency, testing of insulators.

**UNIT IV UNDERGROUND CABLES 9**

Underground cables – Types of cables – Construction of single-core and 3-core belted cables – Insulation Resistance – Potential Gradient – Capacitance of single-core and 3-core belted cables – Grading of cables – Power factor and heating of cables– DC cables.

**UNIT V DISTRIBUTION SYSTEMS 9**

Distribution Systems – General Aspects – Kelvin's Law – AC and DC distributions –Concentrated and Distributed loading- Techniques of Voltage Control and Power factor improvement – Distribution Loss – Types of Substations – Trends in Transmission and Distribution: EHVAC, HVDC and FACTS (Qualitative treatment only).

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**

1. D.P.Kothari, I.J. Nagarath, 'Power System Engineering', Mc Graw-Hill Publishing Company limited, New Delhi, Third Edition, 2019.
2. C.L.Wadhwa, 'Electrical Power Systems', New Age International Ltd, seventh edition 2022.
3. S.N. Singh, 'Electric Power Generation, Transmission and Distribution', Prentice Hall of India Pvt. Ltd, New Delhi, Second Edition, 2008.

**REFERENCE BOOKS:**

1. B.R.Gupta, 'Power System Analysis and Design' S. Chand, New Delhi, Sixth Edition, 2011.
2. Luces M.Fualken berry, Walter Coffe, 'Electrical Power Distribution and Transmission', Pearson Education, 2007.
3. Arun Ingole, "Power transmission and distribution" Pearson Education, first edition, 2018
4. J.Brian Hardy and Colin R.Bayliss 'Transmission and Distribution in Electrical Engineering', Newnes; Fourth Edition, 2011.
5. G.Ramamurthy, "Handbook of Electrical power Distribution," Universities Press, 2013.
6. V.K.Mehta, Rohit Mehta, 'Principles of power system', S. Chand & Company Ltd, New Delhi, 2013
7. Hadi Saadat, 'Power System Analysis', McGraw Hill Education Pvt. Ltd., New Delhi, 3<sup>rd</sup> Edition, 23<sup>rd</sup> reprint, 2015.
8. R.K.Rajput, 'A Text Book of Power System Engineering' 2<sup>nd</sup> edition, Laxmi Publications (P) Ltd, New Delhi, 2016.

**COURSE OUTCOMES**

On the successful completion of the course, students will be able to:

- CO1 : Understand the structure of power system, computation of transmission line parameters for different configurations.
- CO2 : Model the transmission lines to determine the line performance and to understand the impact of Ferranti effect and corona on line performance.
- CO3 : Do Mechanical design of transmission lines, grounding and to understand about the insulators in transmission system.
- CO4 : Design the underground cables and understand the performance analysis of underground cable.
- CO5 : Understand the modelling, performance analysis and modern trends in distribution system.

### MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	2	1	-	-	-	-	-	1	-	-	-	-	3	1	1
CO2	3	2	1	1	-	1	-	2	-	-	-	-	3	2	1
CO3	3	2	1	1	-	1	-	2	-	-	-	-	3	3	1
CO4	3	2	1	1	-	1	-	2	-	-	-	-	3	3	1
CO5	3	2	1	1	-	1	-	2	-	-	-	-	3	3	1
Avg	2.8	1.8	1	1		1	-	1.8					3	2.4	1

**EE3402**

### LINEAR INTEGRATED CIRCUITS

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

To impart knowledge on the following topics

- Signal analysis using Op-amp based circuits.
- Applications of Op-amp.
- Functional blocks and the applications of special ICs like Timers, PLL circuits, regulator Circuits.
- IC fabrication procedure.

**UNIT I IC FABRICATION**

**9**

IC classification, fundamental of monolithic IC technology, epitaxial growth, masking and etching, diffusion of impurities. Realisation of monolithic ICs and packaging. Fabrication of diodes, capacitance, resistance, FETs and PV Cell.

**UNIT II CHARACTERISTICS OF OPAMP**

**9**

Ideal OP-AMP characteristics, DC characteristics, AC characteristics, differential amplifier; frequency response of OP-AMP; Voltage-shunt feedback and inverting amplifier - Voltage series feedback: and Non-Inverting Amplifier - Basic applications of op-amp –, summer, differentiator and Integrator-V/I & I/V converters.

**UNIT III APPLICATIONS OF OPAMP**

**9**

Instrumentation amplifier and its applications for transducer Bridge, Log and Antilog Amplifiers- Analog multiplier & Divider, first and second order active filters, comparators, multi vibrators, waveform generators, clippers, clampers, peak detector, S/H circuit,–D/A converter (R- 2R ladder and weighted resistor types), A/D converters using OP-AMPs.

**UNIT IV SPECIAL ICs**

**9**

Functional block, characteristics of 555 Timer and its PWM application - IC-566 voltage controlled oscillator IC; 565-phase locked loop IC, AD633 Analog multiplier ICs.

**UNIT V APPLICATION ICs****9**

AD623 Instrumentation Amplifier and its application as load cell weight measurement - IC voltage regulators –LM78XX, LM79XX; Fixed voltage regulators its application as Linear power supply - LM317, 723 Variability voltage regulators, switching regulator- SMPS - ICL 8038 function generator IC.

**TOTAL :45 PERIODS****COURSE OUTCOMES:**

Upon successful completion of the course, the students will be able to:

- CO1 Explain monolithic IC fabrication process
- CO2 Explain the fabrication of diodes, capacitance, resistance, FETs and PV Cell.
- CO3 Analyze the characteristics and basic applications (inverting/non-inverting amplifier, summer, differentiator, integrator, V/I and I/V converter) of Op-Amp
- CO4 Explain circuit and applications of op-amp based instrumentation amplifier, log/antilog amplifier, analog multiplier /divider, active filters, comparators, waveform generators, A/D and D/A converters
- CO5 Explain Functional blocks, characteristics and applications of Timer, PLL, analog multiplier ICs.
- CO6 Explain the applications of ICs in Instrumentation amplifier, fixed and variable voltage regulator, SMPS and function generator

**TEXT BOOKS:**

1. David A. Bell, 'Op-amp & Linear ICs', Oxford, Third Edition, 2011
2. D. Roy Choudhary, Sheil B. Jani, 'Linear Integrated Circuits', , New Age, Fourth Edition, 2018.
3. Ramakant A.Gayakward, 'Op-amps and Linear Integrated Circuits', IV edition, Pearson Education, PHI 2021.

**REFERENCES**

1. Fiore,"Opamps& Linear Integrated Circuits Concepts & applications", Cengage, 2010.
2. Floyd ,Buchla,"Fundamentals of Analog Circuits, Pearson, 2013.
3. Jacob Millman, Christos C.Halkias, 'Integrated Electronics - Analog and Digital circuits system', McGraw Hill, 2<sup>nd</sup> Edition, 2017.
4. Robert F.Coughlin, Fredrick F. Driscoll, 'Op-amp and Linear ICs', Pearson, 6th edition,2012.
5. Sergio Franco, 'Design with Operational Amplifiers and Analog Integrated Circuits', McGraw Hill, 2016 – Fourth Edition.
6. Muhammad H. Rashid,' Microelectronic Circuits Analysis and Design' Cengage Learning, 2<sup>nd</sup> Edition, 2012.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	2	2	3	2	2	-	-	1	-	-	-	1	3	2	1
CO2	2	2	3	2	2	-	-	1	-	-	-	1	3	2	1
CO3	2	2	3	2	2	-	-	1	-	-	-	1	3	2	1
CO4	2	2	3	2	2	-	-	1	-	-	-	1	3	2	1
CO5	2	2	3	2	2	-	-	1	-	-	-	1	3	2	1
Avg	2	2	3	2	2	-	-	1	-	-	-	1	3	2	1

**COURSE OBJECTIVES**

- To educate the fundamental concepts and characteristics of measurement and errors
- To impart the knowledge on the functional aspects of measuring instruments
- To infer the importance of various bridge circuits used with measuring instruments.
- To educate the fundamental working of sensors and transducers and their applications
- To summarize the overall measurement and instrumentation with the knowledge on digital instrumentation principles.

**UNIT I CONCEPTS OF MEASUREMENTS 9**

Instruments: classification, applications – Elements of a generalized measurement system - Static and dynamic characteristics - Errors in measurement -Statistical evaluation of measurement data.

**UNIT II MEASUREMENT OF PARAMETERS IN ELECTRICAL SYSTEMS 9**

Classification of instruments – moving coil and moving iron meters – Induction type, dynamometer type watt meters – Energy meter – Megger – Instrument transformers (CT & PT).

**UNIT III AC/DC BRIDGES AND INSTRUMENTATION AMPLIFIERS 9**

Wheatstone bridge, Kelvin double bridge - Maxwell, Hay, Wien and Schering bridges – Errors and compensation in A.C. bridges - Instrumentation Amplifiers.

**UNIT IV TRANSDUCERS FOR MEASUREMENT OF NON- ELECTRICAL PARAMETERS 9**

Classification of transducers – Measurement of pressure, temperature, displacement, flow, angular velocity – Digital transducers – Smart Sensors.

**UNIT V DIGITAL INSTRUMENTATION 9**

A/D converters: types and characteristics – Sampling, Errors- Measurement of voltage, Current, frequency and phase - D/A converters: types and characteristics- DSO- Data Loggers – Basics of PLC programming and Introduction to Virtual Instrumentation - Instrument standards.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

Upon successful completion of the course, the students should have the:

CO1: Ability to understand the fundamental art of measurement in engineering.

CO2: Ability to understand the structural elements of various instruments.

CO3: Ability to understand the importance of bridge circuits.

CO4: Ability to understand about various transducers and their characteristics by experiments.

CO5: Ability to understand the concept of digital instrumentation and virtual instrumentation by experiments.

**TEXT BOOKS:**

1. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, New Delhi, Edition 2011.
2. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010

**REFERENCES:**

1. M.M.S. Anand, 'Electronics Instruments and Instrumentation Technology', Prentice Hall India, New Delhi, 2009
2. J.J. Carr, 'Elements of Electronic Instrumentation and Measurement', Pearson Education India, New Delhi, 2011



3. W.Bolton, Programmable Logic Controllers, 6<sup>th</sup> Edition, Elseiver, 2015.
4. R.B. Northrop, 'Introduction to Instrumentation and Measurements', Taylor & Francis, New Delhi, 3<sup>rd</sup> Edition 2014.
5. E. O. Doebelin and D. N. Manik, "Measurement Systems – Application and Design", Tata McGraw-Hill, New Delhi, 6<sup>th</sup> Edition 2017.
6. R. K. Rajput, "Electrical and Electronics Measurements and Instrumentation", Chand Pub, 2016

### MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	3	-	3	2	-	2	-	-	-	3	3	3	3
CO2	3	2	3	2	-	-	-	-	-	3	-	3	3	3	3
CO3	3	2	3	-	3	2	-	-	-	-	-	3	3	3	3
CO4	3	2	3	-	-	-	-	2	-	-	-	-	3	3	3
CO5	3	2	3	2	3	-	-	-	-	3	-	3	3	3	3
Avg	3	2	3	2	3	2	-	2	-	3	-	3	3	3	3

**EE3404**

### MICROPROCESSOR AND MICROCONTROLLER

**LT P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- To study the addressing modes & instruction set of 8085 & 8051
- To develop skills in simple program writing in assembly languages
- To introduce commonly used peripheral/interfacing ICs.
- To study and understand typical applications of micro-processors.
- To study and understand the typical applications of micro-controllers

**UNIT I INTRODUCTION TO 8085 ARCHITECTURE 9**  
Functional block diagram – Memory interfacing–I/O ports and data transfer concepts – Timing Diagram – Interrupt structure.

**UNIT II 8085 INSTRUCTION SET AND PROGRAMMING 9**  
Instruction format and addressing modes – Assembly language format – Data transfer, data manipulation & control instructions – Programming: Loop structure with counting & Indexing - Look up table - Subroutine instructions, stack.

**UNIT III INTERFACING BASICS AND ICS 9**  
Study of Architecture and programming of ICs: 8255 PPI, 8259PIC, 8251USART, 8279 Keyboard display controller and 8254 Timer/Counter – Interfacing with 8085 -A/D and D/A converter interfacing.

**UNIT IV INTRODUCTION TO 8051 MICROCONTROLLER 9**  
Functional block diagram - Instruction format and addressing modes – Interrupt structure – Timer – I/O ports – Serial communication, Simple programming –keyboard and display interface – Temperature control system –stepper motor control - Usage of IDE for assembly language programming.

**UNIT V INTRODUCTION TO RISC BASED ARCHITECTURE****9**

PIC16 /18 architecture, Memory organization – Addressing modes – Instruction set - Programming techniques – Timers – I/O ports – Interrupt programming.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

Upon successful completion of the course, the students should have the:

CO1: Ability to write assembly language program for microprocessor and microcontroller

CO2: Ability to design and implement interfacing of peripheral with microprocessor and microcontroller

CO3: Ability to analyze, comprehend, design and simulate microprocessor based systems used for control and monitoring.

CO4: Ability to analyze, comprehend, design and simulate microcontroller based systems used for control and monitoring.

CO5: Ability to understand and appreciate advanced architecture evolving microprocessor field

**TEXTBOOKS:**

1. Ramesh S. Gaonkar, 'Microprocessor Architecture Programming and Application', Pen ram International (P)ltd., Mumbai, 6<sup>th</sup> Education, 2013.
2. Muhammad Ali Mazidi & Janice Gilli Mazidi, 'The 8051 Micro Controller and Embedded Systems', Pearson Education, Second Edition 2011.
3. Muhammad Ali Mazidi & Janice Gilli Mazidi, 'The PIC Micro Controller and Embedded Systems', 2010

**REFERENCES:**

1. Douglas V. Hall, "Micro-processors & Interfacing", Tata McGraw Hill 3<sup>rd</sup> Edition, 2017.
2. Krishna Kant, "Micro-processors & Micro-controllers", Prentice Hall of India, 2007.
3. Mike Predko, "8051 Micro-controllers", McGraw Hill, 2009
4. Kenneth Ayala, 'The 8051 Microcontroller', Thomson, 3<sup>rd</sup> Edition 2004.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	2	1	2	3	-	-	-	1	-	-	-	3	3	1	3
CO2	2	1	2	3	-	-	-	1	-	-	-	3	3	1	3
CO3	2	1	2	3	-	-	-	1	-	-	-	3	3	1	3
CO4	2	1	2	3	-	-	-	1	-	-	-	3	3	1	3
CO5	2	1	2	3	-	-	-	1	-	-	-	3	3	1	3
Avg	2	1	2	3	-	-	-	1	-	-	-	3	3	1	3

**COURSE OBJECTIVES:**

To impart knowledge on the following Topics

- Construction and performance of salient and non – salient type synchronous generators.
- Principle of operation and performance of synchronous motor.
- Construction, principle of operation and performance of induction machines.
- Starting and speed control of three-phase induction motors.
- Construction, principle of operation and performance of single phase induction motors and special machines.

**UNIT I SYNCHRONOUS GENERATOR 9**

Constructional details – Types of rotors –winding factors- EMF equation – Synchronous reactance – Armature reaction – Phasor diagrams of non-salient pole synchronous generator connected to infinite bus--Synchronizing and parallel operation – Synchronizing torque -Change of excitation and mechanical input- Voltage regulation – EMF, MMF, ZPF and A.S.A method – steady state power-angle characteristics– Two reaction theory –slip test -short circuit transients - Capability Curves.

**UNIT II SYNCHRONOUS MOTOR 9**

Principle of operation – Torque equation – Operation on infinite bus bars - V and Inverted V curves – Power input and power developed equations – Starting methods – Current loci for constant power input, constant excitation and constant power Developed-Hunting – natural frequency of oscillations – damper windings- synchronous condenser.

**UNIT III THREE PHASE INDUCTION MOTOR 9**

Constructional details – Types of rotors – Principle of operation – Slip –cogging and crawling-Equivalent circuit – Torque-Slip characteristics - Condition for maximum torque – Losses and efficiency – Load test - No load and blocked rotor tests - Circle diagram – Separation of losses – Double cage induction motors –Induction generators – Synchronous induction motor.

**UNIT IV STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR 9**

Need for starting – Types of starters – DOL, Rotor resistance, Autotransformer and Star delta starters – Speed control – Voltage control, Frequency control and pole changing – Cascaded Connection-V/f control – Slip power recovery Scheme-Braking of three phase induction motor: Plugging, dynamic braking and regenerative braking.

**UNIT V SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES 9**

Constructional details of single phase induction motor – Double field revolving theory and operation – Equivalent circuit – No load and blocked rotor test – Performance analysis – Starting methods of single-phase induction motors – Capacitor-start capacitor run Induction motor- Shaded pole induction motor - Linear induction motor – Repulsion motor - Hysteresis motor - AC series motor- Servo motors- Stepper motors - introduction to magnetic levitation systems.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon the successful completion of the course, students will have the:

CO1: Ability to understand the construction and working principle of Synchronous generator

CO2: Ability to understand the construction and working principle of Synchronous Motor

CO3: Ability to understand the construction and working principle of Three Phase Induction Motor

CO4: Acquire knowledge about the starting and speed control of induction motors.

CO5: To gain knowledge about the basic principles and working of Single phase induction motors and Special Electrical Machines.

**TEXT BOOKS:**

1. A.E. Fitzgerald, Charles Kingsley, Stephen. D. Umans, 'Electric Machinery', Mc Graw Hill publishing Company Ltd, 6<sup>th</sup> Edition 2017.
2. Stephen J. Chapman, 'Electric Machinery Fundamentals' 4<sup>th</sup> edition, McGraw Hill Education Pvt. Ltd, 4<sup>th</sup> Edition 2017.
3. D.P. Kothari and I.J. Nagrath, 'Electric Machines', McGraw Hill Publishing Company Ltd, 5<sup>th</sup> Edition 2017
4. P.S. Bhimbhra, 'Electrical Machinery', Khanna Publishers, edition 2, 2021.

**REFERENCES**

1. Vincent Del Toro, 'Basic Electric Machines' Pearson India Education, 2016.
2. M.N. Bandyopadhyay, Electrical Machines Theory and Practice, PHI Learning PVT LTD., New Delhi, 2011.
3. B.R.Gupta, 'Fundamental of Electric Machines' New age International Publishers, 3<sup>rd</sup> Edition, Reprint 2015.
4. Murugesh Kumar, 'Electric Machines', Vikas Publishing House Pvt. Ltd, First edition 2010.
5. Alexander S. Langsdorf, 'Theory of Alternating-Current Machinery', McGraw Hill Publications, 2001.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	2	3	3	-	-	1	-	-	-	-	3	3	2
CO2	3	3	2	3	3	-	-	1	-	-	-	-	3	3	2
CO3	3	3	2	3	3	-	-	1	-	-	-	-	3	3	2
CO4	3	3	2	3	3	-	-	1	-	-	-	-	3	3	2
CO5	3	3	1	1	2	-	-	1	-	-	-	-	3	3	2
CO6	3	3	1	1	2	-	-	1	-	-	-	-	3	3	2
Avg	3	3	1.6	2.3	2.6	-	-	1	-	-	-	-	3	3	2

PROGRESS THROUGH KNOWLEDGE

**COURSE OBJECTIVES:**

- To expose the students to the operation of synchronous machines and induction motors and give them experimental skill.

**LIST OF EXPERIMENTS**

- Regulation of three phase alternator by EMF and MMF methods.
- Regulation of three phase alternator by ZPF and ASA methods.
- Regulation of three phase salient pole alternator by slip test.
- Measurements of negative sequence and zero sequence impedance of alternators.
- V and Inverted V curves of Three Phase Synchronous Motor.
- Load test on three-phase induction motor.
- No load and blocked rotor tests on three-phase induction motor (Determination of equivalent circuit parameters).
- Separation of No-load losses of three-phase induction motor.
- Load test on single-phase induction motor.
- No load and blocked rotor test on single-phase induction motor.
- Study of Induction Motor Starters

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

At the end of the course, the student should have the:

CO1: Ability to understand and analyze EMF and MMF methods

CO2: Ability to analyze the characteristics of V and Inverted V curves

CO3: Acquire hands on experience of conducting various tests on alternators and obtaining their performance indices using standard analytical as well as graphical methods. to understand the importance of Synchronous machines

CO4: Acquire hands on experience of conducting various tests on induction motors and obtaining their performance indices using standard analytical as well as graphical methods. to understand the importance of single and three phase Induction motors

CO5: Ability to acquire knowledge on separation of losses

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	1	1	-	-	-	1.5	1	-	-	3	3	3	2
CO2	3	3	1	1	-	-	-	1.5	1	-	-	3	3	3	2
CO3	3	3	1	1	-	-	-	1.5	1	-	-	3	3	3	1
CO4	3	3	1	1	-	-	-	1.5	1	-	-	3	3	3	1
CO5	3	3	1	1	-	-	-	1.5	1	-	-	2	3	3	2
Avg	3	3	1	1	-	-	-	1.5	1	-	-	2.8	3	3	1.6

**COURSE OBJECTIVES:**

- To learn design, testing and characterizing of circuit behavior with combinational logic gate ICs.
- To learn design, testing and characterizing of circuit behavior with register/ counter and sequential logic ICs.
- To learn design, testing and characterizing of circuit behavior with OPAMP ICs.
- To learn design, testing and characterizing of circuit behavior with analog Ics like 555 timer VCO and regulators.
- To learn design, testing and characterizing of circuit behavior with digital Ics like decoders, multiplexers.

**LIST OF EXPERIMENTS**

1. Implementation of Boolean Functions, Adder and Subtractor circuits.
2. Code converters: Excess-3 to BCD and Binary to Gray code converter and vice-versa.
3. Parity generator and parity checking.
4. Encoders and Decoders.
5. Counters: Design and implementation of 3-bit modulo counters as synchronous and Asynchronous types using FF IC's and specific counter IC.
6. Shift Registers: Design and implementation of 4-bit shift registers in SISO, SIPO, PISO, PIPO modes using suitability IC's.
7. Study of multiplexer and de multiplexer
8. Timer IC application: Study of NE/SE 555 timer in Astability, Monostability operation.
9. Application of Op-Amp: inverting and non-inverting amplifier, Adder, comparator, Integrator and Differentiator.
10. Voltage to frequency characteristics of NE/ SE 566 IC.
11. Variability Voltage Regulator using IC LM317.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

At the end of the course, the student should have the:

CO1: Ability to understand and implement Boolean Functions.

CO2: Ability to understand the importance of code conversion

CO3: Ability to Design and implement circuits with digital ICs like decoders, multiplexers, register.

CO4: Ability to acquire knowledge on Application of Op-Amp

CO5: Ability to Design and implement counters using analog ICs like timers, VCOs and digital ICs like Flip-flops and counters.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	-	-	-	3	-	-	-	1.5	-	-	3	3	2	1	2
CO2	-	-	3	3	-	-	-	1.5	-	-	3	3	2	1	2
CO3	-	3	2	3	3	-	-	1.5	-	-	3	3	2	1	2
CO4	-	3	3	3	3	-	-	1.5	-	-	3	3	2	1	2
CO5	-	-	-	-	-	-	-	1.5	-	-	-	3	-	-	-
Avg	-	3	1.6	3	3	-	-	1.5	-	-	3	3	2	1	2

**COURSE OBJECTIVES:**

- To perform simple arithmetic operations using assembly language program and study the addressing modes & instruction set of 8085 & 8051
- To develop skills in simple program writing in assembly languages
- To write an assembly language program to convert Analog input to Digital output and Digital input to Analog output.
- To perform interfacing experiments with  $\mu P8085$
- To perform interfacing experiments with  $\mu C8051$ .

**PROGRAMMING EXERCISES / EXPERIMENTS WITH  $\mu P8085$ :**

1. Simple arithmetic operations: Multi precision addition / subtraction /multiplication / division.
2. Programming with control instructions: Increment / Decrement, Ascending / Descending order, Maximum / Minimum of numbers, Rotate instructions, Hex / ASCII / BCD code conversions.
3. Interface Experiments: A/D Interfacing. D/A Interfacing. Traffic light controller
4. Stepper motor controller interface.
5. Displaying a moving/ rolling message in the student trainer kit's output device.

**PROGRAMMING EXERCISES / EXPERIMENTS WITH  $\mu C8051$ :**

6. Simple arithmetic operations with 8051: Multi precision addition / subtraction / multiplication/ division.
7. Programming with control instructions: Increment / Decrement, Ascending / Descending order, Maximum / Minimum of numbers, Rotate instructions, Hex / ASCII / BCD code conversions.
8. Interface Experiments: A/D Interfacing. D/A Interfacing. Traffic light controller
9. Stepper motor controller interface.
10. Displaying a moving/ rolling message in the student trainer kit's output device.
11. Programming PIC architecture with software tools.

**TOTAL :45 PERIODS****COURSE OUTCOMES:**

After studying the above subject, students should have the:

- CO1: Ability to write assembly language program for microprocessor.
- CO2: Ability to write assembly language program for microcontroller
- CO3: Ability to design and implement interfacing of peripheral with microprocessor and microcontroller
- CO4: Ability to analyze, comprehend, design and simulate microprocessor based systems used for control and monitoring..
- CO5: Ability to analyze, comprehend, design and simulate microcontroller based systems used for control and monitoring.

## MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	2	1	2	3	-	-	-	1.5	-	-	-	3	3	1	3
CO2	2	1	2	3	-	-	-	1.5	-	-	-	3	3	1	3
CO3	2	1	2	3	-	-	-	1.5	-	-	-	3	3	1	3
CO4	2	1	2	3	-	-	-	1.5	-	-	-	3	3	1	3
CO5	2	1	2	3	-	-	-	1.5	-	-	-	3	3	1	3
Avg	2	1	2	3	-	-	-	1.5	-	-	-	3	3	1	3

**EE3501**

**POWER SYSTEM ANALYSIS**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- Impact knowledge on need for operational studies, and To model the power system under steady state operating condition.
- To understand and apply iterative techniques for power flow analysis.
- To model of carry out short circuit studies for power system during symmetrical fault.
- To model of carry out short circuit – studies during
- To study about the various methods for analyzing power system stability

**UNIT I POWER SYSTEM**

**9**

Need for system planning and operational studies - Power scenario in India - Power system components, Representation - Single line diagram - per unit quantities - p.u. impedance diagram - p.u. reactance diagram, Network graph Theory - Bus incidence matrices, Primitive parameters, Formation of bus admittance matrix – Direct inspection method – Singular Transformation method.

**UNIT II POWER FLOW ANALYSIS**

**9**

Bus classification - Formulation of Power Flow problem in polar coordinates - Power flow solution using Gauss Seidel method - Handling of Voltage controlled buses - Power Flow Solution by Newton Raphson method – Flow charts – Comparison of methods.

**UNIT III SYMMETRICAL FAULT ANALYSIS**

**9**

Assumptions in short circuit analysis - Symmetrical short circuit analysis using Thevenin's theorem - Bus Impedance matrix building algorithm (without mutual coupling) - Symmetrical fault analysis through bus impedance matrix - Post fault bus voltages - Fault level - Current limiting reactors.

**UNIT IV UNSYMMETRICAL FAULT ANALYSIS**

**9**

Symmetrical components - Sequence impedances - Sequence networks - Analysis of unsymmetrical faults at generator terminals: LG, LL and LLG - unsymmetrical fault occurring at any point in a power system.



**UNIT V STABILITY ANALYSIS****9**

Classification of power system stability – Rotor angle stability - Power-Angle equation – Steady state stability - Swing equation – Solution of swing equation by step by step method - Swing curve, Equal area criterion - Critical clearing angle and time, Multi-machine stability analysis – modified Euler method.

**TOTAL : 45 PERIODS****COURSE OUTCOMES:**

Upon the successful completion of the course, students should have the:

CO1: Ability to model the power system under steady state operating condition.

CO2: Ability to carry out power flow analysis using.

CO3: Ability to infer the significance of short circuit studies in designing circuit breakers.

CO4: Ability to analyze the state of the power system for various unsymmetrical faults.

CO5: Ability to analyze the stability of power system using different methods.

**TEXT BOOKS:**

1. John J. Grainger, William D. Stevenson, Jr, 'Power System Analysis', Mc Graw Hill Education (India) Private Limited, New Delhi, 2017.
2. Kothari D.P. and Nagrath I.J., 'Power System Engineering', Tata McGraw-Hill Education, 3<sup>rd</sup> edition 2019.
3. Hadi Saadat, 'Power System Analysis', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.

**REFERENCES**

1. Pai M A, 'Computer Techniques in Power System Analysis', Tata Mc Graw-Hill Publishing Company Ltd., New Delhi, Second Edition, 2007.
2. J. Duncan Glover, Mulukutla S.Sarma, Thomas J. Overbye, 'Power System Analysis & Design', Cengage Learning, Fifth Edition, 2012.
3. P. Venkatesh, B. V. Manikandan, A. Srinivasan, S. Charles Raja, "Electrical Power Systems: Analysis, Security and Deregulation" Prentice Hall India (PHI), second edition - 2017
4. Gupta B.R., 'Power System - Analysis and Design', S. Chand Publishing, Reissue edition 2005.
5. Kundur P., 'Power System Stability and Control', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2013

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	2	1	1	-	-	-	1	-	-	-	1	-	2
CO2	3	3	3	2	1	-	-	-	1	-	-	-	1	1	1
CO3	3	3	3	2	1	-	-	-	1	-	-	1	1	1	1
CO4	3	2	2	2	2	-	-	-	1	-	-	1	1	1	2
CO5	3	3	2	2	2	-	-	-	1	-	-	1	1	1	1
Avg	3	2.6	2.4	1.8	1.4	-	-	-	1	-	-	1	1	1	1.4

**COURSE OBJECTIVES:**

- To understand the various applications of power electronic devices for conversion, control and conditioning of the electrical power and to get an overview of different types of power semiconductor devices and their dynamic characteristics.
- To understand the operation, characteristics and performance parameters of controlled rectifiers
- To study the operation, switching techniques and basic topologies of DC-DC switching regulators.
- To learn the different modulation techniques of pulse width modulated inverters and to understand harmonic reduction methods.
- To study the operation of AC voltage controller and various configurations of AC voltage controller.

**UNIT I SWITCHING POWER SUPPLIES****9**

MOSFET dynamic behavior - driver and snubber circuits - low power high switching frequency switching Power supplies, buck, boost, buck-boost converters – Isolated topologies – resonant converters - switching loss calculations and thermal design.

**UNIT II INVERTERS****9**

IGBT: Static and dynamic behavior - single phase half bridge and full bridge inverters - VSI :(1phase and three phase inverters square wave operation) - Voltage control of inverters single, multi pulse, sinusoidal, space vector modulation techniques– various harmonic elimination techniques-CSI

**UNIT III UNCONTROLLED RECTIFIERS****9**

Power Diode – half wave rectifier – mid-point secondary transformer based full wave rectifier – bridge rectifier – voltage doubler circuit – distortion factor – capacitor filter for low power rectifiers – LC filters – Concern for power quality – three phase diode bridge.

**UNIT IV CONTROLLED RECTIFIERS****9**

SCR-Two transistor analogy based turn- ON – turn ON losses – thermal protection – controlled converters (1 pulse, 2 pulse, 3 pulse, 6 pulse) - displacement factor – ripple and harmonic factor - power factor mitigation, performance parameters – effect of source inductance - inverter angle limit.

**UNIT V AC PHASE CONTROLLERS****9**

TRIAC triggering concept with positive and negative gate pulse triggering, TRIAC based phase controllers - various configurations for SCR based single and three phase controllers.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

Upon the successful completion of the course, students will be able to:

CO1: Understand the operation of semiconductor devices and dynamic characteristics and to design & analyze the low power SMPS

CO2: Analyze the various uncontrolled rectifiers and design suitable filter circuits

CO3: Analyze the operation of the n-pulse converters and evaluate the performance parameters

CO4: Understand various PWM techniques and apply voltage control and harmonic elimination methods to inverter circuits.

CO5: Understand the operation of AC voltage controllers and its applications.

**TEXT BOOKS:**

1. Ned Mohan, T.M.Undeland, W.P.Robbins, "Power Electronics: Converters, applications and design", John Wiley and Sons, 3rd Edition (reprint), 2009
2. Rashid M.H., Power Electronics Circuits, Devices and Applications, Prentice Hall India, 3rd Edition, New Delhi, 2004.

**REFERENCES:**

1. Cyril. W.Lander, Power Electronics, McGraw Hill International, Third Edition, 1993.
2. P.S.Bimbhra, Power Electronics, Khanna Publishers, Third Edition 2003
3. Philip T.Krein, Elements of Power Electronics, Oxford University Press, 2013.
4. P.C.Sen, Power Electronics, Tata McGraw-Hill, 30<sup>th</sup> reprint, 2008.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	-	2	1	-	-	3	3	3	3	3
CO2	3	3	3	3	-	-		1	-	-	-	-	3	3	3
CO3	3	3	3	3	-	-	2	1	-	-	2	-	3	3	3
CO4	3	3	3	3	-	-	1	1	-	-	2	3	3	3	3
CO5	3	3	3	3	-	-	1	1	-	-	2	3	3	3	3
Avg.	3	3	3	3	-	-	1.5	1	-	-	2.25	3	3	3	3

**EE3503****CONTROL SYSTEMS****LT P C  
3 0 0 3****COURSE OBJECTIVES:**

- To make the students to familiarize with various representations of systems.
- To make the students to analyze the stability of linear systems in the time domain and frequency domain.
- To make the students to analyze the stability of linear systems in the frequency domain.
- To make the students to design compensator based on the time and frequency domain specifications.
- To develop linear models: mainly state variable model and Transfer function model

**UNIT I MODELING OF LINEAR TIME INVARIANT SYSTEM (LTIV)****9**

Control system: Open loop and Closed loop – Feedback control system characteristics – First principle modeling: Mechanical, Electrical and Electromechanical systems – Transfer function representations: Block diagram and Signal flow graph.

**UNIT II TIME DOMAIN ANALYSIS****9**

Standard test inputs – Time response – Time domain specifications – Stability analysis: Concept of stability – Routh Hurwitz stability criterion – Root locus: Construction and Interpretation. Effect of adding poles and zeros

**UNIT III FREQUENCY DOMAIN ANALYSIS 9**

Bode plot, Polar plot and Nyquist plot: – Frequency domain specifications Introduction to closed loop Frequency Response. Effect of adding lag and lead compensators.

**UNIT IV STATE VARIABLE ANALYSIS 9**

State variable formulation – Non uniqueness of state space model – State transition matrix –Eigen values – Eigen vectors - Free and forced responses for Time Invariant and Time Varying Systems – Controllability – Observability

**UNIT V DESIGN OF FEED BACK CONTROL SYSTEM 9**

Design specifications – Lead, Lag and Lag-lead compensators using Root locus and Bode plot techniques –PID controller - Design using reaction curve and Ziegler-Nichols technique- PID control in State Feedback form.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon the successful completion of the course, students will be able to:

- CO1: Represent simple systems in transfer function and state variable forms.
- CO2: Analyze simple systems in time domain.
- CO3: Analyze simple systems in frequency domain.
- CO4: Infer the stability of systems in time and frequency domain.
- CO5: Interpret characteristics of the system and find out solution for simple control problems.

**TEXT BOOKS:**

1. Benjamin C. Kuo, “Automatic Control Systems”, 7<sup>th</sup> edition PHI Learning Private Ltd, 2010.
2. Nagarath, I.J. and Gopal, M., “Control Systems Engineering”, New Age International Publishers 2010.

**REFERENCES:**

1. Richard C.Dorf and Bishop, R.H., “Modern Control Systems”, Education Pearson, 3 Impression 2009.
2. John J.D., Azzo Constantine, H. and Houpis Sttuart, N Sheldon, “Linear Control System Analysis and Design with MATLAB”, CRC Taylor& Francis Reprint 2009.
3. Katsuhiko Ogata, “Modern Control Engineering”, PHI Learning Private Ltd, 5thEdition, 2010
4. NPTEL Video Lecture Notes on “Control Engineering” by Prof.S.D.Agashe, IIT Bombay.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	1	-	-	-	3	3	3	3
CO2	3	3	3	3	3	-	-	1	-	-	-	3	3	3	3
CO3	3	3	3	3	3	-	-	1	-	-	-	3	3	3	3
CO4	3	3	3	3	3	-	-	1	-	-	-	3	3	3	3
CO5	3	3	3	3	3	-	-	1	-	-	-	3	3	3	3
Avg.	3	3	3	3	3	-	-	1	-	-	-	3	3	3	3

**COURSE OBJECTIVES:**

- To study the VI characteristics of SCR, TRIAC, MOSFET and IGBT.
- To analyze the performance of semi converter, full converter, step up, step down choppers by simulation and experimentation.
- To study the behavior of voltage waveforms of PWM inverter applying various modulation techniques.
- To design and analyze the performance of SMPS.
- To study the performance of AC voltage controller by simulation and Experimentation.

**LIST OF EXPERIMENTS:**

1. Characteristics of SCR and TRIAC.
2. Characteristics of MOSFET and IGBT.
3. AC to DC half controlled converter.
4. AC to DC fully controlled converter.
5. Step down and step up MOSFET based choppers.
6. IGBT based single phase PWM inverter.
7. IGBT based three phase PWM inverter.
8. AC Voltage controller.
9. Switched mode power converter.
10. Simulation of PE circuits (1 $\Phi$  & 3 $\Phi$  semi converter, 1 $\Phi$  & 3 $\Phi$  full converter, dc-dc converters, ac voltage controllers).

**TOTAL :45 PERIODS****COURSE OUTCOMES:**

Upon the successful completion of the course, students will be able to:

CO1: Determine the characteristics of SCR, IGBT, TRIAC, MOSFET and IGBT

CO2: Find the transfer characteristics of full converter, semi converter, step up and step down choppers by simulation experimentation.

CO3: Analyze the voltage waveforms for PWM inverter using various modulation techniques.

CO4: Design and experimentally verify the performance of basic DC/DC converter topologies used for SMPS.

CO5: Understand the performance of AC voltage controllers by simulation and experimentation

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	1.5	-	-	-	3	3	3	3
CO2	3	3	3	3	3	-	-	1.5	-	-	-	3	3	3	3
CO3	3	3	3	3	3	-	-	1.5	-	-	-	3	3	3	3
CO4	3	3	3	3	3	-	-	1.5	-	-	-	3	3	3	3
CO5	3	3	3	3	3	-	-	1.5	-	-	-	3	3	3	3
Avg	3	3	3	3	3	-	-	1.5	-	-	-	3	3	3	3

**COURSE OBJECTIVES:**

- To make the students familiarize with various representations of systems.
- To make the students analyze the stability of linear systems in the time domain and frequency domain.
- To make the students design compensator based on the time and frequency domain Specifications.
- To develop linear models mainly state variable model and transfer function model
- To make the students to design a complete closed loop control system for the physical systems.

**LIST OF EXPERIMENTS:**

1. Analog (op amp based) simulation of linear differential equations.
2. Numerical Simulation of given nonlinear differential equations.
3. Real time simulation of differential equations.
4. Mathematical modeling and simulation of physical systems in at least two fields.
  - Mechanical
  - Electrical
  - Chemical process
5. System Identification through process reaction curve.
6. Stability analysis using Pole zero maps and Routh Hurwitz Criterion in simulation platform.
7. Root Locus based analysis in simulation platform.
8. Determination of transfer function of a physical system using frequency response and Bode's asymptotes.
9. Design of Lag, lead compensators and evaluation of closed loop performance.
10. Design of PID controllers and evaluation of closed loop performance.
11. Discretization of continuous system and effect of sampling.
12. Test of controllability and observability in continuous and discrete domain in simulation platform.
13. State feedback and state observer design and evaluation of closed loop performance.
14. Mini Project 1: Simulation of complete closed loop control systems including sensor and actuator dynamics.
15. Mini Project 2: Demonstration of a closed loop system in hardware.

**TOTAL :60 PERIODS****COURSE OUTCOMES:**

At the end of this course, the students will demonstrate the ability

CO1: To model and analyze simple physical systems and simulate the performance in analog and digital platform.

CO2: To design and implement simple controllers in standard forms.

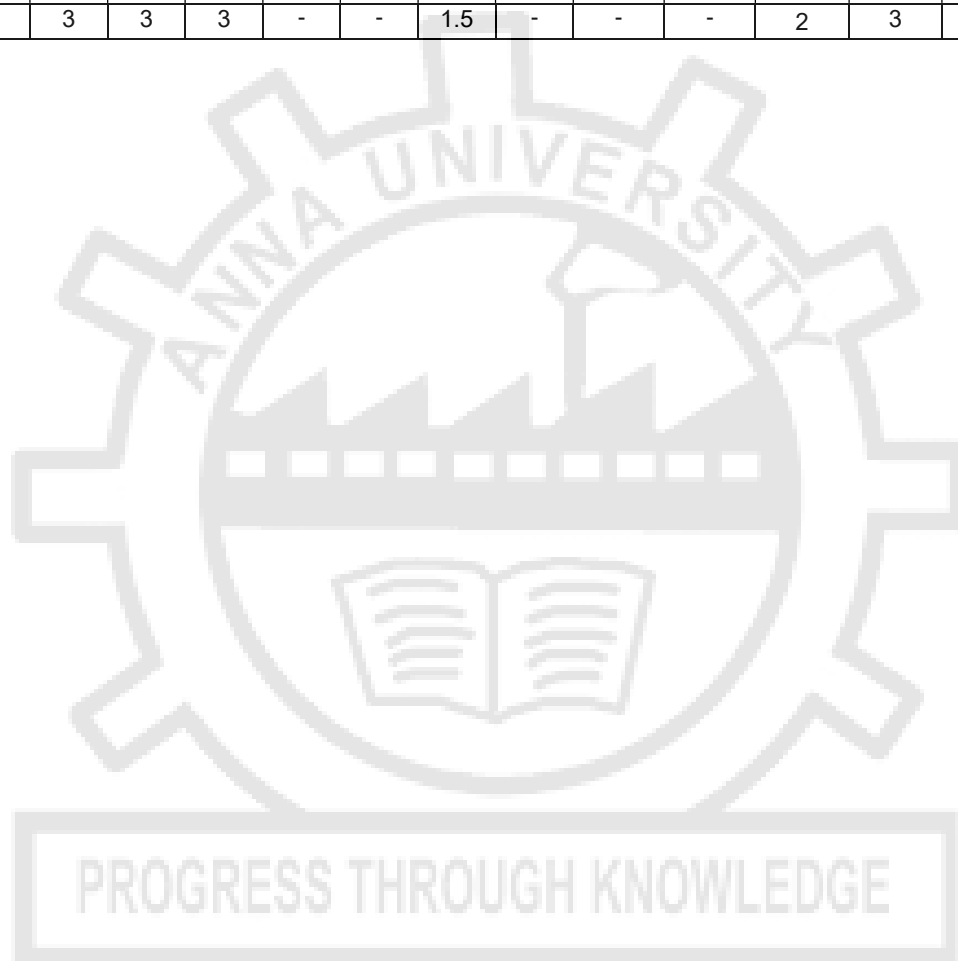
CO3: To design compensators based on time and frequency domain specifications.

CO4: To design a complete closed control loop and evaluate its performance for simple physical systems.

CO5: To analyze the stability of a physical system in both continuous and discrete domains.

### MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	1.5	-	-	-	2	3	3	3
CO2	3	3	3	3	3	-	-	1.5	-	-	-	2	3	3	3
CO3	3	3	3	3	3	-	-	1.5	-	-	-	2	3	3	3
CO4	3	3	3	3	3	-	-	1.5	-	-	-	2	3	3	3
CO5	3	3	3	3	3	-	-	1.5	-	-	-	2	3	3	3
Avg	3	3	3	3	3	-	-	1.5	-	-	-	2	3	3	3



**COURSE OBJECTIVES:**

- To understand the significance of protection, protection schemes and role of earthing.
- To study the characteristics, functions and application areas of various relays.
- To acquire practical knowledge about common faults in power system apparatus and applying suitable protective schemes.
- To understand the functioning of static relays and Numerical protection concepts.
- To understand the problems associated with circuit breaking and to discuss about various circuit breakers.

**UNIT I PROTECTION SCHEMES 9**

Significance and need for protective schemes – nature and causes of faults – types of faults  
Effects of faults - Zones of protection and essential qualities of protection – Types of Protection schemes - Power system Grounding and Methods of Grounding.

**UNIT II BASICS OF RELAYS 9**

Operating principles of relays –Universal torque equation - R-X diagram –Electromagnetic Relays – Over current, Directional and non-directional, Distance, Differential, Negative sequence and Under frequency relays.

**UNIT III OVERVIEW OF EQUIPMENT PROTECTION 9**

Current transformers and Potential transformers and their applications in protection schemes - Protection of transformer, generator, motor, bus bars and transmission line.

**UNIT IV STATIC RELAYS AND NUMERICAL PROTECTION 9**

Static relays – Phase, Amplitude Comparators – Synthesis of various relays using Static comparators – Block diagram of Numerical relays – Over current protection, transformer differential protection, and distance protection of transmission lines.

**UNIT V CIRCUIT BREAKERS 9**

Physics of arcing phenomenon and arc interruption – DC and AC circuit breaking – re-striking voltage and recovery voltage - rate of rise of recovery voltage - current chopping - interruption of capacitive current - resistance switching - Types of circuit breakers – air blast, oil, SF6 and vacuum circuit breakers – comparison of different circuit breakers – HVDC Breaker.

**TOTAL : 45 PERIODS****COURSE OUTCOMES:**

Upon the successful completion of the course, students will have the ability to:

- CO1: Understand and select proper protective scheme and type of earthing.
- CO2: Explain the operating principles of various relays.
- CO3: Suggest suitable protective scheme for the protection of various power system apparatus.
- CO4: Analyze the importance of static relays and numerical relays in power system protection.
- CO5: Summarize the merits and demerits and application areas of various circuit breakers.



**TEXT BOOKS:**

1. Sunil S.Rao, 'Switchgear and Protection', Khanna Publishers, New Delhi, Four Edition, 2010.
2. Badri Ram ,B.H. Vishwakarma, 'Power System Protection and Switchgear', New Age International Pvt Ltd Publishers, Second Edition 2011.
3. B.Rabindranath and N.Chander, 'Power System Protection and Switchgear', New Age International (P) Ltd., Second Edition, 2018.
4. Arun Ingole, 'Switch Gear and Protection' Pearson Education, 2018.

**REFERENCES**

1. Y.G.Paithankar and S.R.Bhide, 'Fundamentals of power system protection', Second Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2013.
2. C.L.Wadhwa, 'Electrical Power Systems', 6th Edition, New Age International (P) Ltd., 2018
3. VK Metha, " Principles of Power Systems", S. Chand, Reprint, 2013
4. Bhavesh Bhalja, R.P. Maheshwari, Nilesh G. Chotani, 'Protection and Switchgear' Oxford University Press, 2<sup>nd</sup> Edition 2018.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2	1	2	1	1	1	1	2	-	3	1	-
CO2	3	1	1	2	1	2	1	1	1	1	2	-	3	1	-
CO3	3	1	1	2	1	2	1	1	1	1	2	-	3	2	-
CO4	3	1	1	2	1	2	1	1	1	1	2	-	3	2	1
CO5	3	1	1	2	2	2	1	1	1	1	2	-	3	1	1
Avg.	3	1	1	2	1.2	2	1	1	1	1	2	-	3	1.4	1

PROGRESS THROUGH KNOWLEDGE

**COURSE OBJECTIVES:**

To impart knowledge on,

- The significance of power system operation and control.
- Real power– frequency interaction and design of power– frequency controller.
- Reactive power– voltage interaction and the compensators for maintaining the voltage profile.
- The generation scheduling and economic operation of power system.
- SCADA and its application for real time operation and control of power systems.

<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>9</b>
Power scenario in Indian grid – National and Regional load dispatching centres – Requirements of good power system – Necessity of voltage and frequency regulation – real power vs frequency and reactive power vs voltage control loops - System load variation, load curves – Load forecasting – Computational methods in load forecasting – Load shedding and Islanding – deregulation - Basics of electrical energy tariff.		
<b>UNIT II</b>	<b>REAL POWER FREQUENCY CONTROL</b>	<b>9</b>
Basics of speed governing mechanisms and modelling – Speed regulation of two generators in parallel Load Frequency Control (LFC) of single area system – Static and dynamic analysis – LFC of two area system –Tie line modelling – Block diagram representation of two area system – Static and dynamic analysis – Tie line with frequency bias control – State variable model – Integration of economic dispatch control with LFC.		
<b>UNIT III</b>	<b>REACTIVE POWER – VOLTAGE CONTROL</b>	<b>9</b>
Generation and absorption of reactive power – Basics of reactive power control – Automatic Voltage Regulator (AVR) – Brushless AC excitation system – Block diagram representation of AVR loop static and dynamic analysis – Stability compensation – Voltage drop in transmission line – Methods of reactive power injection – Tap changing transformer, SVC and STATCOM for voltage control.		
<b>UNIT IV</b>	<b>ECONOMIC OPERATION OF POWER SYSTEM</b>	<b>9</b>
Statement of economic dispatch problem – Input and output characteristics of thermal plant incremental cost curve – Optimal operation of thermal units without and with transmission losses (no derivation of transmission loss coefficients) – Lambda–iteration method – Base point and participation factors method. Statement of Unit Commitment (UC) problem – Constraints on UC problem – Solution of UC problem using priority list – Special aspects of short term and long-term hydrothermal scheduling problems.		
<b>UNIT V</b>	<b>COMPUTER AIDED CONTROL OF POWER SYSTEM</b>	<b>9</b>
Need of computer control of power system – Concept of energy control centers and functions – PMU system monitoring, Data acquisition and controls – System hardware configurations – SCADA and EMS functions – State estimation – Measurements and errors – Weighted least square estimation – Various operating states – State transition diagram.		

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES:

On the successful completion of the course, students will be able to:

- CO1: Understand the day – to – day operation of power system.
- CO2: Model and analyse the control actions that are implemented to meet the minute-to-minute variation of system real power demand.
- CO3: Model and analyze the compensators for reactive power control and various devices used for voltage control.
- CO4: Prepare day ahead and real time economic generation scheduling.
- CO5: Understand the necessity of computer control of power systems.

## TEXTBOOKS:

1. Olle. I. Elgerd, 'Electric Energy Systems theory – An introduction', McGraw Hill Education Pvt. Ltd., New Delhi, 2<sup>nd</sup> edition, 2017.
2. Allen. J. Wood and Bruce F. Wollen berg, 'Power Generation, Operation and Control', John Wiley & Sons, Inc., 3<sup>rd</sup> edition, 2013.
3. Abhijit Chakrabarti and Sunita Halder, 'Power System Analysis Operation and Control', PHI learning Pvt. Ltd., New Delhi, Fourth Edition, 2018.

## REFERENCE BOOKS:

1. Kothari D.P. and Nagrath I.J., 'Power System Engineering', Tata McGraw– Hill Education, Second Edition, Reprint 2018.
2. Hadi Saadat, 'Power System Analysis', McGraw Hill Education Pvt. Ltd., New Delhi, 23rd reprint, 2015.
3. Kundur P., 'Power System Stability and Control, McGraw Hill Education Pvt. Ltd., New Delhi, 12th reprint, 2015.
4. B.M. Weedy, B.J. Cory et al, 'Electric Power systems', Wiley, Fifth Edition, 2012.

## MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	-	-	-	-	-	1	-	-	-	2	3	3	3
CO2	3	2	1	1	-	1	-	2	-	2	-	2	3	3	3
CO3	3	2	1	1	-	1	-	2	-	2	-	2	3	3	3
CO4	3	2	1	1	-	1	-	2	-	2	-	2	3	1	2.33
CO5	2	1	-	-	-	-	-	1	-	2	-	2	3	3	3
Avg.	2	1.6	1	1	-	1	-	1.6	-	2	-	2	3	2.2	2.86

**COURSE OBJECTIVES:**

- 1 To provide a better understanding of modelling of transmission lines in impedance and admittance forms.
- 2 To apply iterative techniques for power flow analysis and to carry out short circuit and stability studies on power system.
- 3 To analyze the load – frequency and voltage controls.
- 4 To analyze optimal dispatch of generators and perform state estimation.
- 5 To understand the operation of relays, characteristics, and applications.

**LIST OF EXPERIMENTS:**

- 1 Computation and modelling of transmission Lines.
- 2 Formation of Bus Admittance and Impedance Matrices.
- 3 Power Flow Analysis Using Gauss-Seidel Method.
- 4 Power Flow Analysis Using Newton Raphson Method.
- 5 Symmetric and Unsymmetrical Fault Analysis.
- 6 Transient Stability Analysis of SMIB System.
- 7 Load – Frequency Dynamics of Single- Area and Two-Area Power Systems.
- 8 Economic Dispatch in Power Systems.
- 9 State estimation: Weighted least square estimation.
- 10 Performance analysis of over current relay.
- 11 Performance analysis of impedance relay.
- 12 Testing of CT, PT, and Insulator string.
- 13 Relay Coordination in Radial Feeder Protection Scheme.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

On the successful completion of the laboratory, students will be able to:

CO1: Model and analyze the performance of the transmission lines.

CO2: Perform power flow, short circuit, and stability analysis for any power system network.

CO3: Understand, design, and analyze the load frequency control mechanism.

CO4: Perform optimal scheduling of generators and compute the state of the power system.

CO5: Understand, analyze, and apply the relays for power system protection.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	-	-	2	1	2	-	3	3	3	3
CO2	3	3	2	2	3	-	-	2	1	2	-	3	3	3	3
CO3	3	3	2	2	3	-	-	2	1	2	-	3	3	3	3
CO4	3	3	2	2	3	-	-	2	1	2	-	3	3	3	3
CO5	3	3	2	2	3	-	-	2	1	2	-	3	3	3	3
Avg	3	3	2	2	3	-	-	2	1	2	-	3	3	3	3

**COURSE OBJECTIVES:**

- Various types of over voltages in power system and protection methods.
- Generation of over voltages in laboratories.
- Measurement of over voltages.
- Nature of Breakdown mechanism in solid, liquid and gaseous dielectrics.
- Testing of power apparatus and insulation coordination.

**UNIT I OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS 9**

Causes of over voltages and its effects on power system – Lightning, switching surges and temporary over voltages – Reflection and Refraction of Travelling waves- protection against over voltages\_ Insulation Coordination.

**UNIT II DIELECTRIC BREAKDOWN 9**

Properties of Dielectric materials - Gaseous breakdown in uniform and non-uniform fields –Corona discharges – Vacuum breakdown – Conduction and breakdown in pure and commercial liquids, Maintenance of oil Quality – Breakdown mechanisms in solid and composite dielectrics- Applications of insulating materials in electrical equipment.

**UNIT III GENERATION AND MEASUREMENTS OF HIGH VOLTAGES AND HIGH CURRENTS 9**

Generation of High DC, AC, impulse voltages and currents - Analysis of DC/AC and Impulse generator circuits - Tripping and control of impulse generators, Measurement of High voltages and High currents – High Resistance with series ammeter – Dividers - Resistance, Capacitance and Mixed dividers - Peak Voltmeter, Generating Voltmeters, Electrostatic Voltmeters – Sphere Gaps, High current shunts- Digital techniques in high voltage measurement.

**UNIT IV HIGH VOLTAGE TESTING & INSULATION COORDINATION 9**

High voltage testing of electrical power apparatus- International and Indian standards – Power frequency, impulse voltage and DC testing of Insulators, circuit breakers, bushing, isolators and transformers - Insulation Coordination.

**UNIT V APPLICATION IN INDUSTRY 9**

Introduction – electrostatic applications- electrostatic precipitation, separation, painting / coating, spraying, imaging, printing, Transport of materials – manufacturing of sand paper – Smoke particle detector – Electrostatic spinning, pumping, propulsion – Ozone generation – Biomedical applications.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

Upon the successful completion of the course, students will be able to:

CO1: Explain various overvoltage's and its effects on power systems.

- CO2: Understand the breakdown phenomena in different medium under uniform and non-uniform fields.
- CO3: Explain the methods of generating and measuring High DC, AC, Impulse voltage and currents.
- CO4: Suggest and Conduct suitable HV testing of Electrical power apparatus as per Standards
- CO5: Explain the Industrial Applications of Electrostatic Fields.

**TEXT BOOKS**

1. M.S.Naidu and V. Kamaraju, 'High Voltage Engineering', Tata McGraw Hill, Fifth Edition, 2013.
2. E. Kuffel and W.S. Zaengl, J.Kuffel, 'High voltage Engineering fundamentals', Newnes Second Edition, Elsevier , New Delhi, 2005.
3. C.L. Wadhwa, 'High voltage Engineering', New Age International Publishers, Fourth Edition, 2020.

**REFERENCES**

1. L.L.Alston, High Voltage Technology, Oxford University Press, First Indian Edition 2006.
2. C.L.Wadhwa, High voltage Engineering, New Age International Publishers, Fourth Edition, 2020
3. Mazen Abdel – Salam, Hussein Anis, Ahdab A-Morshedy, RoshdayRadwan, High Voltage Engineering – Theory &Practice, Second Edition, Taylor & Francis Gourp, 2019
4. Subir Ray.” An Introduction to High Voltage Engineering “PHI Learning Private Limited, New Delhi, Second Edition-2011

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	-	-	-	-	-	-	-	-	-	-	3	2	-
CO2	3	2	-	1	-	-	-	-	-	-	-	-	3	-	-
CO3	2	2	3	1	-	-	-	-	-	-	2	3	3	2	-
CO4	1	2	3	1	-	-	-	1	1	-	-	3	3	2	-
CO5	2	2	1	-	-	2	-	-	-	-	2	-	3	-	2
Avg.	2	2	2.33	1	-	2	-	1	1	-	2	3	3	2	2

PROGRESS THROUGH KNOWLEDGE

**COURSE OBJECTIVES:**

The student should be made to learn methodology to select a good project and able to work in a team leading to development of hardware/software product.prepare a good technical report. Gain Motivation to present the ideas behind the project with clarity.

A Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. The aim of the project work is to deepen Comprehension of principles by applying them to a new problem which may be the design /fabrication of any power component / circuit / sensor / Activator / Controller, a research investigation, a computer or management project or a design problem. The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.

**TOTAL : 300 PERIODS****COURSE OUTCOMES:**

- CO1** Ability to identify, formulate, design, interpret, analyze and provide solutions to complex engineering and societal issues by applying knowledge gained on basics of science and Engineering.
- CO2** Ability to choose, conduct and demonstrate a sound technical knowledge of their selected project topics in the field of power components, protection, high voltage, electronics, process automation, power electronics and drives instrumentation and control by exploring suitable engineering and IT tools.
- CO3** Ability to understand, formulate and propose new learning algorithms to solve engineering and societal problems of moderate complexity through multidisciplinary projects understanding commitment towards sustainable development.
- CO4** Ability to demonstrate, prepare reports, communicate and work in a team as a member/leader by adhering to ethical responsibilities.
- CO5** Ability to acknowledge the value of continuing education for oneself and to stay up with technology advancements.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	-	-	-	-	-	-	-	3	3	3
CO2	-	-	-	-	3	3	-	-	-	-	-	-	3	-	-
CO3	-	-	-	-	-	-	3	-	3	-	-	-	-	-	3
CO4	-	-	-	-	-	-	-	3	3	3	3	-	-	-	3
CO5	-	-	-	-	-	-	-	-	-	-	-	3	3	3	3
Avg.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

1-low, 2-medium, 3-high, '-'- no correlation

## VERTICAL I : POWER ENGINEERING

**EE3001 UTILIZATION AND CONSERVATION OF ELECTRICAL ENERGY**

**LT P C  
3 0 0 3**

### **COURSE OBJECTIVES:**

- To know various electric drives and traction motors with applications
- To introduce the energy saving concept by different ways of illumination.
- To understand the different methods of electric heating and electric welding.
- To know the conversion of solar and wind energies into electrical energy for different applications.
- To study the domestic utilization of electrical energy.

### **UNIT I ELECTRIC DRIVES AND TRACTION (7+2 Skill) 9**

Fundamentals of electric drive - choice of an electric motor - application of motors for particular services traction generator set, traction motors, power transformers - characteristic features of traction motor - systems of railway electrification - electric braking - train movement and energy consumption - traction motor control - track equipment and collection gear.

### **UNIT II ILLUMINATION (7+2 Skill) 9**

Introduction - definition and meaning of terms used in illumination engineering - classification of light sources - incandescent lamps, sodium vapour lamps, mercury vapour lamps, fluorescent lamps – design of illumination systems - indoor lighting schemes - factory lighting halls - outdoor lighting schemes - flood lighting - street lighting - energy saving lamps, LED

### **UNIT III HEATING AND WELDING (7+2 Skill) 9**

Introduction - advantages of electric heating – modes of heat transfer - methods of electric heating - resistance heating - arc furnaces - induction heating - dielectric heating - electric welding – types - resistance welding - arc welding - power supply for arc welding - radiation welding.

### **Unit iv ENERGY CONSERVATION AND ITS IMPORTANCE (7+2 Skill) 9**

Energy conservation act 2001 and its Features-Review of Industrial Energy Conservation-Energy conservation in electrical Industries-Simulation study of energy conservation using power factor controller. (Three phase circuit simulation with and without capacitor)

### **UNIT V DOMESTIC UTILIZATION OF ELECTRICAL ENERGY (7+2 Skill) 9**

House wiring - working principle of air conditioning system, Induction based appliances, Online an OFF line UPS, Batteries - Power quality aspects – nonlinear and domestic loads – Earthing system for Domestic, Industrial and Substation.

**TOTAL: 45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Conter Preparation/Quiz/Surprise Test/Solving Problems) 10**

1. Choosing electrical motors for drives and traction applications.
2. A general design procedure for lighting schemes.
3. Design of heating element and study of welding methods.



4. Practical case studies of energy conservation.
5. Power requirement for different domestic appliances.

### COURSE OUTCOMES:

At the end of the course, students should have the:

- CO1 Ability to choose suitable electric drives for different applications
- CO2 Ability to design the illumination systems for energy saving
- CO3 Ability to demonstrate the utilization of electrical energy for heating and welding purposes
- CO4 Ability to know the effective usage of solar and wind energies for electrical applications
- CO5 Ability to do electric connection for any domestic appliance like refrigerator, battery charging circuit for a specific household application.
- CO6 To illustrate the need for energy conservation and to simulate three phase power control.

### TEXT BOOKS:

1. N.V. Suryanarayana, "Utilisation of Electric Power", Wiley Eastern Limited, New Age International Limited, 1994 & Second Edition 2017 Feb.
2. J.B.Gupta, "Utilisation Electric power and Electric Traction", S.K.Kataria and sons, 2001 2012<sup>th</sup> Edition, 2013, January.
3. G.D.Rai, "Non-Conventional Energy sources", Khanna publications Ltd., New Delhi 1998
4. D.P.Kothari, K.C.Singal, Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", PHI Learning Private Limited, 3<sup>rd</sup> Edition 2022.
5. Industrial Energy Conservation, Volume I-II, S C Bhatia, Sarvesh Devraj, Energy conservation and Management by Akshay A pujara 1<sup>st</sup> edition, June 2018.

### REFERENCES:

1. R.K.Rajput, Utilisation of Electric Power, Laxmi publications 2<sup>nd</sup> Edition 2016.
2. H.Partab, Art and Science of Utilisation of Electrical Energy", Edition, Dhanpat Rai and Co New Delhi-2004.
3. C.L.Wadhwa, "Generation, Distribution and Utilisation of Electrical Energy", New Age international Pvt.Ltd., 3<sup>rd</sup> Edition, 2015 January.

### MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	2	1	-	1	-	1.5	-	-	-	-	3	-	-
CO2	2	1	3	-	-	-	-	1.5	-	-	-	-	3	-	-
CO3	3	2	2	-	-	1	-	1.5	-	-	-	-	3	-	-
CO4	1	2	3	-	-	-	-	1.5	-	-	-	-	3	-	-
CO5	1	1	3	-	-	1	-	1.5	-	-	-	-	3	3	2
CO6	3	3	3	-	-	-	-	1.5	-	-	-	-	3	3	3
Avg	2.2	2	2.6	1	-	1	-	1.5	-	-	-	-	3	3	2.5

**COURSE OBJECTIVES:**

To impart knowledge on the following topics

- Understanding Power Cable Characteristics and Applications.
- Cable Manufacturing.
- Installation of underground power cables
- Underground cable System Fault Locating.
- Testing and maintenance of Underground cable system.
- Cable Performance and Field Assessment of Power Cables

**UNIT I INTRODUCTION TO ELECTRICAL POWER CABLES (7+2 SKILL) 9**

Development of Underground Cables - Electric Lighting- Distribution of Energy for Lighting- - Paper Insulated Cables - Underground Residential Distribution Systems- Underground Residential Distribution Systems- Medium Voltage Cable Development.

**UNIT II CABLE ARCHITECTURE, DIELECTRIC THEORY AND CABLE CHARACTERISTICS (7+2 SKILL) 9**

Architecture of Underground Cabling System - Basic Dielectric Theory of Cable – Conductors - Armour and Protective Finishes - Cable Characteristics: Electrical- Fundamentals of Electrical Insulation Materials - Electrical Properties of Cable Insulating Materials - Cable Standards and Quality Assurance - Cable design parameters- Current Carrying Capacity - Short-circuit Ratings.

**UNIT III SUPPLY DISTRIBUTION SYSTEMS AND CABLES(7+2 SKILL) 9**

Supply Distribution Systems - Distribution Cable Types, Design and Applications - Paper Insulated Distribution Cables - PVC Insulated Cables - Polymeric Insulated Distribution Cables for 6-30 kV - Manufacture of Distribution Cables - Joints and Terminations for Distribution Cables - Testing of Distribution Cables.

**UNIT IV TRANSMISSION SYSTEMS AND CABLES(7+2 SKILL) 9**

Basic Cable Types for A.C. Transmission - Self-contained Fluid-filled Cables - Gas Pressure Cables - High Pressure Fluid-filled Pipe Cables - Polymeric Insulated Cables for Transmission Voltages - Techniques for Increasing Current Carrying Capacity - Transmission Cable Accessories and Jointing for Pressure-assisted and Polymeric Cables.

**UNIT V CABLE INSTALLATION, TESTING, MAINTENANCE(7+2 SKILL) 9**

Installation of Transmission Cables -Splicing, Terminating, and Accessories - Sheath Bonding and Grounding-Testing of Transmission Cable Systems - Underground System Fault Locating - Field Assessment of Power Cable Systems- Condition monitoring tests – PD measurements.

**TOTAL : 45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (GROUP SEMINAR/ MINI PROJECT/ ASSIGNMENT/ CONTENT PREPARATION/ QUIZ/ SURPRISE TEST /SOLVING GATE QUESTIONS /ETC. 10**

1. Demonstration of cable architecture with cable samples of all types.

2. Understanding the cable manufacturing process through factory visit.
3. Familiarization of the cable laying procedure through field visits.
4. Familiarization of cable jointing / end termination techniques.
5. Understanding and familiarization of cable fault locating techniques through field visit to local distribution company or inhouse laboratory.
6. Understanding testing procedures and condition monitoring tests.

**COURSE OUTCOMES:**

- CO1 Ability to understand the fundamental of underground cable system.  
 CO2 Ability to gain knowledge on the architecture of UG cable and physical and electrical characteristics of the UG cable.  
 CO3 Ability to understand different types of cable used in distribution system.  
 CO4 Ability to acquire knowledge on Underground cables used in transmission system  
 CO5 Ability to understand the cable installations procedures and practices.  
 CO6 Ability to understand the theory / methodology of cable fault detection and rectification, testing and maintenance.

**TEXT BOOKS:**

1. William Thue, 'Electrical Power Cable Engineering', CRC Press Taylor & Francis Group., 6000 Broken Sound Parkway NW, Suite 300 Boca Raton, FL 33487-2742, 3<sup>rd</sup> Edition 2017.
2. G. F. Moore, 'Electric Cables Handbook' -Third edition, Blackwell Science Ltd, 9600 Garsington Road, Oxford OX4 2DQ, UK., January 2017.

**REFERENCES:**

1. Leonard L. Grigsby, 'Electrical Power Cable Engineering' - CRC Press, Marcel Dekker, 3<sup>rd</sup> Edition 2012.
2. Christian Flytkjaer Jensen, Online Location of Faults on AC Cables in Underground Transmission Systems (Springer Theses), 2014, March.
3. <https://kafactor.com/content/technical-resources/kerite-underground-cable-engineering-handbook.pdf>
4. Handbook on Cable Fault Localization (April 2020)  
[https://rdso.indianrailways.gov.in/works/uploads/File/Handbook%20on%20Cable%20Fault%20Localization\(2\).pdf](https://rdso.indianrailways.gov.in/works/uploads/File/Handbook%20on%20Cable%20Fault%20Localization(2).pdf)
5. K. H. Ali et al.: Industry Practice Guide for Underground Cable Fault-Finding in the LVND: <https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9807279>, June 2022.
6. R. W. Deltenre, J. J. Schwarz, and H. J. Wagnon, "Underground cable fault location: A handbook to TD-153," BDM Corp., Albuquerque, NM, USA, Final Rep. EPRI EL-363, 1977. [Online]. Available: <https://www.osti.gov/servlets/purl/7233049>, doi: 10.2172/7233049, January 1997.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	2	1	-	3	2	-	3	-	3
CO2	3	2	-	-	-	-	2	1	-	3	2	-	3	-	3
CO3	3	2	-	-	-	-	2	1	-	3	2	-	3	-	3
CO4	3	2	-	-	-	-	2	1	-	3	2	-	3	-	3
CO5	3	2	3	-	-	-	2	1	-	3	2	-	3	3	3
CO6	3	3	-	3	-	-	2	1	-	3	2	-	3	3	3
Avg	3	2.1	3	3	-	-	2	1	-	3	2	-	3	3	3

**COURSE OBJECTIVES:**

- To help engineering students to have a holistic understanding of the concepts behind substation engineering and design.
- The course aims to give an exposure to the students to the requirements of practical aspects including an overview of civil and mechanical aspects.
- Course aims to enhance the knowledge, and give the practical guidelines for site selection, construction, protection along with maintenance, safety in a substation.
- It also aims at providing knowledge about state-of-the-art technology in substation automation system

**UNIT I SUBSTATION DESIGN DEVELOPMENT (7+2 SKILL)****9**

Substation Introduction and Classifications, Different bus bar switching schemes for Substation. Standards and Practices, Factors Influencing Substation Design - Altitude, Ambient Temperature, Earthquake and seismic zones, pollution and corrosion etc., Testing of Electrical Equipment, Concept and development of Single Line Diagram. Requirement of substation calculation.

**UNIT II SUBSTATION EQUIPMENT (7+2 SKILL)****9**

Selection and sizing of main substation equipment: Transformer, Isolator, Circuit Breaker, surge arrester, Instrument transformers, classification of equipment with a practical overview, and the performance parameters. Classifications of MV Switchgear and Key Design Parameters, MV/LV Switchgear construction and design of control scheme. Station Auxiliary equipment: Diesel Generator System, Basics of AC/DC Auxiliary Power System & Sizing of Aux. Transformer, DC System Components, Battery Sizing & charger Sizing, DG Set Classification, and sizing. Introduction to gas insulated substation: Operating principle of GIS, Advantage over AIS, construction of GIS.

**UNIT III PROTECTION AND SUBSTATION AUTOMATION (7+2 SKILL)****9**

Power System protection, Overcurrent and Earth Fault protection and coordination. Distribution Feeder Protection, Transformer – Unit/Main Protection, Familiarization of NUMERICAL Relays, distance/differential protection for transmission line. Substation Automation: Evolution of Substation Automation, Communication System Fundamentals-Protocol fundamental and choosing the right protocol. Substation integration and automation functional architecture, Substation signal list - DI, DO, AI, AO– Bay Control Unit (BCU), Remote Terminal Unit RTU.

**UNIT IV SUBSTATION DESIGN & LAYOUT ENGINEERING (7+2 SKILL)****9**

Layout aspects of Outdoor Air Insulated Substation and GIS: Statutory Clearances, Equipment Layout engineering aspects for Outdoor Substation/GIS and related calculations, and guide lines, Cable routing layout, Erection Key Diagram (EKD), switchyard earthing design as per IEEE80, Importance and Types of Earthing, Earthing Design, Types of Earthing Material, Direct stroke Lightning Protection for switchyard with IS/ IEC 62305. LV Cables - Power & Control, MV Cables, Methods for Cable Installation, Practical aspects of Cable Sizing, Cable accessories, Illumination System Design.

**UNIT V INTERFACE ENGINEERING (7+2 SKILL)****9**

Civil & Structural Engineering - Familiarization of site development plan, equipment supports structures, foundation for equipment, familiarization of control building and substation building, infrastructure development, Mechanical System- Fire Detection, Alarm System and Fire Suppression System for transformer, Heating, Ventilation and Air-conditioning (HVAC) for Substation.

**TOTAL : 45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (GROUP SEMINAR/ MINI PROJECT/ ASSIGNMENT/ CONTENT PREPARATION/ QUIZ/ SURPRISE TEST /SOLVING GATE QUESTIONS /ETC.**

**10**

1. Battery sizing for a substation with a load cycle based on IEEE 1115 Ni-cd - A case study  
OR
2. DG and auxiliary transformer sizing for a substation auxiliary power supply- A case study
3. Overcurrent Relay coordination in a substation- A case study
4. Earthmat sizing calculation for an outdoor substation based on IEEE80- A case study  
OR
5. Direct stroke lightning protection calculation for outdoor switchyard based on IEC 62305- A case study

**COURSE OUTCOMES:**

On successful completion of the course student will be able to:

- CO 1: Understand the key deciding factors involved in substation design and operation
- CO 2: Know about the sizing and selection of equipment which forms part of substation
- CO 3: Know about composite layout design aspects of the substation with different services and the challenges including statutory clearances.
- CO 4: Understand about Interdisciplinary aspects involved in substation design
- CO 5: Understand different protection and control scheme involved in substation design
- CO 6: Know about substation automation system and different communication protocol involved for efficient operation of a substation

**REFERENCES:**

1. McDonald John D, "Electric Power Substations Engineering", CRC Press, 3<sup>rd</sup> Edition, 2012
2. Partap Singh Satnam, P.V. Gupta, "Sub-station Design and Equipment", Dhanpat Rai Publications, 1<sup>st</sup> Edition, 2013
3. Sunil S. Rao, "Switchgear Protection and Power Systems (Theory, Practice & Solved Problems)", Khanna Publications, 14<sup>th</sup> Edition, 2019 .
4. Electrical substation and engineering & practice by S.Rao, 3<sup>rd</sup> Edition, Khanna Publishers 2015
6. Manual on Substation by Central Board of irrigation and Power (CBIP) Publication No 342., 2006.
7. Substation automation system Design and implementation by Evelio Padilla by Wiley Publications, 1<sup>st</sup> Edition, 2015 November.

PROGRESS THROUGH KNOWLEDGE

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	2	-	2	1	3	2	-	-	-	3	3	-	1
CO2	3	3	3	3	2	3	-	1	2	-	-	2	3	-	1
CO3	3	2	3	3	1	3	-	2	2	-	-	3	3	-	1
CO4	3	1	2	-	-	3	2	1	2	-	-	2	3	-	1
CO5	3	3	3	3	-	3	2	1	1	-	-	3	3	-	1
CO6	-	2	3	3	-	3	-	1	-	-	-	3	3	-	1
Avg	2.6	2.3	2.6	3	1.6	2.6	2.3	1.3	1.75	-	-	2.6	3	-	1

**COURSE OBJECTIVES:****To understand:**

- The problems in AC transmission systems and DC transmission systems
- The operation and control of SVC and TCSC
- The concepts of IGBT based FACTS controllers
- The basic operation Line Commutated Converter(LCC) based HVDC links
- The features of voltage source converter based HVDC link..

**UNIT I INTRODUCTION****(7+2 Skill) 9**

Reactive power control in electrical power transmission lines–load & system compensation, Uncompensated transmission line–shunt and series compensation. Need for HVDC Transmission, Comparison between AC & DC Transmission, , Types of HVDC transmission System.

**UNIT II STATIC VAR COMPENSATOR (SVC) AND THYRISTOR CONTROLLED SERIES COMPENSATOR (TCSC)****(7+2 Skill) 9**

VI characteristics of FC+TSR, TSC+TSR, Voltage control by SVC–Advantages of slope in dynamic characteristics–Influence of SVC on system voltage–Design of SVC voltage regulator, Thyristor Controlled Series Compensator (TCSC), Concept of TCSC, Operation of the TCSC–Different modes of operation, Applications:

**UNIT III VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS****(7+2 Skill) 9**

Static Synchronous Compensator (STATCOM)–Principle of operation–V-I Characteristics. Applications: Steady state power transfer-enhancement of transient stability-prevention of voltage instability. SSSC-operation of SSSC VI characteristics, Enhancement in Power transfer capability –, UPSC – Operation Principle Applications.

**UNIT IV LINE COMMUTATED HVDC TRANSMISSION****(7+2 Skill) 9**

Operation of Gratz bridge - Effect of delay in Firing Angle – Effect of commutation overlap - Equivalent circuit,. Basic concept of HVDC transmission. Model of operations and control of power flow CC and CIA mode of operation

**UNIT V VSC BASED HVDC TRANSMISSION****(7+2 Skill) 9**

Basic 2 level IGBT inverter operation- 4 Quadrant operation- phase angle control- dq control- Control of power flow in VSC based HVDC Transmission, Topologies of MTDC system.

**TOTAL: 45 PERIODS****SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)****10**

1. Simulation of FC+TSR connected to IEEE 5 bus system
2. Realization of reactive power, support by SVC in open loop and closed loop control in simulation.
3. Regulation of line flows employing TCSC and TSSC in closed loop control in simulation
4. Simulation of two terminal HVDC Link, closed loop control in CC and CIA mode in simulation
5. Realization of four quadrant operation of VSC in open loop mode in simulation

**COURSE OUTCOMES:**

After completion the above subject, students will be able to understand

CO1: To Identify and understand the problems in AC transmission systems and understand the need for Flexible AC transmission systems and HVDC Transmission

CO2: To understand the operation and control of SVC and TCSC and its applications to enhance the stability and damping.

CO3: To Analyze basic operation and control of voltage source converter based FACTS controllers

CO4: To demonstrate basic operation and control of Line Commutated HVDC Transmission

CO5: To explain the d-q control based operation of VSC based HVDC Transmission

**TEXT BOOKS:**

1. R.Mohan Mathur, Rajiv K.Varma ,“Thyristor–Based Facts Controllers for Electrical Transmission Systems”, IEEE press andJohnWiley&Sons,Inc,2002.
2. Narain G.Hingorani, “Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems”, Standard Publishers Distributors,Delhi-110006,2011.

**REFERENCES:**

1. K.R.Padiyar,“FACTS Controllersin Power Transmission and Distribution”, New Age International (P) Limited, Publishers, New Delhi, 2008
2. A.T.John,“FlexibleA.C.TransmissionSystems”,InstitutionofElectricalandElectronic Engineers(IEEE), 1999.
3. V.K.Sood, HVDC and FACTS controllers–Applications of Static Converters in Power System, APRIL2004,KluwerAcademic Publishers,2004.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	1	3	1	-	-	-	-	-	-	-	2	3	3
CO2	2	3	1	2	3	-	-	-	-	-	-	-	2	3	3
CO3	2	3	1	3	1	-	-	-	-	-	-	-	2	3	3
CO4	3	3	1	2	3	-	-	-	-	-	-	-	2	3	3
CO5	3	3	1	3	1	-	-	-	-	-	-	-	2	3	3
Avg	2.6	3	1	2.6	1.8	-	-	-	-	-	-	-	2	3	3

**COURSE OBJECTIVES:**

- To study the concepts behind economic analysis and Load management.
- To understand the basics of materials and energy balance.
- To analyze the energy efficiency in thermal utilities.
- To know the concept of compressed air system.
- To illustrate the concept of lighting systems and cogeneration.

**UNIT I GENERAL ASPECTS OF ENERGY MANAGEMENT AND ENERGY AUDIT****(7+2 Skill) 9**

Commercial and Non-commercial energy - final energy consumption - energy needs of growing economy - energy pricing - energy conservation and its importance - Re-structuring of the energy supply sector - Energy Conservation Act 2001, Energy Conservation (Amendment) Act, 2010, and its features - electricity tariff - Thermal Basics - need and types of energy audit - Energy management/audit approach- understanding energy costs - maximizing system efficiencies - optimizing the input energy requirements - energy audit instruments - Case study.

**UNIT II MATERIAL AND ENERGY BALANCE****(7+2 Skill) 9**

Methods for preparing process flow - material and energy balance diagrams - Energy policy purpose - location of energy management - roles and responsibilities of energy manager – employees training and planning- Financial Management: financial analysis techniques, simple payback period, return on investment, net present value, internal rate of return – Case Study.

**UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES****(7+2 Skill) 9**

Introduction to fuels - properties of fuel oil, coal and gas - principles of combustion - combustion of oil, coal and gas - Boilers: Types, combustion in boilers, performances evaluation, analysis of losses - energy conservation opportunities - FBC boilers - Steam System: Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, identifying opportunities for energy savings - Furnaces: Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery – Refractory : types, selection and application of refractories, heat loss - Cogeneration: classification and saving potentials - Case Study.

**UNIT IV ENERGY EFFICIENCY IN COMPRESSED AIR SYSTEM****(7+2 Skill) 9**

Compressed Air System: Types of air compressors - efficient compressor operation - Compressed air system components - leakage test - savings opportunities - Refrigeration System: Vapour compression refrigeration cycle – refrigerants - coefficient of performance - factors affecting Refrigeration and Air conditioning system - savings opportunities - Vapour absorption refrigeration system: working principle - types and comparison with vapour compression system - saving potential - Cooling Tower: Types and performance evaluation, efficient system operation - flow control strategies and energy saving - Diesel Generating system: Factors affecting selection - energy performance assessment of diesel conservation avenues - Case Study.



**UNIT V ENERGY EFFICIENCY IN ELECTRICAL UTILITIES (7+2 Skill) 9**

Electrical load management and maximum demand control - power factor improvement and its benefit - selection and location of capacitors - performance assessment of PF capacitors - automatic power factor controllers - transformer losses - Electric motors: Types - losses in induction motors - motor efficiency - factors affecting motor performance - rewinding and motor replacement issues - energy saving opportunities with energy efficient motors - soft starters with energy saver - variable speed drives – Fans and blowers: Types - efficient system operation - flow control strategies -Pumps and Pumping System: Types - system operation - flow control methods - Lighting System: Light source, choice of lighting, luminance requirements – ballast - occupancy sensors - energy efficient lighting controls - energy conservation avenues - Case Study.

**TOTAL : 45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10**

1. Study of energy conservation and audit
2. Performance study of Electric Motors.
3. Analysis on fan characteristic curves at different operating points
4. Case study of illumination system
5. Performance analysis of Compressors

**COURSE OUTCOMES:**

Upon completion of the course, students will be able to:

- CO1 Students able to acquire knowledge in the field of energy management and auditing process.
- CO2 Learned the about basic concepts of economic analysis and load management.
- CO3 Able to design the effective thermal utility system.
- CO4 Able to improve the efficiency in compressed air system.
- CO5 Acquired the design concepts in the field of lighting systems, light sources and various forms of cogeneration.

**TEXTBOOKS:**

1. Mehmet Kanoglu, Yunus A Cengel, "Energy Efficiency and Management for Engineers", McGraw-Hill Education, First Edition, 2020.

**REFERENCES:**

1. Moncef Krati, 'Energy Audit of Building Systems: An Engineering Approach', Third Edition, CRC Press, Dec.2020.
2. Sonal Desai, 'Handbook of Energy Audit', McGraw Hill Education (India) Private Limited, 2015.
3. Michael P.Deru, Jim Kelsey, 'Procedures for Commercial Building Energy Audits', American Society of Heating, Refrigerating and Air conditioning Engineers, 2011.
4. Thomas D.Eastop, 'Energy Efficiency: For Engineers and Technologists', Longman Scientific & Technical, 1990, 1<sup>st</sup> Edition.
5. 'Energy Managers and Energy Auditors Guide book', Bureau of Energy Efficiency, 2006.
6. Larry C. Witte, Philip S.Schmidt, David R.Brown, 'Industrial Energy Management and Utilization', Springer Berlin Heidelberg, 1988.

**List of Open Source Software/ Learning website:**

1. <http://lab.fs.uni-lj.si/kes/erasmus/Energy%20Management%20Handbook.pdf>
2. <https://www.sciencedirect.com/science/article/pii/S2212827114004491>
3. [https://mppolytechnic.ac.in/mp-staff/notes\\_upload\\_photo/CS595EnergyEfficiencyinElectricalUtilities-5391.pdf](https://mppolytechnic.ac.in/mp-staff/notes_upload_photo/CS595EnergyEfficiencyinElectricalUtilities-5391.pdf)
4. <http://knowledgeplatform.in/wp-content/uploads/2017/03/1.3-Energy-management-Audit.pdf>

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	2	-	-	-	1	-	-	-	2	3	2	3
CO2	3	-	-	-	-	-	2	1	3	-	1	2	3	2	3
CO3	3	-	1	2	3	-	-	1	-	-	-	2	3	2	3
CO4	3	3	-	-	-	-	-	1	3	-	-	2	3	2	3
CO5	3	-	1	2	-	-	-	1	-	-	2	2	3	2	3
Avg	3	2.5	1	2	3	-	2	1	3	-	1.5	2	3	2	3

**EE3006****POWER QUALITY****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- To learn the basic definitions in Power Quality.
- To study the power quality issues in Single Phase and Three Phase Systems.
- To understand the principles of Power System Harmonics.
- To know the way to use DSTATCOM for Harmonic Mitigation.
- To learn the concepts related with Series Compensation.

**UNIT I****INTRODUCTION****(7+2 Skill) 9**

Introduction – Characterization of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Non-linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.

**UNIT II            ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM            (7+2 Skill) 9**

Single phase linear and non-linear loads – single phase sinusoidal, non-sinusoidal source – supplying linear and nonlinear loads – three phase balanced system – three phase unbalanced system – three phase unbalanced and distorted source supplying non-linear loads – concept of power factor – three phase- three wire – three phase - four wire system.

**UNIT III            MITIGATION OF POWER SYSTEM HARMONICS            (7+2 Skill) 9**

Introduction - Principle of Harmonic Filters – Series-Tuned Filters – Double Band-Pass Filters – damped Filters – Detuned Filters – Active Filters – Power Converters – Harmonic Filter Design – Tuned Filter – Second-Order Damped Filter – Impedance Plots for Filter Banks – Impedance Plots for a Three-Branch 33 kV Filter.

**UNIT IV            LOAD COMPENSATION USING DSTATCOM            (7+2 Skill) 9**

Compensating single – phase loads – Ideal three phase shunt compensator structure – generating reference currents using instantaneous PQ theory – Instantaneous symmetrical components theory – Generating reference currents when the source is unbalanced –Realization and control of DSTATCOM – DSTATCOM in Voltage control mode.

**UNIT V            SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM            (7+2 Skill) 9**

Rectifier supported DVR – DC Capacitor supported DVR – DVR Structure – Voltage Restoration – Series Active Filter – Unified Power Quality Conditioner.

**TOTAL : 45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)            10**

1. Harmonic analysis of single phase power converters (Semi converters and Full Converters) with R and RL load via simulation
2. Harmonic analysis of three phase power converters (Semi converters and Full Converters) with R and RL load via simulation
3. Harmonic analysis of single phase inverters with R and RL load via simulation
4. Harmonic analysis of three phase inverters with R and RL load via simulation
5. Mitigation of Harmonics using Tuned Filter

**List of Open Source Software/ Learning website:**

1. <http://nptel.iitm.ac.in/courses.php>
2. <https://old.amu.ac.in/emp/studym/2442.pdf>
3. <https://electricalacademia.com/electric-power>
4. <https://www.intechopen.com/books/6214>
5. <https://www.cde.com/resources/technical-papers/Mitigation-of-Harmonics.pdf>
6. [https://www.academia.edu/43237017/Use\\_Series\\_Compensation\\_in\\_Distribution\\_Networks\\_33\\_KV](https://www.academia.edu/43237017/Use_Series_Compensation_in_Distribution_Networks_33_KV)

**COURSE OUTCOMES:**

Upon completion of the course, students will be able to:

- CO1 Use various definitions of power quality for power quality issues
- CO2 Describe the concepts related with single phase / three phase, linear / nonlinear loads and single phase / three phase sinusoidal, non-sinusoidal source
- CO3 Solve problems related with mitigation of Power System Harmonics
- CO4 Use DSTATCOM for load compensation
- CO5 Demonstrate the role of DVR, SAFs UPQC in power distribution systems

**TEXTBOOKS:**

1. Arindam Ghosh and Gerard Ledwich “Power Quality Enhancement Using Custom Power Devices”, Kluwer Academic Publishers, First Edition, 2002
2. G.T.Heydt, “Electric Power Quality”, Stars in a Circle Publications, Second Edition, 2011.
3. George J. Wakileh, “Power System Harmonics – Fundamentals, Analysis and Filter Design”, Springer – Verlag Berlin Heidelberg, New York, 2019.

**REFERENCES:**

1. R.C.Duggan “Electric Power Systems Quality”, Tata MC Graw Hill Publishers, Third Edition, 2012.
2. Arrillga “Power System Harmonics”, John Wiley and Sons, 2003 2<sup>nd</sup> Edition.
3. Derek A.Paice “Power Electronic Converter Harmonics” IEEE Press, 1995, Wiley – IEE Press 1999, 18<sup>th</sup> Edition.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	-	3	3	-	3	-	3	3	3	3
CO2	3	3	3	3	-	-	3	3	-	3	-	3	3	3	3
CO3	3	3	3	3	-	-	3	3	-	3	-	3	3	3	3
CO4	3	3	3	3	-	-	3	3	-	3	-	3	3	3	3
CO5	3	3	3	3	-	-	3	3	-	3	-	3	3	3	3
Avg	3	3	3	3	-	-	3	3	-	3	-	3	3	3	3

**COURSE OBJECTIVES:**

- To understand the evolution of Smart and Interconnected energy systems.
- To understand the various challenges and benefits of smart grid and the national and international initiatives taken
- To understand the concepts related with transmission and distribution in smart grid technologies.
- To get an insight of the various smart measurement technologies.
- To understand the various computing technologies for Smart Operation of the Grid.

**UNIT I INTRODUCTION****(7+2 SKILL) 9**

Evolution of Energy Systems, Concept, Definitions and Need, Difference between Conventional & Smart Grid, Drivers, structures, functions, opportunities, challenges and benefits of Smart Grid, Basics of Micro grid, National and International Initiatives in Smart Grid.

**UNIT II SMART METERING****(7+2 SKILL) 9**

Introduction to Advanced Metering infrastructure (AMI) - drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Real time management and control, Phasor Measurement Unit (PMU).

**UNIT III SMART GRID TECHNOLOGIES (Transmission)****(7+2 SKILL) 9**

Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, Wide area Monitoring, Protection and control.

**UNIT IV SMART GRID TECHNOLOGIES (Distribution)****(7+2 SKILL) 9**

DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Electric Vehicles.

**UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS (7+2 SKILL) 9**

Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Computing technologies for Smart Grid applications (Web Service to CLOUD Computing), Role of big data and IoT, Cyber Security for Smart Grid.

**TOTAL: 45 PERIODS****SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content****Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)****10**

1. Assignment-Familiarization of National and International Initiatives in Smart Grid
2. Simulation of smart meter using (MATLAB/ ETAP/SCILAB/ LABVIEW/ Proteus/Equivalent open source software).
3. Visit to a substation for analysing the Automation Technologies like Monitoring, Protection and control.
4. Awareness about High- Efficiency Distribution Transformers, Phase Shifting Transformers in a substation.
5. Introduction to recent technologies in electric vehicles and understanding the operation of EV, HEV and PHEV.
6. Simulation of IoT based digital communication system for smart grid applications.

**COURSE OUTCOMES:**

**After completion the above subject, students will be able to understand**

CO1: To be able to understand the importance and objectives of Power System Grid.

CO2: To be able to know and understand the concept of a smart grid;

CO3: To identify and discuss smart metering devices and associated technologies.

CO4: To be able to get an overview of Microgrid and Electric Vehicle Technology.

CO5: To be able to have an up to date knowledge on the various computing technologies; to understand the role of Big Data and IoT for effective and efficient operation of Smart Grid.

**TEXT BOOKS:**

1. Smart Grids Advanced Technologies and Solutions, Second Edition, Edited by Stuart Borlase, CRC, 2018.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", John Wiley, 2012
3. James Momoh, Smart Grid Fundamentals of Design and Analysis, IEEE press 2012.

**REFERENCES:**

1. Ahmed F. Zobaa, Trevor J. Bihl, Big data analytics in future power systems, 1st Edition, CRC press 2018.
2. C. Gungor et al., "Smart Grid Technologies: Communication Technologies and Standards," in IEEE Transactions on Industrial Informatics, vol. 7, no. 4, pp. 529-539, Nov. 2011. doi: 10.1109/TII.2011.2166794.
3. X. Fang, S. Misra, G. Xue and D. Yang, "Smart Grid — The New and Improved Power Grid: A Survey," in IEEE Communications Surveys & Tutorials, vol. 14, no. 4, pp. 944-980, Fourth Quarter 2012. doi: 10.1109/SURV.2011.101911.00087.
4. Stuart Borlase "Smart Grid : Infrastructure, Technology and Solutions", CRC Press 2012.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	2	3	3	-	-	1	-	-	-	2	3	3	-
CO2	3	3	2	3	3	-	-	1	-	-	-	2	3	3	-
CO3	3	3	2	3	3	-	-	1	-	-	-	2	3	3	-
CO4	3	3	2	3	3	-	-	1	-	-	-	2	3	3	-
CO5	3	3	2	3	3	-	-	1	-	-	-	2	3	3	-
Avg	3	3	2	3	3	-	-	1	-	-	-	2	3	3	-

**COURSE OBJECTIVES:**

Students will be able to:

- Describe various types of deregulated markets in power system.
- Describe the technical and non-technical issues in deregulated power industry.
- Classify different market mechanisms and summarize the role of various entities in the market.
- Analyze the energy and ancillary services management in deregulated power industry.
- Understand the restructuring framework US and Indian power sector

**UNIT I INTRODUCTION (7+2 SKILL) 9**

Reasons for restructuring - Understanding the restructuring process - objectives of deregulation of various power systems across the world - Consumer behavior - Supplier behavior - Market equilibrium - Short-run and Long-run costs - Various costs of production. The Philosophy of Market Models: Market models based on contractual arrangements - Market architecture .

**UNIT II TRANSMISSION CONGESTION MANAGEMENT (7+2 SKILL) 9**

Importance of congestion management in deregulated environment - Classification of congestion management methods - Calculation of ATC - Non-market methods - Market based methods - Nodal pricing - Inter-zonal Intra-zonal congestion management - Price area congestion management - Capacity alleviation method.

**UNIT III LOCATIONAL MARGINAL PRICES(LMP) AND FINANCIAL TRANSMISSION RIGHTS (7+2 SKILL) 9**

Fundamentals of locational marginal pricing - Lossless DCOPF model for LMP calculation - Loss compensated DCOPF model for LMP calculation - ACOPF model for LMP calculation - Risk Hedging Functionality Of financial Transmission Rights - FTR issuance process - Treatment of revenue shortfall - Secondary trading of FTRs - Flow Gate rights - FTR and market power.

**UNIT IV ANCILLARY SERVICE MANAGEMENT AND PRICING OF TRANSMISSION NETWORK (7+2 SKILL) 9**

Types of ancillary services - Load-generation balancing related services - Voltage control and reactive power support services - Black start capability service - Mandatory provision of ancillary services - Markets for ancillary services - Co-optimization of energy and reserve services - International comparison. Pricing of transmission network: wheeling - principles of transmission pricing - transmission pricing methods - Marginal transmission pricing paradigm - Composite pricing paradigm - loss allocation methods.

**UNIT V MARKET EVOLUTION (7+2 SKILL) 9**

US markets: PJM market - The Nordic power market - Reforms in Indian power sector: Framework of Indian power sector - Reform initiatives - availability based tariff (ABT) - The Electricity Act 2012 - Open Access issues - Power exchange.

**TOTAL: 45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc) 10**

1. Analysis of ATC calculations using any one of the relevant software tool.
2. DCOPF based LMP calculations using any one of the relevant software tool.
3. ACOPF based LMP calculations using any one of the relevant software tool.
4. Analysis of social welfare maximization with different objectives.
5. Analysis of ABT components.

**COURSE OUTCOMES:**

Students will be able to:

- CO1: describe the requirement for deregulation of the electricity market and the philosophy of various market models
- CO2: analyze the various methods of congestion management in deregulated power system
- CO3: analyze the locational marginal pricing and financial transmission rights
- CO4: analyze the ancillary service management
- CO5: analyze transmission pricing paradigm
- CO6: understand the evolution of deregulation in Indian power sector

**TEXT BOOKS:**

1. Mohammad Shahidehpour, Muwaffaq Alomoush, "Restructured electrical power systems: operation, trading and volatility" Marcel Dekker Pub., 2001, 1<sup>st</sup> Edition.
2. Kankar Bhattacharya, MathH.J.Boolen, and Jaap E.Daadler, "Operation of restructured power systems", Kluwer Academic Pub.,2001, 1<sup>st</sup> Edition.

**REFERENCES:**

1. Sally Hunt, "Making competition work in electricity", JohnWiley and Sons Inc. 2002.
2. Steven Stoft, Power System Economics: Designing Markets for Electricity", Wiley-IEEE Press, 2002.
3. Allen. J. Wood and Bruce F. Wollen berg, 'Power Generation, Operation and Control', John Wiley & Sons, Inc., 2016, 3<sup>rd</sup> Edition.

**List of Open Source Software/ Learning website:**

1. S.A. Khaparde, A.R. Abhyankar, "Restructured Power Systems", NPTEL Course, <https://nptel.ac.in/courses/108101005/>.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	3	2	-	-	-	-	-	2	-	2
CO2	3	2	1	-	-	3	-	-	-	-	2	-	2	-	2
CO3	3	2	1	-	-	3	-	-	-	-	2	-	2	-	2
CO4	3	2	1	-	-	3	-	-	-	-	2	-	2	-	2
CO5	3	2	1	-	-	3	-	-	-	-	2	-	2	-	2
CO6	3	-	-	-	-	3	2	1	-	-	2	1	-	-	-
Avg	3	2	1	-	-	3	2	1	-	-	2	1	2	-	2





CO2 Ability to optimally design magnetics required in special machines based drive systems using FEM based software tools.

CO3 Ability to analyse the dynamic performance of special electrical machines

CO4 Ability to understand the operation and characteristics of other special electrical machines.

CO5 Ability to design and conduct experiments towards research.

#### REFERENCES:

- 1.Jacek F. Gieras, Dr. Rong-Jie Wang, Professor Maarten J. Kamper - Axial Flux Permanent Magnet Brushless Machines-Springer Netherlands 2008.
- 2.Bilgin, Berker Emadi, Ali Jiang, James Weisheng - Switched reluctance motor drives: fundamentals to applications-CRC 2019.
- 3.Ramu Krishnan - Permanent Magnet Synchronous and Brushless DC Motor Drives -CRC Press, Marcel Applications -CRC Press 2009
- 6.T.Kenjo, 'Stepping motors and their microprocessor controls', Oxford University press, New Delhi, 2000 Dekker 2009
- 4.T.J.E. Miller, 'Brushless magnet and Reluctance motor drives', Clarendon press, London, 1989
- 5.R. Krishnan - Switched Reluctance Motor Drives Modeling, Simulation, Analysis, Design, and Applications -CRC Press 2017.

#### MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	1	-	1	-	1	3	2	1
CO2	3	3	3	3	-	-	2	1	-	2	-	3	3	3	3
CO3	3	-	-	-	-	-	-	1	-	1	-	1	3	3	3
CO4	3	3	3	3	-	-	-	1	-	3	-	3	3	3	3
CO5	3	3	3	3	-	-	3	1	-	3	-	3	3	3	3
CO6	3	3	3	3	3	-	-	1	-	3	-	3	3	3	3
Avg	3	3	3	3	3	-	2.5	1	-	2.2	-	2.3	3	2.8	2.6

EE3010

ANALYSIS OF ELECTRICAL MACHINES

LT P C

2 0 2 3

#### COURSE OBJECTIVES:

- To model & simulate all types of DC machines
- To develop reference frame equations for various elements like R, L and C
- To model an induction (three phase and 'n' phase) and synchronous machine
- To derive reference frame equations for induction and synchronous machine
- To study the need and working of multiphase induction and synchronous machine

#### UNIT I

#### MODELING OF BRUSHED-DC ELECTRIC MACHINERY

6

Fundamentals of Operation – Introduction – Governing equations and modeling of Brushed DC-Motor – Shunt, Series and Compound – State model derivation – Construction of Model of a DC Machine using state equations- Shunt, Series and Compound..

**UNIT II REFERENCE FRAME THEORY 6**

Historical background – phase transformation and commutator transformation – transformation of variables from stationary to arbitrary reference frame .

**UNIT III INDUCTION MACHINES 6**

Three phase induction machine - equivalent circuit– free acceleration characteristics – voltage and torque equations in machine variables and arbitrary reference frame variables – Simulation under no-load and load conditions- Machine variable form, arbitrary reference variable form.

**UNIT IV SYNCHRONOUS MACHINES 6**

Three phase synchronous machine - voltage and torque equations in machine variables and rotor reference frame variables (Park's equations).

**UNIT V MULTIPHASE (MORE THAN THREE-PHASE) MACHINES CONCEPTS 6**

Preliminary Remarks - Necessity of Multiphase Machines - Evolution of Multiphase Machines- Advantages of Multiphase Machines - Working Principle - Multiphase Induction Machine, Multiphase Synchronous Machine -Modeling of 'n' phase machine. Applications of Multiphase Machines

**30 PERIODS**

**LAB COMPONENT:**

**30 PERIODS**

1. Modeling of DC machines.
2. Simulation under no-load and loaded conditions for a PMDC motor
3. Simulation of smooth starting for DC motor.
4. Simulation under no-load and load conditions of a three phase induction machine in machine variable form and arbitrary reference variable form.
5. Simulation under no-load and load conditions of a three phase synchronous machine in machine variable form and arbitrary reference variable form.

**TOTAL: 30+30 = 60 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, students should be able to:

- CO1: Find the modeling for a brushed DC-Motor (Shunt, Series, Compound and separately excited motor) and to simulate DC motors using state models
- CO2: Apply reference frame theory for, resistive and reactive elements (three phase)
- CO3: Compute the equivalent circuit and torque of three phase induction motor and synchronous motor in machine variable arbitrary reference frame variable
- CO4: Find the need and advantages of multiphase machines
- CO5: Demonstrate the working of multiphase induction and synchronous machine.
- CO6: Compute the model of three phase and multiphase induction and synchronous machine.

**REFERENCES:**

1. Stephen D. Umans, "Fitzgerald & Kingsley's Electric Machinery", Tata McGraw Hill, 7<sup>th</sup> Edition, 2020.
2. Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011, 1<sup>st</sup> Edition.
3. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek, "Analysis of Electric Machinery and Drive Systems", 3<sup>rd</sup> Edition, Wiley-IEEE Press, 2013.
4. R. Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Pearson Education, 1<sup>st</sup> Imprint, 2015, 1<sup>st</sup> Edition.
5. R.Ramanujam, Modeling and Analysis of Electrical Machines, I.k.International Publishing House Pvt.Ltd,2018.
6. Chee Mun Ong, Dynamic Simulation of Electric Machinery using MATLAB, Prentice Hall, 1997,

1<sup>st</sup> Edition.

7. Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK, Wiley, 2021, 1<sup>st</sup> Edition

### MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	2	1	-	3	-	2	3	3	3
CO2	3	3	3	3	3	-	2	1	-	3	-	2	3	3	3
CO3	3	3	3	3	3	-	2	1	-	3	-	2	3	3	3
CO4	3	-	-	-	3	-	2	1	-	3	-	2	3	3	3
CO5	3	-	-	-	3	-	2	1	-	3	-	2	3	3	3
CO6	3	3	3	3	3	-	2	1	-	3	-	2	3	3	3
Avg	3	3	3	3	3	-	2	1	-	3	-	2	3	3	3

<b>EE3011</b>	<b>MULTILEVEL POWER CONVERTERS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>2</b>	<b>0</b>	<b>2</b>	<b>3</b>

#### COURSE OBJECTIVES:

- To learn multilevel topology (Symmetry & Asymmetry) with common DC bus link.
- To study the working of cascaded H Bridge, Diode Clamped and Flying Capacitor MLI.
- To study the working of MLI with reduced switch count.
- To simulate three level diode clamped MLI and three level flying capacitor based MLI with resistive and reactive load
- To simulate the MLI with reduced switch count.

#### **UNIT I                  MULTILEVEL TOPOLOGIES    6**

Introduction – Generalized Topology with a Common DC bus – Converters derived from the generalized topology – symmetric topology without a common DC link – Asymmetric topology.

#### **UNIT II                  CASCADED H-BRIDGE MULTILEVEL INVERTERS    6**

Introduction -H-Bridge Inverter, Bipolar Pulse Width Modulation, Unipolar Pulse Width Modulation. Multilevel Inverter Topologies, CHB Inverter with Equal DC Voltage, H-Bridges with Unequal DC Voltages – PWM, Carrier-Based PWM Schemes, Phase-Shifted Multicarrier Modulation, Level-Shifted Multicarrier Modulation, Comparison Between Phase- and Level-Shifted PWM Schemes- Staircase Modulation

#### **UNIT III                  DIODE CLAMPED MULTILEVEL CONVERTER    6**

Introduction – Converter structure and Functional Description – Modulation of Multilevel converters – Voltage balance Control – Effectiveness Boundary of voltage balancing in DCMC converters – Performance results.

#### **UNIT IV                  FLYING CAPACITOR MULTILEVEL CONVERTER    6**

Introduction – Flying Capacitor topology – Modulation scheme for the FCMC – Dynamic voltage balance of FCMC.

**UNIT V MULTILEVEL CONVERTER WITH REDUCED SWITCH COUNT****6**

Multilevel inverter with reduced switch count-structures, working principles and pulse generation methods.

**30 PERIODS****LAB COMPONENT:****30 PERIODS**

1. Simulation of Fixed PWM, Sinusoidal PWM for an inverter,
2. Simulation of H bridge inverter with R load .
3. Simulation of three level diode clamped MLI with R load.
4. Simulation of three level capacitor clamped MLI with R load
5. Simulation of MLI with reduced switch configuration.

**TOTAL: 30+30 = 60 PERIODS****COURSE OUTCOMES:**

At the end of the course, students should be able to:

- CO1: Examine the different topologies of multilevel inverters (MLIs) with and without DC link capacitor.
- CO2: Examine the performance of MLIs with Bipolar Pulse Width Modulation (PWM) Unipolar PWM Carrier-Based PWM Schemes Phase Level Shifted Multicarrier Modulation
- CO3: Demonstrate the working principles of Cascaded H-Bridge MLI, diode clamped MLI, flying capacitor MLI and MLI with reduced switch count
- CO4: Analyze the voltage balancing performance in Diode clamped MLI.
- CO5: Simulate three level, capacitor clamped and diode clamped MLI with R and RL load.
- CO6: Simulate MLI with reduced switch configuration using fundamental switching scheme

**TEXT BOOKS:**

1. Rashid M.H,"Power Electronics Circuits, Devices and Applications", Prentice Hall India, Third Edition, New Delhi, 2014 Pearson 4<sup>th</sup> edition.
2. Sergio Alberto Gonzalez, Santiago Andres Verne, Maria Ines Valla,"Multilevel Converters for Industrial Applications", CRC Press, 22-Jul-2013, 2017 1<sup>st</sup> Edition.
3. BinWu, Mehdi Narimani,High Power Converters and AC drives by IEEE press 2017, 2<sup>nd</sup> Edition.

**REFERENCEBOOKS:**

1. Thomas A. Lipo, Pulse Width Modulation for Power Converters: Principles and Practice, D.Grahame Holmes, John Wiley & Sons, Oct-2003, 1<sup>st</sup> Edition.
2. Fang Lin Luo, Hong Ye,Advanced DC/AC Inverters: Applications in Renewable Energy, CRC Press, 22-Jan-2013, 2017, 1<sup>st</sup> Edition.
3. Hani Vahedi, Mohamed Trabelsi, Single-DC-Source Multilevel Inverters, Springer, 2019, 1<sup>st</sup> Edition.
4. Ersan Kabalcı, Multilevel Inverters Introduction and Emergent Topologies, Academic Press Inc,2021, 1<sup>st</sup> Edition.
5. Iftekhhar Maswood, Dehghani Tafti,Advanced Multilevel Converters and Applications in Grid Integration, Wiley, 2018, 1<sup>st</sup> Edition.

## MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3	-	-	2	1	-	3	-	3	3	3	3
CO2	3	2	2	3	-	-	2	1	-	3	-	3	3	3	3
CO3	3	2	2	3	-	-	2	1	-	3	-	3	3	3	3
CO4	3	3	3	3	-	-	2	1	-	3	-	3	3	3	3
CO5	3	3	3	3	3	-	2	1	-	3	-	3	3	3	3
CO6	3	3	3	3	3	-	2	1	-	3	-	3	3	3	3
Avg	3	2.5	2.5	3	3	-	2	1	-	3	-	3	3	3	3

EE3012

**ELECTRICAL DRIVES**

**L T P C**  
**2 0 2 3**

**COURSE OBJECTIVES:**

At the end of the course, students should have the:

- To understand steady state operation and transient dynamics of a motor load system.
- To study and analyze the operation of the converter / chopper fed dc drive, both qualitatively and quantitatively.
- To study and understand the operation and performance of AC Induction motor drives.
- To study and understand the operation and performance of AC Synchronous motor drives.
- To analyze and design the current and speed controllers for a closed loop solid state DC motor drives.

**UNIT I DRIVE CHARACTERISTICS 6**

Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, starting & stopping – typical load torque characteristics – Selection of motor.

**UNIT II CONVERTER / CHOPPER FED DC MOTOR DRIVE 6**

Steady state analysis of the single and three phase converter fed separately excited DC motor drive – continuous and discontinuous conduction – Time ratio and current limit control – 4 quadrant operation of converter / chopper fed drive.

**UNIT III INDUCTION MOTOR DRIVES 6**

Stator voltage control – energy efficient drive – v/f control – constant air gap flux – field weakening mode – voltage / current fed inverter – closed loop control,

**UNIT IV SYNCHRONOUS MOTOR DRIVES 6**

V/f control and self-control of synchronous motor: Margin angle control and power factor control – permanent magnet synchronous motor.

**UNIT V DESIGN OF CONTROLLERS FOR DRIVES****6**

Transfer function for DC motor / load and converter – closed loop control with current and speed feedback – armature voltage control and field weakening mode – design of controllers; current controller and speed controller-converter selection and characteristics.

**30 PERIODS****LAB COMPONENT:****30 PERIODS**

1. Simulation of converter and chopper fed DC drive
2. Simulation of closed loop operation of stator voltage control of induction motor drive
3. Simulation of closed loop operation of v/f control of induction motor drive
4. Simulation of synchronous motor drive

**TOTAL: 30+30 = 60 PERIODS****COURSE OUTCOMES:**

After completion the above subject, students will be able to

CO1: Understand the basic requirements of motor selection for different load profiles.

CO2: Analyse the steady state behavior and stability aspects of drive systems.

CO3: Analyse the dynamic performance of the DC drive using converter and chopper control.

CO4: Simulate the AC drive.

CO5: Design the controller for electrical drives.

**TEXTBOOKS:**

1. Gopal K.Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, 2<sup>nd</sup> Edition January 2010.
2. Bimal K.Bose. Modern Power Electronics and AC Drives, Pearson Education, 2002 1<sup>st</sup> Edition.

**REFERENCES:**

1. S.K.Pillai, A First course on Electrical Drives, Wiley Eastern Limited, 3<sup>rd</sup> Edition 2012.
2. Murphy J.M.D and Turnbull, Thyristor Control of AC Motor, Pergamon Press, Oxford 1988, 1<sup>st</sup> Edition.
3. Gopal K.Dubey, Power semiconductor controlled Drives, Prentice Hall Inc., New Jersey, 1989, 1<sup>st</sup> Edition.
4. R.Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Prentice hall of India, 2001, 1<sup>st</sup> Edition.

PROGRESS THROUGH KNOWLEDGE  
**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3	3	-	-	1	-	-	-	2	3	3	2
CO2	3	2	2	3	3	-	-	1	-	-	-	2	3	3	2
CO3	3	2	2	3	3	-	-	1	-	-	-	2	3	3	3
CO4	3	2	2	3	3	-	-	1	-	-	-	2	3	3	3
CO5	3	2	2	3	3	-	-	1	-	-	-	2	3	3	3
CO6	3	2	2	3	3	-	-	1	-	-	-	2	3	3	3
Avg	3	2	2	3	3	-	-	1	-	-	-	2	3	3	2

**COURSE OBJECTIVES:**

- To learn the working of isolated & non-isolated DC-DC converters
- To design isolated & non-isolated DC-DC converters.
- To derive the equations related with converter dynamics.
- To design and simulate P, PI & PID controller for buck, boost and buck-boost converters.
- To identify and study different configurations of the UPS.

**UNIT I ANALYSIS OF NON-ISOLATED DC-DC CONVERTERS 6**

Basic topologies: Buck, Boost and Buck-Boost - Principles of operation – Continuous conduction mode– Concepts of volt-sec balance and charge balance – Analysis and design based on steady-state relationships – Introduction to discontinuous conduction mode.

**UNIT II ANALYSIS OF ISOLATED DC-DC CONVERTERS 6**

Introduction - classification- forward- flyback- pushpull – half bridge – full bridge topologies- C'uk converter as cascade combination of boost followed by buck – isolated version of C'uk converter - design of SMPS – Introduction to design of magnetic components for SMPS, using relevant software- Simulation of bidirectional DC DC converter (both non-isolated and isolated) considering EV as an example application.

**UNIT III CONVERTER DYNAMICS 6**

AC equivalent circuit analysis – State space averaging – Circuit averaging – Transfer function model for buck, boost and buck-boost converters – Simulation of basic topologies using state space model derived – Comparison with the circuit model based simulation already carried out.

**UNIT IV CONTROLLER DESIGN 6**

Review of P, PI, and PID control concepts – gain margin and phase margin – Bode plot based analysis – Design of controller for buck, boost and buck-boost converters.

**UNIT V POWER CONDITIONERS AND UPS 6**

Introduction – Power line disturbances – Power conditioners – UPS: Offline and On-line – Need for filters – Filter for PWM VSI – Front-end battery charger – boost charger.

**30 PERIODS****LAB COMPONENT: 30 PERIODS**

1. Simulation of Basic topologies.
2. Simulation of bidirectional DC DC converter (both non-isolated and isolated) considering EV as an example application.
3. Simulation of basic topologies using state space model derived – Comparison with the circuit model based simulation already carried out.
4. Simulation study of controller design for basic topologies.
5. Simulation of battery charger for EV applications.



**TOTAL: 30+30 = 60 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, students should have the following capabilities:

- CO1: Demonstrate the working of buck boost and buck- boost converters in continuous and discontinuous conduction mode.
- CO2: Build buck/boost converters using suitable design method.
- CO3: Analyze the behaviors of isolated DC-DC converters and to design SMPS for battery operated vehicle.
- CO4: Compute state space averaged model and transfer function for buck, boost and buck-boost converters.
- CO5: Demonstrate the P, PI and PID controller performance analytically and by simulation for buck boost and buck- boost converters.
- CO6: Compare the different topologies of UPS and also simulate them.

**TEXT BOOKS:**

1. Robert W. Erickson & Dragon Maksimovic, " Fundamentals of Power Electronics", Third Edition, 2020
2. Ned Mohan," Power Electronics: A First Course", Johnwiley, 2013.
3. Marian K. Kazimierczuk and Agasthya Ayachit,"Laboratory Manual for Pulse-Width Modulated DC– DC Power Converters", Wiley 2016.
4. Power Electronics handbook, Industrial Electronics series, S.K.Varenina, CRC press, 2002.
5. Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, First Edition 2017.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	-	3	3	-	2	-	3	3	3	3
CO2	3	3	3	3	-	-	3	3	-	2	-	3	3	3	3
CO3	3	3	3	3	-	-	3	-	-	3	-	3	3	3	3
CO4	3	3	3	3	-	-	-	-	-	2	-	3	3	3	3
CO5	3	3	3	3	-	-	3	3	-	3	-	3	3	3	3
CO6	3	3	3	3	-	-	3	3	-	3	-	3	3	3	3
Avg	3	3	3	3	-	-	3	3	-	2.5	-	3	3	3	3

PROGRESS THROUGH KNOWLEDGE

EE3014

**POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS**

**L T P C  
2 0 2 3**

**COURSE OBJECTIVES:**

- To learn the various types of renewable sources of energy.
- To understand the electrical machines to be used for wind energy conversion systems.
- To learn the principles of power converters used in solar PV system.
- To study the principle of power converters used in Wind system.
- To simulate the AC-DC, AC-AC Converters, Matrix Converters and PWM Inverters.

**UNIT I INTRODUCTION TO RENEWABLE ENERGY SYSTEMS 6**

Classification of Energy Sources – Importance of Non-conventional energy sources – Advantages and disadvantages of conventional energy sources - Environmental aspects of energy - Impacts of renewable energy generation on the environment - Qualitative study of renewable energy resources: Ocean energy, Biomass energy, Hydrogen energy, - Solar Photovoltaic (PV), Fuel cells: Operating principles and characteristics, Wind Energy: Nature of wind, Types, control strategy, operating area.

**UNIT II ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEMS (WECS) 6**

Construction, Principle of operation and analysis: Squirrel Cage Induction Generator (SCIG), Doubly Fed Induction Generator (DFIG) - Permanent Magnet Synchronous Generator (PMSG).

**UNIT III POWER CONVERTERS AND ANALYSIS OF SOLAR PV SYSTEMS 6**

Power Converters: Line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing. Simulation of line commutated converters, buck/boost converters. Analysis: Block diagram of the solar PV systems - Types of Solar PV systems: Stand-alone PV systems, Grid integrated solar PV Systems - Grid Connection Issues.

**UNIT IV POWER CONVERTERS FOR WIND SYSTEMS 6**

Power Converters: Three-phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid-Interactive Inverters - Matrix converter.

**UNIT V HYBRID RENEWABLE ENERGY SYSTEMS 9**

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Diesel-PV, Wind-PV, Micro hydel-PV, Biomass-Diesel systems - Maximum Power Point Tracking (MPPT).

**30 PERIODS**

**LAB COMPONENT:**

**30 PERIODS**

1. Simulation on modelling of Solar PV System- V I Characteristics
2. Simulation on Modelling of fuel cell- V I Characteristics
3. Simulation of self- excited Induction Generator.
4. Simulation of DFIG/ PMSG based Wind turbine.
5. Simulation on Grid integration of RES.

**TOTAL: 30+30 = 60 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, students should be able to:

CO1: Examine the available renewable energy sources.

CO2: Demonstrate the working principles of electrical machines and power converters used for wind energy conversion system

CO3: Demonstrate the principles of power converters used for solar PV systems

CO4: Examine the available hybrid renewable energy systems.

CO5: Simulate AC-DC converters, buck/boost converters, AC-AC converters and PWM inverters.

**REFERENCES:**

1. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford University Press, 2009, 7<sup>th</sup> impression.
2. Rashid .M. H "Power electronics Hand book", Academic press, 2<sup>nd</sup> Edition, 2006 4<sup>th</sup> Edition, 2017
3. Rai. G.D, "Non-conventional energy sources", Khanna publishers, 6<sup>th</sup> Edition, 2017.

- Rai. G.D, "Solar energy utilization", Khanna publishers, 5<sup>th</sup> Edition, 2008.
- Gray, L. Johnson, "Wind energy system", prentice hall of india, 2<sup>nd</sup> Edition, 2006.
- H.Khan "Non-conventional Energy sources ",Tata McGraw-hill Publishing Company, New Delhi, 2017, 3<sup>rd</sup> Edition.

### MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	2	-	-	-	-	-	-	2	-	2	3	3	3
CO2	3	-	2	-	-	-	-	-	-	2	-	2	3	3	3
CO3	3	-	2	-	-	-	-	-	-	2	-	2	3	3	3
CO4	3	-	3	-	-	-	-	-	-	2	-	2	3	3	3
CO5	3	3	2.25	3	3	-	-	3	-	2	-	3	3	3	3
Avg	3	3	2	3	3	-	-	3	-	2	-	2.2	3	3	3

**EE3015 CONTROL OF POWER ELECTRONICS CIRCUITS L T P C**  
**2 0 2 3**

#### COURSE OBJECTIVES:

- To learn the basics of control system simulation.
- To do symbolic calculation.
- To study the principles of sliding mode control and the way of apply smc for buck converter.
- To learn the concept of power factor correction.
- To design simulate smc for buck converter and power factor correction circuit with controller.

#### UNIT I SIMULATION BASICS IN CONTROL SYSTEMS 6

Transfer Function-How to build transfer function, identify Poles, zeros, draw time response plots, bode plot (Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double Differentiation Functions, Single Pole and Single Zero Functions, RHP Pole and RHP Zero Functions), state space modelling-transfer function from state space Model.

#### UNIT II SYMBOLIC CALCULATIONS 6

Symbolic Variables - Symbolic Vector Variables, Commands for Handling Polynomial Expressions - Extracting Parts of a Polynomial -. Factorization and Roots of Polynomials, Symbolic Matrix Algebra - Operations with Symbolic Matrices - Other Symbolic Matrix Operations.

#### UNIT III SLIDING MODE CONTROL BASICS 6

Introduction- Introduction to Sliding-Mode Control- Basics of Sliding-Mode Theory- Application of Sliding-Mode Control to DC-DC Converters—Principle-Sliding mode control of buck converter.

#### UNIT IV POWER FACTOR CORRECTION CIRCUITS 6

Introduction, Operating Principle of Single-Phase PFCs, Control of boost converter based PFCs, Designing the Inner Average-Current-Control Loop, Designing the Outer Voltage-Control Loop, Example of Single-Phase PFC Systems.

**UNIT V CONTROLLER DESIGN FOR PFC CIRCUITS****6**

Power factor correction circuit using other SMPS topologies: C'uk and SEPIC converter - PFC circuits employing bridgeless topologies.

**30 PERIODS****LAB COMPONENT:****30 PERIODS**

1. Simulation exercises on zero, first and second order basic blocks.
2. Simulation exercises based on symbolic calculations.
3. Simulation of Sliding mode control based buck converter.
4. Simulation of Single-Phase PFC circuit employing boost converter.
5. Simulation of Single-Phase PFC circuit employing C'uk converters.

**TOTAL: 30+30 = 60 PERIODS****COURSE OUTCOMES:**

At the end of the course, students should have the:

- CO1: To calculate transfer function for constant, differential, integral, First order and Second order factors.
- CO2: To illustrate the effect of poles and zero's in the 's' plane.
- CO3: To select Symbolic equations for solving problems related with Matrices, Polynomial and vectors.
- CO4: To compute the control expression for DC – DC buck converter using sliding mode control theory.
- CO5: To determine the controller expression for power factor correction circuits.
- CO6: To simulate sliding mode control of buck converter and power factor correction circuit.

**TEXT BOOKS:**

1. Feedback Control problems using MATLAB and the Control system tool box By Dean Frederick and Joe Chow, 2000, 1<sup>st</sup> Edition, Cengage Learning.
2. Ned Mohan, "Power Electronics: A First Course", Johnwiley, 2013, 1<sup>st</sup> Edition.
3. Marian K. Kazimierczuk and AgasthyaAyachit, "Laboratory Manual for Pulse-Width Modulated DC-DC Power Converters", Wiley 2016, 1<sup>st</sup> Edition.
4. Power Electronics handbook, Industrial Electronics series, S.K.Varenina, CRC press, 2002, 1<sup>st</sup> Edition.

**REFERENCES:**

1. Sliding mode control for Switching Power Converters:, Techniques and Implementation, Slew-Chong Tan, Yuk Ming Lai Chi-Kong Tse, 1<sup>st</sup> Edition, CRC Press.
2. Andre Kislovski, "Dynamic Analysis of Switching-Mode DC/DC Converters", Springer 1991.
3. MATLAB Symbolic Algebra and Calculus Tools, Lopez Cesar, Apress, 2014.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	1	-	2	-	3	3	3	3
CO2	3	3	3	3	3	-	-	1	-	2	-	3	3	3	3
CO3	3	3	3	3	3	-	-	1	-	2	-	3	3	3	3
CO4	3	3	3	3	3	-	-	1	-	2	-	3	3	3	3
CO5	3	3	3	3	3	-	-	1	-	2	-	3	3	3	3
CO6	3	3	3	3	3	-	-	1	-	2	-	3	3	3	3
Avg	3	3	3	3	3	-	-	1	-	2	-	3	3	3	3

## VERTICAL III : EMBEDDED SYSTEMS

EE3016

**EMBEDDED SYSTEM DESIGN**

**L T P C  
2 0 2 3**

**COURSE OBJECTIVES:**

- To introduce the Building Blocks of an embedded System and Software Tools
- To emphasize the role of Input/output interfacing with Bus Communication protocol.
- To illustrate the ISR and scheduling for the multitasking process.
- To explain the basics of a Real-time operating system
- To analyze the applications based on embedded design approaches

**UNIT I INTRODUCTION TO EMBEDDED SYSTEMS 6**  
Introduction to Embedded Systems –Structural units in Embedded processor, selection of processor & memory devices- DMA — Memory management methods- Timer and Counting devices, Real Time Clock, In-circuit emulator, Target Hardware Debugging.

**UNIT II EMBEDDED NETWORKING 6**  
Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols RS232 standard – RS485 – CAN Bus- Serial Peripheral Interface (SPI) – Inter-Integrated Circuits (I<sup>2</sup>C).

**UNIT III INTERRUPTS THE SERVICE MECHANISM AND DEVICE DRIVER 6**  
Programmed-I/O busy-wait approach without interrupt service mechanism-ISR concept-interrupt sources – multiple interrupts – context and periods for context switching, interrupt latency and deadline – Introduction to Device Drivers.

**UNIT IV RTOS-BASED EMBEDDED SYSTEM DESIGN 6**  
Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communication- shared memory, message passing- Interprocess Communication- Introduction to process synchronization using semaphores.

**UNIT V EMBEDDED SYSTEM APPLICATION DEVELOPMENT 6**  
Embedded Product Development Life Cycle - Case Study: Precision Agriculture- Autonomous car.  
**30 PERIODS**

**LAB COMPONENT: 30 PERIODS**

1. Laboratory exercise: Use any Embedded processor/IDE/open source platform to give hands-on training on basic concepts of embedded system design:
  - a) Introduction to IDE and Programming Environment.
  - b) Configure timer block for signal generation (with given frequency).
  - c) Interrupts programming example using GPIO.
  - d) I<sup>2</sup>C communication with peripherals
  - e) Master-slave communication between processors using SPI.
  - f) Networking of processor using Wi-Fi.
  - g) Basic RTOS concept and programming

2. Assignment: Introduction to VxWorks,  $\mu$ C/OS-II, RT Linux
3. Embedded systems-based Mini project.

**TOTAL: 30+30 = 60 PERIODS**

### COURSE OUTCOMES:

**After completion of the above subject, students will be able to understand**

- CO1: The hardware functionals and software strategies required to develop various Embedded systems
- CO2: The basic differences between various Bus communication standards
- CO3: The incorporation of the interface as Interrupt services
- CO4: The various scheduling algorithms through a Real-time operating system.
- CO5: The various embedded concepts for developing automation applications.

### TEXTBOOKS:

1. Rajkamal, 'Embedded system-Architecture, Programming, Design, McGraw-Hill Edu, 3<sup>rd</sup> edition 2017
2. Peckol, "Embedded system Design", John Wiley & Sons, 2010.

### REFERENCES:

1. Shibu. K.V, "Introduction to Embedded Systems", TataMcgraw Hill, 2<sup>nd</sup> edition 2017.
2. Lya B.Das, "Embedded Systems", Pearson Education, 1<sup>st</sup> edition 2012.
3. Parag H.Dave, Himanshu B.Dave, "Embedded Systems-Concepts, Design and Programming, Pearson Education, 2015, 1<sup>st</sup> edition.
4. Elicia White, "Making Embedded systems", O'Reilly Series, SPD, 2011, 1<sup>st</sup> edition.
5. Jonathan W. Valvano, 'Embedded Microcomputer Systems Real-time Interfacing', Cengage Learning, 3<sup>rd</sup> edition 2010.
6. Tammy Noergaard, "Embedded Systems Architecture", Newnes, 2<sup>nd</sup> edition, 2013.

### List of Open Source Software/ Learning websites:

1. <https://nptel.ac.in/courses/108102045>
2. [https://ece.uwaterloo.ca/~dwharder/icsrts/Lecture materials/A practical introduction to real-time systems for undergraduate engineering.pdf](https://ece.uwaterloo.ca/~dwharder/icsrts/Lecture%20materials/A%20practical%20introduction%20to%20real-time%20systems%20for%20undergraduate%20engineering.pdf)
3. <https://www.circuitbasics.com/basics-of-the-i2c-communication-protocol/>
4. [https://www.tutorialspoint.com/embedded\\_systems/es\\_interrupts.htm](https://www.tutorialspoint.com/embedded_systems/es_interrupts.htm)
5. <https://www.theengineeringprojects.com/2016/11/examples-of-embedded-systems.html#:~:text=Embedded%20Product%3A%20Automatic%20Washing%20Machine,done%20by%20your%20machine%20itself.>

### MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	-	-	-	-	-	-	-	2	2	3
CO2	3	2	3	2	1	-	-	-	-	-	-	-	2	1	3
CO3	3	3	2	3	1	-	-	-	-	-	-	-	2	1	2
CO4	3	2	2	2	1	-	-	-	-	-	-	-	1	2	3
CO5	3	2	1	2	1	-	-	-	1	-	-	-	3	1	2
Avg	3	2.2	2	2.2	1	-	-	-	1	-	-	-	2	1.4	2.6

**COURSE OBJECTIVES:**

- To expose the students to the fundamentals of embedded Programming
- To Introduce the GNU C Programming Tool Chain.
- To study the basic concepts of embedded C.
- To teach the basics of 8051 Programming
- To involve Discussions/ Practice/Exercise in revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills.

**UNIT I BASIC C PROGRAMMING 6**

Typical C Program Development Environment - Introduction to C Programming - Structured Program Development in C - Data Types and Operators - C Program Control - C Functions - Introduction to Arrays.

**UNIT II EMBEDDED C 6**

Adding Structure to 'C' Code: Object-oriented programming with C, Header files for Project and Port, Examples. Meeting Real-time constraints: Creating hardware delays - Need for timeout mechanism - Creating loop timeouts - Creating hardware timeouts.

**UNIT III 8051 Programming in C 6**

Data types and time delay in 8051, I/O programming in 8051, Logic operations in 8051, Data conversion program in 8051 Accessing code ROM space in 8051, Data serialization using 8051

**UNIT IV 8051 SERIAL PORT AND INTERRUPT PROGRAMMING IN C 6**

Basics of serial communication, 8051 interface to RS232- serial port programming in 8051. 8051 interrupts and programming, Programming for timer configuration.

**UNIT V 8051 INTERFACING 6**

8051: ADC interfacing , DAC interfacing, Sensor interfacing, LCD interfacing, Stepper motor interfacing.

**30 PERIODS****LAB COMPONENT: 30 PERIODS**

1. Laboratory exercise: Use 8051 microcontroller/Embedded processor/IDE/open source platform to give hands-on training on Embedded C- programming.
  - a. Introduction to IDE (like code blocks, vscode ,etc)and Programming Environment (like Keililu vision, Proteus)
  - b. Configuring an I/O port using bitwise programming.
  - c. Configuring timer for generating hardware delay.
  - d. Flashing an LED using an interrupt
  - e. Serial communication using UART port of 8051
  - f. Interfacing an ADC with 8051
  - g. Interfacing an analog sensor with 8051
  - h. Interfacing 16x2 LCD with 8051
  - i. configuring timer for generating PWM signal
  - j. Interfacing a stepper motor with 8051

2. Assignment: Introduction to Arduino IDE, Raspberry Pi

### 3. Embedded C-Programming -based Mini project.

**TOTAL: 30+30 = 60 PERIODS**

#### **COURSE OUTCOMES:**

At the end of this course, the students will have the ability to

- CO1: Deliver insight into embedded C programming and its salient features for embedded systems.
- CO2: Illustrate the software and hardware architecture for distributed computing in embedded systems
- CO3: Develop a solution for problems by using the concepts learned in programming using the embedded controllers
- CO4: Develop simple applications with 8051 by using its various features and interfacing with various external hardware.
- CO5: Improved Employability and entrepreneurship capacity due to knowledge upgradation on recent trends in embedded programming skills.

#### **TEXTBOOKS:**

1. Paul Deitel and Harvey Deitel, "C How to Program", 9th Edition, Pearson Education Limited, 2022, 1<sup>st</sup> edition.
2. Michael J Pont, "Embedded C", Addison-Wesley, An imprint of Pearson Education, 2002.
3. William von Hagen, "The Definitive Guide to GCC", 2nd Edition, Apress Inc., 2006.
4. Gowrishankar S and Veena A, "Introduction to Python Programming", CRC Press, Taylor & Francis Group, 2019.

#### **REFERENCES:**

1. Noel Kalicharan, "Learn to Program with C", Apress Inc., 2015, 1<sup>st</sup> edition.
2. Steve Oualline, "Practical C programming", O'Reilly Media, 1997, 3<sup>rd</sup> edition.
3. Muhammad Ali Mazidi, Janice G. Mazidi and Rolin D. McKinlay, 'The 8051 Microcontroller and Embedded Systems' Prentice Hall, 2<sup>nd</sup> Edition 2007.
4. Myke Predko, "Programming and customizing the 8051 microcontrollers", McGraw Hill 2000, 1<sup>st</sup> edition.

List of Open Source Software/ Learning websites:

- <https://www.hackerrank.com/>
- <https://www.cprogramming.com/>
- <https://www.allaboutcircuits.com/technical-articles/introduction-to-the-c-programming-language-for-embedded-applications/>
- [https://onlinecourses.nptel.ac.in/noc19\\_cs42/preview](https://onlinecourses.nptel.ac.in/noc19_cs42/preview)
- <https://microcontrollerslab.com/8051-microcontroller-tutorials-c/>
- <https://www.circuitstoday.com/getting-started-with-keil-uvision>

#### **MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	2	3	1	-	-	-	-	-	-	-	1	2	2
CO2	1	1	2	2	1	-	-	-	-	-	-	-	1	3	2
CO3	2	2	3	2	3	-	-	-	-	-	-	-	2	3	3
CO4	3	2	3	2	3	-	-	-	-	-	-	-	1	1	1
CO5	3	2	1	2	1	-	-	-	1	-	-	-	2	3	2
Avg	2	1.6	2.2	2.2	1.8	-	-	-	1	-	-	-	1.4	2.4	2



**COURSE OBJECTIVES:**

- To introduce the architecture of the ARM processor.
- To train students in ARM programming.
- To discuss memory management, append location development with an ARM processor.
- To involve Discussions/ Practice/Exercise in revising & familiarizing the concepts
- To impart the knowledge on single board embedded processors.

**UNIT I ARM ARCHITECTURE****6**

Architecture – Memory Organization – addressing modes -Registers – Pipeline - Interrupts – Coprocessors – Interrupt Structure

**UNIT II ARM MICROCONTROLLER PROGRAMMING****6**

ARM general Instruction set – Thumb instruction set –Introduction to DSP on ARM- basic programming.

**UNIT III PERIPHERALS OF ARM****6**

ARM: I/O Memory – EEPROM – I/O Ports – SRAM –Timer –UART - Serial Communication with PC – ADC/DAC Interfacing-stepper motor interfacing

**UNIT IV ARM COMMUNICATION****6**

ARM With CAN, I<sup>2</sup>C, and SPI protocols

**UNIT V INTRODUCTION TO SINGLE BOARD EMBEDDED PROCESSOR****6**

Raspberry Pi Architecture - Booting Up RPi- Operating System and Linux Commands -Working with RPi using Python and Sensing Data using Python-programming - GPIO and interfacing peripherals With Raspberry Pi

**30 PERIODS****LAB COMPONENTS:****30 PERIODS**

1. Laboratory exercise:
  - a) Programming with IDE - ARM microcontroller
  - b) Advanced Timer Features, PWM Generator.
  - c) RTC interfacing with ARM using Serial communication programming, Stepper motor control.
  - d) ARM-Based Wireless Environmental Parameter Monitoring System displayed through Mobile device.
2. Seminar:
  - a) ARM and GSM/GPS interfacing
  - b) Introduction to ARM Cortex Processor
3. Raspberry Pi based Mini project.

**TOTAL: 30+30 = 60 PERIODS****COURSE OUTCOMES:**

At the end of this course, the students will have the ability to

CO1: Interpret the basics and functionality of processor functional blocks.

CO2: Observe the specialty of RISC processor Architecture.

CO3: Incorporate the I/O hardware interface of processor with peripherals.

CO4: Emphasis the communication features of the processor.

CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in commercial embedded processors.

**TEXTBOOKS:**

1. Steve Furber, 'ARM system on chip architecture', Addison Wesley, 2<sup>nd</sup> Edition, 2015.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, John Rayfield's ARM System Developer's Guide Designing and Optimizing System Software', Elsevier 2004, 1<sup>st</sup> Edition.

**REFERENCES:**

1. William Hohl, ' ARMAseembly Language' Fundamentals and Techniques, CRC Press, 2<sup>nd</sup> Edition 2014.
2. Rajkamal," Microcontrollers Architecture, Programming, Interfacing, & System Design, Pearson, 2012, 2<sup>nd</sup> Edition.
3. ARM Architecture Reference Manual, LPC214x User Manual www.Nuvoton .com/websites on Advanced ARM Cortex Processors
4. ARM System Developer's Guide: Designing and Optimizing System Software 1st Edition (Designing and Optimizing System Software) Publisher: Morgan Kaufmann Publishers, 2011.

**List of Open Source Software/ Learning websites:**

1. <https://nptel.ac.in/courses/117106111>
2. [https://onlinecourses.nptel.ac.in/noc20\\_cs15/preview](https://onlinecourses.nptel.ac.in/noc20_cs15/preview)
3. [https://www.csie.ntu.edu.tw/~cyy/courses/assembly/12fall/lectures/handouts/lec08\\_ARMarc h.pdf](https://www.csie.ntu.edu.tw/~cyy/courses/assembly/12fall/lectures/handouts/lec08_ARMarc h.pdf)
4. <https://maxembedded.com/2013/07/introduction-to-single-board-computing/>
5. <https://www.youtube.com/watch?v=J4fhE4Pp55E&list=PLGs0VKk2DiYypuwUUM2wxzcl9BJHK4Bfh>

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	P06	P07	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	2	2	1	-	-	-	-	-	-	-	2	1	2
CO2	1	1	2	2	1	-	-	-	-	-	-	-	1	2	2
CO3	3	2	3	2	3	-	-	-	-	-	-	-	3	3	3
CO4	3	2	3	2	3	-	-	-	-	-	-	-	2	3	3
CO5	3	2	1	2	1	-	-	-	1	-	-	-	1	2	2
Avg	2.2	1.6	2.2	2	1.8	-	-	-	1	-	-	-	1.8	2.2	2.4

PROGRESS THROUGH KNOWLEDGE

**COURSE OBJECTIVES:**

- To provide the control concept for electrical drives
- To emphasize the need of embedded systems for controlling the electrical drives
- To provide knowledge about various embedded system-based control strategies for electrical drives
- To Impart the knowledge of optimization and machine learning techniques used for electrical drives
- To familiarize the high-performance computing for electrical drives.

**UNIT I INTRODUCTION TO ELECTRIC DRIVES 6**  
Electric drives and its classification-Four-quadrant drive-Solid State Controlled Drives-Machine learning and optimization techniques for electrical drives.

**UNIT II EMBEDDED SYSTEM FOR MOTOR CONTROL 6**  
Embedded Processors choice for motor control- Sensors and interface modules for Electric drives-IoT for Electrical drives applications

**UNIT III INDUCTION MOTOR CONTROL 6**  
Speed control methods-PWM techniques- VSI fed three-phase induction motor- Fuzzy logic Based speed control for three-phase induction motor- Embedded processor based three phase induction motor speed control.

**UNIT IV BLDC MOTOR CONTROL 6**  
Overview of BLDC Motor -Speed control methods -PWM techniques- Embedded processor based BLDC motor speed control.

**UNIT V SRM MOTOR CONTROL 6**  
Overview of SRM Motor -Speed control methods -PWM techniques- Embedded processor based SRM motor speed control.

**30 PERIODS****LAB COMPONENTS: 30 PERIODS**

1. Laboratory exercise: Use any System level simulator/MATLAB/open source platform to give hands-on training on simulation study on Electric drives and control.
  - a. Simulation of four quadrant operation and speed control of DC motor
  - b. Simulation of 3-phase inverter.
  - c. Simulation of Speed control of Induction motor using any suitable software package.
  - d. Simulation of Speed control of BLDC motor using any suitable software package.
  - e. Simulation of Speed control of SRM using any suitable software package
2. Seminar: IoT-based Control and Monitoring for DC Motor/ any Electric drives.
3. Mini project.: Any Suitable Embedded processor-based speed control of Motors (DC/IM/BLDC/PMSM/SRM)

**TOTAL: 30+30 = 60 PERIODS****COURSE OUTCOMES:**

At the end of this course, the students will have the ability to

CO1: Interpret the significance of embedded control of electrical drives

CO2: Deliver insight into various control strategies for electrical drives.

CO3: Developing knowledge of Machine learning and optimization techniques for motor control.

CO4: Develop embedded system solutions for real-time application such as Electric vehicles and UAVs.

CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded system skills required for motor control strategy.

**TEXT BOOKS:**

1. R.Krishnan, "Electric Motor Drives – Modeling, Analysis and Control", Prentice-Hall of India Pvt. Ltd., New Delhi, 2010, 1<sup>st</sup> Edition.
2. Steve Kilts, "Advanced FPGA Design: Architecture, Implementation, and Optimization" Willey, 2007, 1<sup>st</sup> Edition.

**REFERENCES:**

1. VedamSubramanyam, "Electric Drives – Concepts and Applications", Tata McGraw- Hill publishing company Ltd., New Delhi, 2002, 2<sup>nd</sup> Edition.
2. K. Venkataratnam, Special Electrical Machines, Universities Press, 2014, 1<sup>st</sup> Edition.
3. Steve Furber, 'ARM system on chip architecture', Addison Wesley, 2<sup>nd</sup> Edition 2015.
4. Ron Sass and AnderewG.Schmidt, " Embedded System design with platform FPGAs: Principles and Practices", Elsevier, 2010, 1<sup>st</sup> Edition.
5. Tim Wescott, Applied Control Theory for Embedded Systems, Elsevier, 2006, 1<sup>st</sup> Edition.

**List of Open Source Software/ Learning website:**

- 1) <https://archive.nptel.ac.in/courses/108/104/108104140/>
- 2) <https://www.embedded.com/mcus-or-dsps-which-is-in-motor-control/>
- 3) [https://www.e3s-conferences.org/articles/e3sconf/pdf/2019/13/e3sconf\\_SeFet2019\\_01004.pdf](https://www.e3s-conferences.org/articles/e3sconf/pdf/2019/13/e3sconf_SeFet2019_01004.pdf)
- 4) <https://www.electronics-tutorials.ws/blog/pulse-width-modulation.html>
- 5) <http://kaliasgoldmedal.yolasite.com/resources/SEM/SRM.pdf>

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	2	2	1	-	-	-	-	-	-	-	2	1	2
CO2	2	1	3	2	1	-	-	-	-	-	-	-	2	1	2
CO3	3	2	3	3	3	-	-	-	-	-	-	-	1	3	3
CO4	3	2	3	3	3	-	-	-	-	-	-	-	3	3	3
CO5	3	2	1	2	1	-	-	-	1	-	-	-	2	2	3
Avg	2.4	1.6	2.4	2.4	1.8	-	-	-	1	-	-	-	2	2	2.6

PROGRESS THROUGH KNOWLEDGE

**COURSE OBJECTIVES:**

- To introduce the smart system technologies and its role in real time applications
- To teach the architecture and requirements of Home Automation.
- To provide an insight into smart appliances and energy management concepts.
- To familiarize the design and needs of smart wearable devices
- To teach the basics of robotics and its role for automation.

**UNIT I INTRODUCTION 6**

Overview of a smart system - Hardware and software selection - Smart sensors and Actuators – Communication protocols used for smart systems.

**UNIT II HOME AUTOMATION 6**

Home Automation – System Architecture - Essential Components- Design Considerations: Control Unit, Sensing Requirements, Communication, Data Security.

**UNIT III SMART APPLIANCES AND ENERGY MANAGEMENT 6**

Significance of smart appliances for energy management -Smart Meters: Significance, Architecture & Energy Measurement Technique – Security Considerations.

**UNIT IV SMART WEARABLE DEVICES 6**

Body Area Networks - Sensors– communication protocol for Wearable devices- Application of Smart Wearable in Healthcare & Activity Monitoring.

**UNIT V EMBEDDED SYSTEMS AND ROBOTICS 6**

Fundamental concepts in Robotics- Robots and Controllers components - Embedded processor based: pick and place robot- Mobile Robot Design- UAV.

**30 PERIODS****LAB COMPONENTS: 30 PERIODS**

1. Laboratory exercise: Use Arduino/ R pi/ any other Embedded processors to give hands on training to understand concepts related to smart automation.
  - a) Hands on experiments based on Ubidots & Thing speak / Open-source Analytics Platform
  - b) Design and implementation of a smart home system .
  - c) Bluetooth Based Home Automation Project using Android Phone
  - d) GSM Based Home Devices Control
  - e) Pick and place robots using Arduino/ any suitable Embedded processor
2. Assignment: Revolution of Smart Automation system across the world and its current scope available in India
3. Mini project: Design of a Smart Automation system ( for any application of students choice)

**TOTAL: 30+30 = 60 PERIODS****COURSE OUTCOMES:**

At the end of this course, the students will have the ability to

CO1: Understand the concepts of smart system design and its present developments.

CO2: Illustrate different embedded open-source and cost-effective techniques for developing solution for real time applications.

CO3: Acquire knowledge on different platforms and Infrastructure for Smart system design.

CO4: Infer about smart appliances and energy management concepts.

CO5: Improve Employability and entrepreneurship capacity due to knowledge upgradation on embedded system technologies.

**TEXTBOOKS:**

1. Grimm, Christoph, Neumann, Peter, Mahlkech and Stefan, Embedded Systems for Smart Appliances and Energy Management, Springer 2013, 1<sup>st</sup> Edition.
2. KazemSohraby, Daniel Minoli and TaiebZnati, Wireless Sensor Networks Technology, Protocols, and Applications, John Wiley & Sons, 2007, 1<sup>st</sup> Edition.
3. NilanjanDey, Amartya Mukherjee, Embedded Systems and Robotics with Open-Source Tools, CRC press, 2016, 1<sup>st</sup> Edition.

**REFERENCES:**

1. Thomas Bräunl, Embedded Robotics, Springer, 2003.
2. Raj Kamal, Embedded Systems - Architecture, Programming and Design, McGraw- Hill, 2008
3. Karim Yaghmour, Embedded Android, O'Reilly, 2013.
4. Steven Goodwin, Smart Home Automation with Linux and Raspberry Pi, Apress , 2013
5. C.K. Toh, AdHoc mobile wireless networks, Prentice Hall, Inc, 2002.
6. Anna Ha'c, Wireless Sensor Network Designs, John Wiley & Sons Ltd, 2003.
7. J. J. Craig, "Introduction to Robotics Mechanics and Control", Pearson Education.
8. Y. Koren, "Robotics for Engineers", McGraw-Hill.
9. Robert Faludi, Wireless Sensor Networks, O'Reilly, 2011.

**List of Open Source Software/ Learning website:**

1. <https://microcontrollerslab.com/home-automation-projects-ideas/>
2. <https://www.learnrobotics.org/blog/simple-robot/>
3. <https://robo-labor.ee/homelab/en/iot>
4. [https://electrovolt.ir/wp-content/uploads/2018/03/Exploring\\_Raspberry\\_Pi\\_Molloy\\_Derek\\_ElectroVolt.ir\\_.pdf](https://electrovolt.ir/wp-content/uploads/2018/03/Exploring_Raspberry_Pi_Molloy_Derek_ElectroVolt.ir_.pdf)
5. [http://www.robot.bmstu.ru/files/books/\(Ebook%20-%20English\)%20Mcgraw-Hil.%20Pic%20Robotics%20--%20A%20Beginner'S%20Guide%20To%20Robotic.pdf](http://www.robot.bmstu.ru/files/books/(Ebook%20-%20English)%20Mcgraw-Hil.%20Pic%20Robotics%20--%20A%20Beginner'S%20Guide%20To%20Robotic.pdf)

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	3	1	3	-	-	-	-	-	-	-	1	2	2
CO2	3	1	2	2	3	-	-	-	-	-	-	-	1	1	3
CO3	2	2	3	2	3	-	-	-	-	-	-	-	2	2	2
CO4	2	2	2	1	3	-	-	-	-	-	-	-	1	2	2
CO5	3	2	2	2	3	-	-	-	1	-	-	-	2	2	3
Avg	2.4	1.6	2.4	1.6	3	-	-	-	1	-	-	-	1.4	1.8	2.4

**COURSE OBJECTIVES:**

- To expose the students to the fundamentals and building of Electronic Engine Control systems.
- To teach on sensor functional components for vehicles.
- To discuss on programmable controllers for vehicles management systems.
- To teach logics of automation & communication techniques for vehicle communication.
- To introduce the infotainment system development.

**UNIT I INTRODUCTION TO AUTOMOTIVE SYSTEMS****6**

Overview of Automotive systems, fuel economy, air-fuel ratio, emission limits and vehicle performance; Electronic control Unit– open-source ECU.

**UNIT II SENSORS AND ACTUATORS FOR AUTOMOTIVES****6**

Review of automotive sensors- sensors interface to the ECU, Smart sensor and actuators for automotive applications.

**UNIT III VEHICLE MANAGEMENT SYSTEMS****6**

Energy Management system -Adaptive cruise control - anti-locking braking system - Safety and Collision Avoidance.

**UNIT IV ONBOARD DIAGNOSTICS AND COMMUNICATION****6**

OBD , Vehicle communication protocols- Bluetooth, CAN, LIN, FLEXRAY and MOST.

**UNIT V RECENT TRENDS****6**

Navigation- Autonomous car- Role of IoT in Automotive systems.

**30 PERIODS****LAB COMPONENTS:****30 PERIODS**

1. Laboratory exercise: Use MATLAB SIMULINK /equivalent simulation /open source tools
  - a) Simulation study of automotive sensors and actuators components
  - b) Adaptive cruise control, Anti-Lock Braking System
  - c) CAN Connectivity in an Automotive Application using vehicle network toolbox
  - d) Interfacing a sensor used in car with microcontroller.
  - e) Establishing connection between Bluetooth module and microcontroller.
2. Assignment: AUTOSAR
3. Mini project : Battery Management system for EV batteries.

**TOTAL: 30+30 = 60 PERIODS****COURSE OUTCOMES:**

At the end of this course, the students will have the ability in

CO1: Insight into the significance of the role of embedded system for automotive applications.

CO2: Illustrate the need, selection of sensors and actuators and interfacing with ECU

CO3: Develop the Embedded concepts for vehicle management and control systems.

CO4: Demonstrate the need of Electrical vehicle and able to apply the embedded system technology for various aspects of EVs

CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design and its application in automotive systems.

**TEXTBOOKS:**

1. William B. Ribbens ,”Understanding Automotive Electronics”, Elseiver,8<sup>th</sup> Edition, 2017.
2. Jurgen, R., Automotive Electronics Hand Book, McGraw Hill, 2<sup>nd</sup> Edition, 1999.
3. L.Vlacic,M.Parent,F.Harahima,”Intelligent Vehicle Technologies”,SAE International, 2001, 1<sup>st</sup> Edition, 2017.

**REFERENCES:**

1. Ali Emedi, Mehrdedehsani, John M Miller , “Vehicular Electric power system- land, Sea, Air and Space Vehicles” Marcel Decker, 2004, 1<sup>st</sup> Edition.
2. Jack Erjavec,JeffArias,”Alternate Fuel Technology-Electric ,Hybrid& Fuel Cell Vehicles”,Cengage ,2012, 2<sup>nd</sup> Edition.
3. Electronic Engine Control technology – Ronald K Jurgen Chilton’s guide to Fuel Injection – Ford 2<sup>nd</sup> Edition, 2004.
4. Automotive Electricals / Electronics System and Components, Tom Denton, 5<sup>th</sup> Edition, 2017.
5. Uwe Kiencke, Lars Nielsen, “Automotive Control Systems: For Engine, Driveline, and Vehicle”, Springer; 1<sup>st</sup> Edition, 2005.
6. Automotive Electricals Electronics System and Components, Robert Bosch Gmbh, 5<sup>th</sup> Edition, 2014.
7. Automotive Hand Book, Robert Bosch, Bently Publishers, 10<sup>th</sup> Edition, 2018.

**List of Open Source Software/ Learning website:**

- 1) [https://www.autosar.org/fileadmin/ABOUT/AUTOSAR\\_EXP\\_Introduction.pdf](https://www.autosar.org/fileadmin/ABOUT/AUTOSAR_EXP_Introduction.pdf)
- 2) <https://microcontrollerslab.com/can-communication-protocol/>
- 3) <https://ackodrive.com/car-guide/different-types-of-car-sensors/>
- 4) <https://www.tomtom.com/blog/automated-driving/what-is-adaptive-cruise-control/>
- 5) <https://prodigytechno.com/difference-between-lin-can-and-flexray-protocols/>
- 6) <https://www.synopsys.com/automotive/what-is-autonomous-car.html>

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	2	2	1	-	-	-	-	-	-	-	2	1	3
CO2	2	3	3	2	2	-	-	-	-	-	-	-	2	2	2
CO3	3	3	3	3	3	-	-	-	-	-	-	-	2	1	3
CO4	3	3	3	3	3	-	-	-	-	-	-	-	1	3	2
CO5	3	3	1	2	1	-	-	-	1	-	-	-	2	2	3
Avg	2.4	3	2.4	2.4	2	-	-	-	1	-	-	-	1.8	1.8	2.6



**COURSE OBJECTIVES**

- To explain the basic concepts of CMOS and
- To introduce the IC fabrication methods
- To introduce the Reconfigurable Processor technologies
- To introduce the basics of analog VLSI design and its importance.
- To learn about the programming of Programmable device using Hardware description Language.

**UNIT I CMOS BASICS****6**

MOSFET Scaling - CMOS logic design- Dynamic CMOS –Transmission Gates- BiCMOS

**UNIT II IC FABRICATION****6**

CMOS IC Fabrications: n well, p well, twin tub, Sol - Design Rules and Layout.

**UNIT III PROGRAMABLE LOGIC DEVICES****6**

PAL, PLA, CPLD architecture and application.

**UNIT IV RECONFIGURABLE PROCESSOR****6**

FPGA- Architecture, FPGA based application development- Introduction to FPAA.

**UNIT V HDL PROGRAMMING****6**

Verilog HDL- Overview - structural and behavioural modeling concepts-Design examples- Carry Look ahead adders, ALU, Shift Registers.

**30 PERIODS****LAB COMPONENTS:****30 PERIODS**

1. Laboratory exercise : Use any FPGA Board /IDE/open source package/ platform to give hands on training on CMOS design/ reconfigurable processor based applications.
  - a) CMOS logic circuit simulation using any open source software package
  - b) Experiments : structural and behavioural modeling based Verilog HDL programs
  - c) Experiment: Combinational and sequential Digital logic implementation with FPGA.
  - d) Implementation of carry look ahead adder with FPGA
  - e) Implementation of ALU with FPGA
2. Assignment : Low Power VLSI.
3. FPGA based Mini project .

**TOTAL: 30+30 = 60 PERIODS****COURSE OUTCOMES:**

At the end of this course, the students will have the ability to

CO1: Develop CMOS design techniques

CO2: Learn and build IC fabrication

CO3: Explain the need of reconfigurable computing with PLDs.

CO4: Design and development of reprogrammable FPGA.

CO5: Illustrate and develop HDL computational processes with improved design strategies.

**TEXTBOOKS:**

1. M.J.S Smith, "Application Specific integrated circuits", Addition Wesley Longman Inc. 1<sup>st</sup> Edition 2010.
2. Kamran Eshraghian, Douglas A. Pucknell and Sholeh Eshraghian, "Essentials of VLSI circuits and system", Prentice Hall India, 2005, 1<sup>st</sup> Edition.

**REFERENCES:**

1. Donald G. Givone, "Digital principles and Design", Tata McGraw Hill 2002, 1<sup>st</sup> Edition.
2. Charles H. Roth Jr., "Fundamentals of Logic design", Thomson Learning, 7<sup>th</sup> Edition 2013.
3. Nurmi, Jari (Ed.) "Processor Design System-On-Chip Computing for ASICs and FPGAs" Springer, 2007, 1<sup>st</sup> Edition.
4. Joao Cardoso, Michael Hübner, "Reconfigurable Computing: From FPGAs to Hardware/Software Codesign" Springer, 2011, 1<sup>st</sup> Edition.
5. Pierre-Emmanuel Gaillardon, "Reconfigurable Logic: Architecture, Tools, and Applications", 1<sup>st</sup> Edition, CRC Press, 2018.

**List of Open Source Software/ Learning website:**

- 1) <https://archive.nptel.ac.in/courses/108/107/108107129/>
- 2) [http://gn.dronacharya.info/ECEDept/Downloads/QuestionPapers/7th\\_Sem/VLSI-DESIGN/UNIT-1/Lecture-3.pdf](http://gn.dronacharya.info/ECEDept/Downloads/QuestionPapers/7th_Sem/VLSI-DESIGN/UNIT-1/Lecture-3.pdf)
- 3) <https://web.itu.edu.tr/~ateserd/vlsi2/2007/FPGAs&CPLD.pdf>
- 4) [https://kanchiuniv.ac.in/coursematerials/GSK\\_Notes\\_on\\_PLD\\_in\\_VLSI\\_design.pdf](https://kanchiuniv.ac.in/coursematerials/GSK_Notes_on_PLD_in_VLSI_design.pdf)
- 5) <https://www.xilinx.com/products/silicon-devices/resources/programming-an-fpga-an-introduction-to-how-it-works.html>
- 6) <https://www.allaboutcircuits.com/technical-articles/what-is-an-fpga-introduction-to-programmable-logic-fpga-vs-microcontroller/>
- 7) [https://www.tutorialspoint.com/vlsi\\_design/vlsi\\_design\\_vhdl\\_introduction.htm#:~:text=VHDL%20stands%20for%20very%20high,DoD\)%20under%20the%20VHSIC%20program.](https://www.tutorialspoint.com/vlsi_design/vlsi_design_vhdl_introduction.htm#:~:text=VHDL%20stands%20for%20very%20high,DoD)%20under%20the%20VHSIC%20program.)

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2	1	-	-	-	-	-	-	-	2	2	3
CO2	3	1	2	3	1	-	-	-	-	-	-	-	1	1	3
CO3	3	2	2	2	3	-	-	-	-	-	-	-	2	1	3
CO4	3	2	2	2	3	-	-	-	-	-	-	-	2	2	3
CO5	3	2	1	3	3	-	-	-	1	-	-	-	2	2	3
Avg	3	1.6	1.6	2.4	2.2	-	-	-	1	-	-	-	1.8	1.6	3

PROGRESS THROUGH KNOWLEDGE

**COURSE OBJECTIVES:**

- To introduce the diverse technological and functional approaches of MEMS/NEMS and applications.
- To understand the microstructures and fabrication methods.
- To provide an insight of micro and nano sensors, actuators.
- To emphasize the need for NEMS technology.
- To update the ongoing trends and real time applications of MEMS and NEMS technology.

<b>UNIT I</b>	<b>INTRODUCTION TO MEMS and NEMS</b>	<b>6</b>
Overview of Micro electro mechanical systems and Nano Electro mechanical systems, devices and technologies, Laws of scaling- Materials for MEMS and NEMS - Applications of MEMS and NEMS.		
<b>UNIT II</b>	<b>MICRO-MACHINING AND MICROFABRICATION TECHNIQUES</b>	<b>6</b>
Photolithography- Micro manufacturing, Bulk micro machining, surface micro machining, LIGA.		
<b>UNIT III</b>	<b>MICRO SENSORS AND MICRO ACTUATORS</b>	<b>6</b>
Micromachining : Capacitive Sensors- Piezoresistive Sensors- Piezoelectric actuators.		
<b>UNIT IV</b>	<b>NEMS TECHNOLOGY</b>	<b>6</b>
Atomic scale precision engineering- Nano Fabrication techniques – NEMS for sensors and actuators.		
<b>UNIT V</b>	<b>MEMS and NEMS APPLICATION</b>	<b>6</b>
Bio MEMS- Optical NEMS- Micro motors- Smart Sensors - Recent trends in MEMS and NEMS.		

**30 PERIODS****LAB COMPONENTS:****30 PERIODS**

1. Laboratory experiment: Simulation of MEMS sensors and actuators using Multi physics tool
  - a) Simulation of a typical piezo resistive sensor
  - b) Simulation of a typical Piezoelectric actuator
  - c) Simulation study of a bio sensor
  - d) Simulation study of a micro motor
2. Assignment: Role of MEMS AND NEMS devices for Industry Standard 5.0.
3. Mini project : Design and analysis of any MEMS/NEMS device using multi physics tool.

**TOTAL: 30+30 = 60 PERIODS****COURSE OUTCOMES:**

At the end of this course, the students will have the ability to

CO1: Explain the material properties and the significance of MEMS and NEMS for industrial automation.

CO2: Demonstrate knowledge delivery on micromachining and micro fabrication.

CO3: Apply the fabrication mechanism for MEMS sensor and actuators.

CO4: Apply the concepts of MEMS and NEMS to models, simulate and process the sensors and actuators.

CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on MEMS and NEMS technology.

**TEXTBOOKS:**

1. Chang Liu, "Foundations of MEMS", Pearson International Edition, 2011, 2<sup>nd</sup> Edition.
2. Tai-Ran Hsu, "MEMS and Microsystems: design , manufacture, and Nanoscale"- 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008.
3. Lyshevski, S.E. " Nano- and Micro-Electromechanical Systems: Fundamentals of Nano-and Microengineering " (2nd ed.). CRC Press,2005.
4. Julian W Gardner and Vijay K Varadan, " Microsensors, MEMS and Smart Devices", John Wiley and Sons Ltd, 2001, 1<sup>st</sup> Edition.

**REFERENCES:**

1. Marc F madou" Fundamentals of micro fabrication" CRC Press 2002 2nd Edition Marc Madou.
2. M.H.Bao "Micromechanical transducers :Pressure sensors, accelerometers and gyroscopes",Elsevier, Newyork, 16 Oct 2000, 1<sup>st</sup> Edition.
3. Maluf, Nadim "An introduction to Micro Electro-mechanical Systems Engineering "AR Tech house, Boston, June 30 2004, 2nd Edition.
4. Mohamed Gad – el – Hak "MEMS Handbook" Edited CRC Press 2001, 1<sup>st</sup> Edition.

**List of Open Source Software/ Learning website:**

1. [https://www.academia.edu/Lectures\\_on\\_MEMS\\_and\\_MICROSYSTEMS\\_DESIGN\\_AND\\_M ANUFACTURE](https://www.academia.edu/Lectures_on_MEMS_and_MICROSYSTEMS_DESIGN_AND_MANUFACTURE)
2. <https://nptel.ac.in/courses>
3. <https://www.iitk.ac.in/me/mems-fabrication>
4. <http://mems.iiti.ac.in/>
5. [https://onlinecourses.nptel.ac.in/noc22\\_ee36/preview](https://onlinecourses.nptel.ac.in/noc22_ee36/preview)

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	1	1	-	-	-	-	-	-	-	1	3	2
CO2	2	1	2	2	1	-	-	-	-	-	-	-	1	1	2
CO3	2	2	2	1	3	-	-	-	-	-	-	-	2	3	3
CO4	3	2	2	2	3	-	-	-	-	-	-	-	2	2	3
CO5	3	2	3	3	3	-	-	-	1	-	-	-	2	1	2
Avg	2.4	1.8	2	1.8	2.4	-	-	-	1	-	-	-	1.6	2	2.4

PROGRESS THROUGH KNOWLEDGE

**COURSE OBJECTIVES:**

- To introduce the concept of analyzing discrete time signals & systems in the time and frequency domain through mathematical representation.
- To study the various time to frequency domain transformation techniques.
- To Understand the computation algorithmic steps for Fourier Transform.
- To study about filters and their design for digital implementation.
- To introduce the programmable digital signal processor & its application.

**UNIT I INTRODUCTION****6**

Classification of systems: Continuous, discrete, linear, causal, stable, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; spectral density; sampling techniques, quantization, quantization error, Nyquist rate, aliasing effect. Digital signal representation.

**UNIT II DISCRETE TIME SYSTEM ANALYSIS****6**

Z-transform and its properties, inverse z-transforms; difference equation – Solution by z-transform, application to discrete systems - Stability analysis, frequency response – Convolution – Introduction to Fourier Transform– Discrete time Fourier transform.

**UNIT III DISCRETE FOURIER TRANSFORM & COMPUTATION****6**

DFT properties, magnitude and phase representation - Computation of DFT using FFT algorithm – DIT & DIF - FFT using radix 2 – Butterfly structure.

**UNIT IV DESIGN OF DIGITAL FILTERS****6**

FIR & IIR filter realization – Parallel & cascade forms. FIR design: Windowing Techniques – Need and choice of windows – Linear phase characteristics. IIR design: Analog filter design - Butterworth and Chebyshev approximations; digital design using impulse invariant and bilinear transformation - Warping, prewarping -Frequency transformation.

**UNIT V DIGITAL SIGNAL PROCESSORS****6**

Introduction – Architecture of one DSP processor for motor control – Features – Addressing Formats– Functional modes - Introduction to Commercial Processors

**30 PERIODS****LAB COMPONENTS:****30 PERIODS**

1. Laboratory exercise : Use any DSP processor/MATLAB/open source platform to give hands on training on basic concepts of Digital Signal Processing
  - a) To determine impulse and step response of two vectors
  - b) To perform convolution between two vectors .
  - c) To compute DFT and IDFT of a given sequence.
  - d) To perform linear convolution of two sequence using DFT
  - e) Design and Implementation of FIR Filter
  - f) Design and Implementation of IIR Filter
  - g) To determine z-transform from the given transfer function and its ROC
2. Assignment : Implementation of FIR/IIR filter with FPGA.
3. DSP processors based Mini project.

**TOTAL: 30+30 = 60 PERIODS**

**COURSE OUTCOMES:**

At the end of this course, the students will have the ability to

- CO1: Explain the concepts of digital signal processing  
 CO2: Illustrate the system representation using transforms  
 CO3: Learn the transformation techniques for time to frequency conversion  
 CO4: Design suitable digital FIR, IIR algorithm for the given specification  
 CO5: Use digital signal processor for application development

**TEXTBOOKS:**

1. J.G. Proakis and D.G. Manolakis, 'Digital Signal Processing Principles, Algorithms and Applications', Pearson Education, New Delhi, 4<sup>th</sup> Edition 2007.
2. Robert J.Schilling & Sandra L.Harris , ' Introduction to Digital Signal Processing using MATLAB', Cengage Learning, 2nd Edition 2013.

**REFERENCES:**

1. Emmanuel C Ifeachor and Barrie W Jervis , "Digital Signal Processing – A Practical approach" Pearson Education, Second edition, 2002.
2. Alan V. Oppenheim, Ronald W. Schafer and John R. Buck, 'Discrete – Time Signal Processing', Pearson Education, New Delhi, 2<sup>nd</sup> Edition 2012.
3. SenM.kuo, Woonseng...s.gan, "Digital Signal Processors, Architecture, Implementations & Applications, Pearson, 1<sup>st</sup> Edition 2004.
4. S.K. Mitra, 'Digital Signal Processing – A Computer Based Approach', Tata McGraw Hill, New Delhi, 4<sup>th</sup> Edition 2013.
5. B. Venkataramani, M. Bhaskar, 'Digital Signal Processors, Architecture, Programming and Applications', Tata McGraw Hill, New Delhi, 2003, 1<sup>st</sup> Edition.

**List of Open Source Software/ Learning website:**

1. <https://nptel.ac.in/courses/117102060>
2. [https://www.tutorialspoint.com/digital\\_signal\\_processing/index.htm](https://www.tutorialspoint.com/digital_signal_processing/index.htm)
3. <https://www.elprocus.com/digital-signal-processor/>
4. <https://www.sciencedirect.com/topics/computer-science/digital-signal-processing-algorithm#:~:text=Digital%20signal%20processing%20algorithms%20are,known%20as%20operations%20or%20ops.>
5. <https://www.electronicshub.org/introduction-to-fpga/>

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	2	2	1	-	-	-	-	-	-	-	1	2	1
CO2	2	3	3	2	2	-	-	-	-	-	-	-	2	3	1
CO3	3	3	3	3	3	-	-	-	-	-	-	-	2	2	2
CO4	3	3	3	3	3	-	-	-	-	-	-	-	2	2	3
CO5	3	3	3	2	1	-	-	-	1	-	-	-	2	2	3
Avg	2.4	3	2.8	2.4	2	-	-	-	1	-	-	-	1.8	2.2	2

## VERTICAL IV : ELECTRIC VEHICLE TECHNOLOGY

EE3025	ELECTRIC VEHICLE ARCHITECTURE	L	T	P	C
		3	0	0	3

### COURSE OBJECTIVES:

- To learn the structure of Electric Vehicle, Hybrid Electric Vehicle
- To study about the EV conversion components
- To know about the details and specifications for Electric Vehicles
- To understand the concepts of Plug-in Hybrid Electric Vehicle
- To model and simulate all types of DC motors

**UNIT I VEHICLE ARCHITECTURE and SIZING (7+2 Skill) 9**  
Electric Vehicle History, and Evolution of Electric Vehicles. Series, Parallel and Series parallel Architecture, Micro and Mild architectures. Mountain Bike - Motorcycle- Electric Cars and Heavy Duty EVs. -Details and Specifications.

**UNIT II VEHICLE MECHANICS (7+2 Skill) 9**  
Vehicle mechanics- Roadway fundamentals, Laws of motion, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tire –Road mechanics, Propulsion System Design.

**UNIT III POWER COMPONENTS AND BRAKES (7+2 Skill) 9**  
Power train Component sizing- Gears, Clutches, Differential, Transmission and Vehicle Brakes. EV power train sizing, HEV Powertrain sizing, Example.

**UNIT IV HYBRID VEHICLE CONTROL STRATEGY (7+2 Skill) 9**  
Vehicle supervisory control, Mode selection strategy, Modal Control strategies.

**UNIT V PLUG-IN HYBRID ELECTRIC VEHICLE (7+2 Skill) 9**  
Introduction-History-Comparison with electrical and hybrid electrical vehicle-Construction and working of PHEV-Block diagram and components-Charging mechanisms-Advantages of PHEVs.

**TOTAL : 45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc) Basics of MATLAB simulation 10**

1. Variables and Expressions Formats, Vectors and Matrices,
2. Arrays, Vectors,
3. Matrices, Built-in functions, Trigonometric functions,
4. Data types and Plotting.
5. Simulation of drive cycles.

### COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1: Summarize the History and Evolution of EVs, Hybrid and Plug-In Hybrid EVs

CO2: Describe the various EV components

CO3: Describe the concepts related in the Plug-In Hybrid Electric Vehicles

CO4: Analyse the details and Specifications for the various EVs developed.

CO5: Describe the hybrid vehicle control strategy.

## REFERENCES:

1. Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.
2. Build Your Own Electric Vehicle, Seth Leitman , Bob Brant, McGraw Hill, Third Edition 2013.
3. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, First edition 2017.
4. The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles, and Bicycles -- Includes EV Components, Kits, and Project Vehicles Mark Warner, HP Books, 2011.
5. Heavy-duty Electric Vehicles from Concept to Reality, Shashank Arora, Alireza Tashakori Abkenar, Shantha Gamini Jayasinghe, Kari Tammi, Elsevier Science, 2021
6. Electric Vehicles Modern Technologies and Trends, Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen Springer, 2020
7. Hybrid Electric Vehicles: A Review of Existing Configurations and Thermodynamic Cycles, Rogelio León , Christian Montaleza , José Luis Maldonado , Marcos Tostado-Véliz and Francisco Jurado, Thermo, **2021**, 1, 134–150. <https://doi.org/10.3390/thermo1020010>.

## MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	2	-	-	-	-	1	-	-	-	2	3	-	-
CO2	3	-	2	-	-	-	-	1	-	-	-	2	3	3	3
CO3	3	-	2	-	-	-	-	1	-	-	-	2	3	-	-
CO4	3	-	2	-	-	-	-	1	-	-	-	2	3	-	-
CO5	3	-	3	3	3	-	-	1	-	-	-	2	3	3	3
Avg	3	-	2.2	3	3	-	-	1	-	-	-	2	3	3	3

EE3026

### DESIGN OF MOTOR AND POWER CONVERTERS FOR ELECTRIC VEHICLES

L T P C  
2 0 2 3

#### COURSE OBJECTIVES:

- To review the drive cycles and requirements of EVs
- To know the working of motors used in Electric Vehicle
- To analyze and model the buck/boost converter operation and to design the same
- To learn the simulation basics of control systems
- To derive transfer functions for DC-DC converters

#### UNIT I ELECTRIC VEHICLE DYNAMICS

6

Standard drive cycles-Dynamics of Electric Vehicles-Tractive force-Maximum speed, torque, power, energy requirements of EVs.

#### UNIT II MOTORS FOR ELECTRIC VEHICLES

6

Introduction – Speed And Torque control of above and below rated speed-Speed control of EV in the constant power region of electric motors. DC Motors, Induction Motor, Permanent Magnet Synchronous Motors (PMSM), Brushless DC Motors, Switched Reluctance Motors (SRMs). Synchronous Reluctance Machines-Choice of electric machines for EVs.



**UNIT III BASICS OF SIMULATION IN CONTROL SYSTEMS 6**

Transfer Function-How to build transfer function, identify Poles, zeros, draw time response plots, bode plot (Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double Differentiation Functions, Single Pole and Single Zero Functions, RHP Pole and RHP Zero Functions), state space modelling-transfer function from state space Model.

**UNIT IV MODELING OF DC-DC CONVERTERS 6**

Overview of PWM Converter Modelling -Power Stage Modelling - PWM Block Modelling - Voltage Feedback Circuit and Small-Signal Model of PWM Converter - Averaging Power Stage Dynamics - Average Models for buck/boost Converter - Small-Signal Model of Converter Power Stage - Frequency Response of Converter

**UNIT V POWER STAGE TRANSFER FUNCTIONS OF DC – DC CONVERTERS 6**

Power Stage Transfer Functions of buck-boost Converter in CCM Operation, Input-to-Output Transfer Function, Duty Ratio-to-Output Transfer Function, Load Current-to-Output Transfer Function.

**30 PERIODS**

**LAB COMPONENT: 30 PERIODS**

1. Simple simulation exercises of basic control systems
2. Bode plots and calculation of Gain margin and Phase margin for power stage transfer function via simulation.
3. Design of buck converter
4. Design of boost converter
5. Simulation of buck, boost and buck boost converter-open loop (With power circuit and Transfer function).

**TOTAL: 30+30 = 60 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, students will be able to:

CO1: To use appropriate electric machine for electric vehicle application

CO2: To compute transfer function with factors such as constant, integral, differential, first order factor and second order factor (both numerators & denominators)

CO3: To compute transfer function from state models

CO4: To design buck, boost and buck-boost converter.

CO5: To compute a power stage transfer functions for DC-DC converters

CO6: To simulate DC-DC converters and to obtain gain margin and phase margin.

**REFERENCES:**

1. Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, First Edition 2017.
2. Fundamentals of Power Electronics with MATLAB, Randall Shaffer, 2<sup>nd</sup> Edition, 2013, Lakshmi publications
3. Feedback Control problems using MATLAB and the Control system tool box, Dean Frederick and Joe Cho, 2000, 1<sup>st</sup> Edition, Cengage learning.
4. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005, 1<sup>st</sup> Edition.
5. Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK, Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, Wiley, 2021, 1<sup>st</sup> Edition.
6. Emerging Power Converters for Renewable Energy and Electric Vehicles Modeling, Design, and Control, Md. Rabiul Islam, Md. Rakibuzzaman Shah, Mohd. Hasan Ali, CRC Press, 2021, 1<sup>st</sup> Edition.
7. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Second Edition" CRC Press, Taylor & Francis Group, Third Edition 2021.



**LAB COMPONENT:****30 PERIODS**

1. Develop a model that could estimate Soc and SoH of Li-Ion Battery.
2. Modelling and thermal analysis of Li-Ion Battery.
3. Simulation of boost converter and calculating gain and phase margin from the transfer function.
4. Simulation of vector control of induction motor

**TOTAL: 30+30 = 60 PERIODS****COURSE OUTCOMES:**

Upon completion of the course, students will be able to:

CO1: To describe the concepts related with EV, HEV and to compare the same with internal combustion engine vehicles

CO2: To find gain margin & phase margin for various types of transfer functions of boost converter

CO3: To demonstrate the Control of A C Machines

CO4: To explain the concepts related with batteries and parameters of battery

CO5: To module the battery and to study the research and development for batteries

**REFERENCES:**

1. Electric and Hybrid Vehicles, Design Fundamentals, Third Edition, Iqbal Husain, CRC Press, 2021.
2. Power Electronic Converters, Dynamics and Control in Conventional and Renewable Energy Applications, Teuvo Suntio, Tuomas Messo, Joonas Puukko, 1<sup>st</sup> Edition, Wiley - VCH.
3. Ali Emadi, Mehrdad Ehsani, John M. Miller, "Vehicular Electric Power Systems", Special Indian Edition, Marcel Dekker, Inc 2003, 1<sup>st</sup> Edition.
4. C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University Press, 2001, 1<sup>st</sup> Edition.
5. Wie Liu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, John Wiley & Sons, 2017, 2<sup>nd</sup> Edition.
6. Dynamic Simulation of Electric Machinery using MATLAB, Chee Mun Ong, Prentice Hall, 1997, 1<sup>st</sup> Edition.
7. Electrical Machine Fundamentals with Numerical Simulation using MATLAB/ SIMULINK, Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, Wiley, 2021, 1<sup>st</sup> Edition.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	1	2	-	2	3	-	3
CO2	3	-	-	-	-	-	-	-	1	3	-	2	3	-	3
CO3	3	-	-	-	-	-	3	-	1	2	-	2	3	-	3
CO4	3	-	-	-	-	-	3	-	1	2	-	2	3	-	3
CO5	3	-	-	-	-	-	3	-	1	2	-	2	3	2	3
Avg	3	3	3	3	3	-	3	-	1	2.3	-	2	3	2.5	3

<b>EE3028</b>	<b>DESIGN OF ELECTRIC VEHICLE CHARGING SYSTEM</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>2</b>	<b>0</b>	<b>2</b>	<b>3</b>

**COURSE OBJECTIVES:**

- To know the charging station and standards
- To learn the concepts of power converters in charging
- To find the charging scheme in renewable based EV charging
- To demonstrate the wireless power transfer technique
- To design & simulate power factor correction circuits

**UNIT I CHARGING STATIONS AND STANDARDS 6**

Introduction-Charging technologies- Conductive charging, EV charging infrastructure, International standards and regulations - Inductive charging, need for inductive charging of EV, Modes and operating principle, Static and dynamic charging, Bidirectional power flow, International standards and regulations

**UNIT II POWER ELECTRONICS FOR EV CHARGING 6**

Layouts of EV Battery Charging Systems-AC charging-DC charging systems- Power Electronic Converters for EV Battery Charging- AC-DC converter with boost PFC circuit, with bridge and without bridge circuit - Bidirectional DC-DC Converters- Non-isolated DC-DC bidirectional converter topologies- Half-bridge bidirectional converter.

**UNIT III EV CHARGING USING RENEWABLE AND STORAGE SYSTEMS 6**

Introduction- - EV charger topologies , EV charging/discharging strategies - Integration of EV charging-home solar PV system , Operation modes of EVC-HSP system , Control strategy of EVC-HSP system - fast-charging infrastructure with solar PV and energy storage.

**UNIT IV WIRELESS POWER TRANSFER 6**

Introduction - Inductive, Magnetic Resonance, Capacitive types. Wireless Chargers for Electric Vehicles - Types of Electric Vehicles - Battery Technology in EVs -Charging Modes in EVs - Benefits of WPT. - WPT Operation Modes - Standards for EV Wireless Chargers, SAE J2954, IEC 61980. ISO 19363

**UNIT V POWER FACTOR CORRECTION IN CHARGING SYSTEM 6**

Need for power factor correction- Boost Converter for Power Factor Correction, Sizing the Boost Inductor, Average Currents in the Rectifier and calculation of power losses-

**30 PERIODS**

**LAB COMPONENT: 30 PERIODS**

1. Simulation and analysis for bi-directional charging V2G and G2V.
2. Design and demonstrate solar PV based EV charging station.
3. Simulate and infer wireless power charging station for EV charging.
4. Simulation of boost converter based power factor correction.

**TOTAL: 30+30 = 60 PERIODS**

**COURSE OUTCOMES:**

- CO1: To illustrate various charging techniques and to know charging standards and regulations.  
CO2: To demonstrate the working of DC-DC converters used for charging systems and principles  
CO3: To illustrate the advantages of renewable system based charging systems  
CO4: To demonstrate the principles of wireless power transfer.  
CO5: To analyze the standards for wireless charging  
CO6: To design and simulate boost converter based power factor correction.

**REFERENCES:**

1. Mobile Electric Vehicles Online Charging and Discharging, Miao Wang Ran Zhang Xuemin (Sherman) Shen, Springer 2016, 1<sup>st</sup> Edition.
2. Alicia Triviño-Cabrera, José M. González-González, José A. Aguado, Wireless Power Transferor Electric Vehicles: Foundations and Design Approach, Springer Publisher 1<sup>st</sup> Edition. 2020.
3. Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, Electric Vehicles Modern Technologies and Trends. Springer Publisher 1<sup>st</sup> Edition, 2021.
4. Cable Based and Wireless Charging Systems for Electric Vehicles, Technology and control, management and grid integration, Rajiv Singh, Sanjeevikumar Padmanaban, Sanjeet Dwivedi, Marta Molinas and Frede Blaabjerg, IET 2021, 1<sup>st</sup> Edition.
5. Electric and Hybrid Electric Vehicles, James D Halderman, Pearson, 2022, 1<sup>st</sup> Edition.
6. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	-	2	2	-	3	-	3	3	--	-
CO2	3	3	3	3	-	-	2	2	-	3	-	3	3	3	3
CO3	3				-	-			-		-		3	3	3
CO4	3	3	3	3	-	-	2	2	-	2	-	1	3	3	3
CO5	3	-	-	-	-	-	-	-	-	-	-	-	3	3	3
CO6	3	3	3	3	3	-	2	2	-	3	-	2	3	3	3
Avg	3	3	3	3	3	-	2	2	-	2.75	-	2.25	3	3	3

<b>EE3029</b>	<b>TESTING OF ELECTRIC VEHICLES</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>2</b>	<b>0</b>	<b>2</b>	<b>3</b>

**COURSE OBJECTIVES:**

- To know various standardization procedures
- To learn the testing procedures for EV & HEV components
- To know the functional safety and EMC
- To realize the effect of EMC in EVs
- To study the effect of EMI in motor drives and in DC-DC converter system

**UNIT I EV STANDARDIZATION 6**  
 Introduction - Current status of standardization of electric vehicles, electric Vehicles and Standardization - Standardization Bodies Active in the Field – Standardization activities in countries like Japan. The International Electro Technical Commission - Standardization of Vehicle Components.

**UNIT II TESTING OF ELECTRIC MOTORS AND CONTROLLERS FOR ELECTRIC AND HYBRID ELECTRIC VEHICLES 6**  
 Test Procedure Using M-G Set, electric motor, controller, application of Test Procedure, Analysis of Test Items for the Type Test - Motor Test and Controller Test (Controller Only). - Test Procedure Using Eddy Current Type Engine Dynamometer, Test Strategy, Test Procedure, Discussion on Test Procedure. Test Procedure Using AC Dynamometer.

**UNIT III      FUNDAMENTALS OF FUNCTIONAL SAFETY AND EMC      6**

Functional safety life cycle - Fault tree analysis - Hazard and risk assessment – software development - Process models - Development assessments - Configuration management - Reliability - Reliability block diagrams and redundancy - Functional safety and EMC - Functional safety and quality - Standards - Functional safety of autonomous vehicles.

**UNIT IV      EMC IN ELECTRIC VEHICLES      6**

Introduction - EMC Problems of EVs, EMC Problems of Motor Drive, EMC Problems of DC-DC Converter System, EMC Problems of Wireless Charging System, EMC Problem of Vehicle Controller, EMC Problems of Battery Management System, Vehicle EMC Requirements-

**UNIT V      EMI IN MOTOR DRIVE AND DC-DC CONVERTER SYSTEM      6**

Overview -EMI Mechanism of Motor Drive System, Conducted Emission Test of Motor Drive System, IGBT EMI Source, EMI Coupling Path, EMI Modelling of Motor Drive System. EMI in DC-DC Converter, EMI Source, The Conducted Emission High-Frequency, Equivalent Circuit of DC-DC Converter System, EMI Coupling Path

**30 PERIODS**

**LAB COMPONENT:**

**30 PERIODS**

1. Design and simulate motor controller for hybrid electric vehicle applications
2. Simulation of EMC analysis for Wireless power transfer EV charging.
3. Design and simulation of EMI filter

**TOTAL: 30+30 = 60 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, students will be able to:

- CO1: To describe the status and other details of standardization of EVs  
CO2: To illustrate the testing protocols for EVs and HEV components  
CO3: To analyze the safety cycle and need for functions safety for EVs  
CO4: To analyze the problems related with EMC for EV components.  
CO5: To evaluate the EMI in motor drive and DC-DC converter system.

**REFERENCES:**

1. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005, 1<sup>st</sup> Edition.
2. Electromagnetic Compatibility of Electric Vehicle, Li Zhai, Springer 2021, 1<sup>st</sup> Edition.
3. EMC and Functional Safety of Automotive Electronics, Kai Borgeest, IET 2018, 1<sup>st</sup> Edition.
4. EMI/EMC Computational Modeling Handbook, Druce Archambeault, Colin Branch, Omar M. Ramachi, Springer 2012, 2<sup>nd</sup> Edition.
5. Automotive EMC, Mark Steffika, Springer 2013, 1<sup>st</sup> Edition.
6. Electric Vehicle Systems Architecture and Standardization Needs, Reports of the PPP European Green Vehicles Initiative, Beate Müller, Gereon Meyer, Springer 2015, 1<sup>st</sup> Edition.



**UNIT V GRID INTEGRATION AND MANAGEMENT OF EVS****(7+2 Skill) 9**

Introduction - Machine to Machine (M2M) in distributed energy management systems - M2M communication for EVs - M2M communication architecture (3GPP) - Electric vehicle data logging - Scalability of electric vehicles -M2M communication with scheduling.

**TOTAL : 45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc)** **10**

1. Simulation of connecting three phase inverter to the grid.
2. Simulate and analyse the power quality issues of V2G systems
3. Design and simulate battery management system for smart grid with distributed generation.

**COURSE OUTCOMES:**

Upon completion of the course, students will be able to:

CO1 : Explain the concepts related with V2G

CO2 : Study the grid connection of 3 phase Q inverter

CO3 : Explain the technical, economics. business, regulatory & political challenges related with V2G

CO4 : Demonstrate the impact of EV and V2G on smart grid and renewable energy system

CO5 : Explain the concept of grid integration and management of EVs.

**REFERENCES:**

1. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press 2017, 1<sup>st</sup> Edition.
2. Plug In Electric Vehicles in Smart Grids, Charging Strategies, Sumedha Rajakaruna , Farhad Shahnian and Arindam Ghosh, Springer, 2015, 1<sup>st</sup> Edition.
3. ICT for Electric Vehicle Integration with the Smart Grid, Nand Kishor <sup>1</sup>; Jesus Fraile-Ardanuy, IET 2020, 1<sup>st</sup> Edition.
4. Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid, Junwei Lu and Jahangir Hossain, IET 2015, 1<sup>st</sup> Edition.
5. Lance Noel · Gerardo Zarazua de Rubens Johannes Kester · Benjamin K. Sovacool, Vehicle-to-Grid A Sociotechnical Transition Beyond Electric Mobility, 2019, 1<sup>st</sup> Edition.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	2	1	-	2	-	-	3	3	1
CO2	3	3	-	-	3	-	2	1	-	2	-	-	3	-	-
CO3	3	-	-	-	-	-	2	1	-	2	-	-	3	-	-
CO4	3	-	-	-	-	-	2	1	-	2	-	-	3	-	2
CO5	3	-	-	-	-	-	2	1	-	2	-	-	3	-	3
Avg	3	3	-	-	3	-	2	1	-	2	-	-	3	3	1.2



<b>EE3031</b>	<b>INTELLIGENT CONTROL OF ELECTRIC VEHICLES</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>2</b>	<b>0</b>	<b>2</b>	<b>3</b>

**COURSE OBJECTIVES:**

- To design and drive the mathematical model of a BLDC motor and its characteristics
- To learn the different control schemes for BLDC motor
- To study the basics of fuzzy logic
- To study the FPGA & VHDL basics
- To implement fuzzy logic control of BLDC motor in real time

**UNIT I MATHEMATICAL MODEL AND CHARACTERISTICS ANALYSIS OF THE BLDC MOTOR 6**

Structure and Drive Modes - Basic Structure, General Design Method, Drive Modes. Mathematical Model, Differential Equations, Transfer Functions, State-Space Equations. Characteristics Analysis, Starting Characteristics, Steady-State Operation, Dynamic Characteristics, Load Matching Commutation Transients

**UNIT II SPEED CONTROL FOR ELECTRIC DRIVES 6**

Introduction -PID Control Principle, Anti windup Controller, Intelligent Controller. Vector Control. Control applied to BLDC motor-.

**UNIT III FUZZY LOGIC 6**

Membership functions: features, fuzzification, methods of membership value assignments  
Defuzzification: lambda cuts - methods - fuzzy arithmetic and fuzzy measures: fuzzy arithmetic - extension principle - fuzzy measures - measures of fuzziness -fuzzy integrals - fuzzy rule base and approximate reasoning : truth values and tables, fuzzy propositions, formation of rules decomposition of rules, aggregation of fuzzy rules, fuzzy reasoning-fuzzy inference systems, overview of fuzzy expert system-fuzzy decision making..

**UNIT IV FPGA AND VHDL BASICS 6**

Introduction – FPGA Architecture-Advantages-Review of FPGA family processors- Spartan 3, Spartan 6 and Spartan 7. VHDL Basics- Fundamentals-Instruction set-data type-conditional statements- programs like arithmetic, sorting, PWM generation, Speed detection.

**UNIT V REAL TIME IMPLEMENTATION 6**

Inverter design, identifying rotor position via hall effect sensors, open loop and fuzzy logic control of 48 V BLDC motor using FPGA. .

**30 PERIODS**

**LAB COMPONENT: 30 PERIODS**

1. Design and simulate speed controller for induction motors in EV for both dynamic and steady state performance
2. Simulate a fuzzy logic controller based energy storage system for EV.
3. Fuzzy logic control of BLDC motor using FPGA in real time

**TOTAL: 30+30 = 60 PERIODS**

**COURSE OUTCOMES:**

Upon the successful completion of the course, students will be able to:

- CO1: To design the mathematical model of a BLDC motor and to discuss about its characteristics  
CO2: To demonstrate the PID control, ant windup controller, Intelligent Controller and Vector Control. Control applied to BLDC motor.  
CO3: To illustrate the basics of fuzzy logic system

CO4: To describe the basics of VHDL & FPGA applied to control of EVs.

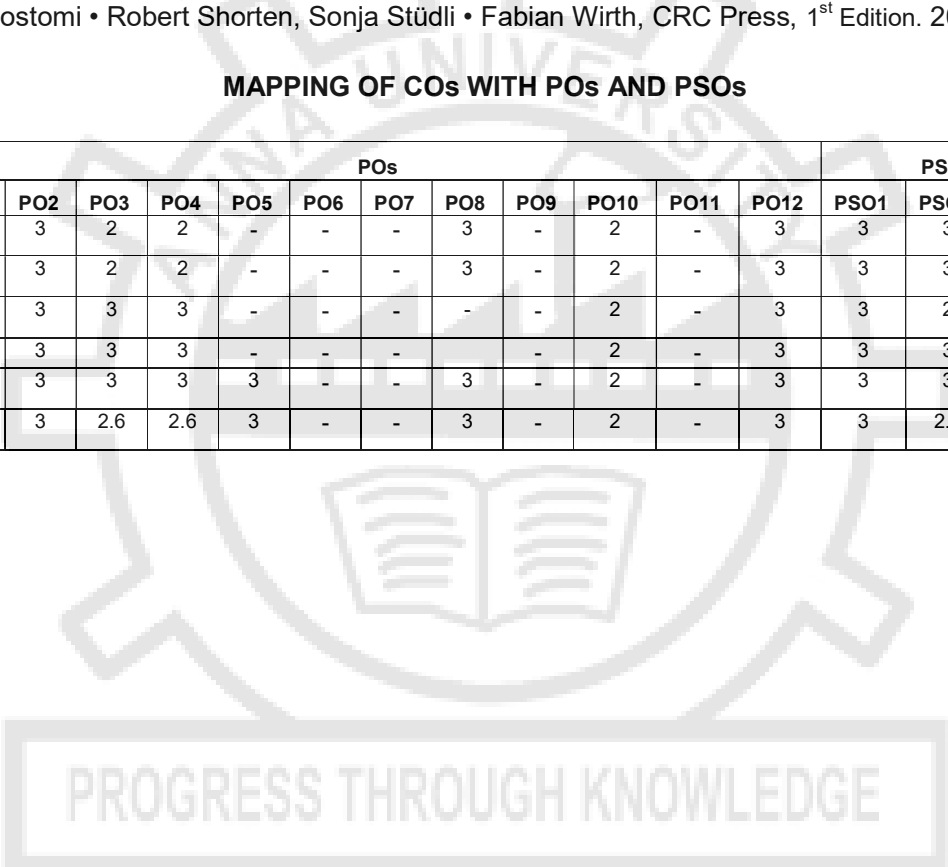
CO5: To design and implement of fuzzy logic control scheme for BLDC motor using FPGA in real time.

**REFERENCES:**

1. Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, John G. Hayes, G. Abas Goodarzi, Wiley 1<sup>st</sup> Edition 2018.
2. VHDL Primer, A (3rd Edition), Jayaram Bhasker, Prentice Hall, 1<sup>st</sup> Edition 2015.
3. Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals, Third Edition” CRC Press, Taylor & Francis Group, 2021, 1<sup>st</sup> Edition.
4. Chang-liang, Permanent Magnet Brushless DC Motor Drives and Controls, Xia Wiley 2012, 1<sup>st</sup> Edition.
5. M.N. Cirstea, A. Dinu, J.G. Khor, M. McCormick, Neural and Fuzzy Logic Control of Drives and Power Systems, Newnes publications, 1<sup>st</sup> Edition, 2002.
6. Wei Liu, Hybrid Electric Vehicle System Modeling and Control, Wiley 2017, 2<sup>nd</sup> Edition
7. Electric and Plug-in Hybrid Vehicle Networks Optimization and Control, Emanuele Crisostomi • Robert Shorten, Sonja Stüdl • Fabian Wirth, CRC Press, 1<sup>st</sup> Edition. 2018.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	-	-	-	3	-	2	-	3	3	3	-
CO2	3	3	2	2	-	-	-	3	-	2	-	3	3	3	3
CO3	3	3	3	3	-	-	-	-	-	2	-	3	3	2	3
CO4	3	3	3	3	-	-	-	-	-	2	-	3	3	3	3
CO5	3	3	3	3	3	-	-	3	-	2	-	3	3	3	3
Avg	3	3	2.6	2.6	3	-	-	3	-	2	-	3	3	2.8	2.4



## VERTICAL V : ADVANCED CONTROL

CIC331	<b>PROCESS MODELING AND SIMULATION</b>	L	T	P	C
		3	0	0	3

### COURSE OBJECTIVES:

- To understand the important of mathematical models for Industrial processes
- To acquaint students with different forms of mathematical models.
- To develop and simulate mathematical models for different Industrial processes.
- To apply Mathematical tools while developing mathematical models.
- To analyze the graphical response of developed mathematical models.

### **UNIT I GENERAL PRINCIPLES OF MODELLING (7+2 SKILL) 9**

Introduction to mathematical modeling; Advantages and limitations of models and applications of process models of stand-alone unit operations and unit processes; Classification of models: Linear vs Nonlinear, Lumped parameter vs. Distributed parameter; Static vs. Dynamic, Continuous vs. Discrete; Numerical Methods: Iterative convergence methods, Numerical integration of ODE- IVP and ODEBVP

### **UNIT II MODELLING OF DISTRIBUTED PROCESSES (7+2 SKILL) 9**

Steady state models giving rise to differential algebraic equation (DAE) systems; Rate based Approaches for staged processes; Modeling of differential contactors – distributed parameter models of packed beds; Packed bed reactors; Modeling of reactive separation processes; Review of solution strategies for Differential Algebraic Equations (DAEs), Partial Differential Equations (PDEs), and available numerical software libraries.

### **UNIT III INTRODUCTION TO PROCESS MODELLING (7+2 SKILL) 9**

Concept of degree of freedom analysis: System and its subsystem, System interaction, Degree of freedom in a system e.g. Heat exchanger, Equilibrium still, Reversal of information flow, Design variable selection algorithm, Information flow through subsystems, Structural effects of design variable selection, Persistent Recycle.

### **UNIT IV MODELLING OF INDUSTRIAL PROCESSES (7+2 SKILL) 9**

Simple examples of process models; Models giving rise to nonlinear algebraic equation (NAE) systems, -steady state models of flash vessels, equilibrium staged processes distillation columns, absorbers, strippers, CSTR, heat exchangers, etc.; Review of solution procedures and available numerical software libraries

### **UNIT V SIMULATION OF MATHEMATICAL MODELLING (7+2 SKILL) 9**

Simulation and their approaches, Modular, Sequential, Simultaneous and Equation solving approach, Simulation softwares and their applications, Review of solution techniques and available numerical software libraries.- Case Studies.

**TOTAL : 45 PERIODS**

### **SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10**

1. Developing steady state /Dynamic mathematical model of different unit processes (ODE or PDE)
2. Simulation of steady state/ dynamic models using appropriate software
3. Open loop study based on the developed mathematical model.
4. Development and simulation of unsteady state models for simple processes.

**COURSE OUTCOMES:**

- CO1** Will be able to understand different methods of developing models for industrial processes.
- CO2** Able to build mathematical models by applying relevant mathematics.
- CO3** Able to implement mathematical models using relevant software.
- CO4** Effectively perform analysis and subsequent conclusion for the developed mathematical models.
- CO5** Able to interpret the results obtained from the mathematical model in terms of original real world problem

**TEXT BOOKS:**

1. Denn M. M., "Process Modeling", Longman, 1986, 1<sup>st</sup> Edition.
2. Aris R., "Mathematical Modeling, A Chemical Engineering Perspective (Process System Engineering)", Academic Press, 1999, Volume 1.

**REFERENCES:**

1. Luyben W.L., "Process Modeling, Simulation, and Control for Chemical Engineering", McGraw Hill, 2<sup>nd</sup> Edition, 1990.
2. D. F. Rudd and C. C. Watson, "Strategy of Process Engineering", Wiley international, 1<sup>st</sup> Edition, 1968.
3. M.M. Denn, "Process Modelling", Wiley, New York, 1<sup>st</sup> Edition, 1986.
4. A. K. Jana, "Chemical Process Modelling and Computer Simulation", PHI, 1<sup>st</sup> Edition, 2011.
5. C.D. Holland, "Fundamentals of Modelling Separation Processes", Prentice Hall, , 1<sup>st</sup> Edition, 1975.
6. Hussain Asghar, "Chemical Process Simulation", Wiley Eastern Ltd., New Delhi, , 1<sup>st</sup> Edition, 1986.

**List of Open Source Software/ Learning website:**

<https://archive.nptel.ac.in/courses/103/107/103107096/>

<https://nptel.ac.in/courses/103101111>

<https://nptel.ac.in/courses/111107105>

[https://www.academia.edu/37228967/Process\\_Modeling\\_Simulation\\_and\\_Control\\_for\\_Chemical\\_Engineers](https://www.academia.edu/37228967/Process_Modeling_Simulation_and_Control_for_Chemical_Engineers)

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	-	-	2	1	-	1	1	1	1	1	1	2	2
CO2	3	1	2	-	-	1	-	1	1	1	1	1	1	2	2
CO3	1	-	2	3	-	1	-	1	1	1	1	1	1	2	2
CO4	1	-	3	-	-	1	2	1	1	1	1	1	1	2	2
CO5	1	2	-	3	-	1		1	1	1	1	1	1	2	2
Avg.	3	1	-	-	2	1	2	1	1	1	1	1	1	2	2

**COURSE OBJECTIVES:**

- To represent the linear time invariant System in discrete State Space form
- To analyze the controllability, observability and stability of a Discrete time System.
- To estimate model parameters from input/output measurements
- To Design Digital Controllers
- To Design Multi-loop and Multivariable Controllers for multivariable system

**UNIT I DISCRETE STATE-VARIABLE TECHNIQUE****(7+2 SKILL) 9**

State equation of discrete data system with sample and hold – State transition equation – Methods of computing the state transition matrix – Decomposition of discrete data transfer functions – State diagrams of discrete data systems – System with zero-order hold – Controllability and observability of linear time invariant discrete data system–Stability tests of discrete-data system.

**UNIT II SYSTEM IDENTIFICATION****(7+2 SKILL) 9**

Identification of Non-Parametric Input-Output Models: -Transient analysis–Frequency analysis–Correlation analysis– Spectral analysis – Identification of Parametric Input-Output Models: -Least Squares Method – Recursive Least Square Method.

**UNIT III DIGITAL CONTROLLER DESIGN****(7+2 SKILL) 9**

Review of z-transform – Modified of z-transform – Pulse transfer function – Digital PID controller – Dead-beat controller and Dahlin's controller – Kalman's algorithm, Pole Placement Controller

**UNIT IV MULTI-LOOP REGULATORY CONTROL****(7+2 SKILL) 9**

Multi-loop Control - Introduction – Process Interaction – Pairing of Inputs and Outputs -The Relative Gain Array (RGA) – Properties and Application of RGA - Multi-loop PID Controller – Biggest Log Modulus Tuning Method – De-coupler.

**UNIT V MULTIVARIABLE REGULATORY CONTROL****(7+2 SKILL) 9**

Introduction to Multivariable control –Multivariable PID Controller – Multivariable Dynamic Matrix Controller – Case Studies: - Distillation Column, CSTR and Four-tank system.

**TOTAL : 45 PERIODS****SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/ Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10**

1. Calculate the RGA to determine the recommended pairing between controlled and manipulated variables for any system.
2. Seminar on LS, RLS methods.
3. Design of DMC for distillation Column, CSTR and Four-tank system in MATLAB.
4. Design a Multi-loop & Multivariable controller for MIMO system.
5. Design a model for any industrial process using parametric & non-parametric system.

**COURSE OUTCOMES:**

- CO1** Develop mathematical models for discrete time systems using state variable techniques and analyze the stability of the systems. L4
- CO2** Construct models from input-output data by least square and recursive least square method. L5
- CO3** Ability to design different digital controllers to satisfy the required criterion. L5
- CO4** Design a multi-loop controller and multivariable controller for multi-variable systems. L5
- CO5** Ability to design multivariable dynamic matrix controller for industrial processes. L5

**TEXT BOOKS:**

1. Stephanopoulos, G., “Chemical Process Control -An Introduction to Theory and Practice”, Prentice Hall of India, 1<sup>st</sup> Edition, 2015.
2. Sigurd Skogestad, Ian Postlethwaite, “Multivariable Feedback Control: Analysis and Design”, John Wiley and Sons, 2005, 2<sup>nd</sup> Edition.

**REFERENCE**

1. Thomas E. Marlin, Process Control – Designing Processes and Control systems for Dynamic Performance, Mc-Graw-Hill,2000, 2<sup>nd</sup> Edition.
2. Gopal, M., “Digital Control and State Variable Methods”, Tata Mc Graw Hill, 4<sup>th</sup> Edition, 2017.
3. P. Albertos and A. Sala, “Multivariable Control Systems An Engineering Approach”, Springer Verlag, 1<sup>st</sup> Edition, 2004
4. Bequette, B.W., “Process Control Modeling, Design and Simulation”, Prentice Hall of India, 1<sup>st</sup> Edition, 2003.
5. Dale E. Seborg, Duncan A. Mellichamp, Thomas F. Edgar, “Process Dynamics and Control”, Wiley John and Sons, 4<sup>th</sup> Edition, 2016.

**List of Open Source Software/ Learning website:**

<https://nptel.ac.in/courses/103104050>

<https://www.mathworks.com/matlabcentral/mlc-downloads/downloads/submissions/10816/versions/1/previews/Mimotools/rga.m/index.html>  
<https://in.mathworks.com/help/ident/>

<https://ctms.engin.umich.edu/CTMS/index.php?example=Introduction&section=ControlDigital>

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	1	1	1	1	1	1	1	2	2	2
CO2	3	3	3	3	1	1	1	1	1	1	1	1	2	2	2
CO3	3	3	3	3	1	1	1	1	1	1	1	1	2	2	2
CO4	3	3	3	3	1	1	1	1	1	1	1	1	2	2	2
CO5	3	3	3	3	1	1	1	1	1	1	1	1	2	2	2
Avg.	3	3	3	2.8	1	1	1	1	1	1	1	1	2	2	2

**COURSE OBJECTIVES:**

- To elaborate the concept of estimating the state variables of a system using state estimation algorithms.
- To elaborate the concept of estimating the parameters of the Input-output models using parameter estimation algorithms.
- To make the student understand the various closed loop system identification techniques.
- To make the student understand the various closed loop system identification techniques.
- To provide the background on the practical aspects of conducting experiments for real time system identification.

**UNIT I NON PARAMETRIC METHODS (7+2 SKILL) 9**

Nonparametric methods: Transient analysis - frequency analysis - Correlation analysis - Spectral analysis.

**UNIT II PARAMETRIC METHODS (7+2 SKILL) 9**

Parametric model structures: ARX, ARMAX, OE, BJ models - The Least square estimate - Best linear unbiased estimation under linear constraints - Updating the Parameter estimates for linear regression models - Prediction error methods: Description of Prediction error methods - Optimal Prediction – Relationships between prediction error methods and other identification methods - theoretical analysis. Instrumental variable methods: Description of Instrumental variable methods - Theoretical analysis - covariance matrix of IV estimates - Comparison of optimal IV and prediction error methods.

**UNIT III RECURSIVE IDENTIFICATION METHODS (7+2 SKILL) 9**

The recursive least squares method - Recursive Instrumental variable method-the recursive prediction error method-model validation and model structure determination. Identification of systems operating in closed loop: Identifiability considerations - Direct identification - Indirect identification - Joint input – Output identification.

**UNIT IV CLOSED- LOOP IDENTIFICATION (7+2 SKILL) 9**

Identification of systems operating in closed loop: direct identification and indirect identification – Subspace Identification methods: classical and innovation forms – Relay feedback identification of stable processes.

**UNIT V NONLINEAR SYSTEM IDENTIFICATION (7+2 SKILL) 9**

Modeling of nonlinear systems using ANN- NARX & NARMAX - Training Feed-forward and Recurrent Neural Networks – TSK model – Adaptive Neuro-Fuzzy Inference System (ANFIS) - Introduction to Support Vector Regression.

**TOTAL : 45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content 10 Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)**

1. Familiarization of various system identification methods in MATLAB.
2. Seminar on ANFIS
3. Exploration of other advanced system identification methods.

**COURSE OUTCOMES:**

- CO1** Ability to design and implement state estimation schemes. L5  
**CO2** Ability to develop various models (Linear & Nonlinear) from the experimental data. L5  
**CO3** Be able to choose a suitable model and parameter estimation algorithm for the identification of systems. L3  
**CO4** Be able to illustrate verification and validation of identified model. L3

**CO5** Ability to develop the model for prediction and simulation purposes using suitable control schemes. L5

**TEXT BOOKS:**

1. Lennart Ljung, "System Identification: Theory for the user", 2<sup>nd</sup> Edition, Prentice Hall, 1999.
2. Dan Simon, "Optimal State Estimation Kalman, H-infinity and Non-linear Approaches", John Wiley and Sons, 2006,
3. Tangirala, A.K., "Principles of System Identification: Theory and Practice", CRC Press, 2014, 1<sup>st</sup> Edition.

**REFERENCE**

1. Cortes, C., and Vapnik, V., "Support-Vector Networks, Machine Learning", 1995, 1<sup>st</sup> Edition.
2. Miller, W.T., Sutton, R.S., and Webrose, P.J., "Neural Networks for Control", MIT Press, 1996, 1<sup>st</sup> Edition.
3. Van der Heijden, F., Duin, R.P.W., De Ridder, D., and Tax, D.M.J., "Classification, Parameter Estimation and State Estimation", An Engineering Approach Using MATLAB, John Wiley & Sons Ltd., 2017, 2<sup>nd</sup> Edition.
4. Karel J. Keesman, "System Identification an Introduction", Springer, 2011, 1<sup>st</sup> Edition.
5. Tao Liu and Furong Gao, "Industrial Process Identification and control design, Step-test and relay-experiment-based methods", Springer- Verlag London Ltd., 2012, 1<sup>st</sup> Edition.

**List of Open Source Software/ Learning website:**

- <https://in.mathworks.com/help/ident/>  
<https://nptel.ac.in/courses/103106149>  
<https://in.mathworks.com/help/curvefit/nonparametric-fitting.html>  
<https://nptel.ac.in/courses/111102143>

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	1	1	1	1	1	1	1	2	2	2
CO2	3	3	3	3	1	1	1	1	1	1	1	1	2	2	2
CO3	3	2	2	2	1	1	1	1	1	1	1	1	2	2	2
CO4	3	2	2	2	1	1	1	1	1	1	1	1	2	2	2
CO5	3	3	3	3	1	1	1	1	1	1	1	1	2	2	2
Avg.	3	2.6	2.6	2.6	1	1	1	1	1	1	1	1	2	2	2



CIC336

**MODEL BASED CONTROL**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce the Knowledge about Multivariable and Multiloop systems.
- To understand the Model predictive control schemes and its elements.
- Get exposed to state space MPC along with case studies.
- To acquire knowledge on various constrained MPC.
- To make the student understand the principles of STR, MRAC and Gain scheduling.
- To make the student design simple adaptive controllers for linear systems

**UNIT I INTRODUCTION TO MIMO CONTROL (7+2 SKILL) 9**

Introduction to MIMO Systems-Multivariable control-Multiloop Control-Multivariable IMC-IMCPID-Case studies

**UNIT II MODEL PREDICTIVE CONTROL SCHEMES (7+2 SKILL) 9**

Introduction to Model Predictive Control - Model Predictive Control Elements - Generalized Predictive Control Scheme – Multivariable Generalized Predictive Control Scheme – Multiple Model based Model Predictive Control Scheme Case Studies

**UNIT III STATE SPACE BASED MODEL PREDICTIVE CONTROL SCHEME (7+2 SKILL) 9**

State Space Model Based Predictive Control Scheme - Review of Kalman Update based filters – State Observer Based Model Predictive Control Schemes – Case Studies

**UNIT IV CONSTRAINED MODEL PREDICTIVE CONTROL SCHEME (7+2 SKILL) 9**

Constraints Handling: Amplitude Constraints and Rate Constraints –Constraints and Optimization – Constrained Model Predictive Control Scheme – Case Studies.

**UNIT V ADAPTIVE CONTROL SCHEME (7+2 SKILL) 9**

Introduction to Adaptive Control-Gain Scheduling-Self tuning regulators–MARS-Adaptive Model Predictive Control Scheme –Case Studie

**TOTAL:45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10**

- 1 Explore various MIMO controllers presently used in industries.
- 2 Develop MPC, Adaptive and MIMO controllers for industrial processes.
- 3 Implement the controllers for MIMO systems.
- 4 Using software tools for practical exposures to the controllers used in industries by undergoing training.
- 5 Realisation of various optimization techniques for economical operation of process.

**COURSE OUTCOMES:**

**Students able to**

- CO1** Ability to apply engineering knowledge to understand the control schemes on MIMO systems L3.
- CO2** Ability to design controller for MIMO systemL5.
- CO3** Ability to analyze the control schemes available in industries L4.
- CO4** Ability to design MPC, Adaptive controllers for practical engineering problems L5.
- CO5** Ability to choose suitable controllers for the given problems L5.

**TEXT BOOKS:**

1. Coleman Brosilow, Babu Joseph, "Techniques of Model-Based Control", Prentice Hall PTR Pub 2002, 1<sup>st</sup> Edition.
2. E. F. Camacho, C. Bordons, "Model Predictive Control", Springer-Verlag London Limited 2007, 2<sup>nd</sup> Edition.
3. K.J. Astrom and B. J. Wittenmark, "Adaptive Control", Second Edition, Pearson Education Inc., second Edition 2013.

**REFERENCES:**

1. Paul Serban Agachi, Zoltan K. Nagy, Mircea Vasile Cristea, and Arpad Imre-Lucaci Model Based Control Case Studies in Process Engineering, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim 2007. 1<sup>st</sup> Edition.
2. Ridong Zhang, Anke Xue Furong Gao, "Model Predictive Control Approaches Based on the Extended State Space Model and Extended Non-minimal State Space Model", Springer Nature Singapore Pte Ltd. 2019, 1<sup>st</sup> Edition.
3. J.A. ROSSITER "Model-Based Predictive Control A Practical Approach" Taylor & Francis e-Library, 2005, 1<sup>st</sup> edition.

**List of Open Source Software/ Learning website:**

- 1 <https://nptel.ac.in/courses/103103037>
- 2 <https://nptel.ac.in/courses/108103007>
- 3 [https://onlinecourses.nptel.ac.in/noc21\\_ge01/preview](https://onlinecourses.nptel.ac.in/noc21_ge01/preview)
- 4 <https://nptel.ac.in/courses/127106225>

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	1	1	1	1	1	1	1	2	2	2
CO2	3	3	3	3	1	1	1	1	1	1	1	1	2	2	2
CO3	3	3	3	2	1	1	1	1	1	1	1	1	2	2	2
CO4	3	3	3	3	1	1	1	1	1	1	1	1	2	2	2
CO5	3	3	3	3	1	1	1	1	1	1	1	1	2	2	2
Avg.	3	2.8	2.8	2.6	1	1	1	1	1	1	1	1	2	2	2

PROGRESS THROUGH KNOWLEDGE

CIC334

**NON LINEAR CONTROL**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

- To provide knowledge on design in state variable form
- To provide knowledge in phase plane analysis.
- To give basic knowledge in describing function analysis.
- To study the design of optimal controller.
- To study the design of optimal estimator including Kalman Filter

**UNIT I STATE VARIABLE DESIGN (7+2 SKILL) 9**

Introduction to state Model- effect of state Feedback- Necessary and Sufficient Condition for Arbitrary Pole-placement- pole placement Design- design of state Observers- separation principle- servo design: -State Feedback with integral control

**UNIT II PHASE PLANE ANALYSIS (7+2 SKILL) 9**

Features of linear and non-linear systems - Common physical non-linearities – Methods of linearization Concept of phase portraits – Singular points – Limit cycles – Construction of phase portraits – Phase plane analysis of linear and non-linear systems – Isocline method.

**UNIT III DESCRIBING FUNCTION ANALYSIS (7+2 SKILL) 9**

Basic concepts, derivation of describing functions for common non-linearities – Describing function analysis of non-linear systems – limit cycles – Stability of oscillations.

**UNIT IV OPTIMAL CONTROL (7+2 SKILL) 9**

Introduction - Time varying optimal control – LQR steady state optimal control – Solution of Ricatti's equation – Application examples.

**UNIT V OPTIMAL ESTIMATION (7+2 SKILL) 9**

Optimal estimation – Kalman Bucy Filter-Solution by duality principle-Discrete systems- Kalman Filter-Application examples.

**TOTAL: 45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/**

**Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10**

- 1 Design of linear quadratic regulator (LQR) control system for any application of your own
- 2 Familiarization of Kalman filter in MATLAB
- 3 Seminar on pole placement design

**COURSE OUTCOMES:**

**Students able to**

- CO1** Able to apply the knowledge gained on state feedback control and nonlinear control. (L3)
- CO2** Ability to carryout analysis for common nonlinearities in a system. (L4)
- CO3** Apply advanced control theory to practical engineering problems. (L3)
- CO4** Design optimal controller. (L5)
- CO5** Understand the basics and Importance of Kalman filter. (L2)

**TEXT BOOKS:**

1. G. J. Thaler, "Automatic Control Systems", Jaico Publishing House 1993.
2. M.Gopal, Modern Control System Theory, New Age International Publishers, 2002, 2<sup>nd</sup>

Edition.

3. K. P. Mohandas, "Modern Control Engineering", Sanguine Technical Publishers, 2006, 1<sup>st</sup> Edition.

**REFERENCES:**

1. Ashish Tewari, 'Modern Control Design with Matlab and Simulink', John Wiley, New Delhi, 2002, 1<sup>st</sup> Edition.
2. K. Ogata, 'Modern Control Engineering', 5th Edition, PHI, New Delhi, 2009.
3. T. Glad and L. Ljung,, "Control Theory –Multivariable and Non-Linear Methods", Taylor & Francis, 2002, 1<sup>st</sup> Edition.
4. D.S.Naidu, "Optimal Control Systems" First Indian Reprint, CRC Press, 2009, 1<sup>st</sup> Edition.
5. William S Levine, "Control System Fundamentals," The Control Handbook, CRC Press, Tayler and Francies Group, 2011, 2<sup>nd</sup> Edition.

**List of Open Source Software/ Learning website:**

<https://in.mathworks.com/discovery/kalman-filter.html>

<https://in.mathworks.com/help/control/getstart/design-an-lqr-servo-controller-insimulink.html>

[https://onlinecourses.nptel.ac.in/noc22\\_ee24/preview](https://onlinecourses.nptel.ac.in/noc22_ee24/preview)

<http://www.nitttrc.edu.in/nptel/courses/video/101108047/lec22.pdf>

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	1	1	3	1	3	1	1	2	2	2
CO2	3	3	3	2	1	1	1	3	1	3	1	1	2	2	2
CO3	3	2	2	2	1	1	1	3	1	3	1	1	2	2	2
CO4	3	3	3	3	1	1	1	3	1	3	1	1	2	2	2
CO5	2	1	2	1	1	1	1	2	1	2	1	1	2	2	2
Avg.	2.8	2.2	2.4	2	1	1	1	2.8	1	2.8	1	1	2	2	2

PROGRESS THROUGH KNOWLEDGE

**COURSE OBJECTIVES:**

- To provide an exposure to different type of optimal control problems such as time- optimal, fuel optimal, energy optimal control problems.
- To impart knowledge and skills needed to design Linear Quadratic Regulator for Time-invariant and Time-varying Linear system (Continuous time and Discrete-time systems).
- To introduce concepts needed to design optimal controller using Dynamic Programming Approach and H-J-B equation.
- To provide an exposure to various types of fault tolerant control schemes such as Passive and active approaches.
- To introduce concepts needed to design optimal controller in the presence of state constraints and time optimal controller.

**UNIT I CALCULUS OF VARIATIONS AND OPTIMAL CONTROL (7+2 SKILL) 9**

Introduction – Performance Index- Constraints – Formal statement of optimal control system – Calculus of variations – Function, Functional, Increment, Differential and variation and optimum of function and functional – The basic variation problem Extrema of functions and functional with conditions – variational approach to optimal control system

**UNIT II LINEAR QUADRATIC OPTIMAL CONTROL SYSTEM (7+2 SKILL) 9**

Problem formulation – Finite time Linear Quadratic regulator – Infinite time LQR system: Time Varying case- Time-invariant case – Stability issues of Time-invariant regulator – Linear Quadratic Tracking system: Fine time case and Infinite time case

**UNIT III DISCRETE TIME OPTIMAL CONTROL SYSTEMS (7+2 SKILL) 9**

Variational calculus for Discrete time systems – Discrete time optimal control systems:- Fixedfinal state and open-loop optimal control and Free-final state and open-loop optimal control - Discrete time linear state regulator system – Steady state regulator system

**UNIT IV PONTRYAGIN MINIMUM PRINCIPLE (7+2 SKILL) 9**

Pontryagin Minimum Principle – Dynamic Programming:- Principle of optimality, optimal control using Dynamic Programming – Optimal Control of Continuous time and Discrete-time systems – Hamilton-Jacobi-Bellman Equation – LQR system using H-J-B equation

**UNIT V CONSTRAINED OPTIMAL CONTROL SYSTEMS (7+2 SKILL) 9**

Time optimal control systems – Fuel Optimal Control Systems- Energy Optimal Control Systems – Optimal Control Systems with State Constraints

**TOTAL:45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)** **10**

1. Interactive MATLAB based project learning in an optimal control system.
2. Familiarize yourself with optimal control software tool boxes.
3. Arrange a group brainstorming process to generate new ideas and possible solutions to an optimal control problem in any field.
4. Analyse the difference between optimal control systems with other types of control system.
5. Homework assignment on optimal control.

**COURSE OUTCOMES:****Students able to**

- CO1** Explain different type of optimal control problems such as time-optimal, fuel optimal, energy optimal control problems.
- CO2** Design Linear Quadratic Regulator for Time-invariant and Time-varying Linear system (Continuous time and Discrete-time systems)
- CO3** Design optimal controller using Dynamic Programming Approach and H-J-B equation.
- CO4** Explain the Pontryagin Minimum Principle.
- CO5** Design optimal controller in the presence of state constraints and time optimal controller.
- CO6** Understand the concepts of dynamic programming

**TEXT BOOKS:**

1. Donald E. Kirk, Optimal Control Theory – An Introduction, Dover Publications, Inc. Mineola, New York, 2012, 10<sup>th</sup> Edition.

**REFERENCE BOOKS**

1. D. Subbaram Naidu, Optimal Control Systems, CRC Press, New York, 2003, 1<sup>st</sup> Edition.
2. Frank L. Lewis, Draguna Vrabie, Vassilis L. Syrmos, Optimal Control, 3rd Edition, Wiley Publication, 2012, 3<sup>rd</sup> Edition.
3. Yan Wang, Cheng-Lin Liu, Zhi-Cheng Ji, Quantitative Analysis and Optimal Control of Energy Efficiency in Discrete Manufacturing System, Springer, 2020, 1<sup>st</sup> Edition.

**List of Open Source Software/ Learning website:**

- 1 <https://in.mathworks.com/discovery/optimal-control.html#lqrlqg>
- 2 <https://www.codeproject.com/Articles/863257/Simple-Software-for-Optimal-Control>
- 3 <https://joss.theoj.org/papers/10.21105/joss.02809>
- 4 <https://www.ieee-ras.org/model-based-optimization-for-robotics/resources/optimization-tools>
- 5 <https://www.vlab.co.in/>
- 6 <https://ocw.mit.edu/courses/16-323-principles-of-optimal-control-spring-2008/>

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	1		1	-	1	1	1	1	1	1	2	2	2
CO2	-	2	2	2	1	2	1	1	1	1	1	1	2	2	2
CO3	2	2	2	-	1	1	1	1	1	1	1	1	2	2	2
CO4	2	2	2	-	1	1	1	1	1	1	1	1	2	2	2
CO5	-	1	2	1	1	1	1	1	1	1	1	1	2	2	2
CO6	1	1	1	1	1	-	1	1	1	1	1	1	2	2	2
Avg.	2	2	1.75	2	1	1.3	1	1	1	1	1	1	2	2	2

CIC335

**ADAPTIVE CONTROL**

L T P C  
3 0 0 3

**COURSE OBJECTIVES:**

- To impart knowledge on how to recursively estimate the parameters of discrete input – output models using recursive parameter estimation methods
- To make the student understand the principles of STR, MRAC and Gain scheduling.
- To make the student design simple adaptive controllers for linear systems using STR, MRAC and Gain scheduling

**UNIT I INTRODUCTION**

**(7+2 SKILL) 9**

Introduction - Adaptive Schemes - The adaptive Control Problem – Applications-Parameter estimation:-LS, RLS: and ERLS

**UNIT II GAIN SCHEDULING**

**(7+2 SKILL) 9**

Introduction- The principle - Design of gain scheduling controllers- Nonlinear transformations - application of gain scheduling - Auto-tuning techniques: Methods based on Relay feedback.

**UNIT III DETERMINISTIC SELF-TUNING REGULATORS**

**(7+2 SKILL) 9**

Introduction- Pole Placement design - Indirect Self-tuning regulators - direct self-tuning regulators – Disturbances with known characteristics

**UNIT IV STOCHASTIC AND PREDICTIVE SELF-TUNING REGULATORS (7+2 SKILL) 9**

Introduction – Design of minimum variance controller - Design of moving average controller - stochastic self-tuning regulators

**UNIT V MODEL – REFERENCE ADAPTIVE SYSTEM**

**(7+2 SKILL) 9**

Introduction- MIT rule – Determination of adaptation gain - Lyapunov theory –Design of MRAS using Lyapunov theory – Relations between MRAS and STR.

**TOTAL:45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10**

- 1 Learn any one relevant software tool (MATLAB/ SCILAB/ LABVIEW/ Equivalent open source software)
- 2 Design of gain scheduling adaptive control using any one software tool
- 3 Analysis/Problem Solving - Ability to identify and define problems and solutions
- 4 Design and verification of MRAC by simulation.

**COURSE OUTCOMES:**

**Students able to**

- CO1** Ability to apply the estimation algorithm to estimate the parameters of the process.(L3)
- CO2** Ability to apply the adaptive control concepts to control a process. (L3)
- CO3** Use appropriate software tools for design of adaptive controllers and analysis of the process. (L5)
- CO4** Identify, formulate, carry out research by designing suitable adaptive schemes for complex instrumentation problem. (L5)
- CO5** Apply the concepts to design adaptive control for multidisciplinary problem(L3)
- CO6** Choose the techniques for self and lifelong learning to keep in pace with the new technology(L3)

**TEXT BOOKS:**

1. K.J. Astrom and B. J. Wittenmark, “Adaptive Control”, Second Edition, Pearson Education Inc., second Edition 2013.

## REFERENCE BOOKS

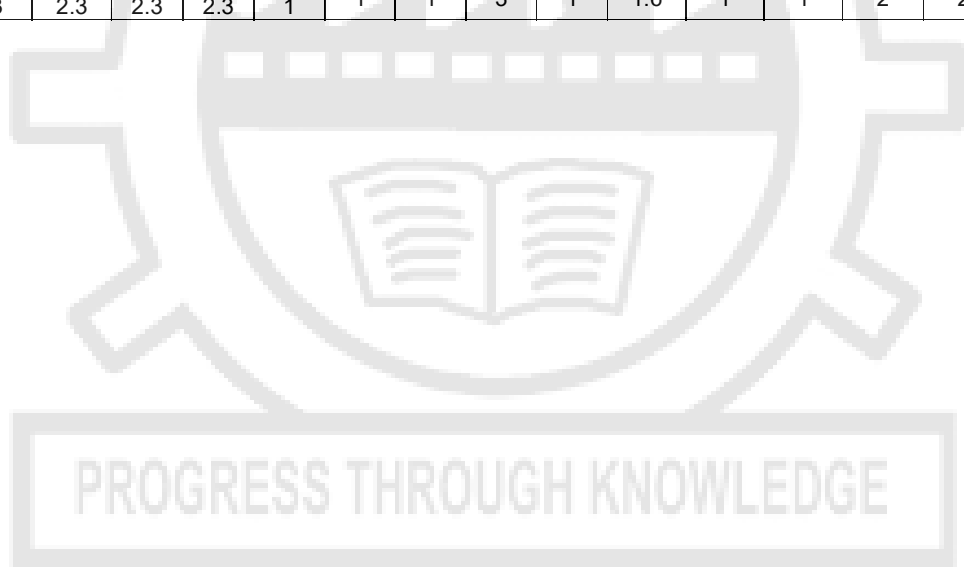
1. T. Soderstrom and Petre Stoica, "System Identification", Prentice Hall International(UK) Ltd., 1989, 1<sup>st</sup> Edition.
2. Lennart Ljung, "System Identification: Theory for the User", Second Edition, Prentice Hall, 1999.

### List of Open Source Software/ Learning website:

- 1 <https://archive.nptel.ac.in/courses/108/102/108102113/>
- 2 <https://in.mathworks.com/help/slcontrol/adaptive-control-design.html>
- 3 <https://in.mathworks.com/videos/nonlinear-model-based-adaptive-robust-controller-in-an-oil-and-gas-wireline-operation-1637577967956.html>
- 4 <https://www.dynalog-us.com/adaptive-robot-control.htm>
- 5 <https://www.vlab.co.in/>

## MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	1	1	3	1	1	1	1	2	2	2
CO2	3	2	2	2	1	1	1	3	1	1	1	1	2	2	2
CO3	3	3	3	3	1	1	1	3	1	3	1	1	2	2	2
CO4	3	3	3	3	1	1	1	3	1	3	1	1	2	2	2
CO5	3	2	2	2	1	1	1	3	1	1	1	1	2	2	2
CO6	3	2	2	2	1	1	1	3	1	1	1	1	2	2	2
Avg.	3	2.3	2.3	2.3	1	1	1	3	1	1.6	1	1	2	2	2





CIC338

**MACHINE MONITORING SYSTEM**

L T P C  
3 0 0 3

**COURSE OBJECTIVES:**

- To make the students familiarize with the concept of condition-based maintenance for effective utilization of machines.
- To Impart the knowledge of artificial intelligence for machinery fault diagnosis.
- To give basic knowledge on vibration monitoring.
- To study the machinery vibrations using signal processing techniques.
- To provide knowledge on FMECA.

**UNIT I INTRODUCTION TO MACHINE CONDITION MONITORING (7+2 SKILL) 9**

Machinery condition monitoring - Present status - Fault prognosis - Future needs.

**UNIT II MACHINERY MAINTENANCE (7+2 SKILL) 9**

Maintenance strategies – Reactive, Preventive, and Predictive – Benefits of planned maintenance – Bath tub curve – Failure Modes Effects and Criticality Analysis (FMECA).

**UNIT III INTRODUCTION TO MACHINERY VIBRATION AND MONITORING (7+2 SKILL) 9**

Characteristics of Vibration systems – Mode shapes & operational deflection shapes – Experimental modal analysis – Principles of vibration monitoring – Machinery faults diagnosed by vibration analysis.

**UNIT IV SIGNAL PROCESSING IN MACHINERY MONITORING (7+2 SKILL) 9**

FFT analysis – Time domain analysis – Time-frequency analysis – Signal filtering – Cepstrum analysis – Health condition of compressor & engine.

**UNIT V MACHINE LEARNING FOR CONDITION MONITORING (7+2 SKILL) 9**

Machine Learning: Feature extraction and feature selection methods – Feature reduction – Classification techniques – Case studies of condition monitoring in Nuclear plant components, Distillation column.

**TOTAL:45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/**

**Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10**

- 1 Survey of critical machinery that requires monitoring system.
- 2 Exposure to practical machinery vibration & monitoring system presently in use.
- 3 Carryout FMECA using software.
- 4 Analyze the health condition of any machinery.

**COURSE OUTCOMES:**

- CO1** Ability to identify the faults in machinery L1.
- CO2** Choose the proper maintenance strategies and condition monitoring techniques for identification of failure in a machine L3.
- CO3** Construct a classifier model for machine learning based fault diagnosis L5.
- CO4** Predict the faulty component in a machine by analyzing the acquired vibration signals L2.
- CO5** Ability to analyze & build a model using modern tools L4.

**TEXT BOOKS:**

1. Cornelius Scheffer and Paresh Girdhar, "Practical Machinery Vibration Analysis and Predictive Maintenance", Elsevier, 2004, 1<sup>st</sup> Edition.
2. A. R. Mohanty, "Machinery Condition Monitoring: Principles and Practices", CRC Press, Taylor & Francis, 1<sup>st</sup> Edition, 2017.

**REFERENCES:**

- 1 Stephen Marsland, Machine Learning: An Algorithmic Perspective, 2<sup>nd</sup> Edition, 2014, CRC, Press.
2. Collacot, “Mechanical Fault Diagnosis and Condition Monitoring”, Chapman- Hall, 1<sup>st</sup> Edition, 2011.
3. Davies, “Handbook of Condition Monitoring – Techniques and Methodology”, Springer, 1<sup>st</sup> Edition, 2011.
4. Ian H. Witten, Eibe Frank, Mark A. Hall, Data Mining: Practical Machine Learning Tools and Techniques, Elsevier, 3rd Edition 2011.
5. Ferdinand van der Heijden, Robert Duin, Dick de Ridder, David M. J. Tax, Classification, Parameter Estimation and State Estimation: An Engineering Approach Using MATLAB, John Wiley & Sons, 2<sup>nd</sup> Edition, 2017.

**List of Open Source Software/ Learning website:**

- 1 [https://onlinecourses.nptel.ac.in/noc22\\_cs29/preview](https://onlinecourses.nptel.ac.in/noc22_cs29/preview)
- 2 <https://www.udemy.com/topic/maintenance-management/>
- 3 <https://www.vi-institute.org/analyst-categories/>
- 4 <https://in.mathworks.com/help/predmaint/ug/condition-monitoring-and-prognostics-using-vibration-signals.html>

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2
CO2	3	2	2	2	1	1	1	1	1	1	1	1	1	2	2
CO3	3	3	3	3	1	1	1	1	1	1	1	1	1	2	2
CO4	2	2	1	2	1	1	1	1	1	1	1	1	1	2	2
CO5	3	3	3	2	1	1	1	1	1	1	1	1	1	2	2
Avg.	2.4	2.2	2	2	1	1	1	1	1	1	1	1	1	2	2



PROGRESS THROUGH KNOWLEDGE

## VERTICAL VI - DIVERSIFIED COURSES

EE3032

ENERGY STORAGE SYSTEMS

LT P C  
3 0 0 3

### COURSE OBJECTIVES:

Students will be able to:

- understand the various types of energy storage Technologies.
- analyze thermal storage system.
- analyze different battery storage technologies
- analyze the thermodynamics of Fuel Cell
- study the various applications of energy storage systems.

### UNIT I INTRODUCTION

(7+2 SKILL) 9

Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications.

### UNIT II THERMAL STORAGE SYSTEM

(7+2 SKILL) 9

Thermal storage – Types – Modeling of thermal storage units – Simple water and rock bed storage system – pressurized water storage system – Modelling of phase change storage system – Simple units, packed bed storage units - Modelling using porous medium approach, Use of TRNSYS.

### UNIT III ELECTRICAL ENERGY STORAGE

(7+2 SKILL) 9

Fundamental concept of batteries – measuring of battery performance, charging and discharging, power density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel – Cadmium, Zinc Manganese dioxide, Li-ion batteries - Mathematical Modelling for Lead Acid Batteries – Flow Batteries.

### UNIT IV FUEL CELL

(7+2 SKILL) 9

Fuel Cell – History of Fuel cell, Principles of Electrochemical storage – Types – Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis – advantages and disadvantages.

### UNIT V ALTERNATE ENERGY STORAGE TECHNOLOGIES

(7+2 SKILL) 9

Flywheel, Super capacitors, Principles & Methods – Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications, Pumped Hydro Storage – Applications.

TOTAL: 45 PERIODS

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc)**

10

1. Model, simulate and analyze the performance characteristics of thermal storage systems
2. Develop a model for latent heat storage in phase changing materials.
3. Model, simulate and analyze the performance characteristics of Lead Acid Batteries
4. Model, simulate and analyze the performance characteristics of Fuel Cell
5. techno-economic analysis of different types of storage systems

### COURSE OUTCOMES:

Upon the successful completion of the course, students will be able to:

CO1: Understand different types storage technologies

- CO2: Design a thermal storage system  
 CO3: Model battery storage system  
 CO4: Analyze the thermodynamics of fuel cell  
 CO5: Analyze the appropriate storage technologies for different applications  
 CO6: explore the alternate energy storage technologies.

**TEXT BOOKS:**

1. Ibrahim Dincer and Mark A. Rosen, 'Thermal Energy Storage Systems and Applications', John Wiley & Sons, 3<sup>rd</sup> Edition, 2021.
2. Ru-shi Liu, Lei Zhang and Xueliang sun, 'Electrochemical technologies for energy storage and conversion', Wiley publications, 2<sup>nd</sup> Volume set, 2012.
3. James Larminie and Andrew Dicks, 'Fuel cell systems Explained', Wiley publications, 3<sup>rd</sup> Edition, 2018.

**REFERENCES:**

1. Lunardini.V.J, 'Heat Transfer in Cold Climates', John Wiley and Sons 1981, 1<sup>st</sup> Edition.
2. Schmidt.F.W. and Willmott.A.J., 'Thermal Energy Storage and Regeneration', Hemisphere Publishing Corporation, 1981, 1<sup>st</sup> Edition.

**List of Open Source Software/ Learning website:**

1. Prof. Subhasish Basu Majumder, "Electrochemical Energy Storage", NPTEL Course, <https://nptel.ac.in/courses/113105102>.
2. Prof. PK Das, "Energy conservation and waste heat recovery", NPTEL Course, <https://nptel.ac.in/courses/112105221>.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1		-	-	-	-	-	-	-	-	-	2	-	3
CO2	3	-	2	-	-	-	-	-	-	-	-	-	2	-	3
CO3	3	-	2	-	-	-	-	-	-	-	-	-	2	-	3
CO4	3	-	2	-	-	-	-	-	-	-	-	-	2	-	3
CO5	3	-	2	-	-	-	-	-	-	-	-	-	2	-	3
CO6	-	3	-	-	-	2	-	1	-	-	-	-	2	-	3
Avg	3	2	2	-	-	2	-	1	-	-	-	-	2	-	3

PROGRESS THROUGH KNOWLEDGE

**COURSE OBJECTIVES:**

- To provide knowledge about different types of hybrid energy systems.
- To analyze the various electrical Generators used for the Wind Energy Conversion Systems.
- To design the power converters used in SPV Systems.
- To analyze the various power converters used in hybrid energy systems and to understand the importance of standalone and grid-connected operation in Hybrid renewable energy systems.
- To analyze the performance of the various hybrid energy systems

**UNIT I INTRODUCTION TO HYBRID ENERGY SYSTEMS (7+2 Skill) 9**

Hybrid Energy Systems – Need for Hybrid Energy Systems – Solar-Wind-Fuel Cell-Diesel, Wind-Biomass-Diesel, Micro-Hydel-PV, Ocean and geyser energy - Classification of Hybrid Energy systems – Importance of Hybrid Energy systems – Advantages and Disadvantages - Environmental aspects of renewable energy - Impacts of renewable energy generation on the environment - Present Indian and international energy scenario of conventional and RE sources - Ocean energy, Hydel Energy - Wind Energy, Biomass energy, Hydrogen energy - Solar Photovoltaic (PV) and Fuel cells: Operating principles and characteristics.

**UNIT II ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEMS (WECS) (7+2 Skill) 9**

Review of reference theory fundamentals –Construction, Principle of operation and analysis: Squirrel Cage Induction Generator (SCIG), Doubly Fed Induction Generator (DFIG) - Permanent Magnet Synchronous Generator (PMSG).

**UNIT III POWER CONVERTERS AND ANALYSIS OF SOLAR PV SYSTEMS (7+2 Skill) 9**

Power Converters for SPV Systems - Line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing - Analysis of SPV Systems - Block diagram of the solar PV systems - Types of Solar PV systems: Stand-alone PV systems,

**UNIT IV ANALYSIS OF POWER CONVERTERS FOR HYBRID ENERGY SYSTEMS (7+2 Skill) 9**

Introduction to Power Converters – Stand-alone Converters -AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters - Bi-Directional Converters - Grid-Interactive Inverters - Matrix converter – Merits and Limitations.

**UNIT V CASE STUDIES FOR HYBRID RENEWABLE ENERGY SYSTEMS (7+2 Skill) 9**

Hybrid Systems- Range and type of Hybrid systems – Performance Analysis – Cost Analysis - Case studies of Diesel-PV, Wind-PV-Fuel-cell, Micro-hydel-PV, Biomass-Diesel-Fuel-cell systems.

**TOTAL : 45 PERIODS****SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10**

1. Simulation of Wind energy conversion system
2. Simulation of power converters
3. Simulations of AC-DC-AC converters, PWM inverters and Matrix Converters with Resistive and dynamic loads

### **COURSE OUTCOMES:**

Upon completion of the course, students will be able to:

- CO1: Analyze the impacts of hybrid energy technologies on the environment and demonstrate them to harness electrical power.
- CO2: Select a suitable Electrical machine for Wind Energy Conversion Systems and simulate wind energy conversion system
- CO3: Design the power converters such as AC-DC, DC-DC, and AC-AC converters for SPV systems.
- CO4: Analyze the power converters such as AC-DC, DC-DC, and AC-AC converters for Hybrid energy systems.
- CO5: Interpret the hybrid renewable energy systems.

### **TEXTBOOKS:**

1. Bahman Zohuri, "Hybrid Energy Systems", Springer, First Edition, 2018.
2. S.M. Muyeen, "Wind Energy Conversion Systems", Springer First Edition, 2012
3. Md. Rabiul Islam, Md. Rakibuzzaman Shah, Mohd Hasan Ali, "Emerging Power Converters for Renewable Energy and Electric Vehicles", CRC Press, First Edition, 2021

### **REFERENCES:**

1. Ernst Joshua, Wind Energy Technology, PHI, India, 2018, 3<sup>rd</sup> Edition.
2. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford University Press, 7<sup>th</sup> Impression, 2005.
3. Rashid.M. H "Power electronics Hand book", Academic press,4<sup>th</sup> Edition, 2018.
4. Rai. G.D, "Non-conventional energy sources", Khanna publishers, 6<sup>th</sup> Edition, 2017.
5. Rai. G.D, "Solar energy utilization", Khanna publishers, 3<sup>rd</sup> Edition, 1987.
6. Gray, L. Johnson, "Wind energy system", Prentice Hall of India, 2<sup>nd</sup> Edition, 2006.
7. B.H.Khan "Non-conventional Energy sources", Tata McGraw hill Publishing Company, New Delhi, 2017, 3<sup>rd</sup> Edition.

### **List of Open Source Software/ Learning website:**

1. <https://www.sciencedirect.com/topics/engineering/hybrid-energy-system>
2. <https://www.sciencedirect.com/topics/engineering/wind-energy-conversion-system>
3. [https://www.academia.edu/35619294/Modeling\\_and\\_Performance\\_Analysis\\_of\\_Solar\\_PV\\_System\\_and\\_DC\\_DC\\_Converters](https://www.academia.edu/35619294/Modeling_and_Performance_Analysis_of_Solar_PV_System_and_DC_DC_Converters)
4. [https://www.mdpi.com/journal/energies/special\\_issues/Power\\_Converter\\_Electric\\_Machines\\_Renewable\\_Energy\\_Systems\\_Transportation](https://www.mdpi.com/journal/energies/special_issues/Power_Converter_Electric_Machines_Renewable_Energy_Systems_Transportation)
5. <https://www.intechopen.com/chapters/64317>

## MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	-	-	-	-	-	3	-	3	3	3	3
CO2	3	3	3	2	3	-	-	-	-	3	-	3	3	3	3
CO3	3	3	3	2	3	-	-	-	-	3	-	3	3	3	3
CO4	3	3	3	2	3	-	-	-	-	3	-	3	3	3	3
CO5	3	3	3	2	-	-	-	-	-	3	-	3	3	3	3
Avg	3	3	3	2	3	-	-	-	-	3	-	3	3	3	3

**EE3034**

### DESIGN AND MODELLING OF RENEWABLE ENERGY SYSTEMS

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- To review the renewable energy systems and technology
- To learn the Single phase grid-connected photovoltaic systems and three phase photovoltaic systems
- To illustrate the small wind energy systems
- To simulate the Doubly-fed induction generator based WECS

**UNIT I RENEWABLE ENERGY SYSTEMS: TECHNOLOGY OVERVIEW AND PERSPECTIVES**

**(7+2 Skill) 9**

Introduction-State of the Art- Examples of Recent Research and Development Challenges and Future Trends

**UNIT II SINGLE-PHASE GRID-CONNECTED PHOTOVOLTAIC SYSTEMS (7+2 Skill) 9**

Introduction- Demands for Grid-Connected PV Systems-Power Converter Technology for Single-Phase PV Systems, Transformer less AC-Module Inverters (Module-Integrated PV Converters, Transformer less Single-Stage String Inverters, DC-Module Converters in Transformer less Double-Stage PV Systems

**UNIT III THREE-PHASE PHOTOVOLTAIC SYSTEMS: STRUCTURES, TOPOLOGIES**

**(7+2 Skill) 9**

Introduction-PV Inverter Structures, Three-Phase PV Inverter Topologies- -Control Building Blocks for PV Inverters, Modulation Strategies for Three-Phase PV Inverters, Implementation of the Modulation Strategies., Grid Synchronization, Implementation of the PLLs for Grid Synchronization, Current Control, Implementation of the Current Controllers, Maximum Power Point Tracking.

**UNIT IV SMALL WIND ENERGY SYSTEMS**

**(7+2 Skill) 9**

Introduction-Generator Selection for Small-Scale Wind Energy Systems- Turbine Selection for Wind Energy- Self-Excited Induction Generators for Small Wind Energy Applications- Permanent Magnet Synchronous Generators for Small Wind Power Applications- Grid-Tied Small Wind Turbine Systems-Magnus Turbine–Based Wind Energy System

## UNIT V DOUBLY-FED INDUCTION GENERATOR-BASED WECS

(7+2 Skill) 9

Introduction – modelling of induction machine in machine variable form and arbitrary reference frame, modelling of Doubly-fed Induction Generator.

**TOTAL : 45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)** **10**

1. Simulation of inverter for PV systems
2. Simulation of WECS with DFIG

**List of Open Source Software/ Learning website:**

1. [https://www.mdpi.com/journal/applsci/topical\\_collections/Susta\\_Energy](https://www.mdpi.com/journal/applsci/topical_collections/Susta_Energy)
2. <https://www.mathworks.com/help/sps/ug/single-phase-grid-connected-in-pv-system.html>
3. <https://www.sciencedirect.com/topics/engineering/three-phase-inverter>
4. [academia.edu/32704493/Wind\\_Power\\_Lecture\\_Notes](https://www.academia.edu/32704493/Wind_Power_Lecture_Notes)
5. <https://www.syscop.de/files/2018ss/WES/handouts/script.pdf>
6. <https://www.sciencedirect.com/topics/engineering/wound-rotor-induction-generator>

### **COURSE OUTCOMES:**

Upon completion of the course, students will be able to:

CO1: Review the perspectives of renewable energy systems

CO2: Integrate photovoltaic systems with grid

CO3: Study inverter for PV systems

CO4: Elaborate the working of small wind power systems

CO5: Study the features of induction machine and doubly fed induction machine

### **TEXT BOOKS:**

1. Ahmad Azar, Nashwa Kamal, "Design, Analysis and Applications of Renewable Energy Systems", Academic Press, First Edition, 2021
2. Ahmad Azar, Nashwa Kamal, "Renewable Energy Systems", Academic Press, First Edition, 2021
3. Nabil Derbel, Quanmin Zhu Modeling, "Identification and Control Methods in Renewable Energy Systems", Springer, First Edition, 2019

### **REFERENCES:**

1. Power Conversion and Control of Wind Energy Systems, Bin Wu, 2011, Wiley-IEEE, 1<sup>st</sup> Edition.
2. Wind Electrical Systems, S.N. Bhadra, 2005, Oxford, 7<sup>th</sup> Impression.
3. Wind Power Integration - Connection and System Operational Aspects, Brendan Fox, 2014, IET, 2<sup>nd</sup> Edition.
4. Renewable Energy Devices and Systems with Simulations in MATLAB and ANSYS, Frede Blaabjerg, Dan M. Ionel, CRC press, 2017, 1<sup>st</sup> Edition.



### MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	3	2	-	-	-	-	-	-	-	-	3	-	2
CO2	3	2	3	3	-	-	-	-	-	-	-	-	3	3	3
CO3	3	2	3	3	2	-	-	-	-	-	-	-	3	3	3
CO4	3	2	3	3	-	-	-	-	-	-	-	-	3	3	3
CO5	3	2	3	3	2	-	-	-	-	-	-	-	3	3	3
Avg	3	2	3	2.8	2	-	-	-	-	-	-	-	3	3	2.8

**EE3035**

**GRID INTEGRATING TECHNIQUES AND CHALLENGES**

**L T P C**

**2 0 2 3**

**COURSE OBJECTIVES:**

- To study about the present power Scenario
- To model a micro grid system
- To model power converter for grid interconnection
- To integrate wind energy conversion system with grid
- To simulate power converters like three phase inverters and DC-DC converters

**UNIT I PRESENT POWER SCENARIO IN INDIA**

**6**

Introduction - Thermal Power Plant , Components of Thermal Power Plant , Major Thermal Power Plants in India- Gas-Based Power Generation - Nuclear Power Plants -Hydropower Generation - Pumped Storage Plants - Solar Power - Wind Energy – Power plants India

**UNIT II POWER GRIDS**

**6**

Introduction -Electric Power ,Background , The Construction of a Power Grid System , Basic Concepts of Power Grids -Load Models - Transformers in Electric Power Grids - Modelling a Microgrid System

**UNIT III MODELING OF CONVERTERS IN POWER GRID DISTRIBUTED GENERATION SYSTEMS**

**6**

Introduction - Single-Phase DC/AC Inverters with Two Switches, Three-Phase DC/AC Inverters, Pulse Width Modulation Methods, The Triangular, The Identity Method, Analysis of DC/AC Three-Phase Inverters. Micro grid of Renewable Energy Systems- DC/DC Converters in Green Energy -Pulse Width Modulation -Sizing of an Inverter for Microgrid Operation, Sizing of a Rectifier for Microgrid Operation, The Sizing of DC/DC Converters for Micro grid

**UNIT IV WIND ENERGY SYSTEM GRID INTEGRATION****6**

Introduction- Significance of Electrical Power Quality in Wind Power System- Integration Issues in Grid-Connected Wind Energy- Effect of Power Quality Issues, Importance of Custom Power Devices- Power Quality Point of View.

**UNIT V GRID INTER CONNECTION****6**

Grid Code requirements-Grid integration of WECS-Grid Integration of PV systems

**30 PERIODS****LAB COMPONENT****30 PERIODS**

1. Develop a model for the control of DC micro grid for non linear loads
2. Simulation study of three phase inverters with fixed and sine PWM techniques, Simulation and Design of buck/boost converters.
3. Simulate a Grid Connected Wind Energy System with STATCOM and investigate the improvement in power quality.

**TOTAL: 30+30 = 60 PERIODS****COURSE OUTCOMES:**

Upon completion of the course, Students able to

- CO1 Review the power sector scenario in India.
- CO2 Model a microgrid system
- CO3 Model a converter for power grid distributed system.
- CO4 Integrate wind energy system.
- CO5 Simulate three phase inverter with fixed and sine PWM.

**TEXT BOOKS:**

1. Brian D'Andrade "The Power Grid", Academic Press, 1st Edition, 2017.
2. Yang Han, "Modeling and Control of Power Electronic Converters for Microgrid Applications", Springer, 1<sup>st</sup> Edition 2022.
3. Siegfried Heier, "Grid Integration of Wind Energy: Onshore and Offshore Conversion Systems", John Wiley & Sons, Ltd, 2014, 3<sup>rd</sup> Edition.

**REFERENCES:**

1. Integration of Renewable Energy Sources with Smart Grid, M. Kathiresh, A. Mahaboob Subahani, and G.R. Kanaga chidambaresan, Scrivener & Wiley, 2021, 1<sup>st</sup> Edition.
2. Control and Operation of Grid-Connected Wind Energy Systems, Ali M. Eltamaly, Almoataz Y. Abdelaziz, Ahmed G. Abo-Khalil, Springer 2021, 1<sup>st</sup> Edition.
3. Design of smart power grid renewable energy systems, Third Edition, Ali Keyhani, Wiley 2019.
4. Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, Wiley 2017, 1<sup>st</sup> Edition.
5. Fundamentals of Power Electronics with MATLAB, Randall Shaffer, Laxmi publications, 2013, 2<sup>nd</sup> Edition.
6. Power Conversion and Control of Wind Energy Systems, Bin Wu, 2011, Wiley-IEEE, 1<sup>st</sup> Edition.
7. Wind Power Integration - Connection and System Operational Aspects, Brendan Fox, 2014, IET, 2<sup>nd</sup> Edition.
8. Renewable Energy Devices and Systems with Simulations in MATLAB and ANSYS, Frede Blaabjerg, Dan M. Ionel, CRC press, 2017, 1<sup>st</sup> Edition.

**List of Open Source Software/ Learning website:**

1. [https://www.academia.edu/14628492/Current\\_Power\\_Scenario\\_In\\_India](https://www.academia.edu/14628492/Current_Power_Scenario_In_India)
2. [https://energyeducation.ca/encyclopedia/Electrical\\_grid](https://energyeducation.ca/encyclopedia/Electrical_grid)
3. [https://www.academia.edu/32120081/Power\\_Converters\\_Modeling\\_in\\_Matlab\\_Simulink\\_for\\_Micr](https://www.academia.edu/32120081/Power_Converters_Modeling_in_Matlab_Simulink_for_Micr)
4. [ogrid\\_Simulations\\_Power\\_Converters\\_Modeling\\_in\\_Matlab\\_Simulink\\_for\\_Microgrid\\_Simulations](https://www.academia.edu/32120081/Power_Converters_Modeling_in_Matlab_Simulink_for_Microgrid_Simulations)
5. <https://dnv.com/services/wind-farm-control-and-grid-integration>
6. <https://www.wind-energy-the-facts.org/images/chapter2.pdf>

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	3	-	3	3	3	3
CO2	3	-	2	-	3	-	-	-	-	3	-	3	3	3	3
CO3	3	3	3	2	3	-	-	-	-	3	-	3	3	3	3
CO4	3	3	1	3	3	-	-	-	-	3	-	3	3	3	3
CO5	3	3	2	3	-	-	-	-	-	3	-	3	3	3	3
Avg	3	3	2	2	3	-	-	-	-	3	-	3	3	3	3

**EE3036**

**SUSTAINABLE AND ENVIRONMENTAL FRIENDLY  
HV INSULATION SYSTEM**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- To Know about the products related with sustainable applicaton.
- To learn about Green Gaseous, liquid solid insulators.
- To understand the standards for green insulation systems.

**UNIT I SUSTAINABLE AND ENVIRONMENTAL ENERGY AND PRODUCTS 9**

Carbon print, global warming potential, environment requirement for any product and system.

**UNIT II ALTERNATE GREEN GASEOUS INSULATORS 9**

SF6 gas and its hazardous environmental effects, alternate gases, gaseous mixtures and other sources and it's properties.

**UNIT III ALTERNATE GREEN LIQUID INSULATORS 9**

hazardous effects of existing liquid dielectric materials (such as organic oil), alternate sources of environmental friendly liquid such as ester oil, vegetable oils dielectric and it's properties.

**UNIT IV ALTERNATE GREEN SOLID INSULATORS 9**

hazardous effects of existing solid dielectric materials, alternate sources of environmental friendly solid dielectric and its properties.

**UNIT V EVOLVING STANDARDS FOR GREEN INSULATION SYSTEMS 9**

Requirements, evolving standards of management, testing, usage and disposal of alternate insulation systems, Major applications and standards

**TOTAL : 45 PERIODS**

**REFERENCES:**

1. <https://www.iso.org/standard/79064.html>
2. <https://www.ictfootprint.eu/en/iec-tr-627252013-factsheet>
3. [https://www.iec.ch/dyn/www/f?p=103:7:0:::FSP\\_ORG\\_ID,FSP\\_LANG\\_ID:1275,25](https://www.iec.ch/dyn/www/f?p=103:7:0:::FSP_ORG_ID,FSP_LANG_ID:1275,25)
4. [https://www.iec.ch/ords/f?p=103:41:628762356646470:::FSP\\_ORG\\_ID,FSP\\_LANG\\_ID:3237,25](https://www.iec.ch/ords/f?p=103:41:628762356646470:::FSP_ORG_ID,FSP_LANG_ID:3237,25)
5. [https://www.iec.ch/dyn/www/f?p=103:7:0:::FSP\\_ORG\\_ID,FSP\\_LANG\\_ID:1299,25](https://www.iec.ch/dyn/www/f?p=103:7:0:::FSP_ORG_ID,FSP_LANG_ID:1299,25)
6. <https://www.iec.ch/sdqs/sdq13>
7. [http://highperformanceinsulation.eu/wp-content/uploads/2016/08/sustainability\\_a\\_guide.pdf](http://highperformanceinsulation.eu/wp-content/uploads/2016/08/sustainability_a_guide.pdf)

**COURSE OUTCOMES:**

Upon completion of the course, students will be able to:

CO1: Know about sustainable and environmental energy and products.

CO2: Describe the alternate green gaseous insulators.

CO3: Describe the alternate green liquid insulators

CO4: Describe the alternate green solid insulators

CO5: Elaborate the standards for Green insulation systems.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	3	-	-	-	3	-	-	-	-	-	3	-	3
CO2	3	-	3	-	-	-	3	-	-	-	-	-	3	-	3
CO3	3	-	3	-	-	-	3	-	-	-	-	-	3	-	3
CO4	3	-	3	-	-	-	3	-	-	-	-	-	3	-	3
CO5	3	-	3	-	-	-	3	-	-	-	-	-	3	-	3
Avg	3	-	3	-	-	-	3	-	-	-	-	-	3	-	3

**EE3037**

**POWER SYSTEM TRANSIENTS**

**LT P C**

**3 0 0 3**

**OBJECTIVES:**

- To study the generation of switching transients and their control using circuit – theoretical concept.
- To study the mechanism of lightning strokes and the production of lightning surges.
- To study the propagation, reflection and refraction of travelling waves.
- To study the impact of voltage transients caused by faults, circuit breaker action, load rejection on integrated power system.

**UNIT I INTRODUCTION AND SURVEY**

**(7+2 Skill) 9**

Sources of different types of transients - RL circuit transient with sine wave excitation - double frequency transients - basic transforms of the RLC circuit transients - study of transients in system planning - Importance of grounding.

**UNIT II SWITCHING TRANSIENTS**

**(7+2 Skill) 9**

Basic concept of switching transients - resistance switching and equivalent circuit for interrupting the resistor current - load switching and equivalent circuit - waveforms for transient voltage across the load and the switch - normal and abnormal switching transients. Current suppression - current

chopping - effective equivalent circuit - capacitance switching with a restrike, with multiple restrikes - ferro resonance.

**UNIT III LIGHTNING TRANSIENTS (7+2 Skill) 9**

Theories of cloud formation - mechanism of lightning discharges and characteristics of lightning strokes – model for lightning stroke - factors contributing to good line design - protection using ground wires - tower footing resistance - Interaction between lightning and power system.

**UNIT IV TRAVELING WAVES ON TRANSMISSION LINE COMPUTATION OF TRANSIENTS (7+2 Skill) 9**

Computation of transients - transient response of systems with series and shunt lumped parameters and distributed lines. Traveling wave concept - step response - Bewely's lattice diagram - standing waves and natural frequencies - reflection and refraction of travelling waves. Computation of overvoltages using EMTP.

**UNIT V TRANSIENTS IN INTEGRATED POWER SYSTEM 9**

The short line and kilometric fault - distribution of voltages in a power system - Line dropping and load rejection - voltage transients on closing and reclosing lines - overvoltage induced by faults - switching surges on integrated system Qualitative application of EMTP for transient computation.

**TOTAL : 45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 8**

1. Simulation of circuit transients
2. Computation of over voltages for switching surges
3. Computation of over voltages for lightning surges
4. Computation of transients

**COURSE OUTCOMES:**

After completing the course, the students will be above to

CO1 : Explain the principles of transients and its concepts

CO2 : Know the different types of switching transients and the way to draw the necessary equivalent circuit.

CO3: Explain the concepts behind lighting and the way to protect the same.

CO4: Compute the transient behavior in transmission line

CO5: Explain the behavior of the Circuit during switching and to learn the simulation tool.

**TEXT BOOKS:**

1. Allan Greenwood, 'Electrical Transients in Power Systems', Wiley Inter Science, New York, 2<sup>nd</sup> Edition, 1991.
2. Pritindra Chowdhari, "Electromagnetic transients in Power System", John Wiley and Sons Inc., Second Edition, 2009.
3. C.S. Indulkar, D.P.Kothari, K. Ramalingam, 'Power System Transients – A statistical approach', PHI Learning Private Limited, Second Edition, 2010.

**REFERENCES:**

1. M.S.Naidu and V.Kamaraju, 'High Voltage Engineering', Tata McGraw Hill, Fifth Edition, 2013.
2. R.D. Begamudre, 'Extra High Voltage AC Transmission Engineering', Wiley Eastern Limited, 1986.
3. Y.Hase, Handbook of Power System Engineering," Wiley India, 2012.
4. J.L.Kirtley, "Electric Power Principles, Sources, Conversion, Distribution and use," Wiley, 2012.

### MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	3	3	2	-	2	-	-	-	-	3	3	3	3
CO2	3	3	3	3	2	-	2	-	-	-	-	3	3	3	3
CO3	3	3	3	3	2	-	2	-	-	-	-	3	3	3	3
CO4	3	3	3	3	2	-	2	-	-	-	-	3	3	3	3
CO5	3	3	3	3	2	-	2	-	-	-	-	3	3	3	3
Avg	3	3	3	3	2	-	2	-	-	-	-	3	3	3	3

**CEI331**

**PLC PROGRAMMING**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To know about the basics of PLC and Automation
- To understand the importance of Automation
- To explore various types and manufactures of PLCs.
- To introduce types of programming languages of PLC and some exercise few programs.

**UNIT I INTRODUCTION**

**(7+2 SKILL) 9**

Programmable Logic Controller (PLC)- Block diagram of PLC- Programming languages of PLC- Basic instruction sets- Design of alarm and interlocks- Networking of PLC- Overview of safety of PLC with case studies- Process Safety Automation: Levels of process safety through use of PLCs- IEC 61131-3 Standard - Application of international standards in process safety control.

**UNIT II IEC 61131-3**

**(7+2 SKILL) 9**

Rails- Rungs- Relay Logic- Latch switch- Timers- Counters- Boolean logics- Math Instructions- Data manipulation Instructions- Requirement of communication networks for PLC, PLC to PC Communication to computer- FBD equivalent to LL- FBD Programming- IL- SFC-ST.

**UNIT III SCADA**

**(7+2 SKILL) 9**

Elements of SCADA system- History of SCADA, Remote Terminal Unit- Discrete control- Analog control, Master Terminal Unit- Operator interface.

**UNIT IV HART and Field Bus**

**(7+2 SKILL) 9**

Introduction- Evolution of signal standards- HART communication protocol- communication modes- HART networks- HART commands- HART and OSI model- Field bus- Architecture- Basic requirements of field Busstandard- Field bus Topology- Interoperability- Interchangeability.

**UNIT V PLC PROGRAMMING**

**(7+2 SKILL) 9**

Exercise in Programming Languages from IEC 61131-3: Traffic Light Control- Two way- Four way – Water Level Control- Automatic Material Sorting System- Automatic Bottle Filling System, Code Converters- DC motor Control- Alarm Circuit.

**TOTAL : 45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)**

**10**

- 1 Taking Local area to implement simple closed loop system for any system using PLC.
- 2 Making a complete automated control loop with Supervisory and HMI system.
- 3 Implementing an Alarm based control scheme and run in a simulated environment.
- 4 Designing an entire PLC logic for filling and draining water tank automatically.

**COURSE OUTCOMES:**

- CO1** Understand the basics and need for Automation in industries .
- CO2** Explain the logic and flow of any particular programming written for a process .
- CO3** Apply the knowledge to design or improve an existing program to increase productivity of any process .
- CO4** Breakdown SCADA architecture and communication protocols.
- CO5** Build and logic in any of the programming languages from IEC- 61131- 3 standard .

**TEXT BOOKS:**

1. Frank D. Petruzella, “Programmable Logic Controllers”, 5th Edition, McGraw- Hill, New York, 2019.
2. Stuart Boyer A, “SCADA: Supervisory control and data Acquisition”, Fourth Edition, ISA- The Instrumentation, Systems, and Automation Society,2010

**REFERENCES**

1. Bolton. W, “Programmable Logic Controllers”, Elsevier Newnes, 6<sup>th</sup> Edition 2015.

**List of Open-Source Software/ Learning website:**

- 1 <https://nptel.ac.in/courses/108105062>
- 2 <https://nptel.ac.in/courses/108105088>
- 3 <http://www.nitttrc.edu.in/nptel/courses/video/105105201/lec56.pdf>
- 4 <https://nptel.ac.in/courses/108106022>
- 5 <https://new.siemens.com/global/en/products/automation/systems/industrial/plc/logo/logo-software.html>
- 6 [https://componentsearchengine.com/library/proteus?gclid=CjwKCAjw\\_ISWBhBkEiwAdqxb9okU2ZZHcQoa9fSRK2Uq41Rq0GZxdGUP6\\_6GIBv77p4JqGt\\_iDAIjhoCksEQAvD\\_BwE](https://componentsearchengine.com/library/proteus?gclid=CjwKCAjw_ISWBhBkEiwAdqxb9okU2ZZHcQoa9fSRK2Uq41Rq0GZxdGUP6_6GIBv77p4JqGt_iDAIjhoCksEQAvD_BwE)

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
<b>CO1</b>	2	2	2	2	-	-	-	1	-	1	-	-	-	-	-
<b>CO2</b>	2	2	2	2	-	-	-	1	-	1	-	-	-	-	-
<b>CO3</b>	3	2	2	2	-	-	-	1	-	1	-	-	-	-	-
<b>CO4</b>	3	3	3	2	-	-	-	1	-	1	-	-	-	-	-
<b>CO5</b>	3	2	2	2	-	-	-	1	-	1	-	-	-	-	-
<b>AVg.</b>	2.6	2.2	2.2	2	-	-	-	1	-	1	-	-	-	-	-

**COURSE OBJECTIVES:**

- To understand big data.
- To learn and use NoSQL big data management.
- To learn mapreduce analytics using Hadoop and related tools.
- To work with map reduce applications
- To understand the usage of Hadoop related tools for Big Data Analytics

**UNIT I UNDERSTANDING BIG DATA 5**

Introduction to big data – convergence of key trends – unstructured data – industry examples of big data – web analytics – big data applications– big data technologies – introduction to Hadoop – open source technologies – cloud and big data – mobile business intelligence – Crowd sourcing analytics – inter and trans firewall analytics.

**UNIT II NOSQL DATA MANAGEMENT 7**

Introduction to NoSQL – aggregate data models – key-value and document data models – relationships – graph databases – schemaless databases – materialized views – distribution models – master-slave replication – consistency - Cassandra – Cassandra data model – Cassandra examples – Cassandra clients

**UNIT III MAP REDUCE APPLICATIONS 6**

MapReduce workflows – unit tests with MRUnit – test data and local tests – anatomy of MapReduce job run – classic Map-reduce – YARN – failures in classic Map-reduce and YARN – job scheduling – shuffle and sort – task execution – MapReduce types – input formats – output formats.

**UNIT IV BASICS OF HADOOP 6**

Data format – analyzing data with Hadoop – scaling out – Hadoop streaming – Hadoop pipes – design of Hadoop distributed file system (HDFS) – HDFS concepts – Java interface – data flow – Hadoop I/O – data integrity – compression – serialization – Avro – file-based data structures - Cassandra – Hadoop integration.

**UNIT V HADOOP RELATED TOOLS 6**

Hbase – data model and implementations – Hbase clients – Hbase examples – praxis. Pig – Grunt – pig data model – Pig Latin – developing and testing Pig Latin scripts. Hive – data types and file formats – HiveQL data definition – HiveQL data manipulation – HiveQL queries.

**TOTAL:30 PERIODS****COURSE OUTCOMES:**

**After the completion of this course, students will be able to:**

**CO1:**Describe big data and use cases from selected business domains.

**CO2:**Explain NoSQL big data management.

**CO3:**Install, configure, and run Hadoop and HDFS.

**CO4:**Perform map-reduce analytics using Hadoop.

**CO5:**Use Hadoop-related tools such as HBase, Cassandra, Pig, and Hive for big data analytics.



**LIST OF EXPERIMENTS:****30 PERIODS**

1. Downloading and installing Hadoop; Understanding different Hadoop modes. Startup scripts, Configuration files.
2. Hadoop Implementation of file management tasks, such as Adding files and directories, retrieving files and Deleting files
3. Implement of Matrix Multiplication with Hadoop Map Reduce
4. Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm.
5. Installation of Hive along with practice examples.
7. Installation of HBase, Installing thrift along with Practice examples
8. Practice importing and exporting data from various databases.

**Software Requirements:****Cassandra, Hadoop, Java, Pig, Hive and HBase.****TOTAL:60 PERIODS****TEXT BOOKS:**

1. Michael Minelli, Michelle Chambers, and AmbigaDhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
2. Eric Sammer, "Hadoop Operations", O'Reilley, 2012.
3. Sadalage, Pramod J. "NoSQL distilled", 2013

**REFERENCES:**

1. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012.
2. Lars George, "HBase: The Definitive Guide", O'Reilley, 2011.
3. Eben Hewitt, "Cassandra: The Definitive Guide", O'Reilley, 2010.
4. Alan Gates, "Programming Pig", O'Reilley, 2011.

**MAPPING OF COs WITH POs AND PSOs**

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3	-	-	-	2	2	3	1	1	3	3
2	3	3	2	3	2	-	-	-	2	2	3	3	2	3	2
3	3	3	3	2	3	-	-	-	2	2	1	2	2	3	3
4	2	3	3	3	3	-	-	-	2	2	3	2	3	3	2
5	3	3	3	3	3	-	-	-	3	1	3	2	3	2	3
AVg.	2.8	3	2.8	2.8	2.8	-	-	-	2.2	1.8	2.6	2	2.2	2.8	2.6



- b) Figurative language.
- c) (Simile, metaphor, conceit, symbol, pun and irony).
- d) Personification and animation.
- e) Rhetoric and trend.

#### 4. Elements of drama

- a) Drama as representational art.
- b) Content mode and elements.
- c) Theatrical performance.
- d) Drama as narration, mediation and persuasion.
- e) Features of tragedy, comedy and satire.

### 3. READINGS:

1. An Introduction to the Study of English Literature, W.H. Hudson, Atlantic, 2007.
2. An Introduction to Literary Studies, Mario Klarer, Routledge, 2013.
3. The Experience of Poetry, Graham Mode, Open college of Arts with Open Unv Press, 1991.
4. The Elements of Fiction: A Survey, Ulf Wolf (ed), Wolfstuff, 2114.
5. The Elements of Drama, J.L.Styan, Literary Licensing, 2011.

#### 3.1 Textbook:

3.2 \*Reference Books:: To be decided by the teacher and student, on the basis of individual student so as to enable him or her to write the term paper.

### 4. OTHER SESSION:

4.1\*Tutorials:

4.2\*Laboratory:

4.3\*Project: The students will write a term paper to show their understanding of a particular piece of literature

### 5.\*ASSESSMENT:

5.1HA:

5.2Quizzes-HA:

5.3Periodical Examination: one

5.4Project/Lab: one (under the guidance of the teachers the students will take a volume of poetry, fiction or drama and write a term paper to show their understanding of it in a given context; sociological, psychological, historical, autobiographical etc.

5.5Final Exam:

**TOTAL : 45 PERIODS**

### OUTCOME OF THE COURSE:

- Students will be able to understand the relevance of literature in human life and appreciate its aspects in developing finer sensibilities.

**MX3083**

**FILM APPRECIATION**

**L T P C  
3 0 0 0**

In this course on film appreciation, the students will be introduced broadly to the development of film as an art and entertainment form. It will also discuss the language of cinema as it evolved over a century. The students will be taught as to how to read a film and appreciate the various nuances of a film as a text. The students will be guided to study film joyfully.

### **Theme - A: The Component of Films**

- A-1: The material and equipment
- A-2: The story, screenplay and script
- A-3: The actors, crew members, and the director
- A-4: The process of film making... structure of a film

### **Theme - B: Evolution of Film Language**

- B-1: Film language, form, movement etc.
- B-2: Early cinema... **silent film** (Particularly French)
- B-3: The emergence of feature films: **Birth of a Nation**
- B-4: Talkies

### **Theme - C: Film Theories and Criticism/Appreciation**

- C-1: Realist theory; Auteurists
- C-2: Psychoanalytic, Ideological, Feminists
- C-3: How to read films?
- C-4: Film Criticism / Appreciation

### **Theme – D: Development of Films**

- D-1: Representative Soviet films
- D-2: Representative Japanese films
- D-3: Representative Italian films
- D-4: Representative Hollywood film and the studio system

### **Theme - E: Indian Films**

- E-1: The early era
- E-2: The important films made by the directors
- E-3: The regional films
- E-4: The documentaries in India

### **READING:**

A Reader containing important articles on films will be prepared and given to the students. The students must read them and present in the class and have discussion on these.

**MX3084**

**DISASTER RISK REDUCTION AND MANAGEMENT**

**L T P C  
3 0 0 0**

### **COURSE OBJECTIVE**

- To impart knowledge on concepts related to disaster, disaster risk reduction, disaster management
- To acquaint with the skills for planning and organizing disaster response

### **UNIT I                    HAZARDS, VULNERABILITY AND DISASTER RISKS                    9**

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Types of Disasters: Natural, Human induced, Climate change induced –Earthquake, Landslide, Flood, Drought, Fire etc – Technological disasters- Structural collapse, Industrial accidents, oil spills -Causes, Impacts including social, Economic, political, environmental, health, psychosocial, etc.- Disaster vulnerability profile of India and Tamil Nadu - Global trends in disasters: urban disasters, pandemics, Complex emergencies, - -, Inter relations between Disasters and Sustainable development Goals.

### **UNIT II                    DISASTER RISK REDUCTION (DRR)                    9**

Sendai Framework for Disaster Risk Reduction, Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community Based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Early Warning System – Advisories from Appropriate Agencies.- Relevance of indigenous Knowledge, appropriate technology and Local resources.

**UNIT III      DISASTER MANAGEMENT      9**

Components of Disaster Management – Preparedness of rescue and relief, mitigation, rehabilitation and reconstruction- Disaster Risk Management and post disaster management – Compensation and Insurance- Disaster Management Act (2005) and Policy - Other related policies, plans, programmes and legislation - Institutional Processes and Framework at State and Central Level- (NDMA –SDMA-DDMA-NRDF- Civic Volunteers)

**UNIT IV      TOOLS AND TECHNOLOGY FOR DISASTER MANAGEMENT      9**

Early warning systems -Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment. - Elements of Climate Resilient Development –Standard operation Procedure for disaster response – Financial planning for disaster Management

**UNIT V      DISASTER MANAGEMENT: CASE STUDIES      9**

Discussion on selected case studies to analyse the potential impacts and actions in the context of disasters-Landslide Hazard Zonation: Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.- Field work-Mock drill -

**TOTAL : 45 PERIODS**

**TEXT BOOKS:**

- 1 Taimpo (2016), Disaster Management and Preparedness, CRC Publications
- 2 Singh R (2017), Disaster Management Guidelines for earthquakes, Landslides, Avalanches and tsunami, Horizon Press Publications
- 3 Singhal J.P. “Disaster Management”, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
- 4 Tushar Bhattacharya, “Disaster Science and Management”, McGraw Hill India Education Pvt. Ltd., 2012. ISBN-10: 1259007367, ISBN-13: 978-1259007361]

**REFERENCES**

1. Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005.
2. Government of India, National Disaster Management Policy, 2009.
3. Shaw R (2016), Community based Disaster risk reduction, Oxford University Press

**COURSE OUTCOME:**

- CO1:** To impart knowledge on the concepts of Disaster, Vulnerability and Disaster Risk reduction (DRR)
- CO2:** To enhance understanding on Hazards, Vulnerability and Disaster Risk Assessment prevention and risk reduction
- CO3:** To develop disaster response skills by adopting relevant tools and technology
- CO4:** Enhance awareness of institutional processes for Disaster response in the country and
- CO5:** Develop rudimentary ability to respond to their surroundings with potential Disaster response in areas where they live, with due sensitivity

### COs – POs & PSOs MAPPING

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	3	-	-	2	2	-	-	2	-	2	-	1
2	3	3	3	3	-	-	2	1	-	-	2	-	2	-	1
3	3	3	3	3	-	-	2	2	-	-	-	-	2	-	1
4	3	3	2	3	-	-	2	1	-	-	2	-	2	-	1
5	3	3	2	3	-	-	2	2	-	-	2	-	3	-	1
<b>AVG</b>	3	3	3	3	-	-	2	2	-	-	2	-	2	-	1

### MANDATORY COURSES II

**MX3085**

**WELL-BEING WITH TRADITIONAL PRACTICES-YOGA,  
AYURVEDA AND SIDDHA**

**L T P C  
3 0 0 0**

**COURSE OBJECTIVES:**

- To enjoy life happily with fun filled new style activities that help to maintain health also
- To adapt a few lifestyle changes that will prevent many health disorders
- To be cool and handbill every emotion very smoothly in every walk of life
- To learn to eat cost effective but healthy foods that are rich in essential nutrients
- To develop immunity naturally that will improve resistance against many health disorders

**UNIT I HEALTH AND ITS IMPORTANCE**

**2+4**

**Health: Definition - Importance of maintaining health** - More importance on prevention than treatment

Ten types of health one has to maintain - Physical health - Mental health - Social health - Financial health - Emotional health - Spiritual health - Intellectual health - Relationship health - Environmental health - Occupational/Professional health.

**Present health status** - The life expectancy-present status - mortality rate - dreadful diseases - Non-communicable diseases (NCDs) the leading cause of death - 60% - heart disease – cancer – diabetes - chronic pulmonary diseases - risk factors – tobacco – alcohol - unhealthy diet - lack of physical activities.

**Types of diseases and disorders** - Lifestyle disorders – Obesity – Diabetes - Cardiovascular diseases – Cancer – Strokes – COPD - Arthritis - Mental health issues.

**Causes of the above diseases / disorders - Importance of prevention of illness** - Takes care of health - Improves quality of life - Reduces absenteeism - Increase satisfaction - Saves time

**Simple lifestyle modifications to maintain health** - Healthy Eating habits (Balanced diet according to age) Physical Activities (Stretching exercise, aerobics, resisting exercise) - Maintaining BMI-Importance and actions to be taken

## UNIT II DIET

4+6

**Role of diet in maintaining health** - energy one needs to keep active throughout the day - nutrients one needs for growth and repair - helps one to stay strong and healthy - helps to prevent diet-related illness, such as some cancers - keeps active and - helps one to maintain a healthy weight - helps to reduce risk of developing lifestyle disorders like diabetes – arthritis – hypertension – PCOD – infertility – ADHD – sleeplessness -helps to reduce the risk of heart diseases - keeps the teeth and bones strong.

**Balanced Diet and its 7 Components** - Carbohydrates – Proteins – Fats – Vitamins – Minerals - Fibre and Water.

**Food additives and their merits & demerits** - Effects of food additives - Types of food additives - Food additives and processed foods - Food additives and their reactions

### **Definition of BMI and maintaining it with diet**

Importance - Consequences of not maintaining BMI - different steps to maintain optimal BM

### **Common cooking mistakes**

Different cooking methods, merits and demerits of each method

## UNIT III ROLE OF AYURVEDA & SIDDHA SYSTEMS IN MAINTAINING HEALTH

4+4

**AYUSH systems and their role in maintaining health** - preventive aspect of AYUSH - AYUSH as a soft therapy.

**Secrets of traditional healthy living** - Traditional Diet and Nutrition - Regimen of Personal and Social Hygiene - Daily routine (Dinacharya) - Seasonal regimens (Ritucharya) - basic sanitation and healthy living environment - Sadvritta (good conduct) - for conducive social life.

**Principles of Siddha & Ayurveda systems** - Macrocosm and Microcosm theory - Pancheekarana Theory / (Five Element Theory) 96 fundamental Principles - Uyir Thathukkal (Tri-Dosha Theory) - Udal Thathukkal

### **Prevention of illness with our traditional system of medicine**

Primary Prevention - To decrease the number of new cases of a disorder or illness - Health promotion/education, and - Specific protective measures - Secondary Prevention - To lower the rate of established cases of a disorder or illness in the population (prevalence) - Tertiary Prevention - To decrease the amount of disability associated with an existing disorder.

## UNIT IV MENTAL WELLNESS

3+4

**Emotional health** - Definition and types - Three key elements: the subjective experience - the physiological response - the behavioral response - Importance of maintaining emotional health - Role of emotions in daily life -Short term and long term effects of emotional disturbances - Leading a healthy life with emotions - Practices for emotional health - Recognize how thoughts influence emotions - Cultivate positive thoughts - Practice self-compassion - Expressing a full range of emotions.

**Stress management** - Stress definition - Stress in daily life - How stress affects one's life - Identifying the cause of stress - Symptoms of stress - Managing stress (habits, tools, training, professional help) - Complications of stress mismanagement.

**Sleep** - Sleep and its importance for mental wellness - Sleep and digestion.

**Immunity** - Types and importance - Ways to develop immunity

## UNIT V YOGA

2+12

**Definition and importance of yoga** - Types of yoga - How to Choose the Right Kind for individuals according to their age - The Eight Limbs of Yoga - Simple yogasanas for cure and prevention of health disorders - What yoga can bring to our life.

**TOTAL : 45 PERIODS**

### TEXT BOOKS:

1. Nutrition and Dietetics - Ashley Martin, Published by White Word Publications, New York, NY 10001, USA
2. Yoga for Beginners\_ 35 Simple Yoga Poses to Calm Your Mind and Strengthen Your Body,  
by Cory Martin, Copyright © 2015 by Althea Press, Berkeley, California

### REFERENCES:

1. WHAT WE KNOW ABOUT EMOTIONAL INTELLIGENCE How It Affects Learning, Work, Relationships, and Our Mental Health, by Moshe Zeidner, Gerald Matthews, and Richard D. Roberts  
A Bradford Book, The MIT Press, Cambridge, Massachusetts, London, England
2. The Mindful Self-Compassion Workbook, Kristin Neff, Ph.D Christopher Germer, Ph.D,  
Published by The Guilford Press A Division of Guilford Publications, Inc.370 Seventh Avenue,  
Suite 1200, New York, NY 10001
  1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4799645/>
  2. **Simple lifestyle modifications to maintain health**  
<https://www.niddk.nih.gov/health-information/diet-nutrition/changing-habits-better-health#:~:text=Make%20your%20new%20healthy%20habit,t%20have%20time%20to%20cook.>
  3. **Read more:** <https://www.legit.ng/1163909-classes-food-examples-functions.html>
  4. <https://www.yaclass.in/p/science-state-board/class-9/nutrition-and-health-5926>
  5. **Benefits of healthy eating** <https://www.cdc.gov/nutrition/resources-publications/benefits-of-healthy-eating.html>
  6. **Food additives** <https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/food-additives>
  7. **BMI** <https://www.hsph.harvard.edu/nutritionsource/healthy-weight/>  
<https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle---who-recommendations>
  8. **Yoga** <https://www.healthifyme.com/blog/types-of-yoga/>  
<https://yogamedicine.com/guide-types-yoga-styles/>  
**Ayurveda** : <https://vikaspedia.in/health/ayush/ayurveda-1/concept-of-healthy-living-in-ayurveda>
  9. **Siddha** : [http://www.tkdI.res.in/tkdI/langdefault/Siddha/Sid\\_Siddha\\_Concepts.asp](http://www.tkdI.res.in/tkdI/langdefault/Siddha/Sid_Siddha_Concepts.asp)
  10. **CAM** : <https://www.hindawi.com/journals/ecam/2013/376327/>
  11. **Preventive herbs** : <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3847409/>

### COURSE OUTCOMES:

After completing the course, the students will be able to:

- Learn the importance of different components of health
- Gain confidence to lead a healthy life
- Learn new techniques to prevent lifestyle health disorders
- Understand the importance of diet and workouts in maintaining health



**UNIT I CONCEPTS AND PERSPECTIVES**

Meaning of History

Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history

Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation verses evidence, concept of historical inevitability, Historical Positivism.

Science and Technology-Meaning, Scope and Importance, Interaction of science, technology & society, Sources of history on science and technology in India.

**UNIT II HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA**

Introduction to the works of D.D. Kosambi, Dharmpal, Debiprasad Chattopadhyay, Rehman, S. Irfan Habib, Deepak Kumar, Dhruv Raina, and others.

**UNIT III SCIENCE AND TECHNOLOGY IN ANCIENT INDIA**

Technology in pre-historic period

Beginning of agriculture and its impact on technology

Science and Technology during Vedic and Later Vedic times

Science and technology from 1<sup>st</sup> century AD to C-1200.

**UNIT IV SCIENCE AND TECHNOLOGY IN MEDIEVAL INDIA**

Legacy of technology in Medieval India, Interactions with Arabs

Development in medical knowledge, interaction between Unani and Ayurveda and alchemy

Astronomy and Mathematics: interaction with Arabic Sciences

Science and Technology on the eve of British conquest

**UNIT V SCIENCE AND TECHNOLOGY IN COLONIAL INDIA**

Science and the Empire

Indian response to Western Science

Growth of techno-scientific institutions

**UNIT VI SCIENCE AND TECHNOLOGY IN A POST-INDEPENDENT INDIA**

Science, Technology and Development discourse

Shaping of the Science and Technology Policy

Developments in the field of Science and Technology

Science and technology in globalizing India

Social implications of new technologies like the Information Technology and Biotechnology

**TOTAL : 45 PERIODS**

Pre-Requisite: None. (Desirable: Universal Human Values 1, Universal Human Values 2)

**OBJECTIVES:**

- This course will begin with a short overview of human needs and desires and how different political-economic systems try to fulfill them. In the process, we will end with a critique of different systems and their implementations in the past, with possible future directions.

**COURSE TOPICS:**

Considerations for humane society, holistic thought, human being's desires, harmony in self, harmony in relationships, society, and nature, societal systems. **(9 lectures, 1 hour each)**

(Refs: A Nagaraj, M K Gandhi, JC Kumarappa)

Capitalism – Free markets, demand-supply, perfect competition, laissez-faire, monopolies, imperialism. Liberal democracy. **(5 lectures)**

(Refs: Adam smith, J S Mill)

Fascism and totalitarianism. World war I and II. Cold war. **(2 lectures)**

Communism – Mode of production, theory of labour, surplus value, class struggle, dialectical materialism, historical materialism, Russian and Chinese models.

(Refs: Marx, Lenin, Mao, M N Roy) **(5 lectures)**

Welfare state. Relation with human desires. Empowered human beings, satisfaction. **(3 lectures)**

Gandhian thought. Swaraj, Decentralized economy & polity, Community. Control over one's lives. Relationship with nature. **(6 lectures)**

(Refs: M K Gandhi, Schumacher, Kumarappa)

Essential elements of Indian civilization. **(3 lectures)**

(Refs: Pt Sundarlal, R C Mazumdar, Dharampal)

Technology as driver of society, Role of education in shaping of society. Future directions. **(4 lectures)** (Refs: Nandkishore Acharya, David Dixon, Levis Mumford)

**Conclusion (2 lectures)**

**Total lectures: 39**

**Preferred Textbooks:** See Reference Books

**Reference Books:** Authors mentioned along with topics above. Detailed reading list will be provided.

**GRADING:**

Mid sems	30
End sem	20
Home Assign	10
Term paper	40

**TOTAL : 45 PERIODS**

**OUTCOME:**

- The students will get an understanding of how societies are shaped by philosophy, political and economic system, how they relate to fulfilling human goals & desires with some case studies of how different attempts have been made in the past and how they have fared.

**OBJECTIVE:**

The objective of the course is to provide an understanding of the state, how it works through its main organs, primacy of politics and political process, the concept of sovereignty and its changing contours in a globalized world. In the light of this, an attempt will be made to acquaint the students with the main development and legacies of national movement and constitutional development in India, reasons for adopting a Parliamentary-federal system, the broad philosophy of the Constitution of India and the changing nature of Indian Political System. Challenges/ problems and issues concerning national integration and nation-building will also be discussed in the contemporary context with the aim of developing a future vision for a better India.

**TOPICS:**

Understanding the need and role of State and politics.

Development of Nation-State, sovereignty, sovereignty in a globalized world.

Organs of State – Executive, Legislature, Judiciary. Separation of powers, forms of government-unitary-federal, Presidential-Parliamentary, The idea of India.

1857 and the national awakening.

1885 Indian National Congress and development of national movement – its legacies. Constitution making and the Constitution of India.

Goals, objective and philosophy.

Why a federal system?

National integration and nation-building.

Challenges of nation-building – State against democracy (Kothari)

New social movements.

The changing nature of Indian Political System, the future scenario.

What can we do?

**TOTAL : 45 PERIODS**

**OUTCOME OF THE COURSE:**

It is expected that this course will make students aware of the theoretical aspect of the state, its organs, its operationalization aspect, the background and philosophy behind the founding of the present political system, broad streams and challenges of national integration and nation-building in India. It will equip the students with the real understanding of our political system/ process in correct perspective and make them sit up and think for devising ways for better participation in the system with a view to making the governance and delivery system better for the common man who is often left unheard and unattended in our democratic setup besides generating a lot of dissatisfaction and difficulties for the system.

**SUGGESTED READING:**

- i. Sunil Khilnani, The Idea of India. Penguin India Ltd., New Delhi.
- ii. Madhav Khosla, The Indian Constitution, Oxford University Press. New Delhi, 2012.
- iii. Brij Kishore Sharma, Introduction to the Indian Constitution, PHI, New Delhi, latest edition.
- iv. Sumantra Bose, Transforming India: Challenges to the World's Largest Democracy, Picador India, 2013.
- v. Atul Kohli, Democracy and Discontent: India's Growing Crisis of Governability, Cambridge University Press, Cambridge, U. K., 1991.
- vi. M. P. Singh and Rekha Saxena, Indian Politics: Contemporary Issues and Concerns, PHI, New Delhi, 2008, latest edition.

vii. Rajni Kothari, Rethinking Democracy, Orient Longman, New Delhi, 2005.

**MX3089**

**INDUSTRIAL SAFETY**

**L T P C**  
**3 0 0 0**

**OBJECTIVES**

- To Understand the Introduction and basic Terminologies safety.
- To enable the students to learn about the Important Statutory Regulations and standards.
- To enable students to Conduct and participate the various Safety activities in the Industry.
- To have knowledge about Workplace Exposures and Hazards.
- To assess the various Hazards and consequences through various Risk Assessment Techniques.

**UNIT I SAFETY TERMINOLOGIES**

Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators- lag Indicators-Flammability- Toxicity Time-weighted Average (TWA) - Threshold LimitValue (TLV) - Short Term Exposure Limit (STEL)- Immediately dangerous to life or health (IDLH)- acute and chronic Effects- Routes of Chemical Entry-Personnel Protective Equipment- Health and Safety Policy-Material Safety Data Sheet MSDS

**UNIT II STANDARDS AND REGULATIONS**

Indian Factories Act-1948- Health- Safety- Hazardous materials and Welfare- ISO 45001:2018 occupational health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998- Hazard Identification and Risk Analysis- code of practice IS 15656:2006

**UNIT III SAFETY ACTIVITIES**

Toolbox Talk- Role of safety Committee- Responsibilities of Safety Officers and Safety Representatives- Safety Training and Safety Incentives- Mock Drills- On-site Emergency Action Plan- Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment

**UNIT IV WORKPLACE HEALTH AND SAFETY**

Noise hazard- Particulate matter- musculoskeletal disorder improper sitting poster and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety- Toxic gas Release

**UNIT V HAZARD IDENTIFICATION TECHNIQUES**

Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment- Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment

**TOTAL : 45 PERIODS**

**Course outcomes**

on completion of this course the student will be able:

- Understand the basic concept of safety.
- Obtain knowledge of Statutory Regulations and standards.
- Know about the safety Activities of the Working Place.
- Analyze on the impact of Occupational Exposures and their Remedies
- Obtain knowledge of Risk Assessment Techniques.

## TEXTBOOKS

1. R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems KHANNA PUBLISHER
2. L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education

## REFERENCES

1. Frank Lees (2012) 'Lees' Loss Prevention in Process Industries. Butterworth-Heinemann publications, UK, 4th Edition.
2. John Ridley & John Channing (2008) Safety at Work: Routledge, 7th Edition.
3. Dan Petersen (2003) Techniques of Safety Management: A System Approach.
4. Alan Waring. (1996). Safety management system: Chapman & Hall, England
5. Society of Safety Engineers, USA

## ONLINE RESOURCES

ISO 45001:2018 occupational health and safety (OH&S) International Organization for Standardization <https://www.iso.org/standard/63787.html>  
 Indian Standard code of practice on occupational safety and health audit <https://law.resource.org/pub/in/bis/S02/is.14489.1998.pdf>  
 Indian Standard code of practice on Hazard Identification and Risk Analysis IS 15656:2006 <https://law.resource.org/pub/in/bis/S02/is.15656.2006.pdf>

### CO's – PO's & PSO's MAPPING

Course Outcomes	Statement	Program Outcome														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	Understand the basic concept of safety.	3	3	3	1	1	3	2	2	3	3	1	3	3	3	3
CO2	Obtain knowledge of Statutory Regulations and standards.	2	3	2	2	1	3	2	3	3	2	1	3	3	3	3
CO3	Know about the safety Activities of the Working Place.	2	2	2	2	1	2	2	2	3	2	1	2	3	3	3
CO4	Analyze on the impact of Occupational Exposures and their Remedies	3	3	3	2	2	3	2	2	3	2	1	3	3	3	3
CO5	Obtain knowledge of Risk Assessment Techniques.	3	2	3	2	2	3	2	2	3	2	2	3	3	3	3
<b>Industrial safety</b>		3	3	3	2	1	3	2	2	3	2	1	3	3	3	3

**COURSE OBJECTIVES:**

- Sketch the Evolution of Management.
- Extract the functions and principles of management.
- Learn the application of the principles in an organization.
- Study the various HR related activities.
- Analyze the position of self and company goals towards business.

**UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9**

Definition of Management – Science or Art – Manager Vs Entrepreneur- types of managers- managerial roles and skills – Evolution of Management –Scientific, human relations, system and contingency approaches– Types of Business organization- Sole proprietorship, partnership, company-public and private sector enterprises- Organization culture and Environment – Current trends and issues in Management.

**UNIT II PLANNING 9**

Nature and purpose of planning – Planning process – Types of planning – Objectives – Setting objectives – Policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.

**UNIT III ORGANISING 9**

Nature and purpose – Formal and informal organization – Organization chart – Organization structure – Types – Line and staff authority – Departmentalization – delegation of authority – Centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.

**UNIT IV DIRECTING 9**

Foundations of individual and group behaviour– Motivation – Motivation theories – Motivational techniques – Job satisfaction – Job enrichment – Leadership – types and theories of leadership – Communication – Process of communication – Barrier in communication – Effective communication – Communication and IT.

**UNIT V CONTROLLING 9**

System and process of controlling – Budgetary and non - Budgetary control techniques – Use of computers and IT in Management control – Productivity problems and management – Control and performance – Direct and preventive control – Reporting.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

- CO1: Upon completion of the course, students will be able to have clear understanding of managerial functions like planning, organizing, staffing, leading & controlling.
- CO2: Have same basic knowledge on international aspect of management.
- CO3: Ability to understand management concept of organizing.
- CO4: Ability to understand management concept of directing.
- CO5: Ability to understand management concept of controlling.

**TEXT BOOKS:**

1. Harold Koontz and Heinz Weihrich “Essentials of management” Tata McGraw Hill,1998.
2. Stephen P. Robbins and Mary Coulter, “ Management”, Prentice Hall (India)Pvt. Ltd., 10<sup>th</sup> Edition, 2009.

**REFERENCES:**

1. Robert Kreitner and MamataMohapatra, " Management", Biztantra, 2008.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, "Fundamentals of Management" Pearson Education, 7th Edition, 2011.
3. Tripathy PC and Reddy PN, "Principles of Management", Tata Mcgraw Hill, 1999.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3		-	-	-	1	-	-	-	-	-	-	2	1	1
2	-	1	1	-	-	-	-	-	-	-	-	-	2	1	-
3	1		-	2	-	-	1	-	2	-	1	1	-	-	2
4	-	1	1	1	2	-	-	1	2	-	-	-	1	1	1
5	1		-	-	1	1	-	-	-	3	-	1	1	-	1
AVg.	1.66	1	1	1.5	1.5	1	1	1	2	3	1	1	1.5	1	1.25

**GE3752**

**TOTAL QUALITY MANAGEMENT**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- Teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
- Explain the TQM Principles for application.
- Define the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
- Describe Taguchi's Quality Loss Function, Performance Measures and apply Techniques like QFD, TPM, COQ and BPR.
- Illustrate and apply QMS and EMS in any organization.

**UNIT I INTRODUCTION**

**9**

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality –Definition of TQM-- Basic concepts of TQM - Gurus of TQM (Brief introduction) -- TQM Framework- Barriers to TQM –Benefits of TQM.

**UNIT II TQM PRINCIPLES**

**9**

Leadership - Deming Philosophy, Quality Council, Quality statements and Strategic planning- Customer Satisfaction –Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal-- Continuous process improvement –Juran Trilogy, PDSA cycle, 5S and Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating and Relationship development.

**UNIT III TQM TOOLS & TECHNIQUES I**

**9**

The seven traditional tools of quality - New management tools - Six-sigma Process Capability- Bench marking - Reasons to benchmark, Benchmarking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, Learning from the data, Using the findings, Pitfalls and Criticisms of Benchmarking - FMEA - Intent , Documentation, Stages: Design FMEA and Process FMEA.

**UNIT IV TQM TOOLS & TECHNIQUES II 9**

Quality circles – Quality Function Deployment (QFD) - Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures- Cost of Quality - BPR.

**UNIT V QUALITY MANAGEMENT SYSTEM 9**

Introduction-Benefits of ISO Registration-ISO 9000 Series of Standards-Sector-Specific Standards - AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements-Implementation-Documentation- Internal Audits-Registration-ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001-Benefits of EMS.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

**CO1:** Ability to apply TQM concepts in a selected enterprise.

**CO2:** Ability to apply TQM principles in a selected enterprise.

**CO3:** Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.

**CO4:** Ability to understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.

**CO5:** Ability to apply QMS and EMS in any organization.

**COs- POs & PSOs MAPPING**

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
<b>1</b>		3										3	2		3
<b>2</b>						3						3		2	
<b>3</b>					3				3					2	3
<b>4</b>		2			3	2	3	2				3	3	2	
<b>5</b>			3			3	3	2							
<b>AVg.</b>		2.5	3		3	2.6	3	2	3			3	2.5	2	3

**TEXT BOOK:**

1. Dale H. Besterfield, Carol B. Michna, Glen H. Besterfield, Mary B. Sacre, Hemant Urdhware she and Rashmi Urdhware she, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.

**REFERENCES:**

1. Joel E. Ross, "Total Quality Management – Text and Cases", Routledge, 2017.
2. Kiran D.R, "Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.
3. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.
4. Suganthi, L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.



**COURSE OBJECTIVES:**

- Understanding the concept of Engineering Economics.
- Implement various micro economics concept in real life.
- Gaining knowledge in the field of macro economics to enable the students to have better understanding of various components of macro economics.
- Understanding the different procedures of pricing.
- Learn the various cost related concepts in micro economics.

**UNIT I DEMAND & SUPPLY ANALYSIS 9**

Managerial Economics - Relationship with other disciplines - Firms: Types, objectives and goals - Managerial decisions - Decision analysis. Demand - Types of demand - Determinants of demand - Demand function – Demand elasticity - Demand forecasting - Supply - Determinants of supply - Supply function - Supply elasticity.

**UNIT II PRODUCTION AND COST ANALYSIS 9**

Production function - Returns to scale - Production optimization - Least cost input - Isoquants - Managerial uses of production function. Cost Concepts - Cost function - Determinants of cost - Short run and Long run cost curves - Cost Output Decision - Estimation of Cost.

**UNIT III PRICING 9**

Determinants of Price - Pricing under different objectives and different market structures - Price discrimination - Pricing methods in practice.

**UNIT IV FINANCIAL ACCOUNTING (ELEMENTARY TREATMENT) 9**

Balance sheet and related concepts - Profit & Loss Statement and related concepts - Financial Ratio Analysis - Cash flow analysis - Funds flow analysis - Comparative financial statements - Analysis & Interpretation of financial statements.

**UNIT V CAPITAL BUDGETING (ELEMENTARY TREATMENT) 9**

Investments - Risks and return evaluation of investment decision - Average rate of return - Payback Period - Net Present Value - Internal rate of return.

**TOTAL: 45 PERIODS****COURSE OUTCOMES: Students able to**

**CO1:** Upon successful completion of this course, students will acquire the skills to apply the basics of economics and cost analysis to engineering and take economically sound decisions

**CO2:** Evaluate the economic theories, cost concepts and pricing policies

**CO3:** Understand the market structures and integration concepts

**CO4:** Understand the measures of national income, the functions of banks and concepts of globalization

**CO5:** Apply the concepts of financial management for project appraisal

**TEXT BOOKS:**

1. Panneer Selvam, R, "Engineering Economics", Prentice Hall of India Ltd, New Delhi, 2001.
2. Managerial Economics: Analysis, Problems and Cases - P. L. Mehta, Edition, 13. Publisher, Sultan Chand, 2007.

**REFERENCES:**

1. Chan S.Park, "Contemporary Engineering Economics", Prentice Hall of India, 2011.
2. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg. Press, Texas, 2010.
3. Degarmo, E.P., Sullivan, W.G and Canada, J.R, "Engineering Economy", Macmillan, New

York, 2011.

4. Zahid A khan: Engineering Economy, "Engineering Economy", Dorling Kindersley, 2012

5. Dr. S. N. Maheswari and Dr. S.K. Maheshwari: Financial Accounting, Vikas, 2009

### MAPPING OF COS AND POS:

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		3								2			1	3	
2		3												2	2
3		2													
4	2	3	3		2								2	3	
5	3	3	3		2								2		2
AVg.	2.5	2.4	3		2					2			1.8	2.6	2

**GE3754**

**HUMAN RESOURCE MANAGEMENT**

**L T P C**  
**3 0 0 3**

**OBJECTIVE:**

- To provide knowledge about management issues related to staffing,
- To provide knowledge about management issues related to training,
- To provide knowledge about management issues related to performance
- To provide knowledge about management issues related to compensation
- To provide knowledge about management issues related to human factors consideration and compliance with human resource requirements.

**UNIT I INTRODUCTION TO HUMAN RESOURCE MANAGEMENT 9**

The importance of human resources – Objective of Human Resource Management - Human resource policies - Role of human resource manager.

**UNIT II HUMAN RESOURCE PLANNING 9**

Importance of Human Resource Planning – Internal and External sources of Human Resources - Recruitment - Selection – Socialization.

**UNIT III TRAINING AND EXECUTIVE DEVELOPMENT 9**

Types of training and Executive development methods – purpose – benefits.

**UNIT IV EMPLOYEE COMPENSATION 9**

Compensation plan – Reward – Motivation – Career Development - Mentor – Protege relationships.

**UNIT V PERFORMANCE EVALUATION AND CONTROL 9**

Performance evaluation – Feedback - The control process – Importance – Methods – grievances – Causes – Redressal methods.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- CO1:** Students would have gained knowledge on the various aspects of HRM
- CO2:** Students will gain knowledge needed for success as a human resources professional.
- CO3:** Students will develop the skills needed for a successful HR manager.
- CO4:** Students would be prepared to implement the concepts learned in the workplace.

**CO5:** Students would be aware of the emerging concepts in the field of HRM

**TEXT BOOKS:**

1. Decenzo and Robbins, "Human Resource Management", 8th Edition, Wiley, 2007.
2. John Bernardin. H., "Human Resource Management – An Experimental Approach", 5th Edition, Tata McGraw Hill, 2013, New Delhi.

**REFERENCES:**

1. Luis R., Gomez-Mejia, DavidB. Balkin and Robert L. Cardy, "Managing Human Resources", 7th Edition, PHI, 2012.
2. Dessler, "Human Resource Management", Pearson Education Limited, 2007.

**COs- POs & PSOs MAPPING**

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	1	2	2	2	1	1	2	1	1	1	1	1	1
2	3	3	2	3	2	2	2	2	3	1	2	1	1	2	1
3	3	3	3	3	3	3	2	2	3	1	2	1	1	2	1
4	3	3	2	3	3	2	2	2	2	1	1	1	1	1	1
5	3	3	1	2	2	2	2	2	2	1	1	1	1	1	1
<b>AVg.</b>	2.8	2.8	1.8	2.6	2.6	2.2	1.8	1.8	2.4	1	1.4	1	1	1.4	1

**GE3755**

**KNOWLEDGE MANAGEMENT**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

The student should be made to:

- Learn the Evolution of Knowledge management.
- Be familiar with tools.
- Be exposed to Applications.
- Be familiar with some case studies.

**UNIT I INTRODUCTION**

**9**

Introduction: An Introduction to Knowledge Management - The foundations of knowledge management- including cultural issues- technology applications organizational concepts and processes- management aspects- and decision support systems. The Evolution of Knowledge management: From Information Management to Knowledge Management - Key Challenges Facing the Evolution of Knowledge Management - Ethics for Knowledge Management.

**UNIT II CREATING THE CULTURE OF LEARNING AND KNOWLEDGE SHARING**

**9**

Organization and Knowledge Management - Building the Learning Organization. Knowledge Markets: Cooperation among Distributed Technical Specialists – Tacit Knowledge and Quality Assurance.

**UNIT III KNOWLEDGE MANAGEMENT-THE TOOLS**

**9**

Telecommunications and Networks in Knowledge Management - Internet Search Engines and Knowledge Management - Information Technology in Support of Knowledge Management - Knowledge Management and Vocabulary Control - Information Mapping in Information Retrieval - Information Coding in the Internet Environment - Repackaging Information.

**UNIT IV KNOWLEDGE MANAGEMENT APPLICATION****9**

Components of a Knowledge Strategy - Case Studies (From Library to Knowledge Center, Knowledge Management in the Health Sciences, Knowledge Management in Developing Countries).

**UNIT V FUTURE TRENDS AND CASE STUDIES****9**

Advanced topics and case studies in knowledge management - Development of a knowledge management map/plan that is integrated with an organization's strategic and business plan - A case study on Corporate Memories for supporting various aspects in the process life -cycles of an organization.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

Upon completion of the course, the student should be able to:

**CO1:** Understand the process of acquiring knowledge from experts

**CO2:** Understand the learning organization.

**CO3:** Use the knowledge management tools.

**CO4:** Develop knowledge management Applications.

**CO5:** Design and develop enterprise applications.

**COs- POs & PSOs MAPPING**

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1					1											
2					2								1			
3					2									2		
4				1	1				1					1		
5				1	1				1					1		
<b>AVg.</b>				1	1.4				1				1	1.33		

**TEXT BOOK:**

1. Srikantiah, T.K., Koenig, M., "Knowledge Management for the Information Professional" Information Today, Inc., 2000.

**REFERENCE:**

1. Nonaka, I., Takeuchi, H., "The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation", Oxford University Press, 1995.

PROGRESS THROUGH KNOWLEDGE

GE3792

**INDUSTRIAL MANAGEMENT**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES**

- 1 To study the basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.
- 2 To study the planning; organizing and staffing functions of management in professional organization.
- 3 To study the leading; controlling and decision making functions of management in professional organization.
- 4 To learn the organizational theory in professional organization.
- 5 To learn the principles of productivity and modern concepts in management in professional organization.

**UNIT I INTRODUCTION TO MANAGEMENT 9**

Management: Introduction; Definition and Functions – Approaches to the study of Management – Mintzberg's Ten Managerial Roles – Principles of Taylor; Fayol; Weber; Parker – Forms of Organization: Sole Proprietorship; Partnership; Company (Private and Public); Cooperative – Public Sector Vs Private Sector Organization – Business Environment: Economic; Social; Political; Legal – Trade Union: Definition; Functions; Merits & Demerits.

**UNIT II FUNCTIONS OF MANAGEMENT - I 9**

Planning: Characteristics; Nature; Importance; Steps; Limitation; Planning Premises; Strategic Planning; Vision & Mission statement in Planning– Organizing: Organizing Theory; Principles; Types; Departmentalization; Centralization and Decentralization; Authority & Responsibility – Staffing: Systems Approach; Recruiting and Selection Process; Human Resource Development (HRD) Concept and Design.

**UNIT III FUNCTIONS OF MANAGEMENT - II 9**

Directing (Leading): Leadership Traits; Style; Morale; Managerial Grids (Blake-Mounton, Reddin) – Communication: Purpose; Model; Barriers – Controlling: Process; Types; Levels; Guidelines; Audit (External, Internal, Merits); Preventive Control – Decision Making: Elements; Characteristics; Nature; Process; Classifications.

**UNIT IV ORGANIZATION THEORY 9**

Organizational Conflict: Positive Aspects; Individual; Role; Interpersonal; Intra Group; Inter Group; Conflict Management – Maslow's hierarchy of needs theory; Herzberg's motivation-hygiene theory; McClelland's three needs motivation theory; Vroom's valence-expectancy theory – Change Management: Concept of Change; Lewin's Process of Change Model; Sources of Resistance; Overcoming Resistance; Guidelines to managing Conflict.

**UNIT V PRODUCTIVITY AND MODERN TOPICS 9**

Productivity: Concept; Measurements; Affecting Factors; Methods to Improve – Modern Topics (concept, feature/characteristics, procedure, merits and demerits): Business Process Reengineering (BPR); Benchmarking; SWOT/SWOC Analysis; Total Productive Maintenance; Enterprise Resource Planning (ERP); Management of Information Systems (MIS).

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course the students would be able to

CO1 Explain basic concepts of management; approaches to management; contributors to

management studies; various forms of business organization and trade unions function in professional organizations.

- CO2 Discuss the planning; organizing and staffing functions of management in professional organization.
- CO3 Apply the leading; controlling and decision making functions of management in professional organization.
- CO4 Discuss the organizational theory in professional organization.
- CO5 Apply principles of productivity and modern concepts in management in professional organization.

**TEXTBOOKS:**

1. M. Govindarajan and S. Natarajan, "Principles of Management", Prentice Hall of India, New Delhi, 2009.
2. Koontz. H. and Wehrich. H., "Essentials of Management: An International Perspective", 8<sup>th</sup> Edition, Tata McGrawhill, New Delhi, 2010.

**REFERENCES:**

1. Joseph J, Massie, "Essentials of Management", 4<sup>th</sup> Edition, Pearson Education, 1987.
2. Saxena, P. K., "Principles of Management: A Modern Approach", Global India Publications, 2009.
3. S.Chandran, "Organizational Behaviours", Vikas Publishing House Pvt. Ltd., 1994.
4. Richard L. Daft, "Organization Theory and Design", South Western College Publishing, 11<sup>th</sup> Edition, 2012.
5. S. TrevisCerto, "Modern Management Concepts and Skills", Pearson Education, 2018.

**MAPPING OF COS AND POS:**

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
2	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
3	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
4	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
5	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1

PROGRESS THROUGH KNOWLEDGE

## OPEN ELECTIVE I AND II

### OCS351 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FUNDAMENTALS

L T P C  
2 0 2 3

#### **OBJECTIVES:**

The main objectives of this course are to:

1. Understand the importance, principles, and search methods of AI
2. Provide knowledge on predicate logic and Prolog.
3. Introduce machine learning fundamentals
4. Study of supervised learning algorithms.
5. Study about unsupervised learning algorithms.

#### **UNIT I INTELLIGENT AGENT AND UNINFORMED SEARCH 6**

**Introduction** - Foundations of AI - History of AI - The state of the art - Risks and Benefits of AI - **Intelligent Agents** - Nature of Environment - Structure of Agent - Problem Solving Agents - Formulating Problems - **Uninformed Search** - Breadth First Search - Dijkstra's algorithm or uniform-cost search - Depth First Search - Depth Limited Search

#### **UNIT II PROBLEM SOLVING WITH SEARCH TECHNIQUES 6**

**Informed Search** - Greedy Best First - A\* algorithm - Adversarial Game and Search - **Game theory** - Optimal decisions in game - Min Max Search algorithm - Alpha-beta pruning - **Constraint Satisfaction Problems (CSP)** - Examples - Map Coloring - Job Scheduling - Backtracking Search for CSP

#### **UNIT III LEARNING 6**

Machine Learning: Definitions – Classification - Regression - approaches of machine learning models - Types of learning - Probability - Basics - Linear Algebra – Hypothesis space and inductive bias, Evaluation. Training and test sets, cross validation, Concept of over fitting, under fitting, Bias and Variance - **Regression**: Linear Regression - Logistic Regression

#### **UNIT IV SUPERVISED LEARNING 6**

**Neural Network**: Introduction, Perceptron Networks – Adaline - Back propagation networks - **Decision Tree**: Entropy – Information gain - Gini Impurity - classification algorithm - Rule based Classification - **Naïve Bayesian classification** - **Support Vector Machines (SVM)**

#### **UNIT V UNSUPERVISED LEARNING 6**

**Unsupervised Learning** – Principle Component Analysis - **Neural Network**: Fixed Weight Competitive Nets - Kohonen Self-Organizing Feature Maps – **Clustering**: Definition - Types of Clustering – Hierarchical clustering algorithms – k-means algorithm

**TOTAL : 30 PERIODS**

#### **PRACTICAL EXERCISES: 30 PERIODS**

##### **Programs for Problem solving with Search**

1. Implement breadth first search
2. Implement depth first search
3. Analysis of breadth first and depth first search in terms of time and space
4. Implement and compare Greedy and A\* algorithms.

##### **Supervised learning**

5. Implement the non-parametric locally weighted regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs
6. Write a program to demonstrate the working of the decision tree based algorithm.
7. Build an artificial neural network by implementing the back propagation algorithm and test the same using appropriate data sets.
8. Write a program to implement the naïve Bayesian classifier.

##### **Unsupervised learning**

9. Implementing neural network using self-organizing maps

10. Implementing k-Means algorithm to cluster a set of data.
11. Implementing hierarchical clustering algorithm.

Note:

- Installation of gnu-prolog, Study of Prolog (gnu-prolog).
- The programs can be implemented in using C++/JAVA/ Python or appropriate tools can be used by designing good user interface
- Data sets can be taken from standard repositories (<https://archive.ics.uci.edu/ml/datasets.html>) or constructed by the students.

### OUTCOMES:

CO1: Understand the foundations of AI and the structure of Intelligent Agents

CO2: Use appropriate search algorithms for any AI problem

CO3: Study of learning methods

CO4: Solving problem using Supervised learning

CO5: Solving problem using Unsupervised learning

**TOTAL PERIODS: 60**

### TEXT BOOK

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Fourth Edition, 2021
2. S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India.3 rd ed,

### REFERENCES

1. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
2. I. Bratko, "Prolog: Programming for Artificial Intelligencell, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.
3. C. Muller & Sarah Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020.

**OCS352**

**IOT CONCEPTS AND APPLICATIONS**

**L T P C  
2 0 2 3**

### OBJECTIVES:

- To apprise students with basic knowledge of IoT that paves a platform to understand physical and logical design of IOT
- To teach a student how to analyse requirements of various communication models and protocols for cost-effective design of IoT applications on different IoT platforms.
- To introduce the technologies behind Internet of Things(IoT).
- To explain the students how to code for an IoT application using Arduino/Raspberry Pi open platform.
- To apply the concept of Internet of Things in real world scenario.

### UNIT I INTRODUCTION TO INTERNET OF THINGS

**5**

Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT Models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT

### UNIT II COMPONENTS IN INTERNET OF THINGS

**5**

Functional Blocks of an IoT Ecosystem – Sensors, Actuators, and Smart Objects – Control Units - Communication modules (Bluetooth, Zigbee,Wifi, GPS, GSM Modules)

### UNIT III PROTOCOLS AND TECHNOLOGIES BEHIND IOT

**6**

IOT Protocols - IPv6, 6LoWPAN, MQTT, CoAP - RFID, Wireless Sensor Networks, BigData Analytics, Cloud Computing, Embedded Systems.



**UNIT IV OPEN PLATFORMS AND PROGRAMMING 7**

IOT deployment for Raspberry Pi /Arduino platform-Architecture –Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud.

**UNIT V IOT APPLICATIONS 7**

Business models for the internet of things, Smart city, Smart mobility and transport, Industrial IoT, Smart health, Environment monitoring and surveillance – Home Automation – Smart Agriculture

**30 PERIODS**

**PRACTICAL EXERCISES: 30 PERIODS**

1. Introduction to Arduino platform and programming
2. Interfacing Arduino to Zigbee module
3. Interfacing Arduino to GSM module
4. Interfacing Arduino to Bluetooth Module
5. Introduction to Raspberry PI platform and python programming
6. Interfacing sensors to Raspberry PI
7. Communicate between Arduino and Raspberry PI using any wireless medium
8. Setup a cloud platform to log the data
9. Log Data using Raspberry PI and upload to the cloud platform
10. Design an IOT based system

**OUTCOMES:**

**CO 1:** Explain the concept of IoT.

**CO 2:** Understand the communication models and various protocols for IoT.

**CO 3:** Design portable IoT using Arduino/Raspberry Pi /open platform

**CO 4:** Apply data analytics and use cloud offerings related to IoT.

**CO 5:** Analyze applications of IoT in real time scenario.

**TOTAL PERIODS:60**

**TEXTBOOKS**

1. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, CISCO Press, 2017
2. Samuel Greengard, The Internet of Things, The MIT Press, 2015

**REFERENCES**

1. Perry Lea, “Internet of things for architects”, Packt, 2018
2. Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things – Key applications and Protocols”, Wiley, 2012
3. IOT (Internet of Things) Programming: A Simple and Fast Way of Learning, IOT Kindle Edition.
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011.
5. ArshdeepBahga, Vijay Madiseti, “Internet of Things – A hands-on approach”, Universities Press, 2015
6. <https://www.arduino.cc/>  
[https://www.ibm.com/smarterplanet/us/en/?ca=v\\_smarterplanet](https://www.ibm.com/smarterplanet/us/en/?ca=v_smarterplanet)

**COURSE OBJECTIVES:**

- Familiarize students with the data science process.
- Understand the data manipulation functions in Numpy and Pandas.
- Explore different types of machine learning approaches.
- Understand and practice visualization techniques using tools.
- Learn to handle large volumes of data with case studies.

**UNIT I INTRODUCTION****6**

Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – data preparation - Exploratory Data analysis – build the model – presenting findings and building applications - Data Mining - Data Warehousing – Basic statistical descriptions of Data.

**UNIT II DATA MANIPULATION****9**

Python Shell - Jupyter Notebook - IPython Magic Commands - NumPy Arrays-Universal Functions – Aggregations – Computation on Arrays – Fancy Indexing – Sorting arrays – Structured data – Data manipulation with Pandas – Data Indexing and Selection – Handling missing data – Hierarchical indexing – Combining datasets – Aggregation and Grouping – String operations – Working with time series – High performance

**UNIT III MACHINE LEARNING****5**

The modeling process - Types of machine learning - Supervised learning - Unsupervised learning - Semi-supervised learning- Classification, regression - Clustering – Outliers and Outlier Analysis

**UNIT IV DATA VISUALIZATION****5**

Importing Matplotlib – Simple line plots – Simple scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn

**UNIT V HANDLING LARGE DATA****5**

Problems - techniques for handling large volumes of data - programming tips for dealing with large data sets- Case studies: Predicting malicious URLs, Building a recommender system - Tools and techniques needed - Research question - Data preparation - Model building – Presentation and automation.

**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS****LAB EXERCISES**

1. Download, install and explore the features of Python for data analytics.
2. Working with Numpy arrays
3. Working with Pandas data frames
4. Basic plots using Matplotlib
5. Statistical and Probability measures
  - a) Frequency distributions
  - b) Mean, Mode, Standard Deviation
  - c) Variability
  - d) Normal curves
  - e) Correlation and scatter plots
  - f) Correlation coefficient
  - g) Regression

6. Use the standard benchmark data set for performing the following:
  - a) Univariate Analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis.
  - b) Bivariate Analysis: Linear and logistic regression modelling.
7. Apply supervised learning algorithms and unsupervised learning algorithms on any data set.
8. Apply and explore various plotting functions on any data set.

**Note: Example data sets like: UCI, Iris, Pima Indians Diabetes etc.**

**COURSE OUTCOMES:**

**At the end of this course, the students will be able to:**

- CO1:** Gain knowledge on data science process.
- CO2:** Perform data manipulation functions using Numpy and Pandas.
- CO3:** Understand different types of machine learning approaches.
- CO4:** Perform data visualization using tools.
- CO5:** Handle large volumes of data in practical scenarios.

**TOTAL PERIODS:60**

**TEXT BOOKS**

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications, 2016.
2. Jake VanderPlas, "Python Data Science Handbook", O'Reilly, 2016.

**REFERENCES**

1. Robert S. Witte and John S. Witte, "Statistics", Eleventh Edition, Wiley Publications, 2017.
2. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press, 2014.

**CCS333**

**AUGMENTED REALITY/VIRTUAL REALITY**

**L T P C**  
**2 0 2 3**

**OBJECTIVES:**

- To impart the fundamental aspects and principles of AR/VR technologies.
- To know the internals of the hardware and software components involved in the development of AR/VR enabled applications.
- To learn about the graphical processing units and their architectures.
- To gain knowledge about AR/VR application development.
- To know the technologies involved in the development of AR/VR based applications.

**UNIT I**

**INTRODUCTION**

**7**

Introduction to Virtual Reality and Augmented Reality – Definition – Introduction to Trajectories and Hybrid Space-Three I's of Virtual Reality – Virtual Reality Vs 3D Computer Graphics – Benefits of Virtual Reality – Components of VR System – Introduction to AR-AR Technologies-Input Devices – 3D Position Trackers – Types of Trackers – Navigation and Manipulation Interfaces – Gesture Interfaces – Types of Gesture Input Devices – Output Devices – Graphics Display – Human Visual System – Personal Graphics Displays – Large Volume Displays – Sound Displays – Human Auditory System.

**UNIT II**

**VR MODELING**

**6**

Modeling – Geometric Modeling – Virtual Object Shape – Object Visual Appearance – Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants –Object Hierarchies – Viewing the 3D World – Physical Modeling – Collision Detection – Surface Deformation – Force Computation – Force Smoothing and Mapping – Behavior Modeling – Model Management.

**UNIT III VR PROGRAMMING 6**  
VR Programming – Toolkits and Scene Graphs – World ToolKit – Java 3D – Comparison of World ToolKit and Java 3D

**UNIT IV APPLICATIONS 6**  
Human Factors in VR – Methodology and Terminology – VR Health and Safety Issues – VR and Society-Medical Applications of VR – Education, Arts and Entertainment – Military VR Applications – Emerging Applications of VR – VR Applications in Manufacturing – Applications of VR in Robotics – Information Visualization – VR in Business – VR in Entertainment – VR in Education.

**UNIT V AUGMENTED REALITY 5**  
Introduction to Augmented Reality-Computer vision for AR-Interaction-Modelling and Annotation-Navigation-Wearable devices

**30 PERIODS**

**PRACTICAL EXERCISES: 30 PERIODS**

1. Study of tools like Unity, Maya, 3DS MAX, AR toolkit, Vuforia and Blender.
2. Use the primitive objects and apply various projection types by handling camera.
3. Download objects from asset store and apply various lighting and shading effects.
4. Model three dimensional objects using various modelling techniques and apply textures over them.
5. Create three dimensional realistic scenes and develop simple virtual reality enabled mobile applications which have limited interactivity.
6. Add audio and text special effects to the developed application.
7. Develop VR enabled applications using motion trackers and sensors incorporating full haptic interactivity.
8. Develop AR enabled applications with interactivity like E learning environment, Virtual walkthroughs and visualization of historic places.
9. Develop AR enabled simple applications like human anatomy visualization, DNA/RNA structure visualization and surgery simulation.
10. Develop simple MR enabled gaming applications.

**TOTAL PERIODS:60**

**OUTCOMES:**

**On completion of the course, the students will be able to:**

**CO1:** Understand the basic concepts of AR and VR

**CO2:** Understand the tools and technologies related to AR/VR

**CO3:** Know the working principle of AR/VR related Sensor devices

**CO4:** Design of various models using modeling techniques

**CO5:** Develop AR/VR applications in different domains

**TEXTBOOKS:**

1. Charles Palmer, John Williamson, "Virtual Reality Blueprints: Create compelling VR experiences for mobile", Packt Publisher, 2018
2. Dieter Schmalstieg, Tobias Hollerer, "Augmented Reality: Principles & Practice", Addison Wesley, 2016
3. John Vince, "Introduction to Virtual Reality", Springer-Verlag, 2004.
4. William R. Sherman, Alan B. Craig: Understanding Virtual Reality – Interface, Application, Design", Morgan Kaufmann, 2003

## CO's – PO's & PSO's MAPPING

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	-	3	-	-	-	2	2	1	2	2	1	2
2	3	2	2	1	3	-	-	-	3	2	2	3	3	1	2
3	3	3	2	2	3	-	-	-	3	2	1	2	3	2	2
4	3	3	3	2	3	-	-	-	3	2	2	3	3	2	2
5	3	3	3	3	3	-	-	-	3	3	3	3	3	3	3
<b>AVg.</b>	<b>3.00</b>	<b>2.60</b>	<b>2.40</b>	<b>2.00</b>	<b>3.00</b>	-	-	-	<b>2.80</b>	<b>2.20</b>	<b>1.80</b>	<b>2.60</b>	<b>2.80</b>	<b>1.80</b>	<b>2.20</b>

### OPEN ELCTIVE III

**OHS351**

**ENGLISH FOR COMPETITIVE EXAMINATIONS**

**L T P C**  
**3 0 0 3**

**Course Description:**

Students aspiring to take up competitive exams of which the English language is a vital component will find this course useful. Designed for students in the higher semesters, the course will help students to familiarise themselves with those aspects of English that are tested in these examinations.

**Objectives:**

- To train the students in the language components essential to face competitive examinations both at the national (UPSC, Banking, Railway, Defence) and the international level (GRE, TOEFL, IELTS).
- To enhance an awareness of the specific patterns in language testing and the respective skills to tackle verbal reasoning and verbal ability tests.
- To inculcate effective practices in language-learning in order to improve accuracy in usage of grammar and coherence in writing.
- To improve students' confidence to express their ideas and opinions in formal contexts
- To create awareness of accuracy and precision in communication

**UNIT I**

**9**

Orientation on different formats of competitive exams - Vocabulary – Verbal ability – Verbal reasoning - Exploring the world of words – Essential words – Meaning and their usage – Synonyms-antonyms – Word substitution – Word analogy – Idioms and phrases – Commonly confused words – Spellings – Word expansion – New words in use.

**UNIT II**

**9**

Grammar – Sentence improvement –Sentence completion – Rearranging phrases into sentences – Error identification –Tenses – Prepositions – Adjectives – Adverbs – Subject-verb agreement – Voice – Reported speech – Articles – Clauses – Speech patterns.

**UNIT III**

**9**

Reading - Specific information and detail – Identifying main and supporting ideas – Speed reading techniques – Improving global reading skills – Linking ideas – Summarising – Understanding argument – Identifying opinion/attitude and making inferences - Critical reading.

**UNIT IV**

**9**

Writing – Pre-writing techniques – Mindmap - Describing pictures and facts - Paragraph structure – organising points – Rhetoric writing – Improving an answer – Drafting, writing and developing an argument – Focus on cohesion – Using cohesive devices –Analytic writing – Structure and types of essay – Mind maps – Structure of drafts, letters, memos, emails – Statements of Purpose – Structure, Content and Style.

**UNIT V****9**

Listening and Speaking – Contextual listening – Listening to instructions – Listening for specific information – Identifying detail, main ideas – Following signpost words – Stress, rhythm and intonation - Speaking to respond and elicit ideas – Guided speaking – Opening phrases – Interactive communication – Dysfluency -Sentence stress – Speaking on a topic – Giving opinions – Giving an oral presentation – Telling a story or a personal anecdote – Talking about oneself - Utterance – Speech acts- Brainstorming ideas – Group discussion.

**TOTAL: 45 PERIODS****Learning Outcomes:**

At the end of the course, learners will be able

- expand their vocabulary and gain practical techniques to read and comprehend a wide range of texts with the emphasis required
- identify errors with precision and write with clarity and coherence
- understand the importance of task fulfilment and the usage of task-appropriate vocabulary
- communicate effectively in group discussions, presentations and interviews
- write topic based essays with precision and accuracy

**Teaching Methods:**

Instructional methods will involve discussions, taking mock tests on various question papers – Objective, multiple-choice and descriptive. Peer evaluation, self-check on improvement and peer feedback - Practice sessions on speaking assessments, interview and discussion – Using multimedia.

**Evaluative Pattern:**

Internal Tests – 50%

End Semester Exam - 50%

**TEXTBOOKS:**

1.R.P.Bhatnagar - *General English for Competitive Examinations*. Macmillan India Limited, 2009.

**REFERENCEBOOKS:**

1. Educational Testing Service - The Official Guide to the GRE Revised General Test, Tata McGraw Hill, 2010.
2. The Official Guide to the TOEFL Test, Tata McGraw Hill, 2010.
3. R Rajagopalan- *General English for Competitive Examinations*, McGraw Hill Education (India) Private Limited, 2008.

**Websites**

<http://www.examenglish.com/>, <http://www.ets.org/>, <http://www.bankxams.com/>  
<http://civilservicesmentor.com/>, <http://www.educationobserver.com>  
<http://www.cambridgeenglish.org/in/>

**CO-PO & PSO MAPPING**

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	3	3	1	3	3	3	3	1	3	1	3	-	-	-
2	2	3	3	2	3	3	3	3	1	3	3	3	-	-	-
3	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
4	2	2	2	2	2	2	2	2	3	3	3	3	-	-	-
5	2	2	2	2	2	2	2	2	2	3	2	3	-	-	-
AVg.	2	2.6	2.6	2	2.6	2.6	2.6	2.6	2	3	2.4	3	-	-	-

- 1-low, 2-medium, 3-high, '-'- no correlation

**Note:** The average value of this course to be used for program articulation matrix.

**COURSE OBJECTIVES**

- to understand the importance of sustainable development
- to acquire a reasonable knowledge on the legal frameworks pertaining to pollution control and environmental management
- to comprehend the role of NGOs in attaining sustainable development

**UNIT I ENVIRONMENTAL CONCERNS 9**

Introduction to sustainable development goals, Global responsibility of environmental concern, Importance of environmental preservation, Environmental threats, Pollution and its types, Effects of Pollution, Pollution control, Treatment of wastes

**UNIT II ROLE OF NGOS 9**

Role of NGO's in national development, NGO's and participatory management, Challenges and limitations of NGO's, Community Development programmes, Role of NGO's in Community Development programmes, Participation of NGO's in environment management, Corporate Social responsibility, NGO's and corporate social responsibility

**UNIT III SUSTAINABLE DEVELOPMENT 9**

Issues and Challenges of Sustainable Development, Bioenergy, Sustainable Livelihoods and Rural Poor in Sustainable Development, Protecting ecosystem services for sustainable development, Non-renewable sources of energy and its effect, Renewable sources of energy for sustainability, Nuclear resources and Legal Regulation of Hazardous Substances, Sustainable Development: Programme and Policies, Sustainability assessment and Indicators

**UNIT IV NGO'S FOR SUSTAINABILITY 9**

Civil Society Initiatives in Environment Management, Civil Society Initiatives for Sustainable Development, Global Initiatives in Protecting Global Environment, World Summit on Sustainable Development (Johannesburg Summit 2002), Ecological economics, Environmental sustainability, Social inclusion, Health for all, education for all, Food security and Water security, NGOs and Sustainable Development strategies

**UNIT V LEGAL FRAMEWORKS 9**

Need for a Legal framework and its enforcement, Legal measures to control pollution, Environmental Legislations in India, Mechanism to implement Environmental Laws in India, Legal Protection of Forests Act 1927, Legal Protection of Wild Life, Role of NGO's in implementing environmental laws, Challenges in the implementation of environmental legislation

**TOTAL 45 : PERIODS****OUTCOMES**

Upon completion of this course, the student will :

CO1 Have a thorough grounding on the issues and challenges being faced in attaining sustainable development

CO2 have a knowledge on the role of NGOs towards sustainable developemnt

CO 3 present strategies for NGOs in attaining sustainable development

CO 4 recognize the importance of providing energy, food security and health equity to all members of the society without damaging the environment

CO 5 understand the environmental legislations

**REFERENCE BOOKS**

1. Kulsange, S and Kamble, R. (2019). Environmental NGO's: Sustainability Stewardship, Lap Lambert Academic Publishing, India, ISBN-13: 978-6200442444.





- 4 To explore the various bio-energy technologies.
- 5 To study the ocean and geothermal technologies.

**UNIT I ENERGY SCENARIO 9**

Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status-Potential of various renewable energy sources-Global energy status-Per capita energy consumption - Future energy plans

**UNIT II SOLAR ENERGY 9**

Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications.

**UNIT III WIND ENERGY 9**

Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.

**UNIT IV BIO-ENERGY 9**

Bio resources – Biomass direct combustion – thermochemical conversion - biochemical conversion-mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration – Carbonisation – Pyrolysis - Biogas plants – Digesters –Biodiesel production – Ethanol production - Applications.

**UNIT V OCEAN AND GEOTHERMAL ENERGY 9**

Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

At the end of the course the students would be able to

- Discuss the Indian and global energy scenario.
- Describe the various solar energy technologies and its applications.
- Explain the various wind energy technologies.
- Explore the various bio-energy technologies.
- Discuss the ocean and geothermal technologies.

**TEXT BOOKS:**

- Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, cGraw Hill; First edition (10 December 2020), ISBN-10 : 9390385636
- Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 8120344707

**REFERENCES:**

1. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 2012.
2. Rai.G.D., “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 2014.
3. Sukhatme.S.P., “Solar Energy: Principles of Thermal Collection and Storage”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
4. Tiwari G.N., “Solar Energy – Fundamentals Design, Modelling and applications”, Alpha Science Intl Ltd, 2015.
5. Twidell, J.W. & Weir A., “Renewable Energy Resources”, EFNSpon Ltd., UK, 2015.

### CO's – PO's & PSO's MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	1	1	2	3	2	2	1	1	3	2	1	2
2	3	2	2	1	1	1	3	1	1	1	2	3	2	1	2
3	3	2	3	1	2	1	3	1	1	1	1	3	1	1	2
4	2	2	2	1	2	1	3	1	1	1	2	3	2	2	2
5	2	1	2	1	2	1	3	1	1	1	1	3	2	1	2
Low (1) ; Medium (2) ; High (3)															

**OME354**

**APPLIED DESIGN THINKING**

**L T P C  
3 0 0 3**

**OBJECTIVES:**

The course aims to

- Introduce tools & techniques of design thinking for innovative product development
- Illustrate customer-centric product innovation using on simple use cases
- Demonstrate development of Minimum usable Prototypes
- Outline principles of solution concepts & their evaluation
- Describe system thinking principles as applied to complex systems

**UNIT I DESIGN THINKING PRINCIPLES**

**9**

Exploring Human-centered Design - Understanding the Innovation process, discovering areas of opportunity, Interviewing & empathy-building techniques, Mitigate validation risk with FIR [Forge Innovation rubric] - Case studies

**UNIT II ENDUSER-CENTRIC INNOVATION**

**9**

Importance of customer-centric innovation - Problem Validation and Customer Discovery - Understanding problem significance and problem incidence - Customer Validation. Target user, User persona & user stories. Activity: Customer development process - Customer interviews and field visit

**UNIT III APPLIED DESIGN THINKING TOOLS**

**9**

Concept of Minimum Usable Prototype [MUP] - MUP challenge brief - Designing & Crafting the value proposition - Designing and Testing Value Proposition; Design a compelling value proposition; Process, tools and techniques of Value Proposition Design

**UNIT IV CONCEPT GENERATION**

**9**

Solution Exploration, Concepts Generation and MUP design- Conceptualize the solution concept; explore, iterate and learn; build the right prototype; Assess capability, usability and feasibility. Systematic concept generation; evaluation of technology alternatives and the solution concepts

**UNIT V SYSTEM THINKING**

**9**

System Thinking, Understanding Systems, Examples and Understandings, Complex Systems

**TOTAL: 45 PERIODS**

**Course Outcomes**

**At the end of the course, learners will be able to:**

- Define & test various hypotheses to mitigate the inherent risks in product innovations.
- Design the solution concept based on the proposed value by exploring alternate solutions to achieve value-price fit.
- Develop skills in empathizing, critical thinking, analyzing, storytelling & pitching

- Apply system thinking in a real-world scenario

### Text Books

1. Steve Blank, (2013), The four steps to epiphany: Successful strategies for products that win, Wiley.
2. Alexander Osterwalder, Yves Pigneur, Gregory Bernarda, Alan Smith, Trish Papadacos, (2014), Value
3. Proposition Design: How to Create Products and Services Customers Want, Wiley
4. Donella H. Meadows, (2015), "Thinking in Systems -A Primer", Sustainability Institute.
5. Tim Brown,(2012) "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation", Harper Business.

### REFERENCES

1. <https://www.ideou.com/pages/design-thinking#process>
2. [https://blog.forgeforward.in/valuation-risk-versus-validation-risk-in-product-innovations-49f253ca86\\_24](https://blog.forgeforward.in/valuation-risk-versus-validation-risk-in-product-innovations-49f253ca86_24)
3. <https://blog.forgeforward.in/product-innovation-rubric-adf5ebdfd356>
4. <https://blog.forgeforward.in/evaluating-product-innovations-e8178e58b86e>
5. <https://blog.forgeforward.in/user-guide-for-product-innovation-rubric-857181b253dd>
6. <https://blog.forgeforward.in/star-tup-failure-is-like-true-lie-7812cdf9b85>

**MF3003**

**REVERSE ENGINEERING**

**LT P C  
3 0 0 3**

### COURSE OBJECTIVES:

- The main learning objective of this course is to prepare students for:
- Applying the fundamental concepts and principles of reverse engineering in product design and development.
- Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- Applying the concept and principles of material identification and process verification in reverse engineering of product design and development.
- Analysing the various legal aspect and applications of reverse engineering in product design and development.
- Understand about 3D scanning hardware & software operations and procedure to generate 3D model

### UNIT I INTRODUCTION & GEOMETRIC FORM

**9**

Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

### UNIT II MATERIAL CHARACTERISTICS AND PROCESS IDENTIFICATION

**9**

Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification.

### UNIT III DATA PROCESSING

**9**

Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility.

**UNIT IV 3D SCANNING AND MODELLING****9**

Introduction, working principle and operations of 3D scanners: Laser, White Light, Blue Light - Applications- Software for scanning and modelling: Types- Applications- Preparation techniques for Scanning objects- Scanning and Measuring strategies - Calibration of 3D Scanner- Step by step procedure: 3D scanning - Geometric modelling – 3D inspection- Case studies.

**UNIT V INDUSTRIAL APPLICATIONS****9**

Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry. Case studies and Solving Industrial projects in Reverse Engineering. Legality: Patent – Copyrights – Trade Secret – Third-Party Materials.

**TOTAL : 45 PERIODS****COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Apply the fundamental concepts and principles of reverse engineering in product design and development.
- Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.
- Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
- Analyze the various legal aspect
- Applications of reverse engineering in product design and development.

**TEXT BOOKS:**

1. Robert W. Messler, Reverse Engineering: Mechanisms, Structures, Systems & Materials, 1st Edition, McGraw-Hill Education, 2014
2. Wego Wang, Reverse Engineering Technology of Reinvention, CRC Press, 2011

**REFERENCES:**

1. Scott J. Lawrence , Principles of Reverse Engineering, Kindle Edition, 2022
2. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Prentice Hall, 2001
3. Kathryn, A. Ingle, “Reverse Engineering”, McGraw-Hill, 1994.
4. Linda Wills, “Reverse Engineering”, Kluwer Academic Publishers, 1996
5. Vinesh Raj and Kiran Fernandes, “Reverse Engineering: An Industrial Perspective”, Springer-Verlag London Limited 2008.

**OPR351****SUSTAINABLE MANUFACTURING****LT P C****3 0 0 3****COURSE OBJECTIVES:**

- To be acquainted with sustainability in manufacturing and its evaluation.
- To provide knowledge in environment and social sustainability.
- To provide the student with the knowledge of strategy to achieve sustainability.
- To familiarize with trends in sustainable operations.
- To create awareness in current sustainable practices in manufacturing industry.

**UNIT I ECONOMIC SUSTAINABILITY 9**

Industrial Revolution-Economic sustainability: globalization and international issues Sustainability status - Emerging issues- Innovative products- Reconfiguration manufacturing enterprises - Competitive manufacturing strategies - Performance evaluation- Management for sustainability - Assessments of economic sustainability

**UNIT II SOCIAL AND ENVIRONMENTAL SUSTAINABILITY 9**

Social sustainability – Introduction-Work management -Human rights - Societal commitment - Customers -Business practices -Modelling and assessing social sustainability. Environmental issues pertaining to the manufacturing sector: Pollution - Use of resources -Pressure to reduce costs - Environmental management: Processes that minimize negative environmental impacts - environmental legislation and energy costs - need to reduce the carbon footprint of manufacturing Operations-Modelling and assessing environmental sustainability

**UNIT III SUSTAINABILITY PRACTICES 9**

Sustainability awareness - Measuring Industry Awareness-Drivers and barriers -Availability of sustainability indicators -Analysis of sustainability practicing -Modeling and assessment of sustainable practicing -Sustainability awareness -Sustainability drivers and barriers - Availability of sustainability indicators- Designing questionnaires- Optimizing Sustainability Indexes-Elements – Cost and time model.

**UNIT IV MANUFACTURING STRATEGY FOR SUSTAINABILITY 9**

Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.

**UNIT V TRENDS IN SUSTAINABLE OPERATIONS 9**

Principles of sustainable operations - Life cycle assessment manufacturing and service activities - influence of product design on operations - Process analysis – Capacity management - Quality management -Inventory management - Just-In-Time systems - Resource efficient design - Consumerism and sustainable well-being.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

- CO1: Discuss the importance of economic sustainability.
- CO2: Describe the importance of sustainable practices.
- CO3: Identify drivers and barriers for the given conditions.
- CO4: Formulate strategy in sustainable manufacturing.
- CO5: Plan for sustainable operation of industry with environmental, cost consciousness.

**TEXT BOOKS:**

1. Ibrahim Garbie, "Sustainability in Manufacturing Enterprises Concepts, Analyses and Assessments for Industry 4.0", Springer International Publishing., United States, 2016, ISBN-13: 978-3319293042.
2. Davim J.P., "Sustainable Manufacturing", John Wiley & Sons., United States, 2010,ISBN: 978-1-848-21212-1.

**REFERENCES:**

1. Jovane F, Emper, W.E. and Williams, D.J., "The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing", Springer,2009, United States, ISBN 978-3-540-77011-4.
2. Kutz M., "Environmentally Conscious Mechanical Design", John Wiley & Sons., United States, 2007, ISBN: 978-0-471-72636-4.
3. Seliger G., "Sustainable Manufacturing: Shaping Global Value Creation", Springer, United States, 2012, ISBN 978-3-642-27289-9.

### CO's – PO's & PSO's MAPPING

COs/Pos &PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	-	2	-	-	-	2	2	-	1	1	2	2	2	1
CO2	3	-	-	-	-	-	2	-	-	1	1	2	1	2	2
CO3	3	-	-	-	-	-	2	3	-	1	1	2	1	2	2
CO4	3	-	3	-	-	-	2	-	-	1	1	2	2	2	1
CO5	3	-	3	-	-	-	2	2	-	1	1	2	2	2	1
CO/PO & PSO Average	3	-	3	-	-	-	2	2	-	1	1	2	2	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

**AU3791**

**ELECTRIC AND HYBRID VEHICLES**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

The objective of this course is to prepare the students to know about the general aspects of Electric and Hybrid Vehicles (EHV), including architectures, modelling, sizing, and sub system design and hybrid vehicle control.

**UNIT I DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES 9**

Need for Electric vehicle- Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. - Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refuelling Systems.

**UNIT II ENERGY SOURCES 9**

Battery Parameters- - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion-Sodium based- Metal Air. Battery Modelling - Equivalent circuits, Battery charging- Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System.

**UNIT III MOTORS AND DRIVES 9**

Types of Motors- DC motors- AC motors, PMSM motors, BLDC motors, Switched reluctance motors working principle, construction and characteristics.

**UNIT IV POWER CONVERTERS AND CONTROLLERS 9**

Solid state Switching elements and characteristics – BJT, MOSFET, IGBT, SCR and TRIAC - Power Converters – rectifiers, inverters and converters - Motor Drives - DC, AC motor, PMSM motors, BLDC motors, Switched reluctance motors – four quadrant operations –operating modes

**UNIT V HYBRID AND ELECTRIC VEHICLES 9**

Main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of this course, the student will be able to

1. Understand the operation and architecture of electric and hybrid vehicles
2. Identify various energy source options like battery and fuel cell
3. Select suitable electric motor for applications in hybrid and electric vehicles.



**OUTCOMES:**

- Illustrate the history of aviation & developments over the years
- Ability to identify the types & classifications of components and control systems
- Explain the basic concepts of flight & Physical properties of Atmosphere
- Identify the types of fuselage and constructions.
- Distinguish the types of Engines and explain the principles of Rocket

**TEXT BOOKS:**

1. John D. Anderson, Introduction to Flight, 8 th Ed., McGraw-Hill Education, New York,2015.
2. E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021.
3. Stephen. A. Brandt, "Introduction to Aeronautics: A design perspective &quot; American Institute of Aeronautics & Astronautics,1997.

**REFERENCE:**

1. Kermode, A.C., "Mechanics of Flight", Himalayan Book, 1997.

**OIM351****INDUSTRIAL MANAGEMENT****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- To introduce fundamental concepts of industrial management
- To understand the approaches to the study of Management
- To learn about Decision Making, Organizing and leadership
- To analyze the Managerial Role and functions
- To know about the Supply Chain Management'

**UNIT I INTRODUCTION****9**

Technology Management - Definition - Functions - Evolution of Modern Management - Scientific Management Development of Management Thought. Approaches to the study of Management, Forms of Organization -Individual Ownership - Partnership - Joint Stock Companies - Co-operative Enterprises - Public Sector Undertakings, Corporate Frame Work- Share Holders - Board of Directors - Committees - Chief Executive Line and Functional Managers,-Financial-Legal-Trade Union

**UNIT II FUNCTIONS OF MANAGEMENT****9**

Planning - Nature and Purpose - Objectives - Strategies – Policies and Planning Premises - Decision Making - Organizing - Nature and Process - Premises - Departmentalization - Line and staff - Decentralization -Organizational culture, Staffing - selection and training .Placement - Performance appraisal - Career Strategy – Organizational Development. Leading - Managing human factor - Leadership .Communication, Controlling - Process of Controlling - Controlling techniques, productivity and operations management - Preventive control, Industrial Safety.

**UNIT III ORGANIZATIONAL BEHAVIOUR****9**

Definition - Organization - Managerial Role and functions -Organizational approaches, Individual behaviour - causes - Environmental Effect - Behaviour and Performance, Perception - Organizational Implications. Personality - Contributing factors - Dimension – Need Theories - Process Theories - Job Satisfaction, Learning and Behaviour-Learning Curves, Work Design and approaches.

**UNIT IV GROUPDYNAMICS****9**

Group Behaviour - Groups - Contributing factors - Group Norms, Communication - Process - Barriers to communication - Effective communication, leadership - formal and informal characteristics – Managerial Grid - Leadership styles - Group Decision Making - Leadership Role in



Group Decision, Group Conflicts - Types -Causes - Conflict Resolution -Inter group relations and conflict, Organization centralization and decentralization - Formal and informal - Organizational Structures Organizational Change and Development -Change Process – Resistance to Change - Culture and Ethics.

**UNIT V MODERN CONCEPTS**

**9**

Management by Objectives (MBO) - Management by Exception (MBE),Strategic Management - Planning for Future direction - SWOT Analysis -Evolving development strategies, information technology in management Decisions support system-Management Games Business Process Re-engineering(BPR) –Enterprises Resource Planning (ERP) - Supply Chain Management (SCM) - Activity Based Management (AM) - Global Perspective - Principles and Steps Advantages and disadvantage

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- CO1: Understand the basic concepts of industrial management
- CO2: Identify the group conflicts and its causes.
- CO3: Perform swot analysis
- CO4 : Analyze the learning curves
- CO5 : Understand the placement and performance appraisal

**REFERENCES:**

1. Maynard H.B, “Industrial Engineering Hand book”, McGraw-Hill, sixth 2008

**CO's – PO's & PSO's MAPPING**

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1											2	1	
2		3	2	3											2
3	2	3	2	3									1	2	3
4	2	2	3	3										3	3
5	2	2											2		
AVg.	2	2.2	2.3	3									1.8	2	2.6

**OIE354**

**QUALITY ENGINEERING**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- Developing a clear knowledge in the basics of various quality concepts.
- Facilitating the students in understanding the application of control charts and its techniques.
- Developing the special control procedures for service and process oriented industries.
- Analyzing and understanding the process capability study.
- Developing the acceptance sampling procedures for incoming raw material.

**UNIT I INTRODUCTION**

**9**

Quality Dimensions–Quality definitions–Inspection–Quality control–Quality Assurance–Quality planning–Quality costs–Economics of quality– Quality loss function

**UNIT II CONTROLCHARTS**

**9**

Chance and assignable causes of process variation, statistical basis of the control chart, control charts for variables- X , R and S charts, attribute control charts - p, np, c and u- Construction and application.

**UNIT III SPECIAL CONTROL PROCEDURES****9**

Warning and modified control limits, control chart for individual measurements, multi-vari chart, Xchart with a linear trend, chart for moving averages and ranges, cumulative-sum and exponentially weighted moving average control charts.

**UNIT IV STATISTICAL PROCESS CONTROL****9**

Process stability, process capability analysis using a Histogram or probability plots and control chart. Gauge capability studies, setting specification limits.

**UNIT V ACCEPTANCE SAMPLING****9**

The acceptance sampling fundamental, OC curve, sampling plans for attributes, simple, double, multiple and sequential, sampling plans for variables, MIL-STD-105D and MIL-STD-414E & IS 2500 standards.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

Students will be able to:

**CO1:** Control the quality of processes using control charts for variables in manufacturing industries.

**CO2:** Control the occurrence of defective product and the defects in manufacturing companies.

**CO3:** Control the occurrence of defects in services.

**CO4:** Analyzing and understanding the process capability study.

**CO5:** Developing the acceptance sampling procedures for incoming raw material.

**CO's – PO's & PSO's MAPPING**

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	3		3			1	2			2	1		
2		3	3		3	3			3			3		2	
3	3	3	3		3				3			3	1		
4	3		2		3						1		1		
5		2			3				3			3			1
<b>AVg.</b>	2.6	2.7	2.7		3	3		1	2.7		1	2.7	1	2	1

**OSF351****FIRE SAFETY ENGINEERING****L T P C  
3 0 0 3****COURSE OBJECTIVES**

1: To enable the students to acquire knowledge of Fire and Safety Studies

2: To learn about the effect of fire on materials used for construction, the method of test for non-combustibility & fire resistance

3: To learn about fire area, fire stopped areas and different types of fire-resistant doors

4: To learn about the method of fire protection of structural members and their repair due to fire damage.

5: To develop safety professionals for both technical and management through systematic and quality-based study programmes

**UNIT I INHERENT SAFETY CONCEPTS****9**

Compartment fire-factors controlling fire severity, ventilation controlled and fuel controlled fires; Spread of fire in rooms, within building and between buildings. Effect of temperature on the properties of structural materials- concrete, steel, masonry and wood; Behavior of non-structural materials on fire- plastics, glass, textile fibres and other house hold materials.

## **UNIT II PLANT LOCATIONS**

**9**

Compartment temperature-time response at pre-flashover and post flashover periods; Equivalence of fire severity of compartment fire and furnace fire; Fire resistance test on structural elements-standard heating condition, Indian standard test method, performance criteria.

## **UNIT III WORKING CONDITIONS**

**9**

Fire separation between building- principle of calculation of safe distance. Design principles of fire resistant walls and ceilings; Fire resistant screens- solid screens and water curtains; Local barriers; Fire stopped areas-in roof, in fire areas and in connecting structures; Fire doors- Low combustible, Non-combustible and Spark-proof doors; method of suspension of fire doors; Air-tight sealing of doors;

## **UNIT IV FIRE SEVERITY AND REPAIR TECHNIQUES**

**9**

Fabricated fire proof boards-calcium silicate, Gypsum, Vermiculite, and Perlite boards; Fire protection of structural elements - Wooden, Steel and RCC.. Reparability of fire damaged structures- Assessment of damage to concrete, steel, masonry and timber structures, Repair techniques- repair methods to reinforced concrete Columns, beams and slabs, Repair to steel structural members, Repair to masonry structures.

## **UNIT V WORKING AT HEIGHTS**

**9**

Safe Access - Requirement for Safe Work Platforms- Stairways - Gangways and Ramps-Fall Prevention & Fall Protection - Safety Belts - Safety nets - Fall Arrestors- Working on Fragile Roofs - Work Permit Systems-Accident Case Studies.

**TOTAL : 45 PERIODS**

## **COURSE OUTCOMES**

On completion of the course the student will be able to

**CO1:** Understand the effect of fire on materials used for construction

**CO2:** Understand the method of test for non-combustibility and fire resistance; and will be able to select different structural elements and their dimensions for a particular fire resistance rating of a building.

**CO3:** To understand the design concept of fire walls, fire screens, local barriers and fire doors and able to select them appropriately to prevent fire spread.

**CO4:** To decide the method of fire protection to RCC, steel, and wooden structural elements and their repair methods if damaged due to fire.

**CO5:** Describe the safety techniques and improve the analytical and intelligence to take the right decision at right time.

## **TEXT BOOKS**

- Roytman, M. Y, "Principles of fire safety standards for building construction". Amerind Publishing Co. Pvt. Ltd., New Delhi, 1975
- John A. Purkiss, "Fire safety engineering design of structures" (2nd edn.), Butterworth Heinemann, Oxford, UK, 2009.

## **REFERENCES:**

1. Smith, E.E. and Harmathy, T.Z. (Editors), "Design of buildings for fire safety". ASTM Special Publication 685, American Society for Testing and Materials, Boston, U.S.A, 1979.
2. Butcher, E. G. and Parnell, A. C, "Designing of fire safety". JohnWiley and Sons Ltd., New York, U.S.A. 1983.
3. Jain, V.K, "Fire safety in buildings" (2nd edn.). New Age International(P) Ltd., New Delhi, 2010.
4. Hazop&Hazan, "Identifying and Assessing Process Industry Hazards", Fourth Edition , 1999
4. Frank R. Spellman, Nancy E. Whiting, "The Handbook of Safety Engineering: Principles and Applications", 2009.

### COs- POs & PSOs MAPPING

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1	2	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-
2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
3	1	-	2	-	-	-	3	-	-	1	-	-	-	-	-	-
4	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
5	2	-	1	-	-	1	1	1	-	1	-	1	-	-	-	-
AVg.	1.3	-	1.75	-	-	1	1.3	1	-	1	-	1	-	-	-	-

**OML351**

### INTRODUCTION TO NON-DESTRUCTIVE TESTING

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basic importance of NDT in quality assurance.
- Imbibing the basic principles of various NDT techniques, its applications, limitations, codes and standards.
- Equipping themselves to locate a flaw in various materials, products.
- Applying apply the testing methods for inspecting materials in accordance with industry specifications and standards.
- Acquiring the knowledge on the selection of the suitable NDT technique for a given application

**UNIT I**

#### INTRODUCTION TO NDT & VISUAL TESTING

**9**

Concepts of Non-destructive testing-relative merits and limitations-NDT Versus mechanical testing, Fundamentals of Visual Testing – vision, lighting, material attributes, environmental factors, visual perception, direct and indirect methods – mirrors, magnifiers, boroscopes and fibroscopes – light sources and special lighting.

**UNIT II**

#### LIQUID PENETRANT & MAGNETIC PARTICLE TESTING

**9**

Liquid Penetrant Inspection: principle, applications, advantages and limitations, dyes, developers and cleaners, Methods & Interpretation.

Magnetic Particle Inspection: Principles, applications, magnetization methods, magnetic particles, Testing Procedure, demagnetization, advantages and limitations, – Interpretation and evaluation of test indications.

**UNIT III**

#### EDDY CURRENT TESTING & THERMOGRAPHY

**9**

Eddy Current Testing: Generation of eddy currents– properties– eddy current sensing elements, probes, Instrumentation, Types of arrangement, applications, advantages, limitations – Factors affecting sensing elements and coil impedance, calibration, Interpretation/Evaluation.

Thermography- Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal – Concept, example, advantages & limitations. Electromagnetic spectrum, infrared thermography- approaches, IR detectors, Instrumentation and methods, applications.

**UNIT IV**

#### ULTRASONIC TESTING & AET

**9**

Ultrasonic Testing: Types of ultrasonic waves, characteristics, attenuation, couplants, probes, EMAT. Inspection methods-pulse echo, transmission and phased array techniques, types of scanning and displays, angle beam inspection of welds, time of flight diffraction (TOFD) technique, Thickness determination by ultrasonic method, Study of A, B and C scan presentations, calibration. Acoustic Emission Technique – Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages & Limitations, Interpretation of Results, Applications.

**UNIT V RADIOGRAPHY TESTING****9**

Sources-X-rays and Gamma rays and their characteristics-absorption, scattering. Filters and screens, Imaging modalities-film radiography and digital radiography (Computed, Direct, Real Time, CT scan). Problems in shadow formation, exposure factors, inverse square law, exposure charts, Penetrameters, safety in radiography.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

After completion of this course, the students will be able to

1. Realize the importance of NDT in various engineering fields.
2. Have a basic knowledge of surface NDE techniques which enables to carry out various inspection in accordance with the established procedures.
3. Calibrate the instrument and inspect for in-service damage in the components by means of Eddy current testing as well as Thermography testing.
4. Differentiate various techniques of UT and AET and select appropriate NDT methods for better evaluation.
5. Interpret the results of Radiography testing and also have the ability to analyse the influence of various parameters on the testing.

**TEXT BOOKS:**

1. Baldev Raj, T. Jayakumar and M. Thavasimuthu, Practical Non Destructive Testing, Alpha Science International Limited, 3rd edition, 2002.
2. J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition, 2011.
3. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010.

**REFERENCES:**

1. ASM Metals Handbook, V-17, "Nondestructive Evaluation and Quality Control", American Society of Metals, USA, 2001.
2. Barry Hull and Vernon John, "Nondestructive Testing", Macmillan, 1989.
3. Chuck Hellier, "Handbook of Nondestructive Evaluation", Mc Graw Hill, 2012.
4. Louis Cartz, "Nondestructive Testing", ASM International, USA, 1995.

**CO's- PO's & PSO's MAPPING**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
<b>C01</b>	2	2	2	3			2	2				2	1	2	
<b>C02</b>	3	1	2	2			2	2				2	2	2	1
<b>C03</b>	3	2	1	2			2	2				2	2	2	
<b>CO4</b>	3	1	2	2			2	2				2	2	2	2
<b>CO5</b>	3	2	2	2			2	2				2	2	2	1
<b>Avg</b>	2.8	1.6	1.8	2.2			2	2				2	1.8	2	1.3

OMR351

**MECHATRONICS**

L	T	P	C
3	0	0	3

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

1. Selecting sensors to develop mechatronics systems.
2. Explaining the architecture and timing diagram of microprocessor, and also interpret and develop programs.
3. Designing appropriate interfacing circuits to connect I/O devices with microprocessor.
4. Applying PLC as a controller in mechatronics system.
5. Designing and develop the apt mechatronics system for an application.

**UNIT I INTRODUCTION AND SENSORS 9**  
Introduction to Mechatronics – Systems – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and Dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance Sensors – Strain Gauges – Eddy Current Sensor – Hall Effect Sensor – Temperature Sensors – Light Sensors.

**UNIT II 8085 MICROPROCESSOR 9**  
Introduction – Pin Configuration - Architecture of 8085 – Addressing Modes – Instruction set, Timing diagram of 8085.

**UNIT III PROGRAMMABLE PERIPHERAL INTERFACE 9**  
Introduction – Architecture of 8255, Keyboard Interfacing, LED display – Interfacing, ADC and DAC Interface, Temperature Control – Stepper Motor Control – Traffic Control Interface.

**UNIT IV PROGRAMMABLE LOGIC CONTROLLER 9**  
Introduction – Architecture – Input / Output Processing – Programming with Timers, Counters and Internal relays – Data Handling – Selection of PLC.

**UNIT V ACTUATORS AND MECHATRONICS SYSTEM DESIGN 9**  
Types of Stepper and Servo motors – Construction – Working Principle – Characteristics, Stages of Mechatronics Design Process – Comparison of Traditional and Mechatronics Design Concepts with Examples – Case studies of Mechatronics Systems – Pick and Place Robot – Engine Management system – Automatic Car Park Barrier.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

- CO1: Select sensors to develop mechatronics systems.  
CO2: Explain the architecture and timing diagram of microprocessor, and also interpret and develop programs.  
CO3: Design appropriate interfacing circuits to connect I/O devices with microprocessor.  
CO 4: Apply PLC as a controller in mechatronics system.  
CO 5: Design and develop the apt mechatronics system for an application.

**TEXT BOOKS**

1. Bolton W., "Mechatronics", Pearson Education, 6th Edition, 2015.
2. Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Penram International Publishing Private Limited, 6th Edition, 2013.

**REFERENCES**

1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., "Mechatronics", Chapman and Hall, 1993.
2. Davis G. Alciatore and Michael B. Histan, "Introduction to Mechatronics and Measurement systems", McGraw Hill Education, 2011.



**UNIT IV SENSORS IN ROBOTICS****9**

Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors, safety considerations in robotic cell, proximity sensors, fail safe hazard sensor systems, and compliance mechanism. Machine vision system - camera, frame grabber, sensing and digitizing image data – signal conversion, image storage, lighting techniques, image processing and analysis – data reduction, segmentation, feature extraction, object recognition, other algorithms, applications – Inspection, identification, visual serving and navigation.

**UNIT V PROGRAMMING AND APPLICATIONS OF ROBOT****9**

Teach pendant programming, lead through programming, robot programming languages – VAL programming – Motion Commands, Sensors commands, End-Effector Commands, and simple programs - Role of robots in inspection, assembly, material handling, underwater, space and medical fields.

**TOTAL : 45 PERIODS****COURSE OUTCOMES**

At the end of the course, students will be able to:

CO1: Interpret the features of robots and technology involved in the control.

CO2: Apply the basic engineering knowledge and laws for the design of robotics.

CO3: Explain the basic concepts like various configurations, classification and parts of end effectors compare various end effectors and grippers and tools and sensors used in robots.

CO4: Explain the concept of kinematics, degeneracy, dexterity and trajectory planning.

CO5: Demonstrate the image processing and image analysis techniques by machine vision system.

**TEXT BOOKS:**

1. Ganesh.S.Hedge, "A textbook of Industrial Robotics", Lakshmi Publications, 2006.
2. Mikell.P.Groover , "Industrial Robotics – Technology, Programming and applications" McGraw Hill 2<sup>ND</sup> edition 2012.

**REFERENCES:**

1. Fu K.S. Gonalz R.C. and ice C.S.G."Robotics Control, Sensing, Vision and Intelligence", McGraw Hill book co. 2007.
2. YoramKoren, "Robotics for Engineers", McGraw Hill Book, Co., 2002.
3. Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill 2005.
4. John. J.Craig, "Introduction to Robotics: Mechanics and Control" 2nd Edition, 2002.
5. Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer India reprint, 2010.

**CO's- PO's & PSO's MAPPING**

COs/POs&P SOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	1								1			3
CO2	3	2	1	1								1			3
CO3	3	2	1	1								1			3
CO4	3	2	1	1								1			3
CO5	3	2	1	1								1			3
CO/PO & PSO Average															

1 – Slight, 2 – Moderate, 3 – Substantial



**OBJECTIVES:**

- To acquire the knowledge on the Historical evaluation of Airplanes
- To learn the different component systems and functions
- To know the concepts of basic properties and principles behind the flight
- To learn the basics of different structures & construction
- To learn the various types of power plants used in aircrafts

**UNIT I HISTORY OF FLIGHT****8**

Balloon flight-ornithopter-Early Airplanes by Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

**UNIT II AIRCRAFT CONFIGURATIONS AND ITS CONTROLS****10**

Different types of flight vehicles, classifications-Components of an airplane and their functions- Conventional control, powered control- Basic instruments for flying-Typical systems for control actuation.

**UNIT III BASICS OF AERODYNAMICS****9**

Physical Properties and structures of the Atmosphere, Temperature, pressure and altitude relationships, Newton's Law of Motions applied to Aeronautics-Evolution of lift, drag and moment. Aerofoils, Mach number, Maneuvers.

**UNIT IV BASICS OF AIRCRAFT STRUCTURES****9**

General types of construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Metallic and non-metallic materials. Use of Aluminium alloy, titanium, stainless steel and composite materials. Stresses and strains-Hooke's law- stress-strain diagrams-elastic constants-Factor of Safety.

**UNIT V BASICS OF PROPULSION****9**

Basic ideas about piston, turboprop and jet engines – use of propeller and jets for thrust production- Comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space.

**TOTAL : 45 PERIODS****OUTCOMES:**

- Illustrate the history of aircraft & developments over the years
- Ability to identify the types & classifications of components and control systems
- Explain the basic concepts of flight & Physical properties of Atmosphere
- Identify the types of fuselage and constructions.
- Distinguish the types of Engines and explain the principles of Rocket

**TEXT BOOKS**

1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition , 2015
2. E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021
3. Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.

## REFERENCE

1. SADHU SINGH, "INTERNAL COMBUSTION ENGINES AND GAS TURBINE"-, SS Katarraia & sons, 2015
2. KERMODE , "FLIGHT WITHOUT FORMULAE", -, Pitman; 4th Revised edition 1989

**OGI351**

**REMOTE SENSING CONCEPTS**

**L T P C**

**3 0 0 3**

### OBJECTIVES:

- To introduce the concepts of remote sensing processes and its components.
- To expose the various remote sensing platforms and sensors and to introduce the elements of data interpretation

### UNIT I REMOTE SENSING AND ELECTROMAGNETIC RADIATION 9

Definition – components of RS – History of Remote Sensing – Merits and demerits of data collation between conventional and remote sensing methods - Electromagnetic Spectrum – Radiation principles - Wave theory, Planck's law, Wien's Displacement Law, Stefan's Boltzmann law, Kirchoff's law – Radiation sources: active & passive - Radiation Quantities

### UNIT II EMR INTERACTION WITH ATMOSPHERE AND EARTH MATERIAL 9

Standard atmospheric profile – main atmospheric regions and its characteristics – interaction of radiation with atmosphere – Scattering, absorption and refraction – Atmospheric windows - Energy balance equation – Specular and diffuse reflectors – Spectral reflectance & emittance – Spectroradiometer – Spectral Signature concepts – Typical spectral reflectance curves for vegetation, soil and water – solid surface scattering in microwave region.

### UNIT III ORBITS AND PLATFORMS 9

Motions of planets and satellites – Newton's law of gravitation - Gravitational field and potential - Escape velocity - Kepler's law of planetary motion - Orbit elements and types – Orbital perturbations and maneuvers – Types of remote sensing platforms - Ground based, Airborne platforms and Space borne platforms – Classification of satellites – Sun synchronous and Geosynchronous satellites – Lagrange Orbit.

### UNIT IV SENSING TECHNIQUES 9

Classification of remote sensors – Resolution concept : spatial, spectral, radiometric and temporal resolutions - Scanners - Along and across track scanners – Optical-infrared sensors – Thermal sensors – microwave sensors – Calibration of sensors - High Resolution Sensors - LIDAR , UAV – Orbital and sensor characteristics of live Indian earth observation satellites

### UNIT V DATA PRODUCTS AND INTERPRETATION 9

Photographic and digital products – Types, levels and open source satellite data products – selection and procurement of data– Visual interpretation: basic elements and interpretation keys - Digital interpretation – Concepts of Image rectification, Image enhancement and Image classification

**TOTAL:45 PERIODS**

### COURSE OUTCOMES:

- On completion of the course, the student is expected to
- CO 1** Understand the concepts and laws related to remote sensing
- CO 2** Understand the interaction of electromagnetic radiation with atmosphere and earth material
- CO3** Acquire knowledge about satellite orbits and different types of satellites
- CO4** Understand the different types of remote sensors
- CO5** Gain knowledge about the concepts of interpretation of satellite imagery

**TEXTBOOKS:**

1. Thomas M.Lillesand, Ralph W. Kiefer and Jonathan W. Chipman, Remote Sensing and Image interpretation, John Wiley and Sons, Inc, New York,2015.
2. George Joseph and C Jeganathan, Fundamentals of Remote Sensing,Third Edition Universities Press (India) Private limited, Hyderabad, 2018

**REFERENCES:**

1. Janza, F.Z., Blue H.M. and Johnson,J.E. Manual of Remote Sensing. Vol.1, American Society of Photogrametry, Virginia, USA, 2002.
2. Verbyla, David, Satellite Remote Sensing of Natural Resources. CRC Press, 1995
3. Paul Curran P.J. Principles of Remote Sensing. Longman, RLBS, 1988.
4. Introduction to Physics and Techniques of Remote Sensing , Charles Elachi and Jacob Van Zyl, 2006 Edition II, Wiley Publication.
5. Basudeb Bhatta, Remote Sensing and GIS, Oxford University Press, 2011

**CO's- PO's & PSO's MAPPING**

PO	Graduate Attribute	Course Outcome					Average
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering Knowledge	3	3	3	3	3	3
PO2	Problem Analysis				3	3	3
PO3	Design/Development of Solutions				3	3	3
PO4	Conduct Investigations of Complex Problems				3	3	3
PO5	Modern Tool Usage				3	3	3
PO6	The Engineer and Society						
PO 7	Environment and Sustainability						
PO 8	Ethics						
PO 9	Individual and Team Work						
PO 10	Communication						
PO 11	Project Management and Finance						
PO 12	Life-long Learning	3		3	3	3	3
PSO 1	Knowledge of Geoinformatics discipline	3	3	3	3	3	3
PSO 2	Critical analysis of Geoinformatics Engineering problems and innovations	3	3	3	3	3	3
PSO 3	Conceptualization and evaluation of Design solutions	3	3	3	3	3	3

OAI351

URBAN AGRICULTURE

L T P C  
3 0 0 3**OBJECTIVES:**

- To introduce the students the principles of agricultural crop production and the production practices of crops in modern ways.
- To delineate the role of agricultural engineers in relation to various crop production practices.

**UNIT I INTRODUCTION****9**

Benefits of urban agriculture- economic benefits, environmental benefits, social and cultural benefits, educational, skill-building and job training benefits, health, nutrition and food accessibility benefits.

**UNIT II VERTICAL FARMING****9**

**Vertical farming- types**, green facade, living/green wall-modular green wall , vegetated mat wall- Structures and components for green wall system: plant selection, growing media, irrigation and

plant nutrition: Design, light, benefits of vertical gardening. Roof garden and its types. Kitchen garden, hanging baskets: **The house plants/ indoor plants**

**UNIT III SOIL LESS CULTIVATION 9**

Hydroponics, aeroponics, aquaponics: merits and limitations, costs and Challenges, backyard gardens- tactical gardens- street landscaping- forest gardening, greenhouses, urban beekeeping

**UNIT IV MODERN CONCEPTS 9**

Growth of plants in vertical pipes in terraces and inside buildings, micro irrigation concepts suitable for roof top gardening, rain hose system, Green house, polyhouse and shade net system of crop production on roof tops.

**UNIT V WASTE MANAGEMENT 9**

Concept, scope and maintenance of waste management- **recycle of organic waste, garden wastes- solid waste management-scope**, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, waste utilization.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

1. Demonstrate the principles behind crop production and various parameters that influences the crop growth on roof tops
2. Explain different methods of crop production on roof tops
3. Explain nutrient and pest management for crop production on roof tops
4. Illustrate crop water requirement and irrigation water management on roof tops
5. Explain the concept of waste management on roof tops

**TEXT BOOKS:**

1. Martellozzo F and J S Landry. 2020. Urban Agriculture. Scitus Academics Llc.
2. Rob Roggema. 2016. Sustainable Urban Agriculture and Food Planning. Routledge Taylor and Francis Group.
3. Akrong M O. 2012. Urban Agriculture. LAP Lambert Academic Publishing.

**REFERENCES:**

1. Agha Rokh A. 2008. Evaluation of ornamental flowers and fishes breeding in Bushehr urban wastewater using a pilot-scale aquaponic system. Water and Wastewater, 19 (65): 47–53.
2. Agrawal M, Singh B, Rajput M, Marshall F and Bell J. N. B. 2003. Effect of air pollution on peri-urban agriculture: A case study. Environmental Pollution, 126 (3): 323–329. <https://www.sciencedirect.com/science/article/pii/S0269749103002458#aep-section-id24>.
3. Jac Smit and Joe Nasr. 1992. Urban agriculture for sustainable cities: using wastes and idle land and water bodies as resources. Environment and Urbanization, 4 (2):141-152.

**CO's- PO's & PSO's MAPPING**

PO/PSO		CO1	CO2	CO3	CO4	CO5	Overall correlation of COs with POs
PO1	Engineering Knowledge	1	2	1	1	2	1
PO2	Problem Analysis	1	1	1	1	1	2
PO3	Design/ Development of Solutions	1	2	1	1	3	2
PO4	Conduct Investigations of Complex Problems	1	1	2	2	1	1
PO5	Modern Tool Usage	1	2	1	1	1	2
PO6	The Engineer and Society	1	2	1	2	1	1
PO7	Environment and sustainability	1	2	1	1	2	1
PO8	Ethics	2	1	1	1	2	1
PO9	Individual and team work:	1	1	2	1	1	1
PO10	Communication	1	2	1	1	2	1
PO11	Project management and finance	1	1	1	1	1	2

PO12	Life-long learning:	1	2	1	1	3	2
PSO1	To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	1	2	1	1	2	1
PSO2	To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.	2	1	2	1	1	1
PSO3	To inculcate entrepreneurial skills through strong Industry-Institution linkage.	1	2	1	2	1	2

**OEN351**

**DRINKING WATER SUPPLY AND TREATMENT**

**L T P C**

**3 0 0 3**

**OBJECTIVE:**

- To equip the students with the principles and design of water treatment units and distribution system.

**UNIT I SOURCES OF WATER**

**9**

Public water supply system - Planning, Objectives, Design period, Population forecasting; Water demand - Sources of water and their characteristics, Surface and Groundwater - Impounding Reservoir - Development and selection of source - Source Water quality - Characterization - Significance - Drinking Water quality standards.

**UNIT II CONVEYANCE FROM THE SOURCE**

**9**

Water supply - intake structures - Functions; Pipes and conduits for water - Pipe materials - Hydraulics of flow in pipes - Transmission main design - Laying, jointing and testing of pipes - appurtenances - Types and capacity of pumps - Selection of pumps and pipe materials.

**UNIT III WATER TREATMENT**

**9**

Objectives - Unit operations and processes - Principles, functions, and design of water treatment plant units, aerators of flash mixers, Coagulation and flocculation – sand filters - Disinfection – Construction, Operation and Maintenance aspects.

**UNIT IV ADVANCED WATER TREATMENT**

**9**

Water softening - Desalination- R.O. Plant - demineralization - Adsorption - Ion exchange- Membrane Systems - Iron and Manganese removal - Defluoridation - Construction and Operation and Maintenance aspects

**UNIT V WATER DISTRIBUTION AND SUPPLY**

**9**

Requirements of water distribution - Components - Selection of pipe material - Service reservoirs - Functions - Network design - Economics - Computer applications - Appurtenances - Leak detection - Principles of design of water supply in buildings - House service connection - Fixtures and fittings, systems of plumbing and types of plumbing.

**TOTAL: 45 PERIODS**

**OUTCOMES**

CO1: an understanding of water quality criteria and standards, and their relation to public health

CO2: the ability to design the water conveyance system

CO3: the knowledge in various unit operations and processes in water treatment

CO4: an ability to understand the various systems for advanced water treatment

CO5: an insight into the structure of drinking water distribution system

**TEXTBOOKS :**

1. Garg. S.K., "Water Supply Engineering", Khanna Publishers, Delhi, September 2008.
2. Punmia B.C, Arun K.Jain, Ashok K.Jain, " Water supply Engineering" Lakshmi publication private limited, New Delhi, 2016.
3. Rangwala "Water Supply and Sanitary Engineering", February 2022
4. Birdie.G.S., "Water Supply and Sanitary Engineering", Dhanpat Rai and sons, 2018.

**REFERENCES :**

1. Fair. G.M., Geyer.J.C., "Water Supply and Wastewater Disposal", John Wiley and Sons, 1954.
2. Babbit.H.E, and Donald.J.J, "Water Supply Engineering" , McGraw Hill book Co, 1984.
3. Steel. E.W.et al., "Water Supply Engineering" , Mc Graw Hill International book Co, 1984.
4. Duggal. K.N., "Elememts of public Health Engineering", S.Chand and Company Ltd, New Delhi, 1998.

**COs- POs & PSOs MAPPING**

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		3						3		3			3		
2		3		2		2				3			3		
3				2		2				3			3		
4			3	2				3	2	3			3		
5			3	2			1		2	3		1			
Avg.		3	3	2		2	1	3	2	3		1	3		

1.low, 2-medium, 3-high, ‘-‘- no correlation

Note: The average value of this course to be used for program articulation matrix.

**OCE353**

**LEAN CONCEPTS, TOOLS AND PRACTICES**

**L T P C**

**3 0 0 3**

**OBJECTIVE:**

- To impart knowledge about the basics of lean principles, tools and techniques, and implementation in the construction industry.

**UNIT I INTRODUCTION**

**9**

Introduction and overview of the construction project management - Review of Project Management & Productivity Measurement Systems - Productivity in Construction - Daily Progress Report-The state of the industry with respect to its management practices -construction project phases - The problems with current construction management techniques.

**UNIT II LEAN MANAGEMENT**

**9**

Introduction to lean management - Toyota’s management principle-Evolution of lean in construction industry - Production theories in construction –Lean construction value - Value in construction - Target value design - Lean project delivery system- Forms of waste in construction industry - Waste Elimination.

**UNIT III CORE CONCEPTS IN LEAN****9**

Concepts in lean thinking – Principles of lean construction – Variability and its impact – Traditional construction and lean construction – Traditional project delivery - Lean construction and workflow reliability – Work structuring – Production control.

**UNIT IV LEAN TOOLS AND TECHNIQUES****9**

Value Stream Mapping – Work sampling – Last planner system – Flow and pull based production – Last Planner System – Look ahead schedule – constraint analysis – weekly planning meeting- Daily Huddles – Root cause analysis – Continuous improvement – Just in time.

**UNIT V LEAN IMPLEMENTATION IN CONSTRUCTION INDUSTRY****9**

Lean construction implementation- Enabling lean through information technology - Lean in design - Design Structure - BIM (Building Information Modelling) - IPD (Integrated Project Delivery) – Sustainability through lean construction approach.

**TOTAL : 45 PERIODS****OUTCOME:**

On completion of this course, the student is expected to be able to

- CO1** Explains the contemporary management techniques and the issues in present scenario.
- CO2** Apply the basics of lean management principles and their evolution from manufacturing industry to construction industry.
- CO3** Develops a better understanding of core concepts of lean construction tools and techniques and their importance in achieving better productivity.
- CO4** Apply lean techniques to achieve sustainability in construction projects.
- CO5** Apply lean construction techniques in design and modeling.

**REFERENCES:**

1. Corfe, C. and Clip, B., Implementing lean in construction: Lean and the sustainability agenda, CIRIA, 2013.
2. Shang Gao and Sui Pheng Low, Lean Construction Management: The Toyota Way, Springer, 2014.
3. Dave, B., Koskela, L., Kiviniemi, A., Owen, R., andTzortzopoulos, P.,Implementing lean in construction: Lean construction and BIM, CIRIA, 2013.
4. Ballard, G., Tommelein, I., Koskela, L. and Howell, G., Lean construction tools and techniques, 2002.
5. Salem, O., Solomon, J., Genaidy, A. and Luegring, M., Site implementation and Assessment of Lean Construction Techniques, Lean Construction Journal, 2005.

**OEI353****INTRODUCTION TO PLC PROGRAMMING****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

1. Understand basic PLC terminologies digital principles, PLC architecture and operation.
2. Familiarize different programming language of PLC.
3. Develop PLC logic for simple applications using ladder logic.
4. Understand the hardware and software behind PLC and SCADA.

5. Exposures about communication architecture of PLC/SCADA.

**UNIT I INTRODUCTION TO PLC 9**

Introduction to PLC: Microprocessor, I/O Ports, Isolation, Filters, Drivers, Microcontrollers/DSP, PLC/DDC- PLC Construction: What is a PLC, PLC Memories, PLC I/O, , PLC Special I/O, PLC Types.

**UNIT II PLC INSTRUCTIONS 9**

PLC Basic Instructions: PLC Ladder Language- Function block Programming- Ladder/Function Block functions- PLC Basic Instructions, Basic Examples (Start Stop Rung, Entry/Reset Rung)- Configuration of Sensors, Switches, Solid State Relays-Interlock examples- Timers, Counters, Examples.

**UNIT III PLC PROGRAMMING 9**

Different types of PLC program, Basic Ladder logic, logic functions, PLC module addressing, registers basics, basic relay instructions, Latching Relays, arithmetic functions, comparison functions, data handling, data move functions, timer-counter instructions, input-output instructions, sequencer instructions

**UNIT IV COMMUNICATION OF PLC AND SCADA 9**

Communication Protocol – Modbus, HART, Profibus- Communication facilities SCADA: - Hardware and software, Remote terminal units, Master Station and Communication architectures

**UNIT V CASE STUDIES 9**

Stepper Motor Control- Elevator Control-CNC Machine Control- conveyor control-Interlocking Problems

**TOTAL:45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 5**

1. Market survey of the recent PLCs and comparison of their features.
2. Summarize the PLC standards
3. Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)
4. Market survey of Communication Network Used for PLC/SCADA.

**COURSE OUTCOMES:**

- CO1** Know the basic requirement of a PLC input/output devices and architecture. (L1)  
**CO2** Ability to apply Basics Instruction Sets used for ladder Logic and Function Block Programming.(L2)  
**CO3** Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.(L3)  
**CO4** Able to develop a PLC logic for a specific application on real world problem. (L5)  
**CO5** Ability to Understand the Concepts of Communication used for PLC/SCADA.(L1)

**TEXT BOOKS:**

1. Frank Petruzzola, Programmable Logic Controllers, Tata Mc-Graw Hill Edition
2. John W. Webb, Ronald A. Reis, Programmable Logic Controllers Principles and Applications, PHI publication

**REFERENCES:**

1. MadhuchandMitra and SamerjitSengupta, Programmable Logic Controllers Industrial Automation an Introduction, Penram International Publishing Pvt. Ltd.
2. J. R. Hackworth and F. D. Hackworth, Programmable Logic Controllers Principles andApplications, Pearson publication

**List of Open Source Software/ Learning website:**

1. <https://nptel.ac.in/courses/108105063>



2. <https://www.electrical4u.com/industrial-automation/>
3. <https://www.etf.ues.rs.ba/~slubura/Procesni%20racunari/Programmable%20Logic%20Controllers%20Programming%20Methods.pdf>
4. <https://www.electrical4u.com/industrial-automation/>

### CO's- PO's & PSO's MAPPING

PO, PSO CO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1					1		1					
CO2	3	3	2					1		1	2				2
CO3	3	3	3	3	1			1		1					
CO4	3	3		3	3			1		1			3	3	
CO5	3	3	3	2	1			1		1			3	3	3
Avg	3	2.9	2.25	2.6	1.6			1		1			3	3	2.9

OCH351

### NANO TECHNOLOGY

L T P C  
3 0 0 3

#### UNIT I INTRODUCTION 8

General definition and size effects–important nano structured materials and nano particles- importance of nano materials- Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials- surface area - band gap energy and applications. Photochemistry and Electrochemistry of nanomaterials –ionic properties of nanomaterials- Nano catalysis.

#### UNIT II SYNTHESIS OF NANOMATERIALS 8

Bottom up and Top-down approach for obtaining nano materials - Precipitation methods – sol gel technique – high energy ball milling, CVD and PVD methods, gas phase condensation, magnetron sputtering and laser deposition methods – laser ablation, sputtering.

#### UNIT III NANO COMPOSITES 10

Definition- importance of nanocomposites- nano composite materials-classification of composites- metal/metal oxides, metal-polymer- thermoplastic based, thermoset based and elastomer based- influence of size, shape and role of interface in composites applications.

#### UNIT IV NANO STRUCTURES AND CHARACTERIZATION TECHNIQUES 10

Classifications of nanomaterials - Zero dimensional, one-dimensional and two-dimensional nanostructures- Kinetics in nanostructured materials- multilayer thin films and superlattice-clusters of metals, semiconductors and nanocomposites. Spectroscopic techniques, Diffraction methods, thermal analysis method, BET analysis method.

#### UNIT V APPLICATIONS OF NANO MATERIALS 9

Overview of nanomaterials properties and their applications, nano painting, nano coating, nanomaterials for renewable energy, Molecular Electronics and Nanoelectronics – Nanobots- Biological Applications. Emerging technologies for environmental applications- Practice of nanoparticles for environmental remediation and water treatment.

**OUTCOMES:**

- CO1 understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications.
- CO2 able to acquire knowledge about the different types of nano material synthesis
- CO3 describes about the shape, size, structure of composite nano materials and their interference
- CO4 understand the different characterization techniques for nanomaterials
- CO5 develop a deeper knowledge in the application of nanomaterials in different fields.

**TEXT BOOKS**

1. Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmom, Burkhard Raguse, “ Nano Technology: Basic Science & Engineering Technology”, 2005, Overseas Press
2. G. Cao, “Nanostructures & Nanomaterials: Synthesis, Properties & Applications” Imperial College Press, 2004
3. William A Goddard “Handbook of Nanoscience, Engineering and Technology”, 3<sup>rd</sup> Edition, CRC Taylor and Francis group 2012.

**REFERENCES**

1. R.H.J.Hannink & A.J.Hill, Nanostructure Control, Wood Head Publishing Ltd., Cambridge, 2006.
2. C.N.R.Rao, A.Muller, A.K.Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications Vol. I & II, 2nd edition, 2005, Wiley VCH Verlag Gbtl & Co
3. Ivor Brodie and Julius J.Murray, 'The physics of Micro/Nano – Fabrication', Springer International Edition, 2010

**CO's- PO's & PSO's MAPPING**

Course Outcomes	Statement	Program Outcome														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications	2	3	2	3	3	-	-	-	1	1	-	3	1	1	3
CO2	acquire knowledge about the different types of nano material synthesis	2	3	1	3	3	-	-	-	1	1	-	3	2	1	3
CO3	describes about the shape, size, structure of composite nano materials and their interference	2	2	2	3	3	1	1	-	1	1	-	3	2	1	3
CO4	understand the different characterization techniques for nanomaterials	2	2	1	3	3	1	1	1	1	-	1	3	1	1	3
CO5	develop a deeper knowledge in the application of nanomaterials in different fields	2	2	1	3	3	1	1	1	1	-	1	3	2	1	3
Overall CO		3	2	2	1	3	3	1	1	1	1	1	1	3	2	1

**OBJECTIVE:**

- The course emphasis on the molecular self assembly and materials for polymer electronics

**UNIT I INTRODUCTION 9**

Historical Perspectives, Lessons from the Nature, Engineering the Functions, Tuning the functions, Multiscale Modeling and Computation, Classification of Functional Materials, Functional Diversity of Materials, Hybrid Materials, Technological Relevance, Societal Impact.

**UNIT II MOLECULAR SELF ASSEMBLY 9**

Molecular Organization, Self-Assembly in Biology, Energetics of Self-Organization, A Few Case Studies, Synthetic Protocols and Challenges, Solvent-assisted Self-Assembly, Directed Assembly-Langmuir-Blodgett and Langmuir-Schaefer techniques, Technological Applications of SAMs.

**UNIT III BIO-INSPIRED MATERIALS 9**

Bio-inspired materials, Classification, Biomimicry, Spider Silk, Lotus Leaf, Gecko feet, Synovial fluid, 'Bionics'-Bio-inspired Information Technologies, Artificial Sensory Organs, Biomineralization-En route to Nanotechnology.

**UNIT IV SMART OR INTELLIGENT MATERIALS 9**

Criteria for Smartness, Significance of Smart Materials, Representative Examples like Smart Gels and Polymers, Electro/Magneto Rheological Fluids, Smart Electroceramics, Technical Limitations and Challenges, Functional Nanocomposites, Polymer-carbon nanotube composites.

**UNIT V MATERIALS FOR POLYMER ELECTRONICS 9**

Polymers for Electronics, Organic Light Emitting Diodes, Working Principle of OLEDs, Illustrated Examples, Organic Field-Effect Transistors Operating Principle, Design Considerations, Polymer FETs vs Inorganic FETs, Liquid Crystal Displays, Engineering Aspects of Flat Panel Displays, Intelligent Polymers for Data Storage, Polymer-based Data Storage-Principle, Magnetic Vs. Polymer-based Data Storage.

**TOTAL: 45 PERIODS****OUTCOME:**

- Students will be able to differentiate among various functional properties and select appropriate material for certain functional applications, analyze the nature and potential of functional material.

**TEXT BOOK:**

1. Vijayamohan K. Pillai and MeeraParthasarathy, "Functional Materials: A chemist's perspective", Universities Press Hyderabad (2012).

**REFERENCE:**

1. Stephen Manne "Biomimetic Materials Chemistry" Wiley-VCH Newyork, 1966.

**OBJECTIVE:**

- To help students acquire a sound knowledge on diversities of foods, food habits and patterns in India with focus on traditional foods.

**UNIT I HISTORICAL AND CULTURAL PERSPECTIVES 9**

Food production and accessibility - subsistence foraging, horticulture, agriculture and pastoralization, origin of agriculture, earliest crops grown. Food as source of physical sustenance, food as religious and cultural symbols; importance of food in understanding human culture - variability, diversity, from basic ingredients to food preparation; impact of customs and traditions on food habits, heterogeneity within cultures (social groups) and specific social contexts - festive occasions, specific religious festivals, mourning etc. Kosher, Halal foods; foods for religious and other fasts.

**UNIT II TRADITIONAL METHODS OF FOOD PROCESSING 9**

Traditional methods of milling grains – rice, wheat and corn – equipments and processes as compared to modern methods. Equipments and processes for edible oil extraction, paneer, butter and ghee manufacture – comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation – sundrying, osmotic drying, brining, pickling and smoking.

**UNIT III TRADITIONAL FOOD PATTERNS 9**

Typical breakfast, meal and snack foods of different regions of India. Regional foods that have gone Pan Indian / Global. Popular regional foods; Traditional fermented foods, pickles and preserves, beverages, snacks, desserts and sweets, street foods; IPR issues in traditional foods

**UNIT IV COMMERCIAL PRODUCTION OF TRADITIONAL FOODS 9**

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods – types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods – ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters.

**UNIT V HEALTH ASPECTS OF TRADITIONAL FOODS 9**

Comparison of traditional foods with typical fast foods / junk foods – cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments / illnesses.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

- CO1 To understand the historical and traditional perspective of foods and food habits  
CO2 To understand the wide diversity and common features of traditional Indian foods and meal patterns.

**TEXT BOOKS:**

- Sen, Colleen Taylor "Food Culture in India" Greenwood Press, 2005.
- Davidar, Ruth N. "Indian Food Science: A Health and Nutrition Guide to Traditional Recipes: East West Books, 2001.

**OBJECTIVE:**

- The course aims to introduce the students to the area of Food Processing. This is necessary for effective understanding of a detailed study of food processing and technology subjects. This course will enable students to appreciate the importance of food processing with respect to the producer, manufacturer and consumer.

**UNIT I PROCESSING OF FOOD AND ITS IMPORTANCE 9**

Source of food - plant, animal and microbial origin; different foods and groups of foods as raw materials for processing – cereals, pulses, grains, vegetables and fruits, milk and animal foods, sea weeds, algae, oil seeds & fats, sugars, tea, coffee, cocoa, spices and condiments, additives; need and significance of processing these foods.

**UNIT II METHODS OF FOOD HANDLING AND STORAGE 9**

Nature of harvested crop, plant and animal; storage of raw materials and products using low temperature, refrigerated gas storage of foods, gas packed refrigerated foods, sub atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; freezing of raw and processed foods.

**UNIT III LARGE-SCALE FOOD PROCESSING 12**

Milling of grains and pulses; edible oil extraction; Pasteurisation of milk and yoghurt; canning and bottling of foods; drying – Traditional and modern methods of drying, Dehydration of fruits, vegetables, milk, animal products etc; preservation by use of acid, sugar and salt; Pickling and curing with microorganisms, use of salt, and microbial fermentation; frying, baking, extrusion cooking, snack foods.

**UNIT IV FOOD WASTES IN VARIOUS PROCESSES 6**

Waste disposal-solid and liquid waste; rodent and insect control; use of pesticides; ETP; selecting and installing necessary equipment.

**UNIT V FOOD HYGIENE 9**

Food related hazards – Biological hazards – physical hazards – microbiological considerations in foods. Food adulteration – definition, common food adulterants, contamination with toxic metals, pesticides and insecticides; Safety in food procurement, storage handling and preparation; Relationship of microbes to sanitation, Public health hazards due to contaminated water and food; Personnel hygiene; Training & Education for safe methods of handling and processing food; sterilization and disinfection of manufacturing plant; use of sanitizers, detergents, heat, chemicals, Cleaning of equipment and premises.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

On completion of the course the students are expected to

CO1 Be aware of the different methods applied to processing foods.

CO2 Be able to understand the significance of food processing and the role of food and beverage industries in the supply of foods.

**TEXT BOOKS/REFERENCES:**

1. Karnal, Marcus and D.B. Lund "Physical Principles of Food Preservation". Rutledge, 2003.
2. VanGarde, S.J. and Woodburn. M "Food Preservation and Safety Principles and Practice". Surbhi Publications, 2001.
3. Sivasankar, B. "Food Processing & Preservation", Prentice Hall of India, 2002.
4. Khetarpaul, Neelam, "Food Processing and Preservation", Daya Publications, 2005.

**COURSE OBJECTIVES:**

- To provide the basic fundamental knowledge of different forms of Intellectual Property Rights in national and international level.
- To provide the significance of the Intellectual Property Rights about the patents, copyrights, industrial design, plant and geographical indications.
- This paper is to study significance of the amended patent act on pharma industry.

**UNIT I INTRODUCTION- INTELLECTUAL PROPERTY RIGHTS 9**

Introduction, Types of Intellectual Property Rights -patents, plant varieties protection, geographical indicators, copyright, trademark, trade secrets.

**UNIT II PATENTS 9**

Patents-Objective, Introduction, Requirement for patenting- Novelty, Inventive step (Non-obviousness) and industrial application (utility), Non-patentable inventions, rights of patent owner, assignment of patent rights, patent specification (provisional and complete), parts of complete specification, claims, procedure for obtaining patents, compulsory license.

**UNIT III PLANT VARIETY-TRADITIONAL KNOWLEDGE –GEOGRAPHICAL INDICATIONS 9**

Plant variety- Justification, criteria for protection of plant variety and protection in India. Traditional knowledge- Concept of traditional knowledge, protection of traditional knowledge under Intellectual Property frame works in national level and Traditional knowledge digital library (TKDL). Geographical Indications – Justification for protection, National and International position.

**UNIT IV ENFORCEMENT AND PRACTICAL ASPECTS OF IPR 9**

Introduction – civil remedies – injunction, damage, account of profit – criminal remedies – patent, trademark. Practical aspects – Introduction, benefits of licensing, licensing of basic types of IPR, licensing clauses of IPR. Case studies of patent infringement, compulsory licensing, simple patent license agreements.

**UNIT V INTERNATIONAL BACKGROUND OF INTELLECTUAL PROPERTY 9**

International Background of Intellectual Property- Paris Convention, Berne convention, World Trade Organization (WTO), World Intellectual Property Organization (WIPO), Trade Related Aspects of Intellectual Property Rights (TRIPS) and Patent Co-operation Treaty (PCT).

**TOTAL:45 PERIODS****TEXT BOOKS:**

1. N. Nagpal, M. Arora, M.R.D. Usman, S. Rahar, "Intellectual Property Rights" Edu creation Publishing, New Delhi, 2017.
2. The Patents Act, 1970 (Bare Act with Short Notes) (New Delhi: Universal Law Publishing Company Pvt. Ltd. 2012.
3. B.S. Rao, P.V. Appaji, "Intellectual Property Rights in Pharmaceutical Industry: Theory and Practice", 2015.

**REFERENCES:**

1. Patents for Chemicals, Pharmaceuticals, & Biotechnology-Fundamentals of Global Law, Practice and Strategy. Philip W. Grubb, Oxford University Press, 2004.
2. Basic Principles of patent law – Basics principles and acquisition of IPR. Ramakrishna T. CIPRA, NLSIU, Bangalore, 2005
3. S. Lakshmana Prabu, TNK. Suriyaprakash, "Intellectual Property Rights", 1st ed., In Tech open access, Croatia, 2017.

## Course Outcome

The student will be able to

- C1** Understand and differentiate the categories of intellectual property rights.
- C2** Describe about patents and procedure for obtaining patents.
- C3** Distinguish plant variety, traditional knowledge and geographical indications under IPR.
- C4** Provide the information about the different enforcements and practical aspects involved in protection of IPR.
- C5** Provide different organizations role and responsibilities in the protection of IPR in the international level.
- C6** Understand the interrelationships between different Intellectual Property Rights on International Society

### CO's- PO's & PSO's MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>C1</b>	3	3		2					2	2		
<b>C2</b>		3	3				2	2				
<b>C3</b>	3	3					2	2				1
<b>C4</b>					2		3	3		2	2	
<b>C5</b>		3					3			2		1
<b>C6</b>	3	2				2	2					2

OTT351

### BASICS OF TEXTILE FINISHING

L T P C  
3 0 0 3

#### OBJECTIVE:

- To enable the students to understand the basics and different types of finishes required for textile materials and machines used for finishing.

#### UNIT I RESIN FINISHING

9

Importance of finishing and its classification. Resin finishing: Mechanism of creasing, Types of Resins .Anti crease, wash and wear, durable press resin finishing. Study about eco friendly method of anti crease finishing.

#### UNIT II FLAME PROOF & WATERPROOF

9

Concept of Flame proof & flame retardancy. Flame retardant finishes for cotton, Concept of waterproof and water repellent Finishes, Durable & Semi durable and Temporary finishes, Concept of Antimicrobial finish.

#### UNIT III SOIL RELEASE AND ANTISTATIC FINISHES

9

Soil Release Finishing: Mechanism of soil retention & soil release. Anti pilling Finishing: chemical and mechanical methods to produce anti pilling. Concept of UV Protection finishes- Concept of antistatic finishes.

#### UNIT IV MECHANICAL FINISHES

9

Mechanical finishing of textile materials - calendaring, compacting, Sanforising, Peach finishing. Object of Heat setting. Various methods of heat setting and mechanism of heat setting.

## UNIT V STIFFENING AND SOFTENING

9

Concept of stiffening and softening of textile materials. Mechanism in the weight reduction of PET .Concept of Micro encapsulation techniques in finishing process, Nano finish, Plasma Treatment and Bio finishing.

**TOTAL: 45 PERIODS**

### OUTCOMES:

Upon completion of the course, the students will be able to Understand the

CO: 1 Basics of Resin Finishing Process.

CO: 2 Concept of Flame proof & flame retardancy, waterproof and water repellent, Antimicrobial finishes.

CO: 3 Concept of Soil Release, Anti Pilling, UV Protection and Antistatic finishes.

CO: 4 Concept of Mechanical finishing.

CO: 5 Basics of Micro encapsulation techniques, Nano finish, Plasma Treatment.

### TEXT BOOKS:

1. V.A.Shennai, "Technology of Finishing", Vol X, Sevak Publications, Mumbai
2. Perkins, W.S., "Textile colouration and finishing", Carolina Academic Press., U.K, ISBN: 0890898855.2004.

### REFERENCES:

1. Microencapsulation in finishing, Review of progress of Colouration, SDC, 2001 62
2. Chakraborty, J.N, Fundamentals and Practices in colouration of Textiles, Woodhead Publishing India, 2009, ISBN-13:978-81-908001-4-3
3. W. D. Schindler and P. J. Hauser "Chemical finishing of textiles", Woodhead Publishing Cambridge England,2004.

## OTT352 INDUSTRIAL ENGINEERING FOR GARMENT INDUSTRY

LT P C  
3 0 0 3

### OBJECTIVES:

- To enable the students to learn about basics of industrial engineering and different tools of industrial engineering and its application in apparel industry

### UNIT I INTRODUCTION

9

Scope of industrial engineering in apparel Industry, role of industrial engineers.

**Productivity:** Definition - Productivity, Productivity measures .Reduction of work content due to the product and process, Reduction of ineffective time due to the management, due to the worker. Causes for low productivity in apparel industry and measures for improvement.

### UNIT II WORK STUDY

9

Definition, Purpose, Basic procedure and techniques of work-study.

**Work environment** – Lighting, Ventilation, Climatic condition on productivity. Temperature control, humidity control, noise control measures. Safety and ergonomics on work station and work environment

**Material Handling** – Objectives, Classification and characteristics of material handling equipments, Specialized material handling equipments.

### UNIT III METHOD STUDY

9

Definition, Objectives, Procedure, Process charts and symbols. Various charts – Charts indicating process sequence: Outline process chart, flow process chart (man type, material type and equipment type); Charts using time scale – multiple activity chart. Diagrams indicating



movement – flow diagram, string diagram, cycle graph, chrono cycle graph, travel chart  
**MOTION STUDY:** Principle of motion economy, Two handed process chart, micro motion analysis – therbligs, SIMO chart.

**UNIT IV WORK MEASUREMENT 9**

Definition, purpose, procedure, equipments, techniques. Time study - Definition, basics of time study- equipments. Time study forms, Stop watch procedure. Predetermined motion time standards (PMTS). Time Study rating, calculation of standard time, Performance rating – relaxation and other allowances. Calculation of SAM for different garments, GSD.

**UNIT V WORK STUDY APPLICATION 9**

Application of work study techniques in cutting, stitching and packing in garment industry. Workaids in sewing, Pitch diagram, Line balancing, Capacity planning, scientific method of training.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon the completion of the course the student shall be able to understand

- CO1: Fundamental concepts of industrial Engineering and productivity
- CO2: Method study
- CO3: Motion analysis
- CO4: Work measurement and SAM
- CO5: Ergonomics and its application to garment industry

**TEXTBOOKS:**

1. George Kanwaty, "Introduction to Work Study ", ILO, Geneva, 1996, ISBN: 9221071081 | ISBN-13: 9789221071082
2. Enrick N. L., "Time study manual for Textile industry", Wiley Eastern (P) Ltd., 1989, ISBN: 0898740444 | ISBN-13: 9780898740448
3. Khanna O. P., and Sarup A., "Industrial Engineering and Management", Dhanpat Rai Publications, New Delhi, 2010, ISBN: 818992835X / ISBN: 978-8189928353

**REFERENCES**

1. Norberd Lloyd Enrick., "Industrial Engineering Manual for Textile Industry", Wiley Eastern (P) Ltd., New Delhi, 1988, ISBN: 0882756311 | ISBN-13: 9780882756318
2. Chuter A. J., "Introduction to Clothing Production Management", Wiley-Black well Science, U.S. A., 1995, ISBN: 0632039396 | ISBN-13: 9780632039395
3. GordanaColovic., "Ergonomics in the garment industry", Wood publishing India Pvt. Ltd., India, 2014, ISBN: 0857098225 | ISBN-13: 9780857098221
4. Rajesh Bheda, "Managing Productivity in Apparel Industry "CBS Publishers & Distributors, 2008

**CO's- PO's & PSO's MAPPING**

Course Outcomes	Statement	Program														
		Outcome												PSO		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Fundamental concepts of industrial Engineering and productivity	2	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO2	Method study	1	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO3	Motion analysis	1	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO4	Work measurement and SAM	1	2	3	3	2	1	1	2	2	1	3	2	1	1	-

CO5	Ergonomics and its application to garment industry	1	2	3	3	2	1	2	2	2	1	3	2	1	1	-
<b>Overall CO</b>		1.2	2	3	3	2	1	1.2	2	2	1	2.4	2	1	1	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OTT353**

**BASICS OF TEXTILE MANUFACTURE**

**L T P C**  
**3 0 0 3**

**OBJECTIVES:**

- To enable the students to learn about the basics of fibre forming, yarn production, fabric formation, coloration of fabrics and garment manufacturing

**UNIT I NATURAL FIBRES**

**9**

Introduction: Definition of staple fibre, filament; Classification of natural and man-made fibres, essential and desirable properties of fibres. Production and cultivation of Natural Fibres: Cultivation of cotton, production of silk (sericulture), wool and jute – physical and chemical structure of these fibres..

**UNIT II REGENERATED AND SYNTHETIC FIBRES**

**9**

Production sequence of regenerated and modified cellulosic fibres: viscose rayon, Acetate Rayon, high wet modulus and high tenacity fibres; synthetic fibres – chemical structure, fibre forming polymers, production principles.

**UNIT III BASICS OF SPINNING**

**9**

Spinning – principle of yarn formation, sequence of machines for yarn production with short staple fibres and blends, principles of opening and cleaning machines; yarn numbering - calculations

**UNIT IV BASICS OF WEAVING**

**9**

Woven fabric – warp, weft, weaving, path of warp; looms – classification, handloom and its parts, powerloom, automatic looms, shuttleless looms, special type of looms; preparatory machines for weaving process and their objectives; basic weaving mechanism - primary, secondary and auxiliary mechanisms,

**UNIT V BASICS OF KNITTING AND NONWOVEN**

**9**

Knitting – classification, principle, types of fabrics; nonwoven process –classification, principle, types of fabrics.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

On completion of this course, the students shall have the basic knowledge on

CO1: Classification of fibres and production of natural fibres

CO2: Regenerated and synthetic fibres

CO3: Yarn spinning

CO4: Weaving

CO5: Knitting and nonwoven

## TEXTBOOKS

1. Mishra S. P. , “A Text Book of Fibre Science and Technology”, New Age Publishers, 2000, ISBN: 8122412505
2. Marks R., and Robinson. T.C., “Principles of Weaving”, The Textile Institute, Manchester, 1989, ISBN: 0 900739 258.
3. Spencer D.J., “Knitting Technology”, III Ed., Textile Institute, Manchester, 2001, ISBN: 185573 333 1.

## REFERENCES:

1. Hornberer M., Eberle H., Kilgus R., Ring W. and Hermeling H., “Clothing Technology: From Fibre to Fabric”, Europa LehrmittelVerlag, 2008, ISBN: 3808562250 / ISBN: 978-3808562253.
2. Wynne A., “Motivate Series-Textiles”, Maxmillan Publications, London, 1997.
3. Carr H. and Latham B., “The Technology of Clothing Manufacture” Backwell Science, U.K., 1994, ISBN: 0632037482 / ISBN:13: 9780632037483. Klein W., “The Rieter Manual of Spinning, Vol.1”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-1-4 / ISBN 13 978-3-9523173-1-0.
4. Klein W., “The Rieter Manual of Spinning, Vol.2”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-2-2 / ISBN 13 978-3-9523173-2-7.
5. Klein W., “The Rieter Manual of Spinning, Vol.1-3”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-3-0 / ISBN 13 978-3-9523173-3-4.
6. Talukdar. M.K., Sriramulu. P.K., and Ajgaonkar. D.B., “Weaving: Machines, Mechanisms, Management”, Mahajan Publishers, Ahmedabad, 1998, ISBN: 81-85401-16-0.
7. Morton W. E., and Hearle J. W. S., “Physical Properties of Textile Fibres”, The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95
8. Gohl E. P. G., “Textile Science”, CBS Publishers and distributors, 1987, ISBN 0582685958

## CO's- PO's & PSO's MAPPING

Course Outcomes	Statement	Program Outcome														
		PO1	P O 2	P O 3	P O 4	P O 5	P O 6	P O 7	P O 8	P O 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1.	Classification of fibres and production of natural fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO2.	Regenerated and synthetic fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO3.	Yarn spinning	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO4.	Weaving	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO5.	Knitting and nonwoven	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>Overall CO</b>		-	-	-	-	-	-	-	2	1	-	1	1	-	1	-

**1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively**

**OBJECTIVE:**

- The course is aimed to Gain knowledge about petroleum refining process and production of petrochemical products.

**UNIT I ORIGIN, FORMATION AND REFINING OF CRUDE OIL 9**  
Origin, Formation and Evaluation of Crude Oil. Testing of Petroleum Products. Refining of Petroleum - Atmospheric and Vacuum Distillation.

**UNIT II CRACKING 9**  
Cracking, Thermal Cracking, Vis-breaking, Catalytic Cracking (FCC), Hydro Cracking, Coking and Air Blowing of Bitumen

**UNIT III REFORMING AND HYDROTREATING 9**  
Catalytic Reforming of Petroleum Feed Stocks. Lube oil processing- Solvent Treatment Processes, Dewaxing, Clay Treatment and Hydrofining. Treatment Techniques: Removal of Sulphur Compounds in all Petroleum Fractions to improve performance.

**UNIT IV INTRODUCTION TO PETROCHEMICALS 9**  
Petrochemicals - Cracking of Naphtha and Feed stock gas for the production of Ethylene, Propylene, Isobutylene and Butadiene. Production of Acetylene from Methane, and Extraction of Aromatics.

**UNIT V PRODUCTION OF PETROCHEMICALS 9**  
Production of Petrochemicals like Dimethyl Terephthalate(DMT), Ethylene Glycol, Synthetic glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate (MMA), Vinyl Acetate Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol, Acetone, Methanol, Formaldehyde, Acetaldehyde, Pentaerythritol and production of Carbon Black.

**TOTAL: 45 PERIODS****OUTCOMES:**

On the completion of the course students are expected to

- CO1:** Understand the classification, composition and testing methods of crude petroleum and its products. Learn the mechanism of refining process.
- CO2:** Understand the insights of primary treatment processes to produce the precursors.
- CO3:** Study the secondary treatment processes cracking, vis-breaking and coking to produce more petroleum products.
- CO4:** Appreciate the need of treatment techniques for the removal of sulphur and other impurities from petroleum products.
- CO5:** Understand the societal impact of petrochemicals and learn their manufacturing processes.
- CO6:** Learn the importance of optimization of process parameters for the high yield of petroleum products.

**TEXT BOOKS**

1. Nelson, W. L., "Petroleum Refinery Engineering", 4th Edition., McGraw Hill, New York, 1985.
2. Wiseman. P., "Petrochemicals", UMIST Series in Science and Technology, John Wiley & Sons, 1986.

**REFERENCES**

1. Bhaskara Rao, B. K., "Modern Petroleum Refining Processes", 2nd Edition, Oxford and

IBH Publishing Company, New Delhi, 1990.  
2. Bhaskara Rao, B. K. "A Text on Petrochemicals", 1st Edition, Khanna Publishers

**CPE334**                                      **ENERGY CONSERVATION AND MANAGEMENT**                                      **L T P C**  
**3 0 0 3**

**OBJECTIVES:**

- At the end of the course, the student is expected to
- understand and analyse the energy data of industries
  - carryout energy accounting and balancing
  - conduct energy audit and suggest methodologies for energy savings and
  - utilise the available resources in optimal ways

**UNIT I INTRODUCTION** **9**

Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

**UNIT II ELECTRICAL SYSTEMS** **9**

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

**UNIT III THERMAL SYSTEMS** **9**

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution & U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

**UNIT IV ENERGY CONSERVATION IN MAJOR UTILITIES** **9**

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems –Cooling Towers – D.G. sets

**UNIT V ECONOMICS** **9**

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of this course, the students can able to analyze the energy data of industries.

CO1: Remember the knowledge for Basic combustion and furnace design and selection of thermal and mechanical energy equipment.

CO2: Study the Importance of Stoichiometry relations, Theoretical air required for complete combustion.

CO3: Skills on combustion thermodynamics and kinetics.

CO4: Apply calculation and design tube still heaters.

CO5: Studied different heat treatment furnace.

CO6: Practical and theoretical knowledge burner design.

**TEXT BOOKS:**

1. Energy Manager Training Manual (4 Volumes) available at [www.energymanagertraining.com](http://www.energymanagertraining.com). a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.

**REFERENCES:**

1. Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988.
2. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford, 1981.
3. Dryden. I.G.C., "The Efficient Use of Energy" Butterworths, London, 1982
4. Turner. W.C., "Energy Management Hand book", Wiley, New York, 1982.
5. Murphy. W.R. and G. Mc KAY, "Energy Management", Butterworths, London 1987

**OPT351****BASICS OF PLASTICS PROCESSING****L T P C  
3 0 0 3****COURSE OBJECTIVES**

- Understand the fundamentals of plastics processing, such as the relationships between material structural properties and required processing parameters, and so on
- To gain practical knowledge on the polymer selection and its processing
- Understanding the major plastic material processing techniques (Extrusion, Injection molding, Compression and Transfer molding, Blow molding, Thermoforming and casting)
- To understand suitable additives for plastics compounding
- To Propose troubleshooting mechanisms for defects found in plastics products manufactured by various processing techniques

**UNIT I INTRODUCTION TO PLASTICS PROCESSING****9**

Introduction to plastic processing – Principles of plastic processing: processing of plastics vs. metals and ceramics. Factors influencing the efficiency of plastics processing: molecular weight, viscosity and rheology. Difference in approach for thermoplastic and thermoset processing. Additives for plastics compounding and processing: antioxidants, light stabilizers, UV stabilizers, lubricants, impact modifiers, flame retardants, antistatic agents, stabilizers and plasticizers. Compounding: plastic compounding techniques, plasticization, pelletization.

**UNIT II EXTRUSION****9**

Extrusion – Principles of extrusion. Features of extruder: barrel, screw, types of screws, drive mechanism, specifications, heating & cooling systems, types of extruders. Flow mechanism: process variables, die entry effects and exit instabilities. Die swell, Defects: melt fracture, shark skin, bambooning. Factors determining efficiency of an extruder. Extrusion of films: blown and cast films. Tube/pipe extrusion. Extrusion coating: wire & cable. Twin screw extruder and its applications. Applications of extrusion and new developments.

**UNIT III INJECTION MOLDING****9**

Injection molding – Principles and processing outline, machinery, accessories and functions, specifications, process variables, mould cycle. Types of clamping: hydraulic and toggle mechanisms. Start-up and shut down procedures-Cylinder nozzles- Press capacity projected area -Shot weight Basic theoretical concepts and their relationship to processing - Interaction of moulding process aspect effects in quoted variables. Basic mould types. Reciprocating vs. plunger type injection moulding. Thermoplastic vs. thermosetting injection moulding. Injection moulding vs. other plastic processing techniques. State-of-the art injection moulding techniques - Introduction to trouble shooting

#### **UNIT IV COMPRESSION AND TRANSFER MOLDING**

**9**

Compression moulding – Basic principles of compression and transfer moulding-Meaning of terms-Bulk factor and flow properties, moulding materials, process variables and process cycle, Inter relation between flow properties-Curing time-Mould temperature and Pressure requirements. Preforms and preheating- Techniques of preheating. Machines used-Types of compression mould- positive, semi-positive and flash. Common moulding faults and their correction- Finishing of mouldings. Transfer moulding: working principle, equipment, Press capacity-Integral moulds and auxiliary ram moulds, moulding cycle, moulding tolerances, pot transfer, plunger transfer and screw transfer moulding techniques, advantages over compression moulding

#### **UNIT V BLOW MOLDING, THERMOFORMING AND CASTING**

**9**

Blow moulding: principles and terminologies. Injection blow moulding. Extrusion blow moulding. Design guidelines for optimum product performance and appearance. Thermoforming: principle, vacuum forming, pressure forming mechanical forming. Casting: working principle, types and applications.

**TOTAL: 45 PERIODS**

#### **COURSE OUTCOMES**

- Ability to find out the correlation between various processing techniques with product properties.
- Understand the major plastics processing techniques used in moulding (injection, blow, compression, and transfer), extrusion, thermoforming, and casting.
- Acquire knowledge on additives for plastic compounding and methods employed for the same
- Familiarize with the machinery and ancillary equipment associated with various plastic processing techniques.
- Select an appropriate processing technique for the production of a plastic product

#### **REFERENCES**

1. S. S. Schwart, S. H. Goodman, *Plastics Materials and Processes*, Van Nostrand Reinhold Company Inc. (1982).
2. F. Hensen (Ed.), *Plastic Extrusion Technology*, Hanser Gardner (1997).
3. W. S. Allen and P. N. Baker, *Hand Book of Plastic Technology, Volume-1, Plastic Processing Operations [Injection, Compression, Transfer, Blow Molding]*, CBS Publishers and Distributors (2004).
4. M. Chanda, S. K. Roy, *Plastic Technology handbook*, 4th Edn., CRC Press (2007).
5. I. I. Rubin, *Injection Molding Theory & Practice*, Society of Plastic Engineers, Wiley (1973).
6. D.V. Rosato, M. G. Rosato, *Injection Molding Hand Book*, Springer (2012).
7. M. L. Berins (Ed.), *SPI Plastic Engineering Hand Book of Society of Plastic Industry Inc.*, Springer (2012).
8. B. Strong, *Plastics: Material & Processing*, A, Pearson Prentice hall (2005).
9. D.V Rosato, *Blow Molding Hand Book*, Carl HanserVerlag GmbH & Co (2003).

**COURSE OBJECTIVES :**

- To understand the basic properties of signal & systems
- To know the methods of characterization of LTI systems in time domain
- To analyze continuous time signals and system in the Fourier and Laplace domain
- To analyze discrete time signals and system in the Fourier and Z transform domain

**UNIT I CLASSIFICATION OF SIGNALS AND SYSTEMS 9**

Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids\_ Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals - Classification of systems- CT systems and DT systems- – Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable.

**UNIT II ANALYSIS OF CONTINUOUS TIME SIGNALS 9**

Fourier series for periodic signals - Fourier Transform – properties- Laplace Transforms and Properties

**UNIT III LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS 9**

Impulse response - convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems - Systems connected in series / parallel.

**UNIT IV ANALYSIS OF DISCRETE TIME SIGNALS 9**

Baseband signal Sampling–Fourier Transform of discrete time signals (DTFT)– Properties of DTFT - Z Transform & Properties

**UNIT V LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS 9**

Impulse response–Difference equations-Convolution sum- Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:****At the end of the course, the student will be able to:**

- CO1:determine if a given system is linear/causal/stable  
 CO2: determine the frequency components present in a deterministic signal  
 CO3:characterize continuous LTI systems in the time domain and frequency domain  
 CO4:characterize discrete LTI systems in the time domain and frequency domain  
 CO5:compute the output of an LTI system in the time and frequency domains

**TEXT BOOKS:**

1. Oppenheim, Willsky and Hamid, “Signals and Systems”, 2nd Edition, Pearson Education, New Delhi, 2015.(Units I - V)
2. Simon Haykin, Barry Van Veen, “Signals and Systems”, 2nd Edition, Wiley, 2002

**REFERENCES :**

1. B. P. Lathi, “Principles of Linear Systems and Signals”, 2<sup>nd</sup> Edition, Oxford, 2009.
2. M. J. Roberts, “Signals and Systems Analysis using Transform methods and MATLAB”, McGraw- Hill Education, 2018.
3. John Alan Stuller, “An Introduction to Signals and Systems”, Thomson, 2007.



**CO's- PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	3	-	3	2	-	-	-	-		3	-	-	1
2	3	-	3	-	-	2	-	-	-	-		3	-	3	-
3	3	3	-	-	3	2	-	-	-	-		3	2	-	-
4	3	3	-	-	3	2	-	-	-	-		3	-	3	1
5	3	3	-	3	3	2	-	-	-	-		3	-	3	1
<b>CO</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>1</b>



**COURSE OBJECTIVES :**

- To give a comprehensive exposure to all types of devices and circuits constructed with discrete components. This helps to develop a strong basis for building linear and digital integrated circuits
- To analyze the frequency response of small signal amplifiers
- To design and analyze single stage and multistage amplifier circuits
- To study about feedback amplifiers and oscillators principles
- To understand the analysis and design of multi vibrators

**UNIT I SEMICONDUCTOR DEVICES 9**

PN junction diode, Zener diode, BJT, MOSFET, UJT –structure, operation and V-I characteristics, Rectifiers – Half Wave and Full Wave Rectifier, Zener as regulator

**UNIT II AMPLIFIERS 9**

Load line, operating point, biasing methods for BJT and MOSFET, BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response –Analysis of CS and Source follower – Gain and frequency response- High frequency analysis.

**UNIT III MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER 9**

Cascode amplifier, Differential amplifier – Common mode and Difference mode analysis – Tuned amplifiers – Gain and frequency response – Neutralization methods.

**UNIT IV FEEDBACK AMPLIFIERS AND OSCILLATORS 9**

Advantages of negative feedback – Analysis of Voltage / Current, Series , Shunt feedback Amplifiers – positive feedback–Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.

**UNIT V POWER AMPLIFIERS AND DC/DC CONVERTERS 9**

Power amplifiers- class A-Class B-Class AB-Class C-Temperature Effect- Class AB Power amplifier using MOSFET –DC/DC convertors – Buck, Boost, Buck-Boost analysis and design.

**TOTAL: 45 PERIODS****COURSE OUTCOMES :**

At the end of the course the students will be able to

CO1: Explain the structure and working operation of basic electronic devices.

CO2: Design and analyze amplifiers.

CO3: Analyze frequency response of BJT and MOSFET amplifiers

CO4: Design and analyze feedback amplifiers and oscillator principles.

CO5: Design and analyze power amplifiers and supply circuits

**TEXT BOOKS :**

1. David A. Bell, "Electronic Devices and Circuits", Oxford Higher Education press, 5 th Edition, 2010.
2. Robert L. Boylestad and Louis Nasheresky, "Electronic Devices and Circuit Theory", 10th Edition, Pearson Education / PHI, 2008.
3. Adel .S. Sedra, Kenneth C. Smith, "Micro Electronic Circuits", Oxford University Press, 7 th Edition, 2014.

**REFERENCES :**

1. Donald.A. Neamen, "Electronic Circuit Analysis and Design", Tata McGraw Hill, 3 rd Edition, 2010.

2. D.Schilling and C.Belove, "Electronic Circuits", McGraw Hill, 3 rd Edition, 1989
3. Muhammad H.Rashid, "Power Electronics", Pearson Education / PHI , 2004.

### CO's- PO's & PSO's MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
1	3	3	3	3	2	1	-	-	-	-	-	1	2	1	1
2	3	2	2	3	2	2	-	-	-	-	-	1	2	1	1
3	3	3	3	2	1	2	-	-	-	-	-	1	2	1	1
4	3	3	2	3	2	2	-	-	-	-	-	1	2	1	1
5	3	2	3	2	2	1	-	-	-	-	-	1	2	1	1
CO	3	3	3	3	2	2	-	-	-	-	-	1	2	1	1

**CBM348      FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT      L T P C**  
**3 0 0 3**

**OBJECTIVES:**

- To understand the global trends and development methodologies of various types of products and services
- To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
- To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification
- To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
- To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

**UNIT I      BASICS OF PRODUCT DEVELOPMENT      9**

Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies - Product Life Cycle – Product Development Planning and Management.

**UNIT II      REQUIREMENTS AND SYSTEM DESIGN      9**

Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - System Design & Modeling - Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.

**UNIT III      DESIGN AND TESTING      9**

Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines - Concept Screening & Evaluation - Detailed Design - Component Design and Verification – Mechanical, Electronics and Software Subsystems - High Level Design/Low Level Design of S/W Program - Types of

Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping - Introduction to Rapid Prototyping and Rapid Manufacturing - System Integration, Testing, Certification and Documentation

**UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT 9**

Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - Sustenance -Maintenance and Repair – Enhancements - Product EoL - Obsolescence Management – Configuration Management - EoL Disposal

**UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY 9**

The Industry - Engineering Services Industry - Product Development in Industry versus Academia –The IPD Essentials - Introduction to Vertical Specific Product Development processes - Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of the course, the students will be able to:

- Define, formulate, and analyze a problem
- Solve specific problems independently or as part of a team
- Gain knowledge of the Innovation & Product Development process in the Business Context
- Work independently as well as in teams
- Manage a project from start to finish

**TEXT BOOKS:**

1. Book specially prepared by NASSCOM as per the MoU.
2. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011.
3. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.

**REFERENCES:**

1. Hiriappa B, "Corporate Strategy – Managing the Business", Author House, 2013.
2. Peter F Drucker, "People and Performance", Butterworth – Heinemann [Elsevier], Oxford, 2004.
3. Vinod Kumar Garg and Venkita Krishnan N K, "Enterprise Resource Planning – Concepts", Second Edition, Prentice Hall, 2003.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013

**COs- POs & PSOs MAPPING**

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	1						1		1			
2	3	2	3	1						1		1			
3	3	2	3	1	1			1	1	1		1			
4	3	2	3	1	1			1	1	1		1			
5	3	2	3	1	1			1	1	1		1			
AVg.															

**OBJECTIVES:**

The student should be made to:

- To know the hardware requirement various assistive devices
- To understand the prosthetic and orthotic devices
- To know the developments in assistive technology

<b>UNIT I</b>	<b>CARDIAC ASSIST DEVICES</b>	<b>9</b>
Cardiac functions and parameters, principle of External counter pulsation techniques, intra aortic balloon pump, Auxillary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves, cardiac pacemaker.		
<b>UNIT II</b>	<b>HEMODIALYSERS</b>	<b>9</b>
Physiology of kidney, Artificial kidney, Dialysis action, hemodialyser unit, membrane dialysis, portable dialyser monitoring and functional parameters.		
<b>UNIT III</b>	<b>HEARING AIDS</b>	<b>9</b>
Anatomy of ear, Common tests – audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids – principles, drawbacks in the conventional unit, DSP based hearing aids.		
<b>UNIT IV</b>	<b>PROSTHETIC AND ORTHODIC DEVICES</b>	<b>9</b>
Hand and arm replacement – different types of models, externally powered limb prosthesis, feedback in orthotic system, functional electrical stimulation, sensory assist devices.		
<b>UNIT V</b>	<b>RECENT TRENDS</b>	<b>9</b>
Transcutaneous electrical nerve stimulator, bio-feedback, assistive devices in drug delivery		
		<b>TOTAL :45 PERIODS</b>

**OUTCOMES:**

**On successful completion of this course, the student will be able to**

- CO1: Interpret the various mechanical techniques that will help in assisting the heart functions.  
 CO2: Describe the underlying principles of hemodialyzer machine.  
 CO3: Indicate the methodologies to assess the hearing loss.  
 CO4: Evaluate the types of assistive devices for mobilization.  
 CO5: Explain about TENS and biofeedback system.

**TEXT BOOKS**

1. Joseph D. Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press,2006
2. Marion. A. Hersh, Michael A. Johnson, Assistive Technology for visually impaired and blind, Springer Science & Business Media, 1st edition, 12-May-2010
3. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, CRC Press, 1st edition,2010.

**REFERENCES**

1. Kenneth J. Turner Advances in Home Care Technologies: Results of the match Project, Springer, 1st edition, 2011.
2. Gerr M. Craddock Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003.
3. 3D Printing in Orthopaedic Surgery, Matthew Dipaola , Elsevier 2019 ISBN 978 -0-323-

662116

4. Cardiac Assist Devices, Daniel Goldstein (Editor), Mehmet Oz (Editor), Wiley-Blackwell  
 April 2000 ISBN: 978-0-879-93449-1

**CO's- PO's & PSO's MAPPING**

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1	3	1	1	1	1											
2	3	1	1	1	1											
3	3	1	1	1	1											
4	3	1	1	1	1											
5	3	1	1	1	1											
AVg.																

**OMA352**

**OPERATIONS RESEARCH**

**L T P C**  
**3 0 0 3**

**OBJECTIVES:**

This course will help the students to

- determine the optimum solution for Linear programming problems.
- study the Transportation and assignment models and various techniques to solve them.
- acquire the knowledge of optimality, formulation and computation of integer programming problems.
- acquire the knowledge of optimality, formulation and computation of dynamic programming problems.
- determine the optimum solution for non-linear programming problems.

**UNIT I LINEAR PROGRAMMING**

**9**

Formulation of linear programming models – Graphical solution – Simplex method - Big M Method – Two phase simplex method - Duality - Dual simplex method.

**UNIT II TRANSPORTATION AND ASSIGNMENT PROBLEMS**

**9**

Matrix form of Transportation problems – Loops in T.P – Initial basic feasible solution – Transportation algorithm – Assignment problem – Unbalanced assignment problems .

**UNIT III INTEGER PROGRAMMING**

**9**

Introduction – All and mixed I.P.P – Gomory's method – Cutting plane algorithm – Branch and bound algorithm – Zero – one programming.

**UNIT IV DYNAMIC PROGRAMMING PROBLEMS**

**9**

Recursive nature of computation – Forward and backward recursion – Resource Allocation model – Cargo – loading model – Work – force size model - Investment model – Solution of L.P.P by dynamic programming .

**UNIT V NON - LINEAR PROGRAMMING PROBLEMS**

**9**

Lagrange multipliers – Equality constraints – Inequality constraints – Kuhn – Tucker Conditions – Quadratic programming.

**TOTAL:45 PERIODS**

**OUTCOMES :**

At the end of the course, students will be able to

- Could develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems.
- analyze the concept of developing, formulating, modeling and solving transportation and assignment problems.
- solve the integer programming problems using various methods.
- conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming.
- determine the optimum solution for non linear programming problems.

**TEXT BOOKS:**

1. Kanti Swarup, P.K.Gupta and Man Mohan, " Operations Research " , Sultan Chand & Sons, New Delhi, Fifth Edition , 1990.
2. Taha. H.A, " Operations Research – An Introduction , Pearson Education, Ninth Edition , New Delhi, 2012.

**REFERENCES :**

1. J.K.Sharma , " Operations Research - Theory and Applications " Mac Millan India Ltd , Second Edition , New Delhi , 2003.
2. Richard Bronson & Govindasami Naadimuthu , " Operations Research " ( Schaum's Outlines – TMH Edition) Tata McGraw Hill, Second Edition, New Delhi, 2004.
3. Pradeep Prabhakar Pai , " Operations Research and Practice", Oxford University Press, New Delhi , 2012.
4. J.P.Singh and N.P.Singh , " Operations Research , Ane Books Pvt.Ltd, New Delhi , 2014.
5. F.S.Hillier and G.J. Lieberman, " Introduction to Operations Research " , Tata McGraw Hill, Eighth Edition , New Delhi, 2005.

**CO's- PO's & PSO's MAPPING**

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO2	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
CO3	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO4	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO5	3	3	2	2	0	0	0	0	2	0	0	2	-	-	-
Avg	3	3	1	0.8	0	0	0	0	2	0	0	2	-	-	-

**OMA353****ALGEBRA AND NUMBER THEORY****L T P C  
3 0 0 3****OBJECTIVES :**

- To introduce the basic notions of groups, rings, fields which will then be used to solve related problems.
- To examine the key questions in the Theory of Numbers.
- To give an integrated approach to number theory and abstract algebra, and provide a firm basis for further reading and study in the subject.





**COURSE OBJECTIVES:**

- To test the consistency and solve system of linear equations.
- To find the basis and dimension of vector space.
- To obtain the matrix of linear transformation and its eigenvalues and eigenvectors.
- To find orthonormal basis of inner product space and find least square approximation.
- To find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.

**UNIT I MATRICES AND SYSTEM OF LINEAR EQUATIONS 9**

Matrices - Row echelon form - Rank - System of linear equations - Consistency - Gauss elimination method - Gauss Jordan method.

**UNIT II VECTOR SPACES 9**

Vector spaces over Real and Complex fields - Subspace – Linear space - Linear independence and dependence - Basis and dimension.

**UNIT III LINEAR TRANSFORMATION 9**

Linear transformation - Rank space and null space - Rank and nullity - Dimension theorem– Matrix representation of linear transformation - Eigenvalues and eigenvectors of linear transformation – Diagonalization.

**UNIT IV INNER PRODUCT SPACES 9**

Inner product and norms - Properties - Orthogonal, Orthonormal vectors - Gram Schmidt orthonormalization process - Least square approximation.

**UNIT V EIGEN VALUE PROBLEMS AND MATRIX DECOMPOSITION 9**

Eigen value Problems : Power method, Jacobi rotation method - Singular value decomposition – QR decomposition.

**TOTAL : 45 PERIODS****COURSE OUTCOMES:**

After the completion of the course the student will be able to

1. Test the consistency and solve system of linear equations.
2. Find the basis and dimension of vector space.
3. Obtain the matrix of linear transformation and its eigenvalues and eigenvectors.
4. Find orthonormal basis of inner product space and find least square approximation.
5. Find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.

**TEXT BOOKS**

1. Faires J.D. and Burden R., Numerical Methods, Brooks/Cole (Thomson Publications), New Delhi, 2002.
2. Friedberg A.H, Insel A.J. and Spence L, Linear Algebra, Pearson Education, 5<sup>th</sup> Edition, 2019.

**REFERENCES**

1. Bernard Kolman, David R. Hill, Introductory Linear Algebra, Pearson Educations, New Delhi, 8<sup>th</sup> Edition, 2009.

- Gerald C.F. and Wheatley P.O, Applied Numerical Analysis, Pearson Educations, New Delhi, 7<sup>th</sup> Edition, 2007.
- Kumaresan S, Linear Algebra - A geometric approach, Prentice Hall of India, New Delhi Reprint, 2010.
- Richard Branson, Matrix Operations, Schaum's outline series, 1989.
- Strang G, Linear Algebra and its applications, Thomson (Brooks / Cole) New Delhi, 4<sup>th</sup> Edition, 2005.
- Sundarapandian V, Numerical Linear Algebra, Prentice Hall of India, New Delhi, 2014.

### CO's- PO's & PSO's MAPPING

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	3	2	2	2	1	1	1	1	3	-	-	-
CO2	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO3	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO4	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO5	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
Avg	3	3	3	3	2.8	2	2	1	1	1	1	3	-	-	-

**OBT352**

**BASICS OF MICROBIAL TECHNOLOGY**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVE:**

- Enable the Non-biological student's to understand about the basics of life science and their pro and cons for living organisms.

**UNIT I BASICS OF MICROBES AND ITS TYPES 9**

Introduction to microbes, existence of microbes, inventions of great scientist and history, types of microorganisms – Bacteria, Virus, Fungi.

**UNIT II MICROBIAL TECHNIQUES 9**

Sterilization – types – physical and chemical sterilization, Decontamination, Preservation methods, fermentation, Cultivation and growth of microbes, Diagnostic methods.

**UNIT III PATHOGENIC MICROBES 9**

Infectious Disease – Awareness, Causative agent, Prevention and control - Cholera, Dengu, Malaria, Diarrhea, Tuberculosis, Typhoid, Covid, HIV.

**UNIT IV BENEFICIAL MICROBES 9**

Applications of microbes – Clinical microbiology, agricultural microbiology, Food Microbiology, Environmental Microbiology, Animal Microbiology, Marine Microbiology.

**UNIT V PRODUCTS FROM MICROBES 9**

Fermented products – Fermented Beverages, Curd, Cheese, Mushroom, Agricultural products – Biopesticide, Biofertilizers, Vermi compost, Pharmaceutical products - Antibiotics, Vaccines

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

At the end of the course the students will be able to

- Microbes and their types
- Cultivation of microbes
- Pathogens and control measures for safety

4. Microbes in different industry for economy.

**TEXT BOOKS**

1. Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993.
2. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.
3. Prescott L.M., Harley J.P., Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 1996.

**OBT353**

**BASICS OF BIOMOLECULES**

**L T P C**  
**3 0 0 3**

**OBJECTIVES:**

- The objective is to offer basic concepts of biochemistry to students with diverse background in life sciences including but not limited to the structure and function of various biomolecules and their metabolism.

**UNIT I CARBOHYDRATES 9**

Introduction to carbohydrate, classification, properties of monosaccharide, structural aspects of monosaccharides. Introduction to disaccharide (lactose, maltose, sucrose) and polysaccharide (Heparin, starch, and glycogen) biological function of carbohydrate.

**UNIT II LIPID AND FATTY ACIDS 9**

Introduction to lipid, occurrence, properties, classification of lipid. Importance of phospholipids, sphingolipid and glycerolipid. Biological function of lipid. Fatty acid, Introduction, Nomenclature and classification of fatty acid Essential and non essential fatty acids.

**UNIT III AMINO ACIDS AND PROTEIN. 9**

Introduction to amino acid, structure, classification of protein based on polarity. Introduction to protein, classification of protein based on solubility, shape, composition and Function. Peptide bond– Structure of peptide bond. Denaturation – renaturation of protein, properties of protein. Introduction to lipoprotein, glycoprotein and nucleoprotein. Biological function of protein.

**UNIT IV NUCLEIC ACIDS 9**

Introduction to nucleic acid, Difference between nucleotide and nucleoside, composition of DNA & RNA Structure of Nitrogen bases in DNA and RNA along with the nomenclature· DNA double helix (Watson and crick) model, types of DNA, RNA.

**UNIT V VITAMINS AND HORMONES 9**

Different types of vitamins, their diverse biochemical functions and deficiency related diseases. Overview of hormones. Hormone mediated signaling. Mechanism of action of steroid hormones, epinephrine, glucagons and insulin. Role of vitamins and hormones in metabolism; Hormonal disorders; Therapeutic uses of vitamins and hormones.

**OUTCOMES:**

- Students will learn about various kinds of biomolecules and their physiological role.
- Students will gain knowledge about various metabolic disorders and will help them to know the importance of various biomolecules in terms of disease correlation.

**TOTAL: 45 PERIODS**

**TEXT BOOKS**

1. Lehninger Principles of Biochemistry 6th Edition by David L. Nelson, Michael M. Cox W.H. Freeman and Company 2017

2. Satyanarayana, U. and U. Chakerapani, "Biochemistry" 3rd Rev. Edition, Books & Allied (P) Ltd., 2006.
3. Rastogi, S.C. "Biochemistry" 2nd Edition, Tata McGraw-Hill, 2003.
4. Conn, E.E., et al., "Outlines of Biochemistry" 5th Edition, John Wiley & Sons, 1987.
5. Outlines of Biochemistry, 5th Edition: By E E Conn, P K Stumpf, G Bruening and R Y Doi.pp 693. John Wiley and Sons, New York. 1987.

## REFERENCES

1. Berg, Jeremy M. et al. "Biochemistry", 6th Edition, W.H. Freeman & Co., 2006.
2. Murray, R.K., et al "Harper's Illustrated Biochemistry", 31st Edition, McGraw-Hill, 2018.
3. Voet, D. and Voet, J.G., "Biochemistry", 4th Edition, John Wiley & Sons Inc., 2010.

**OBT354                      FUNDAMENTALS OF CELL AND MOLECULAR BIOLOGY                      L T P C**  
**3 0 0 3**

### OBJECTIVES:

- To provide knowledge on the fundamentals of cell biology.
- To understand the signalling mechanisms.
- Understand basic principles of molecular biology at intracellular level to regulate growth, division and development.

**UNIT I                      INTRODUCTION TO CELL                      9**  
 Cell, cell wall and Extracellular Matrix (ECM), composition, cellular dimensions, Evolution, Organisation, differentiation of prokaryotic and Eukaryotic cells, Virus, bacteria, cyanobacteria, mycoplasma and prions.

**UNIT II                      CELL ORGANELLES                      9**  
 Molecular organisation, biogenesis and function Mitochondria, endoplasmic reticulum, golgi apparatus, plastids, chloroplast, leucoplast, centrosome, lysosome, ribosome, peroxisome, Nucleus and nucleolus. Endo membrane system, concept of compartmentalisation.

**UNIT III                      BIO-MEMBRANE TRANSPORT                      9**  
 Physicochemical properties of cell membranes. Molecular constituents of membranes, asymmetrical organisation of lipids and proteins. Solute transport across membrane's-fick's law, simple diffusion, passive-facilitated diffusion, active transport- primary and secondary, group translocation, transport ATPases, membrane transport in bacteria and animals. Transport mechanism- mobile carriers and pores mechanisms. Transport by vesicle formation, endocytosis, exocytosis, cell respiration.

**UNIT IV                      CELL CYCLE                      9**  
 Cell cycle- Cell division by mitosis and meiosis, Comparison of meiosis and mitosis, regulation of cell cycle, cell lysis, Cytokinesis, Cell signaling, Cell communication, Cell adhesion and Cell junction, cell cycle checkpoints.

**UNIT V                      CENTRAL DOGMA                      9**  
 Overview of Central dogma DNA replication: Meselson & Stahl experiment, bi-directional DNA replication, Okazaki fragments. Structure and function of mRNA, rRNA and tRNA. RNA synthesis: Initiation, elongation and termination of RNA synthesis Introduction to Genetic code- Steps in translation: Initiation, Elongation and termination of protein synthesis.

**TOTAL: 45 PERIODS**

### OUTCOMES:

- Understanding of cell at structural and functional level.
- Understand the central dogma of life and its significance.
- Comprehend the basic mechanisms of cell division.

**TEXTBOOKS:**

1. Cooper, G.M. and R.E. Hansman "The Cell: A Molecular Approach", 8th Edition, Oxford University Press, 2018
2. Friefelder, David. "Molecular Biology." Narosa Publications, 1999
3. Weaver, Robert F. "Molecular Biology" 11nd Edition, Tata McGraw-Hill, 2003.

**REFERENCES:**

1. Lodish H, Berk A, MatsudairaP, Kaiser CA, Krieger M, Schot MP, Zipursky L, Darnell J. Molecular Cell Biology, 6th Edition, 2007.
2. Becker, W.M. etal., "The World of the Cell", 9th Edition, Pearson Education, 2003.
3. Campbell, N.A., J.B. Reece and E.J. Simon "Essential Biology", VIIrd Edition, Pearson International, 2007.
4. Alberts, Bruce etal., "Essential Cell Biology", 4th Edition, W.W. Norton, 2013.



## OPEN ELECTIVE IV

OHS352

PROJECT REPORT WRITING

L T P C  
3 0 0 3

### **COURSE OBJECTIVE**

The Course will enable Learners to,

- Understand the essentials of project writing.
- Perceive the difference between general writing and technical writing
- Assimilate the fundamental features of report writing.
- Understand the essential differences that exist between general and technical writing.
- Learn the structure of a technical and project report.

### **UNIT I**

9

Writing Skills – Essential Grammar and Vocabulary – Passive Voice, Reported Speech, Concord, Signpost words, Cohesive Devices – Paragraph writing - Technical Writing vs. General Writing.

### **UNIT II**

9

Project Report – Definition, Structure, Types of Reports, Purpose – Intended Audience – Plagiarism – Report Writing in STEM fields – Experiment – Statistical Analysis.

### **UNIT III**

9

Structure of the Project Report: (Part 1) Framing a Title – Content – Acknowledgement – Funding Details -Abstract – Introduction – Aim of the Study – Background - Writing the research question - Need of the Study/Project Significance, Relevance – Determining the feasibility – Theoretical Framework.

### **UNIT IV**

9

Structure of the Project Report: (Part 2) – Literature Review, Research Design, Methods of Data Collection - Tools and Procedures - Data Analysis - Interpretation - Findings –Limitations - Recommendations – Conclusion – Bibliography.

### **UNIT V**

9

Proof reading a report – Avoiding Typographical Errors – Bibliography in required Format – Font – Spacing – Checking Tables and Illustrations – Presenting a Report Orally – Techniques.

**TOTAL:45 PERIODS**

### **OUTCOMES**

By the end of the course, learners will be able to

- Write effective project reports.
- Use statistical tools with confidence.
- Explain the purpose and intension of the proposed project coherently and with clarity.
- Create writing texts to suit achieve the intended purpose.
- Master the art of writing winning proposals and projects.

## REFERENCES

1. Gerson and Gerson - Technical Communication: Process and Product, 7th Edition, Prentice Hall(2012)
2. Virendra K. Pamecha - Guide to Project Reports, Project Appraisals and Project Finance (2012)
3. Daniel Riordan - Technical Report Writing Today (1998)  
Darla-Jean Weatherford - Technical Writing for Engineering Professionals (2016) Penwell Publishers.

### CO's- PO's & PSO's MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	1	1	1	3	2	2	3	3	3	3	-	-	-
2	2	2	2	1	1	1	2	1	2	3	2	3	-	-	-
3	2	2	3	3	2	3	2	2	2	3	2	3	-	-	-
4	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
5	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
AVg.	2.4	2.2	2.4	2.2	2	2.6	2.4	2.2	2.6	3	2.6	3	-	-	-

- 1-low, 2-medium, 3-high, '-'- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.

**OMA355**

**ADVANCED NUMERICAL METHODS**

**L T P C**  
**3 0 0 3**

#### OBJECTIVE:

- To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in engineering and technology. This will also serve as a precursor for future research.

#### UNIT I ALGEBRAIC EQUATIONS AND EIGENVALUE PROBLEM 9

System of nonlinear equations : Fixed point iteration method - Newton's method; System of linear equations: Thomas algorithm for tri diagonal system - SOR iteration methods ; Eigen value problems: Given's method - Householder's method.

#### UNIT II INTERPOLATION 9

Central difference: Stirling and Bessel's interpolation formulae ; Piecewise spline interpolation: Piecewise linear, piecewise quadratic and cubic spline ; Least square approximation for continuous data (upto 3rd degree).

#### UNIT III NUMERICAL METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS 9

Explicit Adams - Bashforth Techniques - Implicit Adams - Moulton Techniques, Predictor - Corrector Techniques - Finite difference methods for solving two - point linear boundary value problems - Orthogonal Collocation method.

#### UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS 9

Laplace and Poisson's equations in a rectangular region : Five point finite difference schemes - Leibmann's iterative methods - Dirichlet's and Neumann conditions – Laplace equation in polar coordinates : Finite difference schemes .

**UNIT V FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATIONS**

**9**

Parabolic equations : Explicit and implicit finite difference methods – Weighted average approximation - Dirichlet's and Neumann conditions – First order hyperbolic equations - Method of characteristics - Different explicit and implicit methods; Wave equation : Explicit scheme – Stability of above schemes.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

Upon completion of this course, the students will be able to:

- CO1: demonstrate the understandings of common numerical methods for nonlinear equations, system of linear equations and eigenvalue problems;
- CO2: understand the interpolation theory;
- CO3: understand the concepts of numerical methods for ordinary differential equations;
- CO4: demonstrate the understandings of common numerical methods for elliptic equations;
- CO5: understand the concepts of numerical methods for time dependent partial differential equations

**TEXT BOOKS :**

1. Grewal, B.S., "Numerical Methods in Engineering & Science ", Khanna Publications, Delhi, 2013.
2. Gupta, S.K., "Numerical Methods for Engineers", (Third Edition), New Age Publishers, 2015.
3. Jain, M.K., Iyengar, S.R.K. and Jain, R.K., "Computational Methods for Partial Differential Equations", New Age Publishers, 1994.

**REFERENCES:**

1. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
2. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", 9 th Edition, Cengage Learning, New Delhi, 2016.
3. Gupta S.K., "Numerical Methods for Engineers", 4th Edition, New Age Publishers, 2019.
4. Sastry, S.S., "Introductory Methods of Numerical Analysis", 5th Edition, PHI Learning, 2015.
5. Morton, K.W. and Mayers D.F., "Numerical solution of Partial Differential equations", Cambridge University press, Cambridge, 2002.

**CO's- PO's & PSO's MAPPING**

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	3	3	3	3	2	2	2	1	1	1	1	3	-	-	-
<b>CO2</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO3</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO4</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO5</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>Avg</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-

**OMA356**

**RANDOM PROCESSES**

**L T P C  
3 0 0 3**

**OBJECTIVES:**

- To introduce the basic concepts of probability, one and two dimensional random variables with applications to engineering which can describe real life phenomenon.





5. Yates. R.D. and Goodman. D.J., "Probability and Stochastic Processes", Wiley India Pvt. Ltd., Bangalore, 2<sup>nd</sup> Edition, 2012.

### CO's- PO's & PSO's MAPPING

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO2	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO3	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO4	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO5	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
Avg	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-

OMA357

### QUEUEING AND RELIABILITY MODELLING

L T P C  
3 0 0 3

#### OBJECTIVES:

- To provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems in communication engineering.
- To understand the concept of queueing models and apply in engineering.
- To provide the required mathematical support in real life problems and develop probabilistic models which can be used in several areas of science and engineering.
- To study the system reliability and hazard function for series and parallel systems.
- To implement Markovian Techniques for availability and maintainability which opens up new avenues for research.

#### UNIT I RANDOM PROCESSES

9

Classification – Stationary process – Markov process - Poisson process – Discrete parameter Markov chain – Chapman Kolmogorov equations – Limiting distributions.

#### UNIT II MARKOVIAN QUEUEING MODELS

9

Markovian queues – Birth and death processes – Single and multiple server queueing models – Little's formula - Queues with finite waiting rooms.

#### UNIT III ADVANCED QUEUEING MODELS

9

M/G/1 queue – Pollaczek Khinchin formula - M/D/1 and M/E<sub>k</sub>/1 as special cases – Series queues – Open Jackson networks.

#### UNIT IV SYSTEM RELIABILITY

9

Reliability and hazard functions- Exponential, Normal, Weibull and Gamma failure distribution – Time - dependent hazard models – Reliability of Series and Parallel Systems.

#### UNIT V MAINTAINABILITY AND AVAILABILITY

9

Maintainability and Availability functions – Frequency of failures – Two Unit parallel system with repair – k out of m systems.

**TOTAL: 45 PERIODS**

#### OUTCOMES

Upon successful completion of the course, students should be able to:

- Enable the students to apply the concept of random processes in engineering disciplines.
- Students acquire skills in analyzing various queueing models.
- Students can understand and characterize phenomenon which evolve with respect to time in a probabilistic manner.
- Students can analyze reliability of the systems for various probability distributions.
- Students can be able to formulate problems using the maintainability and availability analyses by using theoretical approach.

**TEXT BOOKS**

1. Shortle J.F, Gross D, Thompson J.M,Harris C.M., “Fundamentals of Queueing Theory”, John Wiley and Sons, New York,2018.
2. Balagurusamy E., “Reliability Engineering”, Tata McGraw Hill Publishing Company Ltd., New Delhi,2010.

**REFERENCES**

1. Medhi J, "Stochastic models of Queueing Theory", Academic Press, Elsevier, Amsterdam, 2003.
2. Taha, H.A., "Operations Research", 9<sup>th</sup> Edition, Pearson India Education Services, Delhi, 2016.
3. Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications", 2<sup>nd</sup> Edition, John Wiley and Sons, 2002.
4. Govil A.K., “Reliability Engineering”, Tata-McGraw Hill Publishing Company Ltd., New Delhi,1983.

**CO's- PO's & PSO's MAPPING**

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO2	3	3	2	0	0	0	0	0	2	0	0	2	-	-	-
CO3	3	3	0	2	0	0	0	0	2	0	0	2	-	-	-
CO4	3	3	2	0	0	0	0	0	2	0	0	2	-	-	-
CO5	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
Avg	3	3	1.4	0.8	0	0	0	0	2	0	0	2	-	-	-

**OMG354 PRODUCTION AND OPERATIONS MANAGEMENT FOR ENTREPRENEURS**

**L T P C**  
**3 0 0 3**

**OBJECTIVES:**

- To know the basic concept and function of Production and Operation Management for entrepreneurship.
- To understand the Production process and planning.
- To understand the Production and Operations Management Control for business owners.

**UNIT I INTRODUCTION TO PRODUCTION AND OPERATIONS MANGEMENT**

**9**

Functions of Production Management - Relationship between production and other functions – Production management and operations management, Characteristics of modern production and operation management, organisation of production function, recent trends in production /operations management - production as an organisational function, decision making in production Operations research

## **UNIT II PRODUCTION & OPERATION SYSTEMS**

**9**

Production Systems- principles – Models - CAD and CAM- Automation in Production - Functions and significance- Capacity and Facility Planning: Importance of capacity planning- Capacity measurement – Capacity Requirement Planning (CRP) process for manufacturing and service industry

## **UNIT III PRODUCTION & OPERATIONS PLANNING**

**9**

Facility Planning – Location of facilities – Location flexibility – Facility design process and techniques – Location break even analysis-Production Process Planning: Characteristic of production process systems – Steps for production process- Production Planning Control Functions – Planning phase- Action phase- Control phase - Aggregate production planning

## **UNIT IV PRODUCTION & OPERATIONS MANAGEMENT PROCESS**

**9**

Process selection with PLC phases- Process simulation tools- Work Study – Significance – Methods, evolution of normal/ standard time – Job design and rating - Value Analysis - Plant Layout: meaning – characters – Plant location techniques - Types- MRP and Layout Design - Optimisation and Theory of Constraints (TOC)– Critical Chain Project Management (CCPM)- REL (Relationship) Chart – Assembly line balancing- – Plant design optimisation -Forecasting methods.

## **UNIT V CONTROLLING PRODUCTION & OPERATIONS MANAGEMENT**

**9**

Material requirement planning (MRP)- Concept- Process and control - Inventory control systems and techniques – JIT and Lean manufacturing - Network techniques - Quality Management: Preventive Vs Breakdown maintenance for Quality – Techniques for measuring quality - Control Chart (X , R , p , np and C chart ) - Cost of Quality, Continuous improvement (Kaizen) - Quality awards - Supply Chain Management - Total Quality Management - 6 Sigma approach and Zero Defect Manufacturing.

### **TOTAL 45 : PERIODS**

Upon completion of this course the learners will be able :

- CO 1 To understand the basics and functions of Production and Operation Management for business owners.
- CO 2 To learn about the Production & Operation Systems.
- CO 3 To acquaint on the Production & Operations Planning Techniques followed by entrepreneurs in Industries.
- CO 4 To know about the Production & Operations Management Processes in organisations.
- CO 5 To comprehend the techniques of controlling , Production and Operations in industries.

## **REFERENCES**

1. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson, 2007.
2. Amitabh Raturi, Production and Inventory Management, , 2008.
3. Adam Jr. Ebert, Production and Operations Management, PHI Publication, 1992.
4. Muhlemann, Okland and Lockyer, Production and Operation Management, Macmillan India, 1992.
6. Chary S.N, Production and Operations Management, TMH Publications, 2010.
7. Terry Hill ,Operation Management. Pal Grave McMillan (Case Study).2005.

**OBJECTIVE:**

- To know various multivariate data analysis techniques for business research.

**UNIT I INTRODUCTION****9**

Uni-variate, Bi-variate and Multi-variate techniques – Classification of multivariate techniques – Guidelines for multivariate analysis and interpretation.

**UNIT II PREPARING FOR MULTIVARIATE ANALYSIS****9**

Conceptualization of research model with variables, collection of data – Approaches for dealing with missing data – Testing the assumptions of multivariate analysis.

**UNIT III MULTIPLE LINEAR REGRESSION ANALYSIS, FACTOR ANALYSIS****9**

Multiple Linear Regression Analysis – Inferences from the estimated regression function – Validation of the model. -Approaches to factor analysis – interpretation of results.

**UNIT IV LATENT VARIABLE TECHNIQUES****9**

Confirmatory Factor Analysis, Structural equation modelling, Mediation models, Moderation models, Longitudinal studies.

**UNIT V ADVANCED MULTIVARIATE TECHNIQUES****9**

Multiple Discriminant Analysis, Logistic Regression, Cluster Analysis, Conjoint Analysis, multidimensional scaling.

**TOTAL: 45 PERIODS****OUTCOMES :**

- Demonstrate a sophisticated understanding of the concepts and methods; know the exact scopes and possible limitations of each method; and show capability of using multivariate techniques to provide constructive guidance in decision making.
- Use advanced techniques to conduct thorough and insightful analysis, and interpret the results correctly with detailed and useful information.
- Show substantial understanding of the real problems; conduct deep analysis using correct methods; and draw reasonable conclusions with sufficient explanation and elaboration.
- Write an insightful and well-organized report for a real-world case study, including thoughtful and convincing details.
- Make better business decisions by using advanced techniques in data analytics. ‘

**REFERENCES :**

1. Joseph F Hair, Rolph E Anderson, Ronald L. Tatham & William C. Black, Multivariate Data Analysis, Pearson Education, New Delhi, 2005.
2. Barbara G. Tabachnick, Linda S.Fidell, Using Multivariate Statistics, 6th Edition, Pearson, 2012.
3. Richard A Johnson and Dean W.Wichern, Applied Multivariate Statistical Analysis, Prentice Hall, New Delhi, 2005.
4. David R Anderson, Dennis J Seveency, and Thomas A Williams, Statistics for Business and Economics, Thompson, Singapore, 2002

**COURSE OBJECTIVES:**

- To introduce the development, capabilities, applications, of Additive Manufacturing (AM), and its business opportunities.
- To be acquainted with vat polymerization and material extrusion processes
- To be familiar with powder bed fusion and binder jetting processes.
- To gain knowledge on applications of direct energy deposition, and material jetting processes.
- To impart knowledge on sheet lamination and direct write technologies.

**UNIT I INTRODUCTION****9**

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain - ASTM/ISO 52900 Classification - Benefits - AM Unique Capabilities - AM File formats: STL, AMF Applications: Building Printing, Bio Printing, Food Printing, Electronics Printing, Automobile, Aerospace, Healthcare. Business Opportunities in AM.

**UNIT II VAT POLYMERIZATION AND MATERIAL EXTRUSION****9**

Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process - top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications.  
Material Extrusion: Fused Deposition Modeling (FDM) - Process-Materials -Applications and Limitations.

**UNIT III POWDER BED FUSION AND BINDER JETTING****9**

Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications.  
Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits - Limitations - Applications.

**UNIT IV MATERIAL JETTING AND DIRECTED ENERGY DEPOSITION****9**

Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications.  
Directed Energy Deposition: Laser Engineered Net Shaping (LENS) - Process - Material Delivery - Materials -Benefits -Applications.

**UNIT V SHEET LAMINATION AND DIRECT WRITE TECHNOLOGY****9**

Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding - Materials - Application and Limitation.  
Ink-Based Direct Writing (DW): Nozzle Dispensing Processes, Inkjet Printing Processes, Aerosol DW - Applications of DW.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

At the end of this course students shall be able to:

- CO1: Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.
- CO2: Acquire knowledge on process vat polymerization and material extrusion processes and its applications.
- CO3: Elaborate the process and applications of powder bed fusion and binder jetting.
- CO4: Evaluate the advantages, limitations, applications of material jetting and directed energy deposition processes.
- CO5: Acquire knowledge on sheet lamination and direct write technology.

**TEXT BOOKS:**

1. Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani "Additive manufacturing technologies". 3<sup>rd</sup> edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0
2. Andreas Gebhardt and Jan-Steffen Hötter "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.

**REFERENCES:**

1. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing", Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
2. Milan Brandt, "Laser Additive Manufacturing: Materials, Design, Technologies, and Applications", Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.
3. Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 1<sup>st</sup> Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.
4. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer., United States ,2006, ISBN: 978-1-4614-9842-1.
5. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press., United States, 2011, ISBN: 9780849334092.

**CME343**

**NEW PRODUCT DEVELOPMENT**

L	T	P	C
3	0	0	3

**COURSE OBJECTIVES**

- 1 To introduce the fundamental concepts of the new product development
- 2 To develop material specifications, analysis and process.
- 3 To Learn the Feasibility Studies & reporting of new product development.
- 4 To study the New product qualification and Market Survey on similar products of new product development  
To learn Reverse Engineering. Cloud points generation, converting cloud data to 3D model

**UNIT I**

**FUNDAMENTALS OF NPD**

**9**

Introduction – Reading of Drawing – Grid reading, Revisions, ECN (Engg. Change Note), Component material grade, Specifications, customer specific requirements – Basics of monitoring of NPD applying Gantt chart, Critical path analysis – Fundamentals of BOM (Bill of Materials), Engg. BOM & Manufacturing BOM. Basics of MIS software and their application in industries like SAP, MS Dynamics, Oracle ERP Cloud – QFD.

**UNIT II**

**MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS**

**9**

Material specification standards – ISO, DIN, JIS, ASTM, EN, etc. – Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis, ), Fabrications, Welding process. Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis.

**UNIT III**

**ESSENTIALS OF NPD**

**9**

RFQ (Request of Quotation) Processing – Feasibility Studies & reporting – CFT (Cross Function Team) discussion on new product and reporting – Concept design, Machine selection for tool making, Machining – Manufacturing Process selection, Machining Planning, cutting tool selection – Various Inspection methods – Manual measuring, CMM – GOM (Geometric Optical Measuring), Lay out marking and Cut section analysis. Tool Design and Detail drawings preparation, release of details to machine shop and CAM programing. Tool assembly and shop floor trials. Initial sample submission with PPAP documents.

**UNIT IV CRITERIONS OF NPD****9**

New product qualification for Dimensions, Mechanical & Physical Properties, Internal Soundness proving through X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing frequencies. Market Survey on similar products, Risk analysis, validating samples with simulation results, Lesson Learned & Horizontal deployment in NPD.

**UNIT V REPORTING & FORWARD-THINKING OF NPD****9**

Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) – Purpose & documents, deployment in shop floor. Prototyping & RPT - Concepts, Application and its advantages, 3D Printing – resin models, Sand cores for foundries; Reverse Engineering. Cloud points generation, converting cloud data to 3D model – Advantages & Limitation of RE, CE (Concurrent Engineering) – Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost.)

**TOTAL :45 PERIODS****OUTCOMES:**

At the end of the course the students would be able to

1. Discuss fundamental concepts and customer specific requirements of the New Product development
2. Discuss the Material specification standards, analysis and fabrication, manufacturing process.
3. Develop Feasibility Studies & reporting of New Product development
4. Analyzing the New product qualification and Market Survey on similar products of new product development
5. Develop Reverse Engineering. Cloud points generation, converting cloud data to 3D model

**TEXT BOOKS:**

1. Product Development – Sten Jonsson
2. Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger

**REFERENCES:**

1. Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark
2. Change by Design
3. Toyota Product Development System – James Morgan & Jeffrey K. Liker
4. Winning at New Products – Robert Brands 3rd Edition
5. Product Design & Value Engineering – Dr. M.A. Bulsara &Dr. H.R. Thakkar

**CO's- PO's & PSO's MAPPING**

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	3	1				1	1			1	1	3	2
2	1	1	3	1				1	1			1	1	3	2
3	1	1	3	1				1	1			1	1	3	2
4	1	1	3	1				1	1			1	1	3	2
5	1	1	3	1				1	1			1	1	3	2
Low (1) ; Medium (2) ; High (3)															



**OBJECTIVES:**

The course aims to

- Outline Fundamental concepts in UI & UX
- Introduce the principles of Design and Building an mobile app
- Illustrate the use of CAD in product design
- Outline the choice and use of prototyping tools
- Understanding design of electronic circuits and fabrication of electronic devices

**UNIT I UI/UX 9**

Fundamental concepts in UI & UX - Tools - Fundamentals of design principles - Psychology and Human Factors for User Interface Design - Layout and composition for Web, Mobile and Devices - Typography - Information architecture - Color theory - Design process flow, wireframes, best practices in the industry -User engagement ethics - Design alternatives

**UNIT II APP DEVELOPMENT 9**

SDLC - Introduction to App Development - Types of Apps - web Development - understanding Stack - Frontend - backend - Working with Databases - Introduction to API - Introduction to Cloud services - Cloud environment Setup- Reading and writing data to cloud - Embedding ML models to Apps - Deploying application.

**UNIT III INDUSTRIAL DESIGN 9**

Introduction to Industrial Design - Points, lines, and planes - Sketching and concept generation - Sketch to CAD - Introduction to CAD tools - Types of 3D modeling - Basic 3D Modeling Tools - Part creation – Assembly - Product design and rendering basics - Dimensioning & Tolerancing

**UNIT IV MECHANICAL RAPID PROTOTYPING 9**

Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - Mechanical Prototyping; 3D Printing and classification - Laser Cutting and engraving - RD Works - Additive manufacturing

**UNIT V ELECTRONIC RAPID PROTOTYPING 9**

Basics of electronic circuit design - lumped circuits - Electronic Prototyping - Working with simulation tool - simple PCB design with EDA

**TOTAL: 45 PERIODS**

**Course Outcomes**

**At the end of the course, learners will be able to:**

- Create quick UI/UX prototypes for customer needs
- Develop web application to test product traction / product feature
- Develop 3D models for prototyping various product ideas
- Built prototypes using Tools and Techniques in a quick iterative methodology

**Text Books**

1. Peter Fiell, Charlotte Fiell, Industrial Design A-Z, TASCHEN America Llc(2003)
2. Samar Malik, Autodesk Fusion 360 - The Master Guide.
3. Steve Krug, Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability, Pearson,3rd edition(2014)

## References

1. <https://www.adobe.com/products/xd/learn/get-started.html>
2. <https://developer.android.com/guide>
3. <https://help.autodesk.com/view/fusion360/ENU/courses/>
4. [https://help.prusa3d.com/en/category/prusaslicer\\_204](https://help.prusa3d.com/en/category/prusaslicer_204)

**MF3010**

**MICRO AND PRECISION ENGINEERING**

**LT P C  
3 0 0 3**

### **COURSE OBJECTIVES:**

At the end of this course the student should be able to

- Learn about the precision machine tools
- Learn about the macro and micro components.
- Understand handling and operating of the precision machine tools.
- Learn to work with miniature models of existing machine tools/robots and other instruments.
- Learn metrology for micro system

### **UNIT I INTRODUCTION TO MICROSYSTEMS 9**

Design, and material selection, micro-actuators: hydraulic, pneumatic, electrostatic/ magnetic etc. for medical to general purpose applications. Micro-sensors based on Thermal, mechanical, electrical properties; micro-sensors for measurement of pressure, flow, temperature, inertia, force, acceleration, torque, vibration, and monitoring of manufacturing systems.

### **UNIT II FABRICATION PROCESSES FOR MICRO-SYSTEMS: 9**

Additive, subtractive, forming process, microsystems-Micro-pumps, micro- turbines, micro engines, micro-robot, and miniature biomedical devices

### **UNIT III INTRODUCTION TO PRECISION ENGINEERING 9**

Machine tools, holding and handling devices, positioning fixtures for fabrication/ assembly of microsystems. Precision drives: inch worm motors, ultrasonic motors, stick- slip mechanism and other piezo-based devices.

### **UNIT IV PRECISION MACHINING PROCESSES 9**

Precision machining processes for macro components - Diamond turning, fixed and free abrasive processes, finishing processes.

### **UNIT V METROLOGY FOR MICRO SYSTEMS 9**

Metrology for micro systems - Surface integrity and its characterization.

**TOTAL : 45 PERIODS**

### **COURSE OUTCOMES:**

Upon the completion of this course the students will be able to

- Select suitable precision machine tools and operate
- Apply the macro and micro components for fabrication of micro systems.
- Apply suitable machining process
- Able to work with miniature models of existing machine tools/robots and other instruments.
- Apply metrology for micro system

**TEXT BOOKS:**

1. Davim, J. Paulo, ed. Microfabrication and Precision Engineering: Research and Development. Woodhead Publishing, 2017
2. Gupta K, editor. Micro and Precision Manufacturing. Springer; 2017

**REFERENCES:**

1. Dornfeld, D., and Lee, D. E., Precision Manufacturing, 2008, Springer.
2. H. Nakazawa, Principles of Precision Engineering, 1994, Oxford University Press.
3. Whitehouse, D. J., Handbook of Surface Metrology, Institute of Physics Publishing, Philadelphia PA, 1994.
4. Murthy.R.L, —Precision Engineering in ManufacturingII, New Age International, New Delhi, 2005

**OMF354****COST MANAGEMENT OF ENGINEERING PROJECTS****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

Summarize the costing concepts and their role in decision making  
Infer the project management concepts and their various aspects in selection  
Interpret costing concepts with project execution  
Develop knowledge of costing techniques in service sector and various budgetary control techniques  
Illustrate with quantitative techniques in cost management

**UNIT I INTRODUCTION TO COSTING CONCEPTS 9**

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.'

**UNIT II INTRODUCTION TO PROJECT MANAGEMENT 9**

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts

**UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9**

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing

**UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9**

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

**UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT****9**

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

CO1: Understand the costing concepts and their role in decision making.

CO2: Understand the project management concepts and their various aspects in selection.

CO3: Interpret costing concepts with project execution.

CO4: Gain knowledge of costing techniques in service sector and various budgetary control techniques.

CO5: Become familiar with quantitative techniques in cost management.

**TEXT BOOKS:**

1. John M. Nicholas, Herman Steyn Project Management for Engineering, Business and Technology, Taylor & Francis, 2 August 2020, ISBN: 9781000092561.
2. Albert Lester ,Project Management, Planning and Control, Elsevier/Butterworth-Heinemann, 2007, ISBN: 9780750669566, 075066956X.

**REFERENCES:**

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991.
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988.
3. Charles T. Horngren et al Cost Accounting a Managerial Emphasis, Prentice Hall of India, New Delhi, 2011.
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003.
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007.

**AU3002****BATTERIES AND MANAGEMENT SYSTEM****L T P C****3 0 0 3****COURSE OBJECTIVES:**

The objective of this course is to make the students to understand the working and characteristics of different types of batteries and their management .

**UNIT I ADVANCED BATTERIES****9**

Li-ion Batteries-different formats, chemistry, safe operating area, efficiency, aging. Characteristics- SOC,DOD, SOH. Balancing-Passive Balancing Vs Active Balancing. Other Batteries-NCM and NCA Batteries. *NCR18650B* specifications.

**UNIT II BATTERY PACK****9**

Battery Pack- design, sizing, calculations, flow chart, real and simulation Model.Peak power – definition, testing methods-relationships with Power, Temperature and ohmic Internal Resistance. Cloud based and Local Smart charging.

**UNIT III BATTERY MODELLING****9**

Battery Modelling Methods-Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model, PNGV model. State space Models- Introduction. Battery Modelling software/simulation frameworks

**UNIT IV BATTERY STATE ESTIMATION****9**

SOC Estimation- Definition, importance, single cell Vs series batteries SOC. Estimation Methods- Load voltage, Electromotive force, AC impedance, Ah counting, Neural networks, Neuro-fuzzy forecast method, Kalman filter. Estimation Algorithms.

**UNIT V BMS ARCHITECTURE AND REAL TIME COMPONENTS****9**

Battery Management System- need, operation, classification. BMS ASIC-bq76PL536A-Q1 Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex Ray-CANedge1 package.ARBIN Battery Tester. BMS Development with Modeling software and Model-Based Design.

**TOTAL : 45 PERIODS****COURSE OUTCOMES:**

At the end of this course, students will be able to

1. Acquire knowledge of different Li-ion Batteries performance.
2. Design a Battery Pack and make related calculations.
3. Demonstrate a Battery Model or Simulation.
4. Estimate State-of-Charges in a Battery Pack.
5. Approach different BMS architectures during real world usage.

**TEXT BOOKS**

1. Jiuchun Jiang and Caiping Zhang, "Fundamentals and applications of Lithium-Ion batteries in Electric Drive Vehicles", Wiley, 2015.
2. Davide Andrea, "Battery Management Systems for Large Lithium-Ion Battery Packs" ARTECH House, 2010.

**REFERENCE BOOKS**

1. Developing Battery Management Systems with Simulink and Model-Based Design-whitepaper
2. Panasonic *NCR18650B- DataSheet*
3. bq76PL536A-Q1- IC DataSheet
4. CC2662R-Q1- IC DataSheet

**AU3008****SENSORS AND ACTUATORS****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- The objective of this course is to make the students to list common types of sensor and actuators used in automotive vehicles.

**UNIT I INTRODUCTION TO MEASUREMENTS AND SENSORS****9**

Sensors: Functions- Classifications- Main technical requirement and trends Units and standards- Calibration methods- Classification of errors- Error analysis- Limiting error- Probable error- Propagation of error- Odds and uncertainty- principle of transduction-Classification. Static characteristics- mathematical model of transducers- Zero, First and Second order transducers- Dynamic characteristics of first and second order transducers for standard test inputs.

**UNIT II VARIABLE RESISTANCE AND INDUTANCE SENSORS 9**

Principle of operation- Construction details- Characteristics and applications of resistive potentiometer- Strain gauges- Resistive thermometers- Thermistors- Piezoresistive sensors Inductive potentiometer- Variable reluctance transducers:- EI pick up and LVDT

**UNIT III VARIABLE AND OTHER SPECIAL SENSORS 9**

Variable air gap type, variable area type and variable permittivity type- capacitor microphone Piezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor- digital transducers-Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor.

**UNIT IV AUTOMOTIVE ACTUATORS 9**

Electromechanical actuators- Fluid-mechanical actuators- Electrical machines- Direct-current machines- Three-phase machines- Single-phase alternating-current Machines - Duty-type ratings for electrical machines. Working principles, construction and location of actuators viz. Solenoid, relay, stepper motor etc.

**UNIT V AUTOMATIC TEMPERATURE CONTROL ACTUATORS 9**

Different types of actuators used in automatic temperature control- Fixed and variable displacement temperature control- Semi Automatic- Controller design for Fixed and variable displacement type air conditioning system.

**TOTAL :45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the student will be able to

1. List common types of sensor and actuators used in vehicles.
2. Design measuring equipment's for the measurement of pressure force, temperature and flow.
3. Generate new ideas in designing the sensors and actuators for automotive application
4. Understand the operation of thesesensors, actuators and electronic control.
5. Design temperature control actuators for vehicles.

**TEXT BOOKS:**

1. Doebelin's Measurement Systems: 7th Edition (SIE),Ernest O. Doebelin DhaneshN.Manik McGraw Hill Publishers, 2019.
2. Robert Brandy, "Automotive Electronics and Computer System", Prentice Hall,2001
3. William Kimberley," Bosch Automotive Handbook", 6th Edition, Robert Bosch GmbH, 2004.
4. Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th Edition, 2007, ISBN No: 978-3-658-01783-5.

**REFERENCES:**

1. James D Halderman, "Automotive Electrical and Electronics" , Prentice Hall, USA, 2013
2. Tom Denton, "Automotive Electrical and Electronics Systems," Third Edition, 2004, SAE International.
3. Patranabis.D, "Sensors and Transducers", 2nd Edition, Prentice Hall India Ltd,2003
4. William Ribbens, "Understanding Automotive Electronics -An Engineering Perspective," 7th Edition, Elsevier Butterworth-Heinemann Publishers, 2012.

**OBJECTIVES:**

- To interpret the missile space stations, space vs earth environment.
- To explain the life support systems, mission logistics and planning.
- To deploy the skills effectively in the understanding of space vehicle configuration design.
- To explain Engine system and support of space vehicle
- To interpret nose cone configuration of space vehicle

**UNIT I FUNDAMENTAL ASPECTS 9**

Energy and Efficiencies of power plants for space vehicles – Typical Performance Values – Mission design – Structural design aspects during launch - role of launch environment on launch vehicle integrity.

**UNIT II SELECTION OF ROCKET PROPULSION SYSTEMS 9**

Ascent flight mechanics – Launch vehicle selection process – Criteria for Selection for different missions – selection of subsystems – types of staging – Interfaces – selection and criteria for stages and their role in launch vehicle configuration design.

**UNIT III ENGINE SYSTEMS, CONTROLS, AND INTEGRATION 9**

Propellant Budget – Performance of Complete or Multiple Rocket Propulsion Systems – Engine Design – Engine Controls – Engine System Calibration – System Integration and Engine Optimization.

**UNIT IV THRUST VECTOR CONTROL 9**

TVC Mechanisms with a Single Nozzle – TVC with Multiple Thrust Chambers or Nozzles – Testing – Integration with Vehicle – SITVC method – other jet control methods - exhaust plume problems in space environment

**UNIT V NOSE CONE CONFIGURATION 9**

Aerodynamic aspects on the selection of nose shape of a launch vehicle - design factors in the finalization of nose configuration with respect to payload - nose cone thermal protection system - separation of fairings - payload injection mechanism

**TOTAL: 45 PERIODS****OUTCOMES:**

On successful completion of this course, the student will be able to

- Explain exotic space propulsion concepts, such as nuclear, solar sail, and antimatter.
- Apply knowledge in selecting the appropriate rocket propulsion systems.
- interpret the air-breathing propulsion suitable for initial stages and fly-back boosters.
- Analyze aerodynamics aspect, including boost-phase lift and drag, hypersonic, and re-entry.
- Adapt from aircraft engineers moving into launch vehicle, spacecraft, and hypersonic vehicle design.

**COURSE OBJECTIVES:**

Of this course are

1. To introduce fundamental concepts of management and organization to students.
2. To impart knowledge to students on various aspects of marketing, quality control and marketing strategies.
3. To make students familiarize with the concepts of human resources management.
4. To acquaint students with the concepts of project management and cost analysis.
5. To make students familiarize with the concepts of planning process and business strategies.

**UNIT I INTRODUCTION TO MANAGEMENT AND ORGANISATION 9**

Concepts of Management and organization- nature, importance and Functions of Management, Systems Approach to Management - Taylor's Scientific Management Theory- Fayal's Principles of Management- Maslow's theory of Hierarchy of Human Needs- Douglas McGregor's Theory X and Theory Y- Hertzberg Two Factor Theory of Motivation- Leadership Styles, Social responsibilities of Management, Designing Organisational Structures: Basic concepts related to Organisation - Departmentation and Decentralisation.

**UNIT II OPERATIONS AND MARKETING MANAGEMENT 9**

Principles and Types of Plant Layout- Methods of Production (Job, batch and Mass Production), Work Study - Basic procedure involved in Method Study and Work Measurement - Business Process Reengineering (BPR)- Statistical Quality Control: control charts for Variables and Attributes (simple Problems) and Acceptance Sampling, Objectives of Inventory control, EOQ, ABC Analysis, Purchase Procedure, Stores Management and Store Records - JIT System, Supply Chain Management, Functions of Marketing, Marketing Mix, and Marketing Strategies based on Product Life Cycle.

**UNIT III HUMAN RESOURCES MANAGEMENT 9**

Concepts of HRM, HRD and Personnel Management and Industrial Relations (PMIR), HRM vs PMIR, Basic functions of HR Manager: Manpower planning, Recruitment, Selection, Training and Development, Wage and Salary Administration, Promotion, Transfer, Performance Appraisal, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating - Capability Maturity Model (CMM) Levels.

**UNIT IV PROJECT MANAGEMENT 9**

Network Analysis, Programme Evaluation and Review Technique (PERT), Critical Path Method (CPM), identifying critical path, Probability of Completing the project within given time, Project Cost Analysis, Project Crashing (simple problems).

**UNIT V STRATEGIC MANAGEMENT AND CONTEMPORARY STRATEGIC ISSUES 9**

Mission, Goals, Objectives, Policy, Strategy, Programmes, Elements of Corporate Planning Process, Environmental Scanning, Value Chain Analysis, SWOT Analysis, Steps in Strategy Formulation and Implementation, Generic Strategy alternatives. Benchmarking and Balanced Score Cards as Contemporary Business Strategies.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

Upon completion of the course, Students will be able to

CO1: Plan an organizational structure for a given context in the organisation to carry out production operation through Work-study.

CO2: Survey the markets, customers and competition better and price the given products appropriately

CO3: Ensure quality for a given product or service.



CO4: Plan, schedule and control projects through PERT and CPM.

CO5: Evaluate strategy for a business or service organisation.

**TEXTBOOKS:**

1. Kanishka Bedi, Production and Operations Management, Oxford University Press, 2007.
2. Stoner, Freeman, Gilbert, Management, 6<sup>th</sup> Ed, Pearson Education, New Delhi, 2004.
3. Thomas N. Duening & John M. Ivancevich Management Principles and Guidelines, Biztantra, 2007.
4. P. Vijay Kumar, N. Appa Rao and Ashnab, Chnalill, Cengage Learning India, 2012.

**REFERECES:**

1. Kotler Philip and Keller Kevin Lane: Marketing Management, Pearson, 2012.
2. Koontz and Weihrich: Essentials of Management, McGraw Hill, 2012.
3. Lawrence R Jauch, R. Gupta and William F. Glueck: Business Policy and Strategic Management Science, McGraw Hill, 2012.
4. Samuel C. Certo: Modern Management, 2012.

**CO's- PO's & PSO's MAPPING**

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3			3	3	3		3	3	2			2	3	
2	3			2	3	3		2	3	2				2	
3	3			3	2	2		3	2	2					2
4	3			3	3	2		3	2	3					3
5	3			2	3	3		2	3	3			2	1	
<b>AVg.</b>	3			2.6	2.8	2.6		2.6	2.6	2.4			2	2	2.5

OIM353

**PRODUCTION PLANNING AND CONTROL**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the concept of production planning and control act work study,
- To apply the concept of product planning,
- To analyze the production scheduling,
- To apply the Inventory Control concepts.
- To prepare the manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

**UNIT I INTRODUCTION**

**9**

Objectives and benefits of planning and control-Functions of production control-Types of production- job- batch and continuous-Product development and design-Marketing aspect - Functional aspects- Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration- Standardization, Simplification & specialization- Break even analysis-Economics of a new design.

**UNIT II WORK STUDY****9**

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

**UNIT III PRODUCT PLANNING AND PROCESS PLANNING****9**

Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning- Steps in process planning-Quantity determination in batch production-Machine capacity, balancing- Analysis of process capabilities in a multi product system.

**UNIT IV PRODUCTION SCHEDULING****9**

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance – Flow production scheduling- Batch production scheduling-Product sequencing – Production Control systems-Periodic batch control-Material requirement planning kanban – Dispatching-Progress reporting and expediting- Manufacturing lead time-Techniques for aligning completion times and due dates.

**UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC****9**

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size- ABC analysis - Recorder procedure-Introduction to computer integrated production planning systems- elements of JUST IN TIME SYSTEMS-Fundamentals of MRP II and ERP.

**TOTAL : 45 PERIODS****COURSE OUTCOMES:**

Upon completion of this course,

- CO1:The students can able to prepare production planning and control act work study,
- CO2:The students can able to prepare product planning,
- CO3:The students can able to prepare production scheduling,
- CO4:The students can able to prepare Inventory Control.
- CO5:They can plan manufacturing requirements manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

**TEXT BOOKS:**

1. James. B. Dilworth, "Operations management – Design, Planning and Control for manufacturing and services" Mcgraw Hill International edition 1992.
2. Martand Telsang, "Industrial Engineering and Production Management", First edition, S. Chand and Company, 2000.

**REFERENCES**

1. Chary. S.N., "Theory and Problems in Production & Operations Management", Tata McGraw Hill, 1995.
2. Elwood S.Buffa, and Rakesh K.Sarin, "Modern Production / Operations Management", 8th Edition John Wiley and Sons, 2000
3. Jain. K.C. & Aggarwal. L.N., "Production Planning Control and Industrial Management", Khanna Publishers, 1990
4. Kanishka Bedi, "Production and Operations management", 2nd Edition, Oxford university press, 2007.
5. Melynk, Denzler, " Operations management – A value driven approach" Irwin Mcgraw hill.
6. Norman Gaither, G. Frazier, "Operations Management" 9th Edition, Thomson learning IE, 2007
7. Samson Eilon, "Elements of Production Planning and Control", Universal Book Corpn.1984

8. Upendra Kachru, “ Production and Operations Management – Text and cases” 1st Edition, Excel books 2007

**CO's- PO's & PSO's MAPPING**

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3			3		1				1		3		
2	3	2			3									2	
3		2			3									2	
4		2	2												
5	3	3	2											1	
AVg.	3	2.6	2		3		1				1		3	1.8	

**OIE353**

**OPERATIONS MANAGEMENT**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVE:**

- Recognize and appreciate the concept of Production and Operations Management in creating and enhancing a firm's competitive advantages.
- Describe the concept and contribution of various constituents of Production and Operations Management (both manufacturing and service).
- Relate the interdependence of the operations function with the other key functional areas of a firm.
- Teach analytical skills and problem-solving tools to the analysis of the operations problems.
- Apply scheduling and Lean Concepts for improving System Performance.

**UNIT I INTRODUCTION TO OPERATIONS MANAGEMENT 9**

Operations Management – Nature, Importance, historical development, transformation processes, differences between services and goods, a system perspective, functions, challenges, current priorities, recent trends; Operations Strategy – Strategic fit , framework; Supply Chain Management

**UNIT II FORECASTING, CAPACITY AND FACILITY DESIGN 9**

Demand Forecasting – Need, Types, COURSE OBJECTIVES and Steps. Overview of Qualitative and Quantitative methods. Capacity Planning - Long range, Types, Developing capacity alternatives. Overview of sales and operations planning. Overview of MRP, MRP II and ERP. Facility Location – Theories, Steps in Selection, Location Models. Facility Layout – Principles, Types, Planning tools and techniques.

**UNIT III DESIGN OF PRODUCT, PROCESS AND WORK SYSTEMS 9**

Product Design – Influencing factors, Approaches, Legal, Ethical and Environmental issues. Process – Planning, Selection, Strategy, Major Decisions. Work Study – COURSE OBJECTIVES, Procedure. Method Study and Motion Study. Work Measurement and Productivity – Measuring Productivity and Methods to improve productivity.

**UNIT IV MATERIALS MANAGEMENT 9**

Materials Management – COURSE OBJECTIVES, Planning, Budgeting and Control. Purchasing – COURSE OBJECTIVES, Functions, Policies, Vendor rating and Value Analysis.

Stores Management – Nature, Layout, Classification and Coding. Inventory – COURSE OBJECTIVES, Costs and control techniques. Overview of JIT.

**UNIT V SCHEDULING AND PROJECT MANAGEMENT 9**

Project Management – Scheduling Techniques, PERT, CPM; Scheduling - work centers – nature, importance; Priority rules and techniques, shopfloor control; Flow shop scheduling – Johnson’s Algorithm – Gantt charts; personnel scheduling in services.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- CO1:** The students will appreciate the role of Production and Operations management in enabling and enhancing a firm’s competitive advantages in the dynamic business environment.
- CO2:** The students will obtain sufficient knowledge and skills to forecast demand for Production and Service Systems.
- CO3:** The students will be able to Formulate and Assess Aggregate Planning strategies and Material Requirement Plan.
- CO4:** The students will be able to develop analytical skills to calculate capacity requirements and developing capacity alternatives.
- CO5:** The students will be able to apply scheduling and Lean Concepts for improving System Performance.

**TEXT BOOKS**

1. Richard B. Chase, Ravi Shankar, F. Robert Jacobs, Nicholas J. Aquilano, Operations and Supply Management, Tata McGraw Hill, 12<sup>th</sup> Edition, 2010.
2. Norman Gaither and Gregory Frazier, Operations Management, South Western Cengage Learning, 2002.

**REFERENCES**

1. William J Stevenson, Operations Management, Tata McGraw Hill, 9<sup>th</sup> Edition, 2009.
2. Russel and Taylor, Operations Management, Wiley, Fifth Edition, 2006.
3. Kanishka Bedi, Production and Operations Management, Oxford University Press, 2004.
4. Chary S. N, Production and Operations Management, Tata McGraw Hill, Third Edition, 2008.
5. Aswathappa K and Shridhara Bhat K, Production and Operations Management, Himalaya Publishing House, Revised Second Edition, 2008.
6. Mahadevan B, Operations Management Theory and practice, Pearson Education, 2007.
7. Pannerselvam R, Production and Operations Management, Prentice Hall India, Second Edition, 2008.

**COs- POs & PSOs MAPPING**

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3											2			
2		3	3											3	3
3		2	3	3									2	3	
4		3	3	3									2	3	
5			3	2											
AVg.	3	2.6	3	2.6								2	2	3	3

**COURSE OBJECTIVES:**

1. Demonstrate an understanding of how occupational hygiene standards are set and used in work health and safety.
2. Compare and contrast the roles of environmental and biological monitoring in work health and safety
3. Outline strategies for identifying, assessing and controlling risks associated with airborne gases, vapours and particulates
4. Discuss how personal protective equipment can be used to reduce risks associated with workplace exposures
5. Provide high-level advice on managing and controlling noise and noise-related hazards

**UNIT I INTRODUCTION AND SCOPE****9**

Occupational Health and Environmental Safety Management - Principles practices. Comm on Occupational diseases: Occupational Health Management Services at the work place. Pre-employment, periodic medical examination of workers, medical surveillance for control of occupational diseases and health records.

**UNIT II MONITORING FOR SAFETY, HEALTH & ENVIRONMENT****9**

Occupational Health and Environment Safety Management System, ILO and EPA Standards Industrial Hygiene: Definition of Industrial Hygiene, Industrial Hygiene: Control Methods, Substitution, Changing the process, Local Exhaust Ventilation, Isolation, Wet method, Personal hygiene, housekeeping and maintenance, waste disposal, special control measures.

**UNIT III OCCUPATIONAL HEALTH AND ENVIRONMENTAL SAFETY EDUCATION****9**

Element of training cycle, Assessment of needs. Techniques of training, design and development of training programs. Training methods and strategies types of training. Evaluation and review of training programs. Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety, Exposure Limit .

**UNIT IV OCCUPATIONAL SAFETY, HEALTH AND ENVIRONMENT MANAGEMENT****9**

Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000, OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards, Performance measurements to determine effectiveness of PSM. Importance of Industrial safety, role of safety department,

**UNIT V INDUSTRIAL HAZARDS****9**

i. Radiation: Types and effects of radiation on human body, Measurement and detection of radiation intensity. Effects of radiation on human body, Measurement – disposal of radioactive waste, Control of radiation ii. Noise and Vibration: Sources, and its control, Effects of noise on the auditory system and health, Measurement of noise , Different air pollutants in industries, Effect of different gases and particulate matter ,acid fumes ,smoke, fog on human health, Vibration: effects.

**TOTAL PERIODS: 45****COURSE OUTCOMES:**

Students able to

CO1: Explain and apply human factors engineering concepts in both evaluation of existing systems and design of new systems

CO2: Specify designs that avoid occupation related injuries

CO3: Define and apply the principles of work design, motion economy, and work environment design.

CO4: Identify the basic human sensory, cognitive, and physical capabilities and limitations with respect to human-machine system performance.

CO5: Acknowledge the impact of workplace design and environment on productivity

**TEXT BOOKS:**

1. R. K. Jain and Sunil S. Rao , Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006)
2. Slote. L, Handbook of Occupational Safety and Health, John Willey and Sons, New York .

**REFERENCES:**

1. Jeanne MagerStellman, Encyclopedia of Occupational Health and Safety (ILO) Ms. Irma Jourdan publication
2. Frank P Lees - Loss of prevention in Process Industries, Vol. 1 and 2,
3. ButterworthHeinemann Ltd., London (1991). 2. Industrial Safety - National Safety Council of India
4. Frank P Lees – Loss of prevention in Process Industries , Vol. 1 and 2, Butterworth- Heinemann Ltd., London
5. R. K. Jain and Sunil S. Rao, Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006).

**COs- POs & PSOs MAPPING**

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2		2		2	-	-	-	-	-	2	-	-	-	-
2	-		2		-	-	1	-	-	-	1	-	-	-	-
3	-		-		2	-	-	-	-	-	2	-	-	-	-
4	-		-		-	-	-	-	2	-	3	-	-	-	-
5	-		-		-	-	-	1	-	-	-	-	-	-	-
AVg.	2	-	2	-	-	-	1	1	2	-	2	-	-	-	-

**OSF353**

**CHEMICAL PROCESS SAFETY**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- Teach the principles of safety applicable to the design, and operation of chemical process plants.
- Ensure that potential hazards are identified and mitigation measures are in place to prevent unwanted release of energy.
- Learn about the hazardous chemicals into locations that could expose employees and others to serious harm.
- Focuses on preventing incidents and accidents during large scale manufacturing of chemicals and pharmaceuticals.
- Ensure that the general design of the plant is capable of complying with the dose limits in force and with the radioactive releases.

**UNIT ISAFETY IN THE STORAGE AND HANDLING OF CHEMICALS AND GASES 9**

Types of storage-general considerations for storage layouts- atmospheric venting, pressure and temperature relief - relief valve sizing calculations - storage and handling of hazardous

chemicals and industrial gases, safe disposal methods, reaction with other chemicals, hazards during transportation - pipe line transport - safety in chemical laboratories.

**UNIT II CHEMICAL REACTION HAZARDS 9**

Hazardous inorganic and organic reactions and processes, Reactivity as a process hazard, Detonations, Deflagrations, and Runaways, Assessment and Testing strategies, Self - heating hazards of solids, Explosive potential of chemicals, Structural groups and instability of chemicals, Thermochemical screening,

**UNIT III SAFETY IN THE DESIGN OF CHEMICAL PROCESS PLANTS 9**

Design principles -Process design development -types of designs, feasibility survey, preliminary design, Flow diagrams, piping and instrumentation diagram, batch versus continuous operation, factors in equipment scale up and design, equipment specifications - reliability and safety in designing - inherent safety - engineered safety - safety during startup and shutdown - non destructive testing methods - pressure and leak testing - emergency safety devices - scrubbers and flares- new concepts in safety design and operation- Pressure vessel testing standards- Inspection techniques for boilers and reaction vessels.

**UNIT IV SAFETY IN THE OPERATION OF CHEMICAL PROCESS PLANTS 9**

Properties of chemicals - Material Safety Data Sheets - the various properties and formats used - methods available for property determination. Operational activities and hazards -standards operating procedures - safe operation of pumps, compressors, heaters, column, reactors, pressure vessels, storage vessels, piping systems - effects of pressure, temperature, Flow rate and humidity on operations - corrosion and control measures- condition monitoring - control valves - safety valves - pressure reducing valves, drains, bypass valves, inert gases. Chemical splashes, eye irrigation and automatic showers.

**UNIT V SAFETY AND ANALYSIS 9**

Safety vs reliability- quantification of basic events, system safety quantification, Human error analysis, Accident investigation and analysis, OSHAS 18001 and OSHMS.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**Students able to**

- CO1** Differentiate between inherent safety and engineered safety and recognize the importance of safety in the design of chemical process plants.
- CO2** Develop thorough knowledge about safety in the operation of chemical plants.
- CO3** Apply the principles of safety in the storage and handling of gases.
- CO4** Identify the conditions that lead to reaction hazards and adopt measures to prevent them.
- CO5** Develop thorough knowledge about

**TEXT BOOK**

- 1 David A Crowl & Joseph F Louvar, "Chemical Process safety", Pearson publication, 3<sup>rd</sup> Edition, 2014
- 2 Maurice Jones .A, "Fire Protection Systems, 2<sup>nd</sup> edition, Jones & Bartlett Publishers, 2015

**REFERENCES:**

1. Ralph King and Ron Hirst, "King's safety in the process industries", Arnold, London, 1998.
2. Industrial Environment and its Evolution and Control, NIOSH Publication, 1973.
3. National Safety Council, "Accident prevention manual for industrial operations". Chicago, 1982.
4. Lewis, Richard. J., Sr, "Sax's dangerous properties of materials". (Ninth edition). Van Nostrand Reinhold, New York, 1996.
5. Roy E Sanders, "Chemical Process Safety", 3<sup>rd</sup> Edition, Gulf professional publishing, 2006

**COs- POs & PSOs MAPPING**

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	-	-	-	1	-	-	1	-	-	-	2	-	-
2	-			2	-	-	-	-	1	-		-	-	2	-
3	-	3		1	-	-	-	2	-	-	1	-	-	-	-
4	-	2	-		-	1	-	-	1	-		-	-	-	2
5	-	2	3		-	-	-	1	-	-	1	-	-	-	-
<b>AVg.</b>	2	2.5	3	1.5	-	1	-	1.5	1	-	1		2	2	2

**OML352**

**ELECTRICAL, ELECTRONIC AND MAGNETIC MATERIALS**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

1. Understanding the importance of various materials used in electrical, electronics and magnetic applications
2. Acquiring knowledge on the properties of electrical, electronics and magnetic materials.
3. Gaining knowledge on the selection of suitable materials for the given application
4. Knowing the fundamental concepts in Semiconducting materials
5. Getting equipped with the materials used in optical and optoelectronic applications.

**UNIT I DIELECTRIC MATERIALS**

**9**

Dielectric as Electric Field Medium, leakage currents, dielectric loss, dielectric strength, breakdown voltage, breakdown in solid dielectrics, flashover, liquid dielectrics, electric conductivity in solid, liquid and gaseous dielectrics, Ferromagnetic materials, properties of ferromagnetic materials in static fields, spontaneous, polarization, curie point, anti-ferromagnetic materials, piezoelectric materials, pyroelectric materials.

**UNIT II MAGNETIC MATERIALS**

**9**

Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials, magnetic Anisotropy, Magnetostriction, diamagnetism, magnetically soft and hard materials, special purpose materials, feebly magnetic materials, Ferrites, cast and cermet permanent magnets, ageing of magnets. Factors effecting permeability and Hysteresis

**UNIT III SEMICONDUCTOR MATERIALS**

**9**

Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale Integration techniques. Concept of superconductivity; theories and examples for high temperature superconductivity; discussion on specific superconducting materials; comments on fabrication and engineering applications.

**UNIT IV MATERIALS FOR ELECTRICAL APPLICATIONS**

**9**

Materials used for Resistors, rheostats, heaters, transmission line structures, stranded conductors, bimetal fuses, soft and hard solders, electric contact materials, electric carbon materials, thermocouple materials. Solid, Liquid and Gaseous insulating materials, Effect of moisture on insulation.



**UNIT V OPTICAL AND OPTOELECTRONIC MATERIALS****9**

Principles of photoconductivity - effect of impurities - principles of luminescence-laser principles - He-Ne, injection lasers, LED materials - binary, ternary photoelectronic materials - LCD materials - photo detectors - applications of optoelectronic materials - optical fibres and materials - electro optic modulators - Kerr effect - Pockels effect.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

After completion of this course, the students will be able to

1. Understand various types of dielectric materials, their properties in various conditions.
2. Evaluate magnetic materials and their behavior.
3. Evaluate semiconductor materials and technologies.
4. Select suitable materials for electrical engineering applications.
5. Identify right material for optical and optoelectronic applications

**TEXT BOOKS:**

1. Pradeep Fulay, "Electronic, Magnetic and Optical materials", CRC Press, Taylor and Francis, 2nd illustrated edition, 2017.
2. "R K Rajput", "A course in Electrical Engineering Materials", Laxmi Publications, 2009.

**REFERENCE BOOKS:**

1. T K Basak, "A course in Electrical Engineering Materials", New Age Science Publications, 2009
2. TTTI Madras, "Electrical Engineering Materials", McGraw Hill Education, 2004.
3. Adrianus J. Dekker, "Electrical Engineering Materials", PHI Publication, 2006.
4. S. P. Seth, P. V. Gupta "A course in Electrical Engineering Materials", Dhanpat Rai & Sons, 2011.
5. C. Kittel, "Introduction to Solid State Physics", 7th Edition, John Wiley & Sons, Singapore, (2006).

**CO's- PO's & PSO's MAPPING**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C01	3	2	2	3								2	2	2	1
C02	3	1	2	2								2	2	2	1
C03	3	2	1	2								2	2	2	1
CO4	3	2	1	2								2	2	2	2
CO5	3	2	2	2								2	2	2	1
Avg	3	1.8	1.6	2.2								2	2	2	1.2

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

1. Understanding the evolution of nanomaterials in the scientific era and make them to understand different types of nanomaterials for the future engineering applications
2. Gaining knowledge on dimensionality effects on different properties of nanomaterials
3. Getting acquainted with the different processing techniques employed for fabricating nanomaterials
4. Having knowledge on the different characterisation techniques employed to characterise the nanomaterials
5. Acquiring knowledge on different applications of nanomaterials in different disciplines of engineering.

**UNIT I NANOMATERIALS****9**

Introduction, Classification: 0D, 1D, 2D, 3D nanomaterials and nano-composites, their mechanical, electrical, optical, magnetic properties; Nanomaterials versus bulk materials.

**UNIT II THERMODYNAMICS & KINETICS OF NANOSTRUCTURED MATERIALS****9**

Size and interface/interphase effects, interfacial thermodynamics, phase diagrams, diffusivity, grain growth, and thermal stability of nanomaterials.

**UNIT III PROCESSING****9**

Bottom-up and top-down approaches for the synthesis of nanomaterials, mechanical alloying, chemical routes, severe plastic deformation, and electrical wire explosion technique.

**UNIT IV STRUCTURAL CHARACTERISTICS****9**

Principles of emerging nanoscale X-ray techniques such as small angle X-ray scattering and X-ray absorption fine structure (XAFS), electron and neutron diffraction techniques and their application to nanomaterials; SPM, Nanoindentation, Grain size, phase formation, texture, stress analysis

**UNIT V APPLICATIONS****9**

Applications of nanoparticles, quantum dots, nanotubes, nanowires, nanocoatings; applications in electronic, electrical and medical industries

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

After completion of this course, the students will be able to

1. Evaluate nanomaterials and understand the different types of nanomaterials
2. Recognise the effects of dimensionality of materials on the properties
3. Process different nanomaterials and use them in engineering applications
4. Use appropriate techniques for characterising nanomaterials
5. Identify and use different nanomaterials for applications in different engineering fields.

**TEXT BOOKS:**

1. Bhusan, Bharat (Ed), "Springer Handbook of Nanotechnology", 2nd edition, 2007.
2. Carl C. Koch (ed.), NANOSTRUCTURED MATERIALS, Processing, Properties and Potential Applications, NOYES PUBLICATIONS, Norwich, New York, U.S.A.

**REFERENCES:**

1. Poole C.P, and Owens F.J., Introduction to Nanotechnology, John Wiley 2003

2. Nalwa H.S., Encyclopedia of Nanoscience and Nanotechnology, American Scientific Publishers 2004
3. Zehetbauer M.J. and Zhu Y.T., Bulk Nanostructured Materials, Wiley 2008
4. Wang Z.L., Characterization of Nanophase Materials, Wiley 2000
5. Gutkin Y., Ovid'ko I.A. and Gutkin M., Plastic Deformation in Nanocrystalline Materials, Springer 2004

### CO's- PO's & PSO's MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
C01	2	2	2	3								2	1	2	
C02	3	1	2	2								2	2	2	1
C03	3	2	1	2								2	2	2	
C04	3	1		2								2	2	2	2
C05	3	2	2	2								2	2	2	1
Avg	2.8	1.6	1.7	2.2								2	1.8	2	1.3

**OMR352**

### HYDRAULICS AND PNEUMATICS

**L    T    P    C**  
**3    0    0    3**

**COURSE OBJECTIVES:**

1. To knowledge on fluid power principles and working of hydraulic pumps
2. To obtain the knowledge in hydraulic actuators and control components
3. To understand the basics in hydraulic circuits and systems
4. To obtain the knowledge in pneumatic and electro pneumatic systems
5. To apply the concepts to solve the trouble shooting

**UNIT I                    FLUID POWER PRINCIPLES AND HYDRAULIC PUMPS                    9**

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

**UNIT II                    HYDRAULIC ACTUATORS AND CONTROL COMPONENTS                    9**

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.

**UNIT III                    HYDRAULIC CIRCUITS AND SYSTEMS                    9**

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

**UNIT IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9**

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits

**UNIT V TROUBLE SHOOTING AND APPLICATIONS 9**

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

- CO 1: Analyze the methods in fluid power principles and working of hydraulic pumps
- CO 2: Recognize the concepts in hydraulic actuators and control components
- CO 3: Obtain the knowledge in basics of hydraulic circuits and systems
- CO 4: Know about the basics concept in pneumatic and electro pneumatic systems
- CO 5: Apply the concepts to solve the trouble shooting hydraulic and pneumatics

**TEXT BOOKS**

1. Anthony Esposito, "Fluid Power with Applications", Prentice Hall, 2009.
2. James A. Sullivan, "Fluid Power Theory and Applications", Fourth Edition, Prentice Hall, 1997.

**REFERENCES**

1. Shanmugasundaram.K, "Hydraulic and Pneumatic Controls". Chand & Co, 2006.
2. Majumdar, S.R., "Oil Hydraulics Systems – Principles and Maintenance", Tata McG Raw Hill, 2001.
3. Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata McGRaw Hill, 2007.
4. Dudley, A. Pease and John J Pippenger, "Basic Fluid Power", Prentice Hall, 1987
5. Srinivasan. R, "Hydraulic and Pneumatic Controls", Vijay Nicole Imprints, 2008
6. Joshi.P, Pneumatic Control", Wiley India, 2008.
7. Jagadeesha T, "Pneumatics Concepts, Design and Applications ", Universities Press, 2015.

**CO's- PO's & PSO's MAPPING**

COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1		2	2						1	2	2	1
CO2	3	2	1		2	2						1	2	2	1
CO3	3	2	1		2	2						1	2	2	1
CO4	3	2	1		2	2						1	2	2	1
CO5	3	2	1		2	2						1	2	2	1
CO/PO & PSO Average	3	2	1		2	2						1	2	2	1
1 – Slight, 2 – Moderate, 3 – Substantial															

**COURSE OBJECTIVES:**

1. To learn the various types of sensors, transducers, sensor output signal types, calibration techniques, formulation of system equation and its characteristics.
2. To understand basic working principle, construction, Application and characteristics of displacement, speed and ranging sensors.
3. To understand and analyze the working principle, construction, application and characteristics of force, magnetic and heading sensors.
4. To learn and analyze the working principle, construction, application and characteristics of optical, pressure, temperature and other sensors.
5. To familiarize students with different signal conditioning circuits design and data acquisition system.

**UNIT I            SENSOR CLASSIFICATION, CHARACTERISTICS AND SIGNAL TYPES            9**

Basics of Measurement – Classification of Errors – Error Analysis – Static and Dynamic Characteristics of Transducers – Performance Measures of Sensors – Classification of Sensors – Sensor Calibration Techniques – Sensor Outputs - Signal Types - Analog and Digital Signals, PWM and PPM.

**UNIT II            DISPLACEMENT, PROXIMITY AND RANGING SENSORS            9**

Displacement Sensors – Brush Encoders - Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – Range Sensors - Ultrasonic Ranging - Reflective Beacons - Laser Range Sensor (LIDAR) – GPS - RF Beacons.

**UNIT III            FORCE, MAGNETIC AND HEADING SENSORS            9**

Strain Gage – Types, Working, Advantage, Limitation, and Applications: Load Measurement – Force and Torque Measurement - Magnetic Sensors – Types, Principle, Advantage, Limitation, and Applications - Magneto Resistive – Hall Effect, Eddy Current Sensor - Heading Sensors – Compass, Gyroscope and Inclinometers.

**UNIT IV            OPTICAL, PRESSURE, TEMPERATURE AND OTHER SENSORS            9**

Photo Conductive Cell, Photo Voltaic, Photo Resistive, LDR – Fiber Optic Sensors – Pressure – Diaphragm – Bellows - Piezoelectric - Piezo-resistive - Acoustic, Temperature – IC, Thermistor, RTD, Thermocouple – Non Contact Sensor - Chemical Sensors - MEMS Sensors - Smart Sensors.

**UNIT V            SIGNAL CONDITIONING            9**

Need for Signal Conditioning – Resistive, Inductive and Capacitive Bridges for Measurement - DC and AC Signal Conditioning - Voltage, Current, Power and Instrumentation Amplifiers – Filter and Isolation Circuits – Fundamentals of Data Acquisition System

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

- CO1: Understand various sensor effects, sensor characteristics, signal types, calibration methods and obtain transfer function and empirical relation of sensors. They can also analyze the sensor response.
- CO2: Analyze and select suitable sensor for displacement, proximity and range measurement.
- CO3: Analyze and select suitable sensor for force, magnetic field, speed, position and direction measurement.
- CO4: Analyze and Select suitable sensor for light detection, pressure and temperature measurement and also familiar with other miniaturized smart sensors.

CO5: Select and design suitable signal conditioning circuit with proper compensation and linearizing element based on sensor output signal.

**TEXT BOOKS**

1. Bolton W., “Mechatronics”, Pearson Education, 6th Edition, 2015.
2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, Penram International Publishing Private Limited, 6th Edition, 2013.

**REFERENCES**

1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., “Mechatronics”, Chapman and Hall, 1993.
2. Davis G. Alciatore and Michael B. Hstand, “Introduction to Mechatronics and Measurement systems”, McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, “Mechatronics Systems Design”, Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applications”, McGraw Hill Education, 2015.
5. Smaili. A and Mrad. F, “Mechatronics Integrated Technologies for Intelligent Machines”, Oxford University Press, 2007.

**CO's- PO's & PSO's MAPPING**

COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2								1	2	3	2	1
CO2	3	3	2	1	1	1					1	2	3	2	1
CO3	3	3	2	1	1	1					1	2	3	2	1
CO4	3	3	2	1	1	1					1	2	3	2	1
CO5	3	3	2	1	1	1					1	2	3	2	1
CO/PO & PSO Average	3	3	2	0.8	0.8	0.8					0.8	2	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial															



ORA352

CONCEPTS IN MOBILE ROBOTS

L	T	P	C
3	0	0	3

**COURSE OBJECTIVES**

1. To introduce mobile robotic technology and its types in detail.
2. To learn the kinematics of wheeled and legged robot.
3. To familiarize the intelligence into the mobile robots using various sensors.
4. To acquaint the localization strategies and mapping technique for mobile robot.
5. To aware the collaborative mobile robotics in task planning, navigation and intelligence.

**UNIT I INTRODUCTION TO MOBILE ROBOTICS 9**

Introduction – Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Robots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles

**UNIT II KINEMATICS 9**

Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints – Degree of Mobility and Steerability – **Manoeuvrability** – Workspace – Degrees of Freedom – Path and Trajectory Considerations – Motion Controls - Holonomic Robots

**UNIT III PERCEPTION 9**

Sensor for Mobile Robots – Classification and Performance Characterization – Wheel/Motor Sensors – Heading Sensors - Ground-Based Beacons - Active Ranging - Motion/Speed Sensors – Camera - Visual Appearance based Feature Extraction.

**UNIT IV LOCALIZATION 9**

Localization Based Navigation Versus Programmed Solutions - Map Representation - Continuous Representations - Decomposition Strategies - Probabilistic Map-Based Localization - Landmark-Based Navigation - Globally Unique Localization - Positioning Beacon Systems - Route-Based Localization - Autonomous Map Building - Simultaneous Localization and Mapping (SLAM).

**UNIT V PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS 9**

Introduction - Competences for Navigation: Planning and Reacting - Path Planning - Obstacle Avoidance - Navigation Architectures - Control Localization - Techniques for Decomposition - Case Studies – Collaborative Robots – Swarm Robots.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

**CO1:** Evaluate the appropriate mobile robots for the desired application.

**CO2:** Create the kinematics for given wheeled and legged robot.

**CO3:** Analyse the sensors for the intelligence of mobile robotics.

**CO4:** Create the localization strategies and mapping technique for mobile robot.

**CO5:** Create the collaborative mobile robotics for planning, navigation and intelligence for desired applications.

**TEXTBOOK**

1. Roland Siegwart and IllahR.Nourbakish, "Introduction to Autonomous Mobile Robots" MIT Press, Cambridge, 2004.

**REFERENCES:**

1. Dragomir N. Nenchev, Atsushi Konno, TeppeiTsujiata, "Humanoid Robots: Modelling and Control", Butterworth-Heinemann, 2018
2. MohantaJagadish Chandra, "Introduction to Mobile Robots Navigation", LAP Lambert Academic Publishing, 2015.

3. Peter Corke, "Robotics, Vision and Control", Springer, 2017.
4. Ulrich Nehmzow, "Mobile Robotics: A Practical Introduction", Springer, 2003.
5. Xiao Qi Chen, Y.Q. Chen and J.G. Chase, "Mobile Robots - State of the Art in Land, Sea, Air, and Collaborative Missions", Intec Press, 2009.
6. Alonzo Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, 2013, ISBN: 978-1107031159.

**MV3501**

**MARINE PROPULSION**

**L T P C  
3 0 0 3**

**COOURSE OBJECTIVES:**

1. To impart knowledge on basics of propulsion system and ship dynamic movements
2. To educate them on basic layout and propulsion equipment's
3. To impart basic knowledge on performance of the ship
4. To impart basic knowledge on Ship propeller and its types
5. To impart knowledge on ship rudder and its types

**UNIT I BASICS SHIP PROPULSION SYSTEM AND EQUIPMENTS 9**

law of floatation - Basics principle of propulsion- Earlier methods of propulsion- ship propulsion machinery- boiler, Marine steam engine, diesel engine, ship power transmission system, ship dynamic structure, Marine propulsion equipment - shaft tunnel, Intermediate shaft and bearing, stern tube, stern tube sealing etc. degree of freedom, Modern propelling methods- water jet propulsion , screw propulsion.

**UNIT II SHIPS MOVEMENTS AND SHIP STABILIZATION 9**

Thrust augmented devices, Ship hull, modern ship propulsion design, bow thruster – Advantages, various methods to stabilize the ship- passive and active stabilizer, fin stabilizer, bilge keel - stabilizing and securing ship in port- effect of tides on ship – effect of river water and sea water sailing vessel, Load line and load line of marking- draught markings.

**UNIT III SHIPS SPEED AND ITS PERFORMANCE 9**

Ship propulsion factors, factors affecting ships speed, various velocities of ship, hull drag, effects of fouling on ships hull, ship wake, relation between powers, Fuel consumption of ship, cavitations - effects of cavitation's, ship turning radius.

**UNIT IV BASICS OF PROPELLER 9**

Propeller dimension, Propeller and its types – fixed propeller, control pitch propeller, kort nozzle, ducted propeller, voith schneider, Parts of propeller, 3 blade - 5 blade - 6 blade propellers and its advantages, propeller boss hub, crown nut, propeller skew, pitch of propeller - Thrust creation by propeller. Propeller Material – Propeller balancing- static and dynamic.

**UNIT V BASICS OF RUDDER 9**

Rudder dimension, Area of rudder and its design, Rudder arrangements, Rudder fittings- Rudder pintle - Rudder types- Balanced rudder, semi balanced rudder, Spade rudder, merits and demerits of various types of rudders, Propeller and rudder interaction, Rudder stopper, movement of rudders, Basic construction of Rudder

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to:

- CO1: Explain the basics of propulsion system and ship dynamic movements  
CO2: Familiarize with various components assisting ship stabilization.



- CO3: Demonstrate the performance of the ship.  
 CO4: Classify the Propeller and its types, Materials etc.  
 CO5: Categories the Rudder and its types, design criteria of rudder.

**TEXT BOOKS:**

1. GP. Ghose, "Basic Ship propulsion",2015
2. E.A. Stokoe "Reeds Ship construction for marine engineers", Vol. 5,2010
3. E.A. Stokoe, "Reeds Naval architecture for the marine engineers",4<sup>th</sup> Edition,2009

**REFERENCES BOOKS:**

1. DJ Eyers and GJ Bruse, "Ship Construction", 7<sup>th</sup> Edition, 2006.
2. KJ Rawson and EC Tupper, "Basic Ship theory I" Vol. 1,5<sup>th</sup> Edition,2001.

**CO's- PO's & PSO's MAPPING**

CO	PO												PSO			
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
1	1	1	1	1	1						1	1		1		1
2	1	1	1											1		1
3	1			1	1				1	1	1		1	1		1
4	1		1	1										1		1
5	1		1	1										1		1
Avg	5/5= 1	2/2 =1	4/4 =1	4/4 =1	2/2 =1				1/1 =1	1/1=1	2/2=1	1/1=1	1/1= 1	5/5=1		5/5=1

**OMV351**

**MARINE MERCHANT VESSELS**

**LT P C  
3 0 3**

**OBJECTIVES:**

**At the end of the course, students are expected to acquire**

1. Knowledge on basics of Hydrostatics
2. Familiarization on types of merchant ships
3. Knowledge on Shipbuilding Materials
4. Knowledge on marine propeller and rudder
5. Awareness on governing bodies in shipping industry

**UNIT I Introduction to Hydrostatics**

**9**

Archimedes Principle- Laws of floatation- Meta centre - stability of floating and submerged bodies- Density, relative density - Displacement -Pressure -centre of pressure.

**UNIT II Types of Ship**

**10**

General cargo ship - Refrigerated cargo ships - Container ships - Roll-on Roll-off ships - Oil tankers- Bulk carriers - Liquefied Natural Gas carriers - Liquefied Petroleum Gas carriers - Chemical tankers - Passenger ships

**UNIT III Shipbuilding Materials**

**9**

Types of Steels used in Shipbuilding - High tensile steels, Corrosion resistant steels, Steel sandwich panels, Steel castings, Steel forgings - Other shipbuilding materials, Aluminium alloys, Aluminium alloy sandwich panels, Fire protection especially for Aluminium Alloys, Fiber Reinforced Composites

**UNIT IV Marine Propeller and Rudder****8**

Types of rudder, construction of Rudder-Types of Propeller, Propeller material-Cavitations and its effects on propeller

**UNIT V Governing Bodies for Shipping Industry****9**

Role of **IMO** (International Maritime Organization), **SOLAS** (International Convention for the Safety of Life at Sea), **MARPOL** (International Convention for the Prevention of Pollution from Ships), **MLC** (Maritime Labour Convention), **STCW 2010** (International Convention on Standards of Training, Certification and Watch keeping for Seafarers), Classification societies Administration authorities

**TOTAL: 45 PERIODS****OUTCOMES:****Upon completion of this course, students would**

1. Acquire Knowledge on floatation of ships
2. Acquire Knowledge on features of various ships
3. Acquire Knowledge of Shipbuilding Materials
4. Acquire Knowledge to identify the different types of marine propeller and rudder
5. Understand the Roles and responsibilities of governing bodies

**TEXT BOOKS:**

1. D.J.Eyres, "Ship Constructions", Seventh Edition, Butter Worth Heinemann Publishing, USA, 2015
2. Dr.DA Taylor, "Merchant Ship Naval Architecture" I. Mar EST publications, 2006
3. EA Stokoe, E.A, "Naval Architecture for Marine Engineers", Vol.4, Reeds Publications, 2000

**REFERENCES:**

1. Kemp & Young "Ship Construction Sketches & Notes", Butter Worth Heinemann Publishing, USA, 2011
2. MARPOL Consolidated Edition, Bhandakar Publications, 2018
3. SOLAS Consolidated Edition, Bhandakar Publications, 2016

**OMV352****ELEMENTS OF MARINE ENGINEERING****L T P C****3 0 0 3****OBJECTIVES:****At the end of the course, students are expected to**

1. Understand the role of Marine machinery systems
2. Be familiar with Marine propulsion machinery system
3. Acquaint with Marine Auxiliary machinery system
4. Have acquired basics of Marine Auxiliary boiler system
5. Be aware of ship propellers and steering system

**UNIT I ELEMENTARY KNOWLEDGE ON MARINE MACHINERY SYSTEMS****9**

Marine Engineering Terminologies, Parts of Ship, Introduction to Machinery systems on board ships – Propulsion Machinery system, Electricity Generator system, Steering gear system, Air compressors & Air reservoirs, Fuel oil and Lubricating Oil Purifiers, Marine Boiler systems

**UNIT II MARINE PROPULSION MACHINERY SYSTEM 9**

Two stroke Large Marine slow speed Diesel Engine – General Construction, Basic knowledge of Air starting and reversing mechanism, Cylinder lubrication oil system, Main lubricating oil system and cooling water system

**UNIT III MARINE AUXILIARY MACHINERY SYSTEM 9**

Four stroke medium speed Diesel engine – General Construction, Inline, V-type arrangement of engine, Difference between slow speed and medium speed engines – advantages, limitations and applications

**UNIT IV MARINE BOILER SYSTEM 9**

Types of Boiler – Difference between Water tube boiler and Fire tube boiler, Need for boiler on board ships, Uses of steam, Advantages of using steam as working medium, Boiler mountings and accessories – importance of mountings, need for accessories

**UNIT V SHIP PROPELLERS AND STEERING MECHANISM 9**

Importance of Propellor and Steering gear, Types of propellers - Fixed pitch propellers, Controllable pitch propellers, Water jet propellers, Steering gear systems - 2-Ram and 4 Ram steering gear, Electric steering gear

**TOTAL: 45 PERIODS**

**OUTCOMES:**

**At the end of the course, students should able to,**

1. Distinguish the role of various marine machinery systems
2. Relate the components of marine propulsion machinery system
3. Explain the importance of marine auxiliary machinery system
4. Acquire knowledge of marine boiler system
5. Understand the importance of ship propellers and steering system

**TEXT BOOKS:**

1. Taylor, "Introduction to Marine engineering", Revised Second Edition, Butterworth Heinemann, London, 2011
2. J.K.Dhar, "Basic Marine Engineering", Tenth Edition, G-Maritime Publications, Mumbai, 2011
3. K.Ramaraj, "Text book on Marine Engineering", Eswar Press, Chennai, 2018

**REFERENCES:**

1. Alan L.Rowen, "Introduction to Practical Marine Engineering, Volume 1&2, The Institute of Marine Engineers (India), Mumbai, 2006
2. A.S.Tambwekar, "Naval Architecture and Ship Construction", The Institute of Marine Engineers (India), Mumbai, 2015

PROGRESS THROUGH KNOWLEDGE

**CRA332**

**DRONE TECHNOLOGIES**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

1. To understand the basics of drone concepts
2. To learn and understand the fundamentals of design, fabrication and programming of drone
3. To impart the knowledge of an flying and operation of drone
4. To know about the various applications of drone
5. To understand the safety risks and guidelines of fly safely

**UNIT I INTRODUCTION TO DRONE TECHNOLOGY 9**

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

**UNIT II DRONE DESIGN, FABRICATION AND PROGRAMMING 9**

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

**UNIT III DRONE FLYING AND OPERATION 9**

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone controls Flight operations –management tool –Sensors-Onboard storage capacity -Removable storage devices- Linked mobile devices and applications

**UNIT IV DRONE COMMERCIAL APPLICATIONS 9**

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

**UNIT V FUTURE DRONES AND SAFETY 9**

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

- CO1: Know about a various type of drone technology, drone fabrication and programming.
- CO2: Execute the suitable operating procedures for functioning a drone
- CO3: Select appropriate sensors and actuators for Drones
- CO4: Develop a drone mechanism for specific applications
- CO5: Create the programs for various drones

**TEXT BOOKS**

1. Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, 2021 John Wiley & Sons, Inc.
2. Terry Kilby and Belinda Kilby, “Make:Getting Started with Drones “,Maker Media, Inc, 2016

**REFERENCES**

1. John Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016
2. Završnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance”, Springer, 2018.

**CO’s- PO’s & PSO’s MAPPING**

COs/Pos&P SOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	1	3	2						1	2	1	3
CO2	1	2	3	1	3	2						1	2	1	3
CO3	1	2	3	1	3	2						1	2	1	3
CO4	1	2	3	1	3	2						1	2	1	3
CO5	1	2	3	1	3	2						1	2	1	3
CO/PO & PSO Average	1	2	3	1	3	2						1	2	1	3
1 – Slight, 2 – Moderate, 3 – Substantial															

**OGI352**

**GEOGRAPHICAL INFORMATION SYSTEM**

**L T P C  
3 0 0 3**

**OBJECTIVES:**

- To impart the knowledge on basic components, data preparation and implementation of Geographical Information System.

**UNIT I FUNDAMENTALS OF GIS**

**9**

Introduction to GIS - Basic spatial concepts - Coordinate Systems - GIS and Information Systems – Definitions – History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Proprietary and open source Software - Types of data – Spatial, Attribute data- types of attributes – scales/ levels of measurements.

**UNIT II SPATIAL DATA MODELS**

**9**

Database Structures – Relational, Object Oriented – Entities – ER diagram - data models - conceptual, logical and physical models - spatial data models – Raster Data Structures – Raster Data Compression - Vector Data Structures - Raster vs Vector Models- TIN and GRID data models.

**UNIT III DATA INPUT AND TOPOLOGY****9**

Scanner - Raster Data Input – Raster Data File Formats – Georeferencing – Vector Data Input – Digitizer – Datum Projection and reprojection -Coordinate Transformation – Topology - Adjacency, connectivity and containment – Topological Consistency – Non topological file formats - Attribute Data linking – Linking External Databases – GPS Data Integration

**UNIT IV DATA QUALITY AND STANDARDS****9**

Data quality - Basic aspects - completeness, logical consistency, positional accuracy, temporal accuracy, thematic accuracy and lineage – Metadata – GIS Standards –Interoperability - OGC - Spatial Data Infrastructure

**UNIT V DATA MANAGEMENT AND OUTPUT****9**

Import/Export – Data Management functions- Raster to Vector and Vector to Raster Conversion - Data Output – Map Compilation – Chart/Graphs – Multimedia – Enterprise Vs. Desktop GIS- distributed GIS.

**TOTAL:45 PERIODS****COURSE OUTCOMES:**

- On completion of the course, the student is expected to
- CO1** Have basic idea about the fundamentals of GIS.
- CO2** Understand the types of data models.
- CO3** Get knowledge about data input and topology
- CO4** Gain knowledge on data quality and standards
- CO5** Understand data management functions and data output

**TEXTBOOKS:**

1. Kang - Tsung Chang, Introduction to Geographic Information Systems, McGraw Hill Publishing, 2nd Edition, 2011.
2. Ian Heywood, Sarah Cornelius, Steve Carver, Srinivasa Raju, “An Introduction Geographical Information Systems, Pearson Education, 2nd Edition,2007.

**REFERENCES:**

1. Lo. C. P., Albert K.W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice-Hall India Publishers, 2006

**CO's- PO's & PSO's MAPPING**

PO	Graduate Attribute	Course Outcome					Average
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering Knowledge	3	3	3	3	3	3
PO2	Problem Analysis				3	3	3
PO3	Design/Development of Solutions			3	3	3	3
PO4	Conduct Investigations of Complex Problems			3	3	3	3
PO5	Modern Tool Usage		3		3	3	3
PO6	The Engineer and Society						
PO 7	Environment and Sustainability						
PO 8	Ethics						
PO 9	Individual and Team Work						
PO 10	Communication						
PO 11	Project Management and Finance						

PO 12	Life-long Learning						
PSO 1	Knowledge of Geoinformatics discipline	3	3	3	3	3	3
PSO 2	Critical analysis of Geoinformatics Engineering problems and innovations	3	3	3	3	3	3
PSO 3	Conceptualization and evaluation of Design solutions	3	3	3	3	3	3

**OAI352**

**AGRICULTURE ENTREPRENEURSHIP DEVELOPMENT**

**L T P C  
3 0 0 3**

**OBJECTIVES**

- To introduce the importance of Agri-business management, its characteristics and principles
- To impart knowledge on the functional areas of Agri-business like Marketing management, Product pricing methods and Market potential assessment.

**UNIT I ENTREPRENEURIAL ENVIRONMENT IN INDIAN CONTEXT 9**

Entrepreneur Development(ED): Concept of entrepreneur and entrepreneurship assessing overall business environment in Indian economy- Entrepreneurial and managerial characteristics- Entrepreneurship development programmes (EDP)-Generation incubation and commercialization of ideas and innovations- Motivation and entrepreneurship development- Globalization and the emerging business entrepreneurial environment.

**UNIT II AGRIBUSINESS IN GLOBAL ARENA: LEGAL PERSPECTIVE 9**

Importance of agribusiness in Indian economy - International trade-WTO agreements- Provisions related to agreements in agricultural and food commodities - Agreements on Agriculture (AOA)- Domestic supply, market access, export subsidies agreements on sanitary and phyto-sanitary (SPS) measures, Trade related intellectual property rights (TRIPS).

**UNIT III ENTREPRENEURSHIP MANAGEMENT: FINANCIAL PERSPECTIVE 9**

Entrepreneurship - Essence of managerial Knowledge -Management functions- Planning-organizing-Directing-Motivation-ordering-leading-supervision- communication and control- Understanding Financial Aspects of Business - Importance of financial statements-liquidity ratios-leverage ratios, coverage ratios-turnover ratios-Profitability ratios. Agro-based industries-Project-Project cycle-Project appraisal and evaluation techniques-undiscounted measures-Payback period-proceeds per rupee of outlay, Discounted measures-Net Present Value (NPV)-Benefit-Cost Ratio(BCR)-Internal Rate of Return(IRR)-Net benefit investment ratio(N/K ratio)-sensitivity analysis.

**UNIT IV ENTREPRENEURIAL OPPORTUNITIES: ECONOMIC GROWTH PERSPECTIVE 9**

Managing an enterprise: Importance of planning, budgeting, monitoring evaluation and follow-up managing competition. Role of ED in economic development of a country- Overview of Indian social, political system and their implications for decision making by individual entrepreneurs- Economic system and its implication for decision making by individual entrepreneurs.

**UNIT V ENTREPRENEURIAL PROMOTION MEASURES AND GOVERNMENT SUPPORT 9**

Social responsibility of business. Morals and ethics in enterprise management- SWOT analysis- Government schemes and incentives for promotions of entrepreneurship. Government policy on small and medium enterprises (SMEs)/SSIs/MSME sectors- Venture capital (VC), contract framing (CF) and Joint Venture (JV), public-private partnerships (PPP) - overview of agricultural engineering industry, characteristics of Indian farm

machinery industry.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

1. Judge about agricultural finance, banking and cooperation
2. Evaluate basic concepts, principles and functions of financial management
3. Improve the skills on basic banking and insurance schemes available to customers
4. Analyze various financial data for efficient farm management
5. Identify the financial institutions

**TEXT BOOKS**

1. Joseph L. Massie, 1995, "Essentials of Management", prentice Hall of India Pvt limited, New Delhi
2. Khanka S, 1999, Entrepreneurial Development, S, Chand and Co, New Delhi
3. Mohanty S K, 2007, Fundamentals of Entrepreneurship, Prentice Hall India, New Delhi.

**REFERENCES**

1. Harih S B, Conner U J and Schwab G D, 1981, Management of the Farm Business, Prentice Hall Inc, New Jersey
2. Omri Ralins, N.1980, Introduction to Agricultural: Prentice Hall Inc, New Jersey
3. Gittenger Price, 1989, Economic Analysis of Agricultural project, John Hopkins University, Press, London.
4. Thomas W Zimmer and Norman M Scarborough, 1996, Entrepreneurship, Prentice Hall, New Jersey.
5. Mar J Dollinger, 1999, Entrepreneurship strategies and resources, Prentice –Hall, Upper Saddal Rover, New Jersey.

**CO's- PO's & PSO's MAPPING**

PO/PSO		CO1	CO2	CO3	CO4	CO5	Overall correlation of COs with POs
PO1	Engineering Knowledge	1	2	1	1	1	2
PO2	Problem Analysis	2	1	1	1	2	1
PO3	Design/ Development of Solutions	1	1	1	2	1	2
PO4	Conduct Investigations of Complex Problems	1	1	2	1	1	1
PO5	Modern Tool Usage	2	1	1	1	1	2
PO6	The Engineer and Society	1	2	1	2	1	1
PO7	Environment and sustainability	1	1	2	1	1	1
PO8	Ethics	1	2	1	1	1	1
PO9	Individual and team work:	1	1	1	2	1	1
PO10	Communication	1	1	1	1	2	1
PO11	Project management and finance	1	1	2	1	1	1
PO12	Life-long learning:	1	2	1	1	1	2
PSO1	To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	1	2	1	1	1	1
PSO2	To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.	1	1	2	1	1	1



PSO3	To inculcate entrepreneurial skills through strong Industry-Institution linkage.	1	2	1	1	2	1
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**OEN352**

**BIODIVERSITY CONSERVATION**

**L T P C  
3 0 0 3**

**OBJECTIVE:**

The identification of different aspects of biological diversity and conservation techniques.

**UNIT I INTRODUCTION 9**

Concept of Species, Variation; Introduction to Major Plant Groups; Evolutionary relationships between Plant Groups; Nomenclature and History of plant taxonomy; Systems of Classification and their Application; Study of Plant Groups; Study of Identification Characters; Study of important families of Angiosperms; Plant Diversity Application.

**UNIT II INTRODUCTION TO ANIMAL DIVERSITY AND TAXONOMY 9**

Principles and Rules of Taxonomy; ICZN Rules, Animal Study Techniques; Concepts of Taxon, Categories, Holotype, Paratype, Topotype etc; Classification of Animal kingdom, Invertebrates, Vertebrates, Evolutionary relationships between Animal Groups.

**UNIT III MICROBIAL DIVERSITY 9**

Microbes and Earth History, Magnitude, Occurrence and Distribution. Concept of Species, Criteria for Classification, Outline Classification of Microorganisms (Bacteria, Viruses and Protozoa); Criteria for Classification and Identification of Fungi; Chemical and Biochemical Methods of Microbial Diversity Analysis

**UNIT IV MEGA DIVERSITY 9**

Biodiversity Hot-spots, Floristic and Faunal Regions in India and World; IUCN Red List; Factors affecting Diversity, Impact of Exotic Species and Human Disturbance on Diversity, Dispersal, Diversity-Stability Relationship; Socio- economic Issues of Biodiversity; Sustainable Utilization of Bioresources; National Movements and International Convention/Treaties on Biodiversity.

**UNIT V CONSERVATIONS OF BIODIVERSITY 9**

In-Situ Conservation- National parks, Wildlife sanctuaries, Biosphere reserves; Ex-situ conservation- Gene bank, Cryopreservation, Tissue culture bank; Long term captive breeding, Botanical gardens, Animal Translocation, Zoological Gardens; Concept of Keystone Species, Endangered Species, Threatened Species, Rare Species, Extinct Species

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**

1. A textbook of Botany: Angiosperms- Taxonomy, Anatomy, Economic Botany & Embryology. S. Chand, Limited, Pandey, B. P. January 2001
2. Principles of Systematic Zoology, Mcgraw-Hill College, Ashlock, P.D., Latest Edition.
3. Microbiology, MacGraw Hill Companies Inc, Prescott, L.M., Harley, J.P., and Klein D.A. (2022).
4. Microbiology, Pearson Publisher, Gerard J. Tortora, Berdell R. Funke, Christine L. Case, 13<sup>th</sup> Edition 2019

**REFERENCES:**

1. Ecological Census Technique: A Handbook, Cambridge University Press, Sutherland, W.
2. Encyclopedia of Biodiversity, Academic Press, Simonson Asher Levin.

**OUTCOMES**

Upon successful completion of this course, students will:

CO1: An insight into the structure and function of diversity for ecosystem stability.

CO2: Understand the concept of animal diversity and taxonomy

CO3: Understand socio-economic issues pertaining to biodiversity

CO4: An understanding of biodiversity in community resource management.

CO5: Student can apply fundamental knowledge of biodiversity conservation to solve problems associated with infrastructure development.

**COs- POs & PSOs MAPPING**

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		2						2		2			2	2	
2		2		2	2	2							3	2	
3				2		2							3	2	3
4	3	2			2			2	2	2	2		3	2	3
5		2	3	2			1					1		2	
Avg.	3	2	3	2	2	2	1	2	2	2	2	1	3	2	3

1.low, 2-medium, 3-high, ‘-‘- no correlation

Note: The average value of this course to be used for program articulation matrix.

**OCE354 BASICS OF INTEGRATED WATER RESOURCES MANAGEMENT**

**L T P C  
3 0 0 3**

**OBJECTIVES**

- To introduce the interdisciplinary approach of water management.
- To develop knowledge base and capacity building on IWRM.

**UNIT I OVERVIEW OF IWRM**

**9**

Facts about water - Definition – Key challenges - Paradigm shift - Water management Principles - Social equity - Ecological sustainability – Economic efficiency - SDGs - World Water Forums.

**UNIT II WATER USE SECTORS: IMPACTS AND SOLUTION**

**9**

Water users: People, Agriculture, ecosystem and others - Impacts of the water use sectors on water resources - Securing water for people, food production, ecosystems and other uses - IWRM relevance in water resources management.

**UNIT III WATER ECONOMICS**

**9**

Economic characteristics of water good and services – Economic instruments – Private sector involvement in water resources management - PPP experiences through case studies.

**UNIT IV RECENT TREANDS IN WATER MANAGEMENT**

**9**

River basin management - Ecosystem Regeneration – 5 Rs - WASH - Sustainable livelihood - Water management in the context of climate change.

## UNIT V IMPLEMENTATION OF IWRM

9

Barriers to implementing IWRM - Policy and legal framework - Bureaucratic reforms and inclusive development - Institutional Transformation - Capacity building - Case studies on conceptual framework of IWRM.

**TOTAL: 45 PERIODS**

### OUTCOMES

- On completion of the course, the student will be able to apply appropriate management techniques towards managing the water resources.
- CO1** Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.
- CO2** Discuss on the different water uses; how it is impacted and ways to tackle these impacts.
- CO3** Explain the economic aspects of water and choose the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.
- CO4** Illustrate the recent trends in water management.
- CO5** Understand the implementation hitches and the institutional frameworks.

### TEXT BOOKS

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2. Mollinga P. *et al.* " Integrated Water Resources Management", Water in South Asia Volume I, Sage Publications, 2006.

### REFERENCES

1. Technical Advisory Committee, Background Papers No: 1, 4 and 7, Stockholm, Sweden. 2002.
2. IWRM Guidelines at River Basin Level (UNESCO, 2008).
3. Tutorial on Basic Principles of Integrated Water Resources Management ,CAP-NET. [http://www.pacificwater.org/userfiles/file/IWRM/Toolboxes/introduction%20to%20iwrn/Tutorial\\_text.pdf](http://www.pacificwater.org/userfiles/file/IWRM/Toolboxes/introduction%20to%20iwrn/Tutorial_text.pdf)
4. Pramod R. Bhave, 2011, Water Resources Systems, Narosa Publishers.
5. The 17 Goals, United Nations, <https://sdgs.un.org/goals>.

OEI354

**INTRODUCTION TO INDUSTRIAL AUTOMATION SYSTEMS**

**LT P C  
3 0 0 3**

### COURSE OBJECTIVES:

1. To educate on design of signal conditioning circuits for various applications.
2. To Introduce signal transmission techniques and their design.
3. Study of components used in data acquisition systems interface techniques
4. To educate on the components used in distributed control systems
5. To introduce the communication buses used in automation industries.

## UNIT I INTRODUCTION

9

Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems : Modbus & Profibus

**UNIT II AUTOMATION COMPONENTS 9**

Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.

**UNIT III COMPUTER AIDED MEASUREMENT AND CONTROL SYSTEMS 9**

Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer aided process control software, Computer based data acquisition system, Internet of things (IoT) for plant automation.

**UNIT IV PROGRAMMABLE LOGIC CONTROLLERS 9**

Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.

**UNIT V DISTRIBUTED CONTROL SYSTEM 9**

Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.

**TOTAL:45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content**

**Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 5**

1. Market survey of the recent PLCs and comparison of their features.
2. Summarize the PLC standards
3. Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)
4. Market survey of Industrial Data Networks.

**COURSE OUTCOMES:**

**Students able to**

- CO1** Design a signal conditioning circuits for various application (L3).  
**CO2** Acquire a detail knowledge on data acquisition system interface and DCS system (L2).  
**CO3** Understand the basics and Importance of communication buses in applied automation Engineering (L2).  
**CO4** Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.(L3)  
**CO5** Able to develop a PLC logic for a specific application on real world problem. (L5)

**TEXT BOOKS:**

1. S.K.Singh, "Industrial Instrumentation", Tata Mcgraw Hill, 2nd edition companies,2003.
2. C D Johnson, "Process Control Instrumentation Technology", Prentice Hall India,8th Edition, 2006.
3. E.A.Parr, Newnes ,NewDelhi,"Industrial Control Handbook",3rd Edition, 2000.

**REFERENCES:**

1. John W. Webb and Ronald A. Reis, "Programmable Logic Controllers: Principles and Applications", 5th Edition, Prentice Hall Inc., New Jersey, 2003.
2. Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, McGraw- Hill, New York, 2016.

3. Krishna Kant, "Computer - Based Industrial Control", 2nd Edition, Prentice Hall, New Delhi, 2011.
4. Gary Dunning, Thomson Delmar, "Programmable Logic Controller", Cengage Learning, 3rd Edition, 2005.

**List of Open Source Software/ Learning website:**

1. <https://archive.nptel.ac.in/courses/108/105/108105062/>
2. <https://nptel.ac.in/courses/108105063>
3. <https://www.electrical4u.com/industrial-automation/>
4. <https://realpars.com/what-is-industrial-automation/>
5. <https://automationforum.co/what-is-industrial-automation-2/>

**COs- POs & PSOs MAPPING**

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	2	1	1	-	1	-	1	-	1	1	-	1
CO2	3	1	1	-	1	-	-	1	-	1	-	-	1	-	1
CO3	3	-	1	-	1	-	-	1	-	1	-	-	1	-	1
CO4	3	3	3	3	1	-	-	1	-	1	-	-	1	-	1
CO5	3	3	3	3	1	1	-	1	-	1	-	-	1	-	1
AVg.	3	2.25	2	2.6	1	1	-	1	-	1	-	-	1	-	1

**OCH353**

**ENERGY TECHNOLOGY**

**L T P C**  
**3 0 0 3**

**UNIT I INTRODUCTION**

**8**

Units of energy, conversion factors, general classification of energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, Renewable and non-renewable energy sources and their availability. Prospects of Renewable energy sources

**UNIT II CONVENTIONAL ENERGY**

**8**

Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.

**UNIT III NON-CONVENTIONAL ENERGY**

**10**

Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.

**UNIT IV BIOMASS ENERGY**

**10**

Biomass energy resources, thermo-chemical and biochemical methods of biomass conversion, combustion, gasification, pyrolysis, biogas production, ethanol, fuel cells, alkaline fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, solid polymer electrolyte

fuel cell, magneto hydrodynamic power generation, energy storage routes like thermal energy storage, chemical, mechanical storage and electrical storage.

## UNIT V ENERGY CONSERVATION

9

Energy conservation in chemical process plants, energy audit, energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, steam economy in chemical plants, energy conservation.

**TOTAL : 45 PERIODS**

### OUTCOMES:

On completion of the course, the students will be able to

CO1: Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.

CO2: Students will excel as professionals in the various fields of energy engineering

CO3: Compare different renewable energy technologies and choose the most appropriate based on local conditions.

CO4: Explain the technological basis for harnessing renewable energy sources.

CO5: Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level.

### TEXT BOOKS

1. Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005.
2. Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi, 1984.
3. Bansal, N.K., Kleeman, M. and Meliss, M., Renewable Energy Sources and Conversion Technology, Tata McGraw Hill, 1990.
4. Nagpal, G.R., Power Plant Engineering, Khanna Publishers, 2008.

### REFERENCES

1. Nejat Vezirog, Alternate Energy Sources, IT, McGraw Hill, New York.
2. El. Wakil, Power Plant Technology, Tata McGraw Hill, New York, 2002.
3. Sukhatme. S.P., Solar Energy - Thermal Collection and Storage, Tata McGraw hill, New Delhi, 1981.

### CO's- PO's & PSO's MAPPING

Course Outcomes	Statements	Program Outcomes														
		PO 1	PO 2	PO 3	PO 4	P O5	PO 6	P O 7	PO 8	P O 9	P O 10	PO 11	P O 12	PS O1	PS O2	PS O3
CO1	Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.	2	3	2	3	3	-	-	-	1	1	-	3	1	1	3
CO2	Students will excel as professionals in the various fields of energy engineering	2	3	1	3	3	-	-	-	1	1	-	3	2	1	3
CO3	Compare different renewable energy technologies and choose the most appropriate based on local conditions.	2	2	2	3	3	1	1	-	1	1	-	3	2	1	3
CO4	Explain the technological basis for harnessing	2	2	1	3	3	1	1	1	1	-	1	3	1	1	3

	renewable energy sources.																
CO5	Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level	2	2	1	3	3	1	1	1	1	-	1	3	2	1	3	
OVERALL CO		2	2	1	3	3	2	2	1	1	1	1	3	2	1	3	

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OCH354**

**SURFACE SCIENCE**

**L T P C**  
**3 0 0 3**

**OBJECTIVE:**

- To enable the students to analyze properties of a surfaces and correlate them to structure, chemistry, and physics and surface modification technique.

**UNIT I SURFACE STRUCTURE AND EXPERIMENTAL PROBES 9**

Relevance of surface science to Chemical and Electrochemical Engineering, Heterogeneous Catalysis and Nanoscience; Surface structure and reconstructions, adsorbate structure, Band and Vibrational structure, Importance of UHV techniques, Electronic probes and molecular beams, Scanning probes and diffraction, Qualitative introduction to electronic and vibrational spectroscopy

**UNIT II ADSORPTION, DYNAMICS, THERMODYNAMICS AND KINETICS AT SURFACES 9**

Interactions at the surface, Physisorption, Chemisorption, Diffusion, dynamics and reactions of atoms/molecules on surfaces, Generic reaction mechanism on surfaces, Adsorption isotherms, Kinetics of adsorption, Use of temperature desorption methods

**UNIT III LIQUID INTERFACES 9**

Structure and Thermodynamics of liquid-solid interface, Self-assembled monolayers, Electrified interfaces, Charge transfer at the liquid-solid interfaces, Photoelectrochemical processes, Gratzel cells

**UNIT IV HETEROGENEOUS CATALYSIS 9**

Characterization of heterogeneous catalytic processes, Microscopic kinetics to catalysis, Overview of important heterogeneous catalytic processes: Haber-Bosch, Fischer-Tropsch and Automotive catalysis, Role of promoters and poisons, Bimetallic surfaces, surface functionalization and clusters in catalysis, Role of Sabatier principle in catalyst design, Rate oscillations and spatiotemporal pattern formation

**UNIT V EPITAXIAL GROWTH AND NANO SURFACE-STRUCTURES 9**

Origin of surface forces, Role of stress and strain in epitaxial growth, Energetic and growth modes, Nucleation theory, Nonequilibrium growth modes, MBE, CVD and ablation techniques, Catalytic growth of nanotubes, Etching of surfaces, Formation of nanopillars and nanorods and its application in photoelectrochemical processes, Polymer surfaces and biointerfaces.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- Upon completion of this course, the students can understand, predict and design surface properties based on surface structure. Students would understand the physics and chemistry behind surface phenomena

**TEXT BOOK:**

1. K. W. Kolasinski, "Surface Science: Foundations of catalysis and nanoscience" II Edition, John Wiley & Sons, New York, 2008.

**REFERENCE:**

1. Gabor A. Somorjai and Yimin Li "Introduction to Surface Chemistry and catalysis", II Edition John Wiley & Sons, New York, 2010.

**OFD354****FUNDAMENTALS OF FOOD ENGINEERING****L T P C  
3 0 0 3****OBJECTIVES**

The course aims to

- acquaint and equip the students with different techniques of measurement of engineering properties.
- make the students understand the nature of food constituents in the design of processing equipment

**UNIT I****9**

Engineering properties of food materials: physical, thermal, aerodynamic, mechanical, optical and electromagnetic properties.

**UNIT II****9**

Drying and dehydration: Basic drying theory, heat and mass transfer in drying, drying rate curves, calculation of drying times, dryer efficiencies; classification and selection of dryers; tray, vacuum, osmotic, fluidized bed, pneumatic, rotary, tunnel, trough, bin, belt, microwave, IR, heat pump and freeze dryers; dryers for liquid: Drum or roller dryer, spray dryer and foammat dryers

**UNIT III****9**

Size reduction: Benefits, classification, determination and designation of the fineness of ground material, sieve/screen analysis, principle and mechanisms of comminution of food, Rittinger's, Kick's and Bond's equations, work index, energy utilization; Size reduction equipment: Principal types, crushers (jaw crushers, gyratory, smooth roll), hammer mills and impactors, attrition mills, buhr mill, tumbling mills, tumbling mills, ultra fine grinders, fluid jet pulverizer, colloid mill, cutting machines (slicing, dicing, shredding, pulping)

**UNIT IV****9**

Mixing: theory of solids mixing, criteria of mixer effectiveness and mixing indices, rate of mixing, theory of liquid mixing, power requirement for liquids mixing; Mixing equipment: Mixers for lo.w- or medium-viscosity liquids (paddle agitators, impeller agitators, powder-liquid contacting devices, other mixers), mixers for high viscosity liquids and pastes, mixers for dry powders and particulate solids.

**UNIT V****9**

Mechanical Separations: Theory, centrifugation, liquid-liquid centrifugation, liquid-solid centrifugation, clarifiers, desludging and decanting machine, Filtration: Theory of filtration, rate of filtration, pressure drop during filtration, applications, constant-rate filtration and constant-pressure filtration, derivation of equation; Filtration equipment; plate and frame filter press, rotary filters,



centrifugal filters and air filters, filter aids, Membrane separation: General considerations, materials for membrane construction, ultra-filtration, microfiltration, concentration, polarization, processing variables, membrane fouling, applications of ultra-filtration in food processing, reverse osmosis, mode of operation, and applications; Membrane separation methods, demineralization by electro-dialysis, gel filtration, ion exchange, per-evaporation and osmotic dehydration.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course the students will be able to

CO1 understand the importance of food polymers

CO2 understand the effect of various methods of processing on the structure and texture of food materials

CO3 understand the interaction of food constituents with respect to thermal, electrical properties to develop new technologies for processing and preservation.

**TEXTBOOKS:**

1. R.L. Earle. 2004. Unit Operations in Food Processing. The New Zealand Institute of Food Science & Technology, Nz. Warren L. McCabe, Julian Smith, Peter Harriott. 2004.
2. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA. Christie John Geankoplis. 2003.
3. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed. Prentice-Hall, NY, USA.
4. George D. Saravacos and Athanasios E. Kostaropoulos. 2002. Handbook of Food Processing Equipment. Springer Science+Business Media, New York, USA.
5. J. F. Richardson, J. H. Harker and J. R. Backhurst. 2002. Coulson & Richardson's Chemical Engineering, Vol. 2, Particle Technology and Separation Processes, 5th Ed.

**OFD355**

**FOOD SAFETY AND QUALITY REGULATIONS**

**L T P C  
3 0 0 3**

**OBJECTIVES:**

- To characterize different type of food hazards, physical, chemical and biological in the industry and food service establishments
- To help become skilled in systems for food safety surveillance
- To be aware of the regulatory and statutory bodies in India and the world
- To ensure processed food meets global standards

**UNIT I**

**10**

Introduction to food safety and security: Hygienic design of food plants and equipments, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labeling. Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials. Control of rats, rodents, mice, birds, insects and microbes. Cleaning and Disinfection, ISO 22000 – Importance and Implementation

**UNIT II**

**8**

Food quality: Various Quality attributes of food, Instrumental, chemical and microbial Quality control. Sensory evaluation of food and statistical analysis. Water quality and other utilities.

**UNIT III**

**9**

Critical Quality control point in different stages of production including raw materials and processing materials. Food Quality and Quality control including the HACCP system. Food inspection and Food Law, Risk assessment – microbial risk assessment, dose response and

exposure response modelling, risk management, implementation of food surveillance system to monitor food safety, risk communication

**UNIT IV** **9**  
Indian and global regulations: FAO in India, Technical Cooperation programmes, Bio-security in Food and Agriculture, World Health Organization (WHO), World Animal Health Organization (OIE), International Plant Protection Convention (IPPC)

**UNIT V** **9**  
Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

CO1 Thorough Knowledge of food hazards, physical, chemical and biological in the industry and food service establishments

CO2 Awareness on regulatory and statutory bodies in India and the world

**REFERENCES:**

1. Handbook of food toxicology by S. S. Deshpande, 2002
2. The food safety information handbook by Cynthia A. Robert, 2009
3. Nutritional and safety aspects of food processing by Tannenbaum SR, Marcel Dekker Inc., New York 1979
4. Microbiological safety of Food by Hobbs BC, 1973
5. Food Safety Handbook by Ronald H. Schmidt, Gary E. Rodrick, A John Wiley & Sons Publication, 2003

**OPY353**

**NUTRACEUTICALS**

**L T P C**  
**3 0 0 3**

**OBJECTIVES:**

- To understand the basic concepts of Nutraceuticals and functional food, their chemical nature and methods of extraction.
- To understand the role of Nutraceuticals and functional food in health and disease.

**UNIT I** **INTRODUCTION AND SIGNIFICANCE** **6**  
Introduction to Nutraceuticals and functional foods; importance, history, definition, classification, list of functional foods and their benefits, Phytochemicals, zoochemicals and microbes in food, plants, animals and microbes.

**UNIT II** **PHYTOCHEMICALS AS NUTRACEUTICALS** **11**  
Phytoestrogens in plants; isoflavones; flavonols, polyphenols, tannins, saponins, lignans, lycopene, chitin, caratenoids. Manufacturing practice of selected nutraceuticals such as lycopene, isoflavonoids, glucosamine, phytosterols. Formulation of functional foods containing nutraceuticals - stability, analytical and labelling issues.

**UNIT III** **ASSESSMENT OF ANTIOXIDANT ACTIVITY** **11**  
In vitro and in vivo methods for the assessment of antioxidant activity, Comparison of different *in vitro* methods to evaluate the antioxidant, antioxidant mechanism, Prediction of the antioxidant activity of natural phenolics from electrotopological state indices, Optimising phytochemical release

by process technology; Variation of Antioxidant Activity during technological treatments, new food grade peptidases from plant sources.

**UNIT IV      ROLE IN HEALTH AND DISEASE      11**

The health benefit of - Soy protein, Spirulina, Tea, Olive oil, plant sterols, Broccoli, omega3 fatty acid and eicosanoids. Nutraceuticals and Functional foods in Gastrointestinal disorder, Cancer, CVD, Diabetic Mellitus, HIV and Dental disease; Importance and function of probiotic, prebiotic and synbiotic and their applications, Functional foods and immune competence; role and use in obesity and nervous system disorders.

**UNIT V      SAFETY ISSUES      6**

Health Claims, Adverse effects and toxicity of nutraceuticals, regulations and safety issues International and national.

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**

1. Bisset, Normal Grainger and Max Wich H "Herbal Drugs and Phytopharmaceuticals", 2nd Edition, CRC, 2001.
2. Handbook of Nutraceuticals and Functional Foods: Robert Wildman, CRC, Publications. 2006
3. WEBB, PP, Dietary Supplements and Functional Foods Blackwell Publishing Ltd (United Kingdom), 2006
4. Ikan, Raphael "Natural Products: A Laboratory Guide", 2nd Edition, Academic Press / Elsevier, 2005.

**REFERENCES:**

1. Asian Functional Foods (Nutraceutical Science and Technology) by John Shi (Editor), Fereidoon Shahidi (Editor), Chi-Tang Ho (Editor), CRC Publications, Taylor & Francis, 2007
2. Functional Foods and Nutraceuticals in Cancer Prevention by Ronald Ross Watson (Author), Blackwell Publishing, 2007
3. Marketing Nutrition: Soy, Functional Foods, Biotechnology, and Obesity by Brian Wansink.
4. Functional foods: Concept to Product: Edited by G R Gibson and C M Williams, Wood head Publ., 2000
5. Hanson, James R. "Natural Products: The Secondary Metabolites", Royal Society of Chemistry, 2003.

<b>CO 1</b>	acquire knowledge about the Nutraceuticals and functional foods, their classification and benefits.
<b>CO 2</b>	acquire knowledge of phytochemicals, zoochemicals and microbes in food, plants, animals and microbes
<b>CO 3</b>	attain the knowledge of the manufacturing practices of selected nutraceutical components and formulation considerations of functional foods.
<b>CO 4</b>	distinguish the various <i>In vitro</i> and <i>In vivo</i> assessment of Antioxidant activity of compounds from plant sources.
<b>CO 5</b>	gain information about the health benefits of various functional foods and nutraceuticals in the prevention and treatment of various lifestyle diseases.
<b>CO 6</b>	Attain the knowledge of the regulatory and safety issues of nutraceuticals at national and international level.

### CO's- PO's & PSO's MAPPING

Course outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3											1
CO 2	3											1
CO 3	3					2						
CO 4	3											
CO 5	3					2						1
CO 6	3							2				1

OTT354

### BASICS OF DYEING AND PRINTING

LT P C  
3 0 0 3

**OBJECTIVE:**

- To enable the students to learn about the basics of Pretreatment, dyeing, printing and machinery in textile processing.

**UNIT I INTRODUCTION**

**9**

Impurities present in different fibres, Inspection of grey goods and lot preparation. Shearing,

**UNIT II PRE TREATMENT**

**9**

Desizing-Objective of Desizing- types of Desizing- Objective of Scouring- Mechanism of Scouring- Degumming of Silk, Scouring of wool - Bio Scouring. Bleaching -Objective of Bleaching: Bleaching mechanism of Hydrogen Peroxide, Hypo chlorites. Objective of Mercerizing - Physical and Chemical changes of Mercerizing.

**UNIT III DYEING**

**9**

Dye - Affinity, Substantively, Reactivity, Exhaustion and Fixation. Classification of dyes. Direct dyes: General properties, principles and method of application on cellulosic materials. Reactive dyes – principles and method of application on cellulosic materials hot brand, cold brand.

**UNIT IV PRINTING**

**9**

Definition of printing – Difference between printing and dying- Classification thickeners – Requirements to be good thickener, printing paste Preparation - different styles of printing.

**UNIT V MACHINERIES**

**9**

Fabric Processing - winch, jigger and soft flow machines. Beam dyeing machines: Printing -flat bed screen - Rotary screen. Thermo transfer printing machinery. Garment dyeing machines.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of the course, the students will be able to Understand the

CO1: Basics of grey fabric

CO2: Basics of pre treatment

CO3: Concept of Dyeing

CO4: Concept of Printing

CO5: Machinery in processing industry

**TEXT BOOKS:**

1. Trotman, E.R., Textile Scouring and Bleaching, Charless Griffins, Com. Ltd., London 1990.
2. Shenai V.A. "Technology of Textile Processing Vol. IV" 1998, Sevak Publications, Mumbai.

**REFERENCES:**

1. Trotman E. R., "Dyeing and Chemical Technology of Textile Fibres", Charles Griffin & Co. Ltd., U.K., 1984, ISBN : 0 85264 165 6.
2. Dr. N N Mahapatra., "Textile dyeing", Wood head publishing India, 2018
3. Mathews Kolanjikombil., "Dyeing of Textile substrates III –Fibres, Yarns and Knitted fabrics", Wood head publishing India , 2021
4. Bleaching & Mercerizing – BTRA Silver Jubilee Monograph series
5. Chakraborty, J.N, "Fundamentals and Practices in colouration of Textiles", Wood head Publishing India, 2009, ISBN-13:978-81-908001-4-3.

**CO's- PO's & PSO's MAPPING**

Course Outcomes	Statement	Program Outcome														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
<b>CO1</b>	Classification of fibres and production of natural fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>CO2</b>	Regenerated and synthetic fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>CO3</b>	Yarn spinning	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>CO4</b>	Weaving	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>CO5</b>	Knitting and nonwoven	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>Overall CO</b>		-	-	-	-	-	-	-	2	1	-	1	1	-	1	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**FT3201****FIBRE SCIENCE****L T P C****3 0 0 3****COURSE OBJECTIVES**

- To enable the students to learn about the types of fibre and its properties

**UNIT I INTRODUCTION TO TEXTILE FIBRES****9**

Definition of various forms of textile fibres - staple fibre, filament, bicomponent fibres. Classification of Natural and Man-made fibres, essential and desirable properties of Fibres. Production and cultivation of Natural Fibers: Cotton, Silk, Wool -Physical and chemical structure of the above fibres.

<b>UNIT II</b>	<b>REGENERATED FIBRES</b>	<b>9</b>
Production Sequence of Regenerated Cellulosic fibres: Viscose Rayon, Acetate rayon – High wet modulus fibres: Modal and Lyocel ,Tencel		
<b>UNIT III</b>	<b>SYNTHETIC FIBRES</b>	<b>9</b>
Production Sequence of Synthetic Fibers: polymer-Polyester, Nylon, Acrylic and polypropylene. Mineral fibres: fibre glass ,carbon .Introduction to spin finishes and texturization		
<b>UNIT IV</b>	<b>SPECIALITY FIBRES</b>	<b>9</b>
Properties and end uses of high tenacity and high modulus fibres, high temperature and flame retardant fibres, Chemical resistant fibres		
<b>UNIT V</b>	<b>FUNCTIONAL SPECIALITY FIBRES</b>	<b>9</b>
<b>Properties and end uses</b> : Fibres for medical application – Biodegradable fibres based on PLA ,Super absorbent fibres elastomeric fibres, ultra-fine fibres, electrospun nano fibres, metallic fibres – Gold and Silver coated.		
		<b>TOTAL : 45 PERIODS</b>

#### **COURSE OUTCOMES**

Upon completion of this course, the student would be able to

- Understand the process sequence of various fibres
- Understand the properties of various fibres

#### **TEXT BOOKS:**

1. Morton W. E., and Hearle J. W. S., “Physical Properties of Textile Fibres”, The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95
2. Meredith R., and Hearle J. W. S., “Physical Methods of Investigation of Textiles”, Wiley Publication, New York, 1989, ISBN: B00JCV6ZWU | ISBN-13:
3. Mukhopadhyay S. K., “Advances in Fibre Science”, The Textile Institute,1992, ISBN: 1870812379

#### **REFERENCES:**

1. Meredith R., “Mechanical Properties of Textile Fibres”, North Holland, Amsterdam, 1986, ISBN: 1114790699, ISBN-13: 9781114790698
2. Hearle J. W. S., Lomas B., and Cooke W. D., “Atlas of Fibre Fracture and Damage to Textiles”, The Textile Institute, 2<sup>nd</sup> Edition, 1998, ISBN: 1855733196.
3. Raheel M. (ed.), “Modern Textile Characterization Methods”, Marcel Dekker, 1995, ISBN:0824794737
4. Mukhopadhyay. S. K., “The Structure and Properties of Typical Melt Spun Fibres”, Textile Progress, Vol. 18, No. 4, Textile Institute, 1989, ISBN: 1870812115
5. Hearle J.W.S., “Polymers and Their Properties: Fundamentals of Structures and Mechanics Vol 1”, Ellis Horwood, England, 1982, ISBN: 047027302X | ISBN-13: 9780470273029 36



5. Pradip V.Mehta, "An Introduction to Quality Control for the Apparel Industry", J.S.N. Internationals, 1992.

### CO's- PO's & PSO's MAPPING

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	1	1	1	-	2	-	1	1	-	2	3	1	2	3	1	3
2	2	2	1	1	1	-	1	1	-	2	2	1	2	2	1	2
3	1	1	1	1	1	1	1	1	-	1	2	1	1	3	1	3
4	2	1	1	1	2	2	2	1	1	2	3	1	2	3	1	3
5	2	2	1	1	1	1	2	1	-	2	2	1	2	2	1	2
Avg	1.6	1.2	1	0.8	1.4	0.8	1.4	1	0.2	1.8	2.4	1	1.8	2.6	1	2.6

OPE353

INDUSTRIAL SAFETY

L T P C  
3 0 0 3

#### OBJECTIVES:

- To educate about the health hazards and the safety measures to be followed in the industrial environment.
- Describe industrial legislations (Factories Acts, Workmen's Compensation and other laws) enacted for the protection of employees health at work settings
- Describe methods of prevention and control of Occupational Health diseases, accidents / emergencies and other hazards

#### UNIT I INTRODUCTION

9

Need for developing Environment, Health and Safety systems in work places - Accident Case Studies - Status and relationship of Acts - Regulations and Codes of Practice - Role of trade union safety representatives. International initiatives - Ergonomics and work place.

#### UNIT II OCCUPATIONAL HEALTH AND HYGIENE

9

Definition of the term occupational health and hygiene - Categories of health hazards - Exposure pathways and human responses to hazardous and toxic substances - Advantages and limitations of environmental monitoring and occupational exposure limits - Hierarchy of control measures for occupational health risks - Role of personal protective equipment and the selection criteria - Effects on humans - control methods and reduction strategies for noise, radiation and excessive stress.

#### UNIT III WORKPLACE SAFETY AND SAFETY SYSTEMS

9

Features of Satisfactory and Safe design of work premises – good housekeeping - lighting and colour, Ventilation and Heat Control – Electrical Safety – Fire Safety – Safe Systems of work for manual handling operations – Machine guarding – Working at different levels – Process and System Safety.



**UNIT IV HAZARDS AND RISK MANAGEMENT 9**

Safety appraisal - analysis and control techniques – plant safety inspection – Accident investigation - Analysis and Reporting – Hazard and Risk Management Techniques – major accident hazard control – Onsite and Offsite emergency Plans.

**UNIT V ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT 9**

Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and methods of its effective implementation and review – Elements of Management Principles – Education and Training – Employee Participation.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

After completion of this course, the student is expected to be able to:

- Describe, with example, the common work-related diseases and accidents in occupational setting
- Name essential members of the Occupational Health team
- What roles can a community health practitioners play in an Occupational setting to ensure the protection, promotion and maintenance of the health of the employee

**OPE354 UNIT OPERATIONS IN PETRO CHEMICAL INDUSTRIES L T P C  
3 0 0 3**

**OBJECTIVES:**

- To impart to the student basic knowledge on fluid mechanics, mechanical operations, heat transfer operations and mass transfer operations.

**UNIT I FLUID MECHANICS CONCEPTS 9**

Fluid definition and classification of fluids, types of fluids, Rheological behaviour of fluids & Newton's Law of viscosity. Fluid statics-Pascal's law, Hydrostatic equilibrium, Barometric equation and pressure measurement(problems),Basic equations of fluid flow - Continuity equation, Euler's equation and Bernoulli equation; Types of flow - laminar and turbulent; Reynolds experiment; Flow through circular and non-circular conduits - Hagen Poiseuille equation (no derivation). Flow through stagnant fluids – theory of Settling and Sedimentation – Equipment (cyclones, thickeners) Conceptual numericals.

**UNIT II FLOW MEASUREMENTS & MECHANICAL OPERATIONS 9**

Different types of flow measuring devices (Orifice meter, Venturimeter, Rotameter) with derivations, flow measurements –. Pumps – types of pumps (Centrifugal & Reciprocating pumps), Energy calculations and characteristics of pumps. Size reduction–characteristics of comminute products, sieve analysis, Properties and handling of particulate solids – characterization of solid particles, average particle size, screen analysis- Conceptual numerical of differential and cumulative analysis. Size reduction, crushing laws, working principle of ball mill. Filtration & types, filtration equipments (plate and frame, rotary drum). Conceptual numericals.

**UNIT III CONDUCTIVE & CONVECTIVE HEAT TRANSFER 9**

Modes of heat transfer; Conduction – steady state heat conduction through unilayer and multilayer walls, cylinders; Insulation, critical thickness of insulation. Convection- Forced and Natural convection, principles of heat transfer co-efficient, log mean temperature difference, individual and

overall heat transfer co-efficient, fouling factor; Condensation – film wise and drop wise (no derivation). Heat transfer equipments – double pipe heat exchanger, shell and tube heat exchanger (with working principle and construction with applications).

#### **UNIT IV BASICS OF MASS TRANSFER**

**9**

Diffusion-Fick's law of diffusion. Types of diffusion. Steady state molecular diffusion in fluids at rest and laminar flow (stagnant / unidirection and bi direction). Measurement of diffusivity, Mass transfer coefficients and their correlations. Conceptual numerical.

#### **UNIT V MASS TRANSFER OPERATIONS**

**9**

Basic concepts of Liquid-liquid extraction – equilibrium, stage type extractors (belt extraction and basket extraction). Distillation – Methods of distillation, distillation of binary mixtures using McCabe Thiele method. Drying- drying operations, batch and continuous drying. Conceptual numerical.

**TOTAL: 45 PERIODS**

#### **Course Outcomes:**

At the end of the course the student will be able to:

- State and describe the nature and properties of the fluids.
- Study the different flow measuring instruments, the principles of various size reductions, conveying equipment's, sedimentation and mixing tanks.
- Comprehend the laws governing the heat and mass transfer operations to solve the problems.
- Design the heat transfer equipment suitable for specific requirement.

#### **TEXTBOOK(S)**

1. Unit operations in Chemical Engineering Warren L. McCabe, Julian C. Smith & Peter Harriot McGraw-Hill Education (India) Edition 2014
2. Fluid Mechanics K L Kumar S Chand & Company Ltd 2008
3. Introduction to Chemical Engineering Badger W.I. and Banchemo, J.T., Tata McGraw Hill New York 1997

#### **REFERENCE BOOKS**

1. Principles of Unit Operations Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B. Anderson John Wiley & Sons 2nd edition 2008
2. Unit Operations of Chemical Engineering, Vol I &II Chattopadhyaya Khanna Publishers, Delhi-6 1996
3. Heat Transfer J P Holman McGraw Hill International Ed

**OPT352**

**PROGRESS THROUGH KNOWLEDGE**

**PLASTIC MATERIALS FOR ENGINEERS**

**L T P C  
3 0 0 3**

#### **COURSE OBJECTIVES**

- Understand the advantages, disadvantages and general classification of plastic materials
- To know the manufacturing, sources, and applications of engineering thermoplastics
- Understand the basics as well as the advanced applications of various plastic materials in the industry
- To understand the preparation methods of thermosetting materials
- Select suitable specialty plastics for different end applications

**UNIT I INTRODUCTION TO PLASTIC MATERIALS 9**

Introduction to Plastics – Brief history of plastics, advantages and disadvantages, thermoplastic and thermosetting behavior, amorphous polymers, crystalline polymers and cross-linked structures. General purpose thermoplastics/ Commodity plastics: manufacture, structure, properties and applications of polyethylene (PE), cross-linked PE, chlorinated PE, polypropylene, polyvinyl chloride-compounding, formulation, polypropylene (PP)

**UNIT II ENGINEERING THERMOPLASTICS AND APPLICATIONS 9**

Engineering thermoplastics – Aliphatic polyamides: structure, properties, manufacture and applications of Nylon 6, Nylon 66. Polyesters: manufacture, structure, properties and uses of PET, PBT. Manufacture, structure, properties and uses of Polycarbonates, acetal resins, polyimides, PMMA, polyphenylene oxide, thermoplastic polyurethane (PU)

**UNIT III THERMOSETTING PLASTICS 9**

Thermosetting Plastics – Manufacture, curing, moulding powder, laminates, properties and uses of phenol formaldehyde resins, urea formaldehyde, melamine formaldehyde, unsaturated polyester resin, epoxy resin, silicone resins, polyurethane resins.

**UNIT IV MISCELLANEOUS PLASTICS FOR END APPLICATIONS 9**

Miscellaneous plastics- Manufacture, properties and uses of polystyrene, HIPS, ABS, SAN, poly(tetrafluoroethylene) (PTFE), TFE and copolymers, PVDF, PVA, poly (vinyl acetate), poly (vinyl carbazole), cellulose acetate, PEEK, High energy absorbing polymers, super absorbent polymers-their synthesis, properties and applications

**UNIT V PLASTICS MATERIALS FOR BIOMEDICAL APPLICATIONS 9**

Sources, raw materials, methods of manufacturing, properties and applications of bio-based polymers- poly lactic acid (PLA), poly hydroxy alkanooates (PHA), PBAT, bioplastics- bio-PE, bio-PP, bio-PET, polymers for biomedical applications

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

- To study the importance, advantages and classification of plastic materials
- Summarize the raw materials, sources, production, properties and applications of various engineering thermoplastics
- To understand the application of polyamides, polyesters and other engineering thermoplastics, thermosetting resins
- Know the manufacture, properties and uses of thermosetting resins based on polyester, epoxy, silicone and PU
- To understand the engineering applications of various polymers in miscellaneous areas and applications of different biopolymers

**REFERENCES**

1. Marianne Gilbert (Ed.), Brydson's Plastics Materials, 8<sup>th</sup> Edn., Elsevier (2017).
2. J.A.Brydson, Plastics Materials, 7<sup>th</sup> Edn., Butterworth Heinemann (1999).
3. Manas Chanda, Salil K. Roy, Plastics Technology Handbook, 4<sup>th</sup> Edn., CRC press (2006).
4. A. Brent Strong, Plastics: Materials and Processing, 3<sup>rd</sup> Edn., Pearson Prentice Hall (2006).
5. Olagoke Olabisi, Kolapo Adewale (Eds.), Handbook of Thermoplastics 2<sup>nd</sup> Edn., CRC press(2016).
6. Charles A. Harper, Modern Plastics Handbook, McGraw-Hill, New York, 1999.
7. H. Dominighaus, Plastics for Engineers, Hanser Publishers, Munich, 1988.

**COURSE OBJECTIVES**

- To understand the relevance of standards and specifications as well as the specimen preparation for polymer testing.
- To study the mechanical properties and testing of polymer materials and their structural property relationships.
- To understand the thermal properties of polymers and their testing methods.
- To gain knowledge on the electrical and optical properties of polymers and their testing methods.
- To study about the environmental effects and prevent polymer degradation.

**UNIT I INTRODUCTION TO CHARACTERIZATION AND TESTING OF POLYMERS 9**

Introduction- Standard organizations: BIS, ASTM, ISO, BS, DIN etc. Standards and specifications. Importance of standards in the quality control of polymers and polymer products. Preparation of test pieces, conditioning and test atmospheres. Tests on elastomers: processability parameters of rubbers – plasticity, Mooney viscosity, scorch time, cure time, cure rate index, Processability tests carried out on thermoplastics and thermosets: MFI, cup flow index, gel time, bulk density, bulk factor.

**UNIT II MECHANICAL PROPERTIES 9**

Mechanical properties: Tensile, compression, flexural, shear, tear strength, hardness, impact strength, resilience, abrasion resistance, creep and stress relaxation, compression set, dynamic fatigue, ageing properties, Basic concepts of stress and strain, short term tests: Viscoelastic behavior (simple models: Kelvin model for creep and stress relaxation, Maxwell-Voigt model, strain recovery and dynamic response), Effect of structure and composition on mechanical properties, Behavior of reinforced polymers

**UNIT III THERMAL RHEOLOGICAL PROPERTIES 9**

Thermal properties: Transition temperatures, specific heat, thermal conductivity, co-efficient of thermal expansion, heat deflection temperature, Vicat softening point, shrinkage, brittleness temperature, thermal stability and flammability. Product testing: Plastic films, sheeting, pipes, laminates, foams, containers, cables and tubes.

**UNIT IV ELECTRICAL AND OPTICAL PROPERTIES 9**

Electrical properties: volume and surface resistivity, dielectric strength, dielectric constant and power factor, arc resistance, tracking resistance, dielectric behavior of polymers (dielectric co-efficient, dielectric polarization), dissipation factor and its importance. Optical properties: transparency, refractive index, haze, gloss, clarity, birefringence.

**UNIT V ENVIRONMENTAL AND CHEMICAL RESISTANCE 9**

Environmental stress crack resistance (ESCR), water absorption, weathering, aging, ozone resistance, permeability and adhesion. Tests for chemical resistance. Acids, alkalies, Flammability tests- oxygen index test.

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

- Understand the relevance of standards and specifications.
- Summarize the various test methods for evaluating the mechanical properties of the polymers.
- To know the thermal, electrical & optical properties of polymers.

- Identify various techniques used for characterizing polymers.
- Distinguish the processability tests used for thermoplastics, thermosets and elastomers.

## REFERENCES

1. F.Majewska, H.Zowall, Handbook of analysis of synthetic polymers and plastics, Ellis Horwood Limited Publisher 1977.
2. J.F.Rabek, Experimental Methods in Polymer Chemistry, John Wiley and Sons 1980.
3. R.P.Brown, Plastic test methods, 2<sup>nd</sup> Edn., Harland, Longman Scientific, 1981.
4. A. B. Mathur, I. S. Bharadwaj, Testing and Evaluation of Plastics, Allied Publishers Pvt. Ltd., New Delhi, 2003.
5. Vishu Shah, Handbook of Plastic Testing Technology, 3<sup>rd</sup> Edn., John Wiley & Sons 2007.
6. S. K. Nayak, S. N. Yadav, S. Mohanty, Fundamentals of Plastic Testing, Springer, 2010.

**OEC353**

**VLSI DESIGN**

**L T P C  
3 0 0 3**

### OBJECTIVES:

- Understand the fundamentals of IC technology components and their characteristics.
- Understand combinational logic circuits and design principles.
- Understand sequential logic circuits and clocking strategies.
- Understand Interconnects and Memory Architecture.
- Understand the design of arithmetic building blocks

### UNIT I MOS TRANSISTOR PRINCIPLES

**9**

MOS logic families (NMOS and CMOS), Ideal and Non Ideal IV Characteristics, CMOS devices. MOS(FET) Transistor DC transfer Characteristics ,small signal analysis of MOSFET.

### UNIT II COMBINATIONAL LOGIC CIRCUITS

**9**

Propagation Delays, stick diagram, Layout diagrams, Examples of combinational logic design, Elmore's constant, Static Logic Gates, Dynamic Logic Gates, Pass Transistor Logic, Power Dissipation.

### UNIT III SEQUENTIAL LOGIC CIRCUITS AND CLOCKING STRATEGIES

**9**

Static Latches and Registers, Dynamic Latches and Registers, Pipelines, Timing classification of Digital Systems, Synchronous Design, Self-Timed Circuit Design .

### UNIT IV INTERCONNECT, MEMORY ARCHITECTURE

**9**

Interconnect Parameters – Capacitance, Resistance, and Inductance, Logic Implementation using Programmable Devices (ROM, PLA, FPGA), Memory Architecture and Building Blocks.

### UNIT V DESIGN OF ARITHMETIC BUILDING BLOCKS

**9**

Arithmetic Building Blocks: Data Paths, Adders-Ripple Carry Adder, Carry-Bypass Adder, Carry Select Adder, Carry-Look Ahead Adder, Multipliers, Barrel Shifter, power and speed tradeoffs.

**TOTAL: 45 PERIODS**

### OUTCOMES:

**Upon successful completion of the course the student will be able to**

**CO1:** Understand the working principle and characteristics of MOSFET

- CO2:** Design Combinational Logic Circuits  
**CO3:** Design Sequential Logic Circuits and Clocking systems  
**CO4:** Understand Memory architecture and interconnects  
**CO5:** Design of arithmetic building blocks.

**TEXTBOOKS**

1. Jan D Rabaey, Anantha Chandrakasan, "Digital Integrated Circuits: A Design Perspective", PHI, 2016.(Units II, III IV and V).
2. Neil H E Weste, Kamran Eshraghian, "Principles of CMOS VLSI Design: A System Perspective," Addison Wesley, 2009.( Units - I).

**REFERENCES**

1. D.A. Hodges and H.G. Jackson, Analysis and Design of Digital Integrated Circuits, International Student Edition, McGraw Hill 1983
2. P. Rashinkar, Paterson and L. Singh, "System-on-a-Chip Verification-Methodology and Techniques", Kluwer Academic Publishers,2001
3. Samiha Mourad and Yervant Zorian, "Principles of Testing Electronic Systems", Wiley 2000
4. M. Bushnell and V. D. Agarwal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers,2000

**CO's- PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	2	1	3	-	-	-	-	2	3	3	3	3
2	3	3	2	2	1	-	-	-	-	-	-	2	3	3	3
3	3	-	3	2	1	2	-	-	-	-	3	2	3	2	3
4	3	3	2	2	2	-	-	-	-	-	-	1	3	3	2
5	2	-	3	2	2	1	-	-	-	-	1	1	3	2	2
CO	3	3	2	2	1	2	-	-	-	-	2	2	3	3	3

**CBM370**

**WEARABLE DEVICES**

**L T P C**  
**3 0 0 3**

**OBJECTIVES:**

The student should be made to:

- To know the hardware requirement of wearable systems
- To understand the communication and security aspects in the wearable devices
- To know the applications of wearable devices in the field of medicine

**UNIT I INTRODUCTION TO WEARABLE SYSTEMS AND SENSORS 9**

Wearable Systems- Introduction, Need for Wearable Systems, Drawbacks of Conventional Systems for Wearable Monitoring, Applications of Wearable Systems, Types of Wearable Systems, Components of wearable Systems. Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Impedance plethysmography, Wearable ground reaction force sensor.

**UNIT II SIGNAL PROCESSING AND ENERGY HARVESTING FOR WEARABLE DEVICES 9**

Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, sampling frequency for reduced energy consumption, Rejection of irrelevant

information. Power Requirements- Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.

**UNIT III WIRELESS HEALTH SYSTEMS 9**

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication Techniques.

**UNIT IV SMART TEXTILE 9**

Introduction to smart textile- Passive smart textile, active smart textile. Fabrication Techniques- Conductive Fibres, Treated Conductive Fibres, Conductive Fabrics, Conductive Inks. Case study- smart fabric for monitoring biological parameters - ECG, respiration.

**UNIT V APPLICATIONS OF WEARABLE SYSTEMS 9**

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, neural recording, Gait analysis, Sports Medicine.

**OUTCOMES:**

On successful completion of this course, the student will be able to

- CO1: Describe the concepts of wearable system.
- CO2: Explain the energy harvestings in wearable device.
- CO3: Use the concepts of BAN in health care.
- CO4: Illustrate the concept of smart textile
- CO5: Compare the various wearable devices in healthcare system

**TOTAL: 45 PERIODS**

**TEXT BOOKS**

1. Annalisa Bonfiglio and Danilo De Rossi, Wearable Monitoring Systems, Springer, 2011
2. Zhang and Yuan-Ting, Wearable Medical Sensors and Systems, Springer, 2013
3. Edward Sazonov and Micheal R Neuman, Wearable Sensors: Fundamentals, Implementation and Applications, Elsevier, 2014
4. Mehmet R. Yuce and JamilY.Khan, Wireless Body Area Networks Technology, Implementation applications, Pan Stanford Publishing Pte.Ltd, Singapore, 2012

**REFERENCES**

1. Sandeep K.S, Gupta, Tridib Mukherjee and Krishna Kumar Venkatasubramanian, Body Area Networks Safety, Security, and Sustainability, Cambridge University Press, 2013.
2. Guang-Zhong Yang, Body Sensor Networks, Springer, 2006.

**COs- POs & PSOs MAPPING**

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	2			1					1		1
2	3	2	1	1	2			1					1		1
3	3	2	1	1	2			1					1		1
4	3	2	1	1	2			1					1		1
5	3	2	1	1	2			1					1		1
AVg.															

**Preamble:**

1. To study the applications of information technology in health care management.
2. This course provides knowledge on resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine.

**UNIT I INTRODUCTION TO MEDICAL INFORMATICS 9**

Introduction - Structure of Medical Informatics –Internet and Medicine -Security issues , Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, Health Informatics – Medical Informatics, Bioinformatics

**UNIT II COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING 9**

Automated clinical laboratories-Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System - Computer assisted medical imaging- nuclear medicine, ultrasound imaging, computed X-ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance.

**UNIT III COMPUTERISED PATIENT RECORD 9**

Introduction - conventional patient record, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for patients.

**UNIT IV COMPUTER ASSISTED MEDICAL DECISION-MAKING 9**

Neuro computers and Artificial Neural Networks application, Expert system-General model of CMD, Computer–assisted decision support system-production rule system cognitive model, semantic networks, decisions analysis inclinical medicine-computers in the care of critically ill patients, Computer aids for the handicapped.

**UNIT V RECENT TRENDS IN MEDICAL INFORMATICS 9**

Virtual reality applications in medicine, Virtual endoscopy, Computer assisted surgery, Surgical simulation, Telemedicine - Tele surgery, Computer assisted patient education and health- Medical education and healthcare information, computer assisted instruction in medicine.

**TOTAL : 45 PERIODS****Course Outcomes:****Upon completion of the course, students will be able to:**

1. Explain the structure and functional capabilities of Hospital Information System.
2. Describe the need of computers in medical imaging and automated clinical laboratory.
3. Articulate the functioning of information storage and retrieval in computerized patient record system.
4. Apply the suitable decision support system for automated clinical diagnosis.
5. Discuss the application of virtual reality and telehealth technology in medical industry.

**TEXT BOOKS:**

1. Mohan Bansal, "Medical informatics", Tata McGraw Hill Publishing Ltd, 2003.
2. R.D.Lele, "Computers in medicine progress in medical informatics", Tata McGraw Hill,2005

**REFERENCES:**

1. Kathryn J. Hannah, Marion J Ball, "Health Informatics", 3<sup>rd</sup> Edition, Springer, 2006.





5. To produce the biocompost from wastes
6. To apply the theoretical knowledge for the development of value added products

#### TEXT BOOKS

1. Antoine P. T., (2017) "Biofuels from Food Waste Applications of Saccharification Using Fungal Solid State Fermentation", CRC press
2. Joseph C A., (2019) "Anaerobic Waste-Wastewater Treatment and Biogas Plants-A Practical Handbook", CRC Press,

#### REFERENCE BOOKS

1. Palmiro P. and Oscar F.D'Urso, (2016) 'Biotransformation of Agricultural Waste and By-Products', The Food, Feed, Fibre, Fuel (4F) Economy, Elsevier
2. Kaur Brar S., Gurpreet Singh D. and Carlos R.S., (Eds), (2014)'Biotransformation of Waste Biomass into High Value Biochemicals', Springer.
3. Keikhosro K, Editor, (2015) 'Lignocellulose-Based Bioproducts', Springer.
4. John P, (2014) 'Waste Management Practices-Municipal, Hazardous, and Industrial', Second Edition, CRC Press, 2014

**OBT356** **LIFESTYLE DISEASES** **L T P C**  
**3 0 0 3**

**UNIT I INTRODUCTION** **9**  
Lifestyle diseases – Definition ; Risk factors – Eating, smoking, drinking, stress, physical activity, illicit drug use ; Obesity, diabetes, cardiovascular diseases, respiratory diseases, cancer; Prevention – Diet and exercise.

**UNIT II CANCER** **9**  
Types - Lung cancer, Mouth cancer, Skin cancer, Cervical cancer, Carcinoma oesophagus; Causes Tobacco usage, Diagnosis – Biomarkers, Treatment

**UNIT III CARDIOVASCULAR DISEASES** **9**  
Coronary atherosclerosis – Coronary artery disease; Causes -Fat and lipids, Alcohol abuse -- Diagnosis - Electrocardiograph, echocardiograph, Treatment, Exercise and Cardiac rehabilitation

**UNIT IV DIABETES AND OBESITY** **9**  
Types of Diabetes mellitus; Blood glucose regulation; Complications of diabetes – Paediatric and adolescent obesity – Weight control and BMI

**UNIT V RESPIRATORY DISEASES** **9**  
Chronic lung disease, Asthma, COPD; Causes - Breathing pattern (Nasal vs mouth), Smoking – Diagnosis - Pulmonary function testing

**TOTAL: 45 PERIODS**

#### TEXT BOOKS:

1. R.Kumar&Meenal Kumar, "Guide to Prevention of Lifestyle Diseases", Deep & Deep Publications, 2003
2. Gary Eggar et al, "Lifestyle Medicine", 3rd Edition, Academic Press, 2017

#### REFERENCES:

1. James M.R, "Lifestyle Medicine", 2nd Edition, CRC Press, 2013
2. Akira Miyazaki et al, "New Frontiers in Lifestyle-Related Disease", Springer, 2008

**COURSE OBJECTIVES**

The aim of this course is to

1. Create higher standard of knowledge on healthcare system and services
2. Prioritize advanced technologies for the diagnosis and treatment of various diseases

**UNIT I PUBLIC HEALTH 9**

Definition and Concept of Public Health, Historical aspects of Public Health, Changing Concepts of Public Health, Public Health versus Medical Care, Unique Features of Public Health, Determinants of Health (Social, Economic, Cultural, Environmental, Education, Genetics, Food and Nutrition). Indicators of health, Burden of disease, Role of different disciplines in Public Health.

**UNIT II CLINICAL DISEASES 9**

Communicable diseases: Chickenpox / Shingles, COVID-19, Tuberculosis, Hepatitis B, Hepatitis C, HIV / AIDS, Influenza, Swine flu. Non Communicable diseases: Diabetes mellitus, atherosclerosis, fatty liver, Obesity, Cancer

**UNIT III VACCINOLOGY 9**

History of Vaccinology, conventional approaches to vaccine development, live attenuated and killed vaccines, adjuvants, quality control, preservation and monitoring of microorganisms in seed lot systems. Instruments related to monitoring of temperature, sterilization, environment.

**UNIT IV OUTPATIENT & IN PATIENT SERVICES 9**

Radiotherapy, Nuclear medicine, surgical units, OT Medical units, G & Obs. units Pediatric, neonatal units, Critical care units, Physical medicine & Rehabilitation, Neurology, Gastroenterology, Endoscopy, Pulmonology, Cardiology.

**UNIT V BASICS OF IMAGING MODALITIES 9**

Diagnostic X-rays - Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography – Different types of biotelemetry systems.

**TOTAL: 45 PERIODS****TEXT BOOKS**

1. Joseph J.carr and John M. Brown, Introduction to Biomedical Equipment Technology, John Wiley and sons, New York, 4th Edition, 2012.
2. Thomas M. Devlin.Textbook of Biochemistry with clinical correlations. Wiley Liss Publishers
3. The Vaccine Book (2nd Ed.), Rafi Ahmed, Roy M. Anderson et. al.Editor(s): Barry R.Bloom, PaulHenri Lambert, Academic Press, 2016, Pages xxi-xxiv.

**REFERENCE BOOKS**

1. Suh, Sang, Gurupur, Varadraj P., Tanik, Murat M., Health Care Systems, Technology and Techniques, Springer, 1st Edition, 2011
2. Burtis & Ashwood W.B. Tietz Textbook of Clinical chemistry. Saunders Company
3. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker

## VERTICAL 1: FINTECH AND BLOCK CHAIN

CMG331

FINANCIAL MANAGEMENT

L T P C  
3 0 0 3

### LEARNING OBJECTIVES

1. To acquire the knowledge of the decision areas in finance.
2. To learn the various sources of Finance
3. To describe about capital budgeting and cost of capital.
4. To discuss on how to construct a robust capital structure and dividend policy
5. To develop an understanding of tools on Working Capital Management.

### UNIT I INTRODUCTION TO FINANCIAL MANGEMENT 9

Definition and Scope of Finance Functions - Objectives of Financial Management - Profit Maximization and Wealth Maximization- Time Value of money- Risk and return concepts.

### UNIT II .SOURCES OF FINANCE 9

Long term sources of Finance -Equity Shares – Debentures - Preferred Stock – Features – Merits and Demerits. Short term sources - Bank Sources, Trade Credit, Overdrafts, Commercial Papers, Certificate of Deposits, Money market mutual funds etc

### UNIT III INVESTMENT DECISIONS: 9

Investment Decisions: capital budgeting – Need and Importance – Techniques of Capital Budgeting -- Payback -ARR – NPV – IRR –Profitability Index.  
Cost of Capital - Cost of Specific Sources of Capital - Equity -Preferred Stock- Debt - Reserves - Concept and measurement of cost of capital - Weighted Average Cost of Capital.

### UNIT IVFINANCING AND DIVIDEND DECISION 9

Operating Leverage and Financial Leverage- EBIT-EPS analysis. Capital Structure – determinants of Capital structure- Designing an Optimum capital structure .  
Dividend policy - Aspects of dividend policy - practical consideration - forms of dividend policy - - Determinants of Dividend Policy.

### UNIT V WORKING CAPITAL DECISION 9

Working Capital Management: Working Capital Management - concepts - importance - Determinants of Working capital. Cash Management: Motives for holding cash – Objectives and Strategies of Cash Management. Receivables Management: Objectives - Credit policies.

**TOTAL : 45 PERIODS**

### TEXT BOOKS

1. M.Y. Khan and P.K.Jain Financial management, Text, Tata McGraw Hill
2. M. Pandey Financial Management, Vikas Publishing House Pvt. Ltd

### REFERENCES .

1. James C. Vanhorne –Fundamentals of Financial Management– PHI Learning,.
2. Prasanna Chandra, Financial Management,
3. Srivatsava, Mishra, Financial Management, Oxford University Press, 2011

**OBJECTIVES:**

1. Describe the investment environment in which investment decisions are taken.
2. Explain how to Value bonds and equities
3. Explain the various approaches to value securities
4. Describe how to create efficient portfolios through diversification
5. Discuss the mechanism of investor protection in India.

**UNIT I THE INVESTMENT ENVIRONMENT 9**

The investment decision process, Types of Investments - Commodities, Real Estate and Financial Assets, the Indian securities market, the market participants and trading of securities, security market indices, sources of financial information, Concept of return and risk, Impact of Taxes and Inflation on return.

**UNIT II FIXED INCOME SECURITIES 9**

Bond features, types of bonds, estimating bond yields, Bond Valuation types of bond risks, default risk and credit rating.

**UNIT III APPROACHES TO EQUITY ANALYSIS 9**

Introduction to Fundamental Analysis, Technical Analysis and Efficient Market Hypothesis, dividend capitalisation models, and price-earnings multiple approach to equity valuation.

**UNIT IV PORTFOLIO ANALYSIS AND FINANCIAL DERIVATIVES 9**

Portfolio and Diversification, Portfolio Risk and Return; Mutual Funds; Introduction to Financial Derivatives; Financial Derivatives Markets in India

**UNIT V INVESTOR PROTECTION 9**

Role of SEBI and stock exchanges in investor protection; Investor grievances and their redressal system, insider trading, investors' awareness and activism

**TOTAL : 45 PERIODS****REFERENCES**

1. Charles P. Jones, Gerald R. Jensen. Investments: analysis and management. Wiley, 14<sup>TH</sup> Edition, 2019.
2. Chandra, Prasanna. Investment analysis and portfolio management. McGraw-hill education, 5<sup>th</sup>, Edition, 2017.
3. Rustagi, R. P. Investment Management Theory and Practice. Sultan Chand & Sons, 2021.
4. Zvi Bodie, Alex Kane, Alan J Marcus, Pitab Mohanty, Investments, McGraw Hill Education (India), 11 Edition (SIE), 2019

**OBJECTIVES**

- Understand the Banking system in India
- Grasp how banks raise their sources and how they deploy it
- Understand the development in banking technology
- Understand the financial services in India
- Understand the insurance Industry in India

**UNIT I INTRODUCTION TO INDIAN BANKING SYSTEM****9**

Overview of Banking system – Structure – Functions – Banking system in India - Key Regulations in Indian Banking sector – RBI. Relationship between Banker and Customer - Retail & Wholesale Banking – types of Accounts - Opening and operation of Accounts.

**UNIT II MANAGING BANK FUNDS/ PRODUCTS****9**

Liquid Assets - Investment in securities - Advances - Loans. Negotiable Instruments – Cheques, Bills of Exchange & Promissory Notes. Designing deposit schemes – Asset and Liability Management – NPA's – Current issues on NPA's – M&A's of banks into securities market

**UNIT III DEVELOPMENT IN BANKING TECHNOLOGY****9**

Payment system in India – paper based – e payment – electronic banking – plastic money – e-money – forecasting of cash demand at ATM's – The Information Technology Act, 2000 in India – RBI's Financial Sector Technology vision document – security threats in e-banking & RBI's Initiative.

**UNIT IV FINANCIAL SERVICES****9**

Introduction – Need for Financial Services – Financial Services Market in India – NBFC – Leasing and Hire Purchase – mutual funds. Venture Capital Financing – Bill discounting – factoring – Merchant Banking

**UNIT V INSURANCE****9**

Insurance – Concept - Need - History of Insurance industry in India. Insurance Act, 1938 – IRDA – Regulations – Life Insurance - Annuities and Unit Linked Policies - Lapse of the Policy – revival – settlement of claim

**TOTAL : 45 PERIODS****REFERENCES :**

1. Padmalatha Suresh and Justin Paul, "Management of Banking and Financial Services, Pearson, Delhi, 2017.
2. Meera Sharma, "Management of Financial Institutions – with emphasis on Bank and Risk Management", PHI Learning Pvt. Ltd., New Delhi 2010
3. Peter S. Rose and Sylvia C. and Hudgins, "Bank Management and Financial Services", Tata McGraw Hill, New Delhi, 2017

**UNIT I INTRODUCTION TO BLOCKCHAIN****9**

Blockchain: The growth of blockchain technology - Distributed systems - The history of blockchain and Bitcoin - Features of a blockchain - Types of blockchain, Consensus: Consensus mechanism - Types of consensus mechanisms - Consensus in blockchain. Decentralization: Decentralization using blockchain - Methods of decentralization - Routes to decentralization- Blockchain and full ecosystem decentralization - Smart contracts - Decentralized Organizations- Platforms for decentralization.

**UNIT II INTRODUCTION TO CRYPTOCURRENCY****9**

Bitcoin – Digital Keys and Addresses – Transactions – Mining – Bitcoin Networks and Payments – Wallets – Alternative Coins – Theoretical Limitations – Bitcoin limitations – Name coin – Prime coin – Zcash – Smart Contracts – Ricardian Contracts- Deploying smart contracts on a blockchain

**UNIT III Ethereum****9**

Introduction - The Ethereum network - Components of the Ethereum ecosystem - Transactions and messages - Ether cryptocurrency / tokens (ETC and ETH) - The Ethereum Virtual Machine (EVM), Ethereum Development Environment: Test networks - Setting up a private net - Starting up the private network

**UNIT IV WEB3 AND HYPERLEDGE****9**

Introduction to Web3 – Contract Deployment – POST Requests – Development Frameworks – Hyperledger as a Protocol – The Reference Architecture – Hyperledger Fabric – Distributed Ledger – Corda.

**UNIT V EMERGING TRENDS****9**

Kadena – Ripple – Rootstock – Quorum – Tendermint – Scalability – Privacy – Other Challenges – Blockchain Research – Notable Projects – Miscellaneous Tools.

**TOTAL : 45 PERIODS****REFERENCE**

1. Imran. Bashir. Mastering block chain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained. Packt Publishing, 2<sup>nd</sup> Edition, 2018
2. Peter Borovykh , Blockchain Application in Finance, Blockchain Driven, 2nd Edition, 2018
3. ArshdeepBahga, Vijay Madiseti, "Blockchain Applications: A Hands On Approach", VPT, 2017.

PROGRESS THROUGH KNOWLEDGE

**UNIT I CURRENCY EXCHANGE AND PAYMENT****9**

Understand the concept of Crypto currency- Bitcoin and Applications -Cryptocurrencies and Digital Crypto Wallets -Types of Cryptocurrencies - Cryptocurrencies and Applications, block chain, Artificial Intelligence, machine learning. Fintech users, Individual Payments, RTGS Systems, Immediate Page 54 of 90 Payment Service (IMPS), Unified Payments Interface (UPI).Legal and Regulatory Implications of Crypto currencies, Payment systems and their regulations.Digital Payments Smart Cards, Stored-Value Cards, EC Micropayments, Payment Gateways, Mobile Payments, Digital and Virtual Currencies, Security, Ethical, Legal, Privacy, and Technology Issues

**UNIT II DIGITAL FINANCE AND ALTERNATIVE FINANCE****9**

A Brief History of Financial Innovation, Digitization of Financial Services, Crowd funding, Charity and Equity,. Introduction to the concept of Initial Coin Offering

**UNIT III INSURETECH****9**

InsurTech Introduction , Business model disruption AI/ML in InsurTech • IoT and InsurTech ,Risk Modeling ,Fraud Detection Processing claims and Underwriting Innovations in Insurance Services

**UNIT IV PEER TO PEER LENDING****9**

P2P and Marketplace Lending, New Models and New Products in market place lending P2P Infrastructure and technologies , Concept of Crowdfunding Crowdfunding Architecture and Technology ,P2P and Crowdfunding unicorns and business models , SME/MSME Lending: Unique opportunities and Challenges, Solutions and Innovations

**UNIT V REGULATORY ISSUES****9**

FinTech Regulations: Global Regulations and Domestic Regulations, Evolution of RegTech, RegTech Ecosystem: Financial Institutions, RegTech Ecosystem: StartupsRegTech, Startups: Challenges, RegTech Ecosystem: Regulators, Use of AI in regulation and Fraud detection

**TOTAL : 45 PERIODS****REFERENCE**

1. Swanson Seth, Fintech for Beginners: Understanding and Utilizing the power of technology, Createspace Independent Publishing Platform,2016.
2. Models AuTanda, Fintech Bigtech And Banks Digitalization and Its Impact On Banking Business, Springer, 2019
3. Henning Diedrich, Ethereum: Blockchains, Digital Assets, Smart Contracts, Decentralized Autonomous Organizations, Wildfire Publishing, 2016
4. Jacob William, FinTech:TheBeginner's Guide to Financial Technology, Createspace Independent Publishing Platform, 2016
5. IIBF, Digital Banking, Taxmann Publication, 2016
6. Jacob William, Financial Technology, Create space Independent Pub, 2016
7. Luke Sutton, Financial Technology: Bitcoin & Blockchain, Createspace Independent Pub, 2016



**OBJECTIVES:**

1. To learn about history, importance and evolution of Fintech
2. To acquire the knowledge of Fintech in payment industry
3. To acquire the knowledge of Fintech in insurance industry
4. To learn the Fintech developments around the world
5. To know about the future of Fintech

**UNIT I INTRODUCTION****9**

Fintech - Definition, History, concept, meaning, architecture, significance, Goals, key areas in Fintech, Importance of Fintech, role of Fintech in economic development, opportunities and challenges in Fintech, Evolution of Fintech in different sectors of the industry - Infrastructure, Banking Industry, Startups and Emerging Markets, recent developments in FinTech, future prospects and potential issues with Fintech.

**UNIT II PAYMENT INDUSTRY****9**

FinTech in Payment Industry-Multichannel digital wallets, applications supporting wallets, onboarding and KYC application, FinTech in Lending Industry- Formal lending, Informal lending, P2P lending, POS lending, Online lending, Payday lending, Microfinance, Crowdfunding.

**UNIT III INSURANCE INDUSTRY****9**

FinTech in Wealth Management Industry-Financial Advice, Automated investing, Socially responsible investing, Fractional Investing, Social Investing. FinTech in Insurance Industry- P2P insurance, On-Demand Insurance, On-Demand Consultation, Customer engagement through Quote to sell, policy servicing, Claims Management, Investment linked health insurance.

**UNIT IV FINTECH AROUND THE GLOBE****9**

FinTech developments - US, Europe and UK, Germany, Sweden, France, China, India, Africa, Australia, New Zealand, Brazil and Middle East, Regulatory and Policy Assessment for Growth of FinTech. FinTech as disruptors, Financial institutions collaborating with FinTech companies, The new financial world.

**UNIT V FUTURE OF FINTECH****9**

How emerging technologies will change financial services, the future of financial services, banking on innovation through data, why FinTech banks will rule the world, The FinTech Supermarket, Banks partnering with FinTech start-ups, The rise of BankTech, Fintech impact on Retail Banking, A future without money, Ethics in Fintech.

**TOTAL : 45 PERIODS****REFERENCES**

1. Arner D., Barbers J., Buckley R, The evolution of FinTech: a new post crisis paradigm, University of New South Wales Research Series, 2015
2. Susanne Chishti, Janos Barberis, The FINTECH Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries, Wiley Publications, 2016
3. Richard Hayen, FinTech: The Impact and Influence of Financial Technology on Banking and the Finance Industry, 2016
4. Parag Y Arjunwadkar, FinTech: The Technology Driving Disruption in the financial service industry CRC Press, 2018
5. Sanjay Phadke, Fintech Future : The Digital DNA of Finance Paperback .Sage Publications, 2020
6. Pranay Gupta, T. Mandy Tham, Fintech: The New DNA of Financial Services Paperback, 2018

## VERTICAL 2: ENTREPRENEURSHIP

CMG337

### FOUNDATIONS OF ENTREPRENEURSHIP

L T P C  
3 0 0 3

#### Course Objectives

- To develop and strengthen the entrepreneurial quality and motivation of learners.
- To impart the entrepreneurial skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of entrepreneurship and management in Technology oriented businesses.
- To empower the learners to run a Technology driven business efficiently and effectively

#### UNIT I INTRODUCTION TO ENTREPRENEURSHIP 9

Entrepreneurship- Definition, Need, Scope - Entrepreneurial Skill & Traits - Entrepreneur vs. Intrapreneur; Classification of entrepreneurs, Types of entrepreneurs -Factors affecting entrepreneurial development – Achievement Motivation – Contributions of Entrepreneurship to Economic Development.

#### UNIT II BUSINESS OWNERSHIP & ENVIRONMENT 9

Types of Business Ownership – Business Environmental Factors – Political-Economic-Sociological-Technological-Environmental-Legal aspects – Human Resources Mobilisation-Basics of Managing Finance- Essentials of Marketing Management - Production and Operations Planning – Systems Management and Administration

#### UNIT III FUNDAMENTALS OF TECHNOPRENEURSHIP 9

Introduction to Technopreneurship - Definition, Need, Scope- Emerging Concepts- Principles - Characteristics of a technopreneur - Impacts of Technopreneurship on Society – Economy- Job Opportunities in Technopreneurship - Recent trends

#### UNIT IV APPLICATIONS OF TECHNOPRENEURSHIP 9

Technology Entrepreneurship - Local, National and Global practices - Intrapreneurship and Technology interactions, Networking of entrepreneurial activities – Launching - Managing Technology based Product / Service entrepreneurship – Success Stories of Technopreneurs - Case Studies

#### UNIT V EMERGING TRENDS IN ENTREPRENEURSHIP 9

Effective Business Management Strategies For Franchising - Sub-Contracting- Leasing- Technopreneurs – Agripreneurs - Netpreneurs- Portfolio entrepreneurship - NGO Entrepreneurship – Recent Entrepreneurial Developments - Local – National – Global perspectives.

**TOTAL45 : PERIODS**

#### OUTCOMES:

Upon completion of this course, the student should be able to:

CO 1 Learn the basics of Entrepreneurship

CO 2 Understand the business ownership patterns and environment

CO 3 Understand the Job opportunities in Industries relating to Technopreneurship

CO 4 Learn about applications of technopreneurship and successful technopreneurs

CO 5 Acquaint with the recent and emerging trends in entrepreneurship

#### TEXT BOOKS:

- 1) S.S.Khanka, "Entrepreneurial Development" S.Chand & Co. Ltd. Ram Nagar New Delhi, 2021.

- 2) Donal F Kuratko Entrepreneurship (11th Edition) Theory, Process, Practice by Published 2019 by Cengage Learning,

**REFERENCES :**

- 1) Daniel Mankani. 2003. Technopreneurship: The successful Entrepreneur in the new Economy. Prentice Hall
- 2) Edward Elgar. 2007. Entrepreneurship, Cooperation and the Firm: The Emergence and Survival of High-Technology Ventures in Europe. Edi: Jan Ulijn, Dominique Drillon, and Frank Lasch. Wiley Pub.
- 3) Lang, J. 2002, The High Tech Entrepreneur's Handbook, Ft.com.
- 4) David Sheff 2002, China Dawn: The Story of a Technology and Business Revolution,
- 5) HarperBusiness, <https://fanny.staff.uns.ac.id/files/2013/12/Technopreneur-BASED-EDUCATION-REVOLUTION.pdf>
- 6) JumpStart: A Technopreneurship Fable, Dennis Posadas, (Singapore: Pearson Prentice Hall, 2009
- 7) Basics of Technopreneurship: Module 1.1-1.2, Frederico Gonzales, President-PESO Inc; M. Barcelon, UP
- 8) Journal articles pertaining to Entrepreneurship

**CMG338 TEAM BUILDING & LEADERSHIP MANAGEMENT FOR BUSINESS**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- To develop and strengthen the Leadership qualities and motivation of learners.
- To impart the Leadership skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of Team Building in managing Technology oriented businesses.
- To empower the learners to build robust teams for running and leading a business efficiently and effectively

**UNIT I INTRODUCTION TO MANAGING TEAMS 9**

Introduction to Team - Team Dynamics - Team Formation – Stages of Team Development - Enhancing teamwork within a group - Team Coaching - Team Decision Making - Virtual Teams - Self Directed Work Teams (SDWTs) -Multicultural Teams.

**UNIT II MANAGING AND DEVELOPING EFFECTIVE TEAMS 9**

Team-based Organisations- Leadership roles in team-based organisations - Offsite training and team development - Experiential Learning - Coaching and Mentoring in team building - Building High-Performance Teams - Building Credibility and Trust - Skills for Developing Others - Team Building at the Top - Leadership in Teamwork Effectiveness.

**UNIT III INTRODUCTION TO LEADERSHIP 9**

Introduction to Leadership - Leadership Myths – Characteristics of Leader, Follower and Situation - Leadership Attributes - Personality Traits and Leadership- Intelligence Types and Leadership - Power and Leadership - Delegation and Empowerment .

**UNIT IV LEADERSHIP IN ORGANISATIONS 9**

Leadership Styles – LMX Theory- Leadership Theory and Normative Decision Model - Situational Leadership Model - Contingency Model and Path Goal Theory – Transactional and Transformational Leadership - Charismatic Leadership - Role of Ethics and Values in Organisational Leadership.

## **UNIT V LEADERSHIP EFFECTIVENESS**

**9**

Leadership Behaviour - Assessment of Leadership Behaviors - Destructive Leadership - Motivation and Leadership - Managerial Incompetence and Derailment Conflict Management - Negotiation and Leadership - Culture and Leadership - Global Leadership – Recent Trends in Leadership.

**TOTAL 45 : PERIODS**

Upon completion of this course, the student should be able to:

CO 1 Learn the basics of managing teams for business.

CO 2 Understand developing effective teams for business management.

CO 3 Understand the fundamentals of leadership for running a business.

CO 4 Learn about the importance of leadership for business development.

CO 5 Acquaint with emerging trends in leadership effectiveness for entrepreneurs.”

### **REFERENCES :**

1. Hughes, R.L., Ginnett, R.C., & Curphy, G.J., Leadership: Enhancing the lessons of experience ,9th Ed, McGraw Hill Education, Chennai, India. (2019).
2. Katzenback, J.R., Smith, D.K., The Wisdom of Teams: Creating the High Performance Organisations, Harvard Business Review Press, (2015).
3. Haldar, U.K., Leadership and Team Building, Oxford University Press, (2010).
4. Daft, R.L., The Leadership Experience, Cengage, (2015).
5. Daniel Levi, Group Dynamics for Teams ,4th Ed, (2014), Sage Publications.
6. Dyer, W. G., Dyer, W. G., Jr., & Dyer, J. H..Team building: Proven strategies for improving team performance, 5th ed, Jossey-Bass, (2013).

**CMG339**

**CREATIVITY & INNOVATION IN ENTREPRENEURSHIP**

**L T P C**  
**3 0 0 3**

### **COURSE OBJECTIVES**

- To develop the creativity skills among the learners
- To impart the knowledge of creative intelligence essential for entrepreneurs
- To know the applications of innovation in entrepreneurship.
- To develop innovative business models for business.

### **UNIT I CREATIVITY**

**9**

Creativity: Definition- Forms of Creativity-Essence, Elaborative and Expressive Creativities- Quality of Creativity-Existential, Entrepreneurial and Empowerment Creativities – Creative Environment-Creative Technology- - Creative Personality and Motivation.

### **UNIT II CREATIVE INTELLIGENCE**

**9**

Creative Intelligence: Convergent thinking ability – Traits Congenial to creativity – Creativity Training--Criteria for evaluating Creativity-Credible Evaluation- Improving the quality of our creativity – Creative Tools and Techniques - Blocks to creativity- fears and Disabilities- Strategies for Unblocking- Designing Creativity Enabling Environment.

### **UNIT III INNOVATION**

**9**

Innovation: Definition- Levels of Innovation- Incremental Vs Radical Innovation-Product Innovation and Process- Technological, Organizational Innovation – Indicators- Characteristics of Innovation in Different Sectors. Theories in Innovation and Creativity- Design Thinking and Innovation- Innovation as Collective Change-Innovation as a system

**UNIT IV INNOVATION AND ENTREPRENEURSHIP 9**

Innovation and Entrepreneurship: Entrepreneurial Mindset , Motivations and Behaviours- Opportunity Analysis and Decision Making- Industry Understanding - Entrepreneurial Opportunities- Entrepreneurial Strategies – Technology Pull/Market Push – Product -Market fit

**UNIT V INNOVATIVE BUSINESS MODELS 9**

Innovative Business Models: Customer Discovery-Customer Segments-Prospect Theory and Developing Value Propositions- Developing Business Models: Elements of Business Models – Innovative Business Models: Elements, Designing Innovative Business Models- Responsible Innovation and Creativity.

**TOTAL 45 : PERIODS**

Upon completion of this course, the student should be able to:

CO 1 Learn the basics of creativity for developing Entrepreneurship

CO 2 Understand the importance of creative intelligence for business growth

CO 3 Understand the advances through Innovation in Industries

CO 4 Learn about applications of innovation in building successful ventures

CO 5 Acquaint with developing innovative business models to run the business efficiently and effectively

**Suggested Readings:**

Creativity and Innovation in Entrepreneurship, Kankha, Sultan Chand

Pradip N Khandwalla, Lifelong Creativity, An Unending Quest, Tata Mc Graw Hill, 2004.

Paul Trott, Innovation Management and New Product Development, 4e, Pearson, 2018.

Vinnie Jauhari, Sudanshu Bhushan, Innovation Management, Oxford Higher Education, 2014.

Innovation Management, C.S.G. Krishnamacharyulu, R. Lalitha, Himalaya Publishing House, 2010.

A. Dale Timpe, Creativity, Jaico Publishing House, 2003.

Brian Clegg, Paul Birch, Creativity, Kogan Page, 2009.

Strategic Innovation: Building and Sustaining Innovative Organizations- Course Era, Raj Echambadi.

**CMG340 PRINCIPLES OF MARKETING MANAGEMENT FOR BUSINESS L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- To provide basic knowledge of concepts, principles, tools and techniques of marketing for entrepreneurs
- To provide an exposure to the students pertaining to the nature and Scope of marketing, which they are expected to possess when they enter the industry as practitioners.
- To give them an understanding of fundamental premise underlying market driven strategies and the basic philosophies and tools of marketing management for business owners.

**UNIT I INTRODUCTION TO MARKETING MANAGEMENT 9**

Introduction - Market and Marketing – Concepts- Functions of Marketing - Importance of Marketing - Marketing Orientations - Marketing Mix-The Traditional 4Ps - The Modern Components of the Mix - The Additional 3Ps - Developing an Effective Marketing Mix.

**UNIT II MARKETING ENVIRONMENT 9**

Introduction - Environmental Scanning - Analysing the Organisation's Micro Environment and Macro Environment - Differences between Micro and Macro Environment – Techniques of

Environment Scanning - Marketing organization - Marketing Research and the Marketing Information System, Types and Components.

**UNIT III PRODUCT AND PRICING MANAGEMENT**

**9**

Product- Meaning, Classification, Levels of Products – Product Life Cycle (PLC) - Product Strategies - Product Mix - Packaging and Labelling - New Product Development - Brand and Branding - Advantages and disadvantages of branding Pricing - Factors Affecting Price Decisions - Cost Based Pricing - Value Based and Competition Based Pricing - Pricing Strategies - National and Global Pricing.

**UNIT IV PROMOTION AND DISTRIBUTION MANAGEMENT**

**9**

Introduction to Promotion – Marketing Channels- Integrated Marketing Communications (IMC) - Introduction to Advertising and Sales Promotion – Basics of Public Relations and Publicity - Personal Selling - Process - Direct Marketing - Segmentation, Targeting and Positioning (STP)- Logistics Management- Introduction to Retailing and Wholesaling.

**UNIT V CONTEMPORARY ISSUES IN MARKETING MANAGEMENT**

**9**

Introduction - Relationship Marketing Vs. Relationship Management - Customer Relationship Management (CRM) - Forms of Relationship Management - CRM practices - Managing Customer Loyalty and Development – Buyer-Seller Relationships- Buying Situations in Industrial / Business Market - Buying Roles in Industrial Marketing - Factors that Influence Business - Services Marketing - E-Marketing or Online Marketing.

**TOTAL 45 : PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the students will be able to :

CO1 Have the awareness of marketing management process

CO 2 Understand the marketing environment

CO 3 Acquaint about product and pricing strategies

CO 4 Knowledge of promotion and distribution in marketing management.

CO 5 Comprehend the contemporary marketing scenarios and offer solutions to marketing issues.

**REFERENCES:**

1. Marketing Management, Sherlekar S.A, Himalaya Publishing House, 2016.
2. Marketing Management , Philip Kotler and Kevin Lane Keller, PHI 15th Ed, 2015.
- 3 Marketing Management- An Indian perspective, Vijay Prakash Anand, Biztantra, Second edition, 2016.
4. Marketing Management Global Perspective, Indian Context, V.S.Ramaswamy & S.Namakumari, Macmillan Publishers India,5th edition, 2015.
5. Marketing Management, S.H.H. Kazmi, 2013, Excel Books India.
6. Marketing Management- text and Cases, Dr. C.B.Gupta & Dr. N.Rajan Nair, 17th edition, 2016.

**OBJECTIVES:**

1. To introduce the basic concepts, structure and functions of human resource management for entrepreneurs.
2. To create an awareness of the roles, functions and functioning of human resource department.
3. To understand the methods and techniques followed by Human Resource Management practitioners.

**UNIT I INTRODUCTION TO HRM 9**

Concept, Definition, Objectives- Nature and Scope of HRM - Evolution of HRM - HR Manager Roles- Skills - Personnel Management Vs. HRM - Human Resource Policies - HR Accounting - HR Audit - Challenges in HRM.

**UNIT II HUMAN RESOURCE PLANNING 9**

HR Planning - Definition - Factors- Tools - Methods and Techniques - Job analysis- Job rotation- Job Description - Career Planning - Succession Planning - HRIS - Computer Applications in HR - Recent Trends

**UNIT III RECRUITMENT AND SELECTION 9**

Sources of recruitment- Internal Vs. External - Domestic Vs. Global Sources -eRecruitment - Selection Process- Selection techniques -eSelection- Interview Types- Employee Engagement.

**UNIT IV TRAINING AND EMPLOYEE DEVELOPMENT 9**

Types of Training - On-The-Job, Off-The-Job - Training Needs Analysis – Induction and Socialisation Process - Employee Compensation - Wages and Salary Administration – Health and Social Security Measures- Green HRM Practices

**UNIT V CONTROLLING HUMAN RESOURCES 9**

Performance Appraisal – Types - Methods - Collective Bargaining - Grievances Redressal Methods – Employee Discipline – Promotion – Demotion - Transfer – Dismissal - Retrenchment - Union Management Relationship - Recent Trends

**TOTAL 45 : PERIODS**

Upon completion of this course the learners will be able:

CO 1 To understand the Evolution of HRM and Challenges faced by HR Managers

CO 2 To learn about the HR Planning Methods and practices.

CO 3 To acquaint about the Recruitment and Selection Techniques followed in Industries.

CO 4 To know about the methods of Training and Employee Development.

CO 5 To comprehend the techniques of controlling human resources in organisations.

**REFERENCES**

- 1) Gary Dessler and Biju Varkkey, Human Resource Management, 14e , Pearson, 2015.
- 2) Mathis and Jackson, Human Resource Management, Cengage Learning 15e, 2017.
- 3) David A. Decenzo, Stephen.P.Robbins, and Susan L. Verhulst, Human Resource Management, Wiley, International Student Edition, 11th Edition, 2014
- 4) R. Wayne Mondy, Human Resource Management, Pearson , 2015.
- 5) Luis R.Gomez-Mejia, David B.Balkin, Robert L Cardy. Managing Human Resource. PHI Learning. 2012
- 6) John M. Ivancevich, Human Resource Management, 12e, McGraw Hill Irwin, 2013.
- 7) K. Aswathappa, Sadhna Dash , Human Resource Management - Text and Cases , 9th Edition, McGraw Hill, 2021.
- 8) Uday Kumar Haldar, Juthika Sarkar. Human Resource management. Oxford. 2012

**Course Objectives**

- To develop the basics of business venture financing.
- To impart the knowledge essential for entrepreneurs for financing new ventures.
- To acquaint the learners with the sources of debt and equity financing.
- To empower the learners towards fund raising for new ventures effectively.

**UNIT I ESSENTIALS OF NEW BUSINESS VENTURE****9**

Setting up new Business Ventures – Need - Scope - Franchising - Location Strategy, Registration Process - State Directorate of Industries- Financing for New Ventures - Central and State Government Agencies - Types of loans – Financial Institutions - SFC, IDBI, NSIC and SIDCO.

**UNIT II INTRODUCTION TO VENTURE FINANCING****9**

Venture Finance – Definition – Historic Background - Funding New Ventures- Need – Scope – Types - Cost of Project - Means of Financing - Estimation of Working Capital - Requirement of funds – Mix of Debt and Equity - Challenges and Opportunities.

**UNIT III SOURCES OF DEBT FINANCING****9**

Fund for Capital Assets - Term Loans - Leasing and Hire-Purchase - Money Market instruments – Bonds, Corporate Papers – Preference Capital- Working Capital Management- Fund based Credit Facilities - Cash Credit - Over Draft.

**UNIT IV SOURCES OF EQUITY FINANCING****9**

Own Capital, Unsecured Loan - Government Subsidies , Margin Money- Equity Funding - Private Equity Fund- Schemes of Commercial banks - Angel Funding – Crowdfunding- Venture Capital.

**UNIT V METHODS OF FUND RAISING FOR NEW VENTURES****9**

Investor Decision Process - Identifying the appropriate investors- Targeting investors- Developing Relationships with investors - Investor Selection Criteria- Company Creation- Raising Funds - Seed Funding- VC Selection Criteria – Process- Methods- Recent Trends

**TOTAL 45 : PERIODS****OUTCOMES:**

Upon completion of this course, the students should be able to:

- CO 1 Learn the basics of starting a new business venture.  
 CO 2 Understand the basics of venture financing.  
 CO 3 Understand the sources of debt financing.  
 CO 4 Understand the sources of equity financing.  
 CO 5 Acquaint with the methods of fund raising for new business ventures.

**REFERENCES :**

- 1) Principles of Corporate Finance by Brealey and Myers et al., 12<sup>TH</sup> ed, McGraw Hill Education (India) Private Limited, 2018
- 2) Prasanna Chandra, Projects : Planning ,Analysis, Selection ,Financing, Implementation and Review, McGraw Hill Education India Pvt Ltd ,New Delhi , 2019.
- 3) Introduction to Project Finance. Andrew Fight, Butterworth-Heinemann, 2006.
- 4) Metrick, Andrew; Yasuda, Ayako. Venture Capital And The Finance Of Innovation. Venture Capital And The Finance Of Innovation, 2nd Edition, Andrew Metrick And Ayako Yasuda, Eds., John Wiley And Sons, Inc, 2010.
- 5) Feld, Brad; Mendelson, Jason. Venture Deals. Wiley, 2011.
- 6) May, John; Simons, Cal. Every Business Needs An Angel: Getting The Money You Need To Make Your Business Grow. Crown Business, 2001.



- 7) Gompers, Paul Alan; Lerner, Joshua. The Money Of Invention: How Venture Capital Creates New Wealth. Harvard Business Press, 2001.
- 8) Camp, Justin J. Venture Capital Due Diligence: A Guide To Making Smart Investment Choices And Increasing Your Portfolio Returns. John Wiley & Sons, 2002.
- 9) Byers, Thomas. Technology Ventures: From Idea To Enterprise. Mcgraw-Hill Higher Education, 2014.
- 10) Lerner, Josh; Leamon, Ann; Hardymon, Felda. Venture Capital, Private Equity, And The Financing Of Entrepreneurship. 2012.

### VERTICAL 3: PUBLIC ADMINISTRATION

**CMG343**

**PRINCIPLES OF PUBLIC ADMINISTRATION**

**LT P C  
3 0 0 3**

**UNIT I**

1. Meaning, Nature and Scope of Public Administration
2. Importance of Public Administration
3. Evolution of Public Administration

(9)

**UNIT II**

1. New Public Administration
2. New Public Management
3. Public and Private Administration

(9)

**UNIT III**

1. Relationships with Political Science, History and Sociology
2. Classical Approach
3. Scientific Management Approach

(9)

**UNIT IV**

1. Bureaucratic Approach: Max Weber
2. Human Relations Approach : Elton Mayo
3. Ecological Approach : Riggs

(9)

**UNIT V**

1. Leadership: Leadership - Styles - Approaches
2. Communication: Communication Types - Process - Barriers
3. Decision Making: Decision Making - Types, Techniques and Processes.

(9)

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Avasthi and Maheswari: Public Administration in India, Agra:Lakshmi Narain Agarwal,2013.
2. Ramesh K Arora: Indian Public Administration, New Delhi: Wishwa Prakashan, 2012.
3. R.B. Jain: Public Administration in India,21st Century Challenges for Good Governance, New Delhi: Deep and Deep, 2002.
4. Rumki Basu: Public Administration:Concept and Theories, New Delhi: Sterling, 2013.
5. R. Tyagi, Public Administration, Atma Ram & Sons, New Delhi, 1983.

**CMG344**

**CONSTITUTION OF INDIA**

**L T P C**  
**3 0 0 3**

**UNIT I**

**(9)**

1. Constitutional Development Since 1909 to 1947
2. Making of the Constitution.
3. Constituent Assembly

**UNIT II**

**(9)**

1. Fundamental Rights
2. Fundamental Duties
3. Directive Principles of State Policy

**UNIT III**

**(9)**

1. President
2. Parliament
3. Supreme Court

**UNIT IV**

**(9)**

1. Governor
2. State Legislature
3. High Court

**UNIT V**

**(9)**

1. Secularism
2. Social Justice
3. Minority Safeguards

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Basu. D.D.: Introduction to Indian Constitution ; Prentice Hall; New Delhi.
2. Kapur. A.C: Indian Government and Political System; S.Chand and Company Ltd., New Delhi.
3. Johari J.C.: Indian Politics, Vishal Publications Ltd, New Delhi
4. Agarwal R.C: Indian Political System; S.Chand & Co., New Delhi

**CMG345**

**PUBLIC PERSONNEL ADMINISTRATION**

**L T P C**  
**3 0 0 3**

**UNIT I**

**(9)**

1. Meaning, Scope and Importance of Personnel Administration
2. Types of Personnel Systems: Bureaucratic, Democratic and Representative systems

**UNIT II**

**(9)**

1. Generalist Vs Specialist
2. Civil Servants' Relationship with Political Executive
3. Integrity in Administration.

**UNIT III**

**(9)**

1. Recruitment: Direct Recruitment and Recruitment from Within
2. Training: Kinds of Training
3. Promotion

**UNIT IV** (9)  
 1. All India Services  
 2. Service Conditions  
 3. State Public Service Commission

**UNIT V** (9)  
 1. Employer Employee Relations  
 2. Wage and Salary Administration  
 3. Allowances and Benefits

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Stahl Glean O: Public Personnel Administration
2. Parnandikar Pai V.A: Personnel System for Development Administration.
3. Bhambhiru . P: Bureaucracy and Policy in India.
4. Dwivedi O.P and Jain R.B: India's Administrative state.
5. Muttalis M.A: Union Public Service Commission.
6. Bhakara Rao .V: Employer Employee Relations in India.
7. Davar R.S. Personnel Management & Industrial Relations

**CMG346 ADMINISTRATIVE THEORIES LT P C**  
**3 0 0 3**

**UNIT I** (9)  
 Meaning, Scope and significance of Public Administration, Evolution of Public Administration as a discipline and Identity of Public Administration

**UNIT II** (9)  
 Theories of Organization: Scientific Management Theory, Classical Model, Human Relations Theory

**UNIT III** (9)  
 Organization goals and Behaviour, Groups in organization and group dynamics, Organizational Design.

**UNIT IV** (9)  
 Motivation Theories, content, process and contemporary; Theories of Leadership: Traditional and Modern: Process and techniques of decision-making

**UNIT V** (9)  
 Administrative thinkers: Kautilya, Woodrow Willson, C.I. Barnard . Peter Drucker

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Crozier M : The Bureaucratic phenomenon (Chand)
2. Blau. P.M and Scott. W : Formal Organizations (RKP)
3. Presthus. R : The Organizational Society (MAC)
4. Alvi, Shum Sun Nisa : Eminent Administrative Thinkers.
5. Keith Davis : Organization Theory (MAC)

**CMG347**

**INDIAN ADMINISTRATIVE SYSTEM**

**L T P C**  
**3 0 0 3**

**UNIT I**

**(9)**

Evolution and Constitutional Context of Indian Administration, Constitutional Authorities: Finance Commission, Union Public Services Commission, Election Commission, Comptroller and Auditor General of India, Attorney General of India

**UNIT II**

**(9)**

Role & Functions of the District Collector, Relationship between the District Collector and Superintendent of Police, Role of Block Development Officer in development programmes, Local Government

**UNIT III**

**(9)**

Main Features of 73rd Constitutional Amendment Act 1992, Salient Features of 74th Constitutional Amendment Act 1992

**UNIT IV**

**(9)**

Coalition politics in India, Integrity and Vigilance in Indian Administration

**UNIT V**

**(9)**

Corruption – Ombudsman, Lok Pal & Lok Ayuktha

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. S.R. Maheswari : Indian Administration
2. Khera. S.S : Administration in India
3. Ramesh K. Arora : Indian Public Administration
4. T.N. Chaturvedi : State administration in India
5. Basu, D.D : Introduction to the Constitution of India

**CMG348**

**PUBLIC POLICY ADMINISTRATION**

**L T P C**  
**3 0 0 3**

**UNIT I**

**(9)**

Meaning and Definition of Public Policy - Nature, Scope and Importance of public policy – Public policy relationship with social sciences especially with political science and Public Administration.

**UNIT II**

**(9)**

Approaches in Policy Analysis - Institutional Approach – Incremental Approach and System's Approach – Dror's Optimal Model

**UNIT III**

**(9)**

Major stages involved in Policy making Process – Policy Formulation – Policy Implementation – Policy Evaluation.

**UNIT IV**

**(9)**

Institutional Framework of Policy making – Role of Bureaucracy – Role of Interest Groups and Role of Political Parties.

**UNIT V****(9)**

Introduction to the following Public Policies – New Economic Policy – Population Policy – Agriculture policy - Information Technology Policy.

**TOTAL: 45 PERIODS****REFERENCES:**

1. Rajesh Chakrabarti & Kaushik Sanyal : Public Policy in India, Oxford University Press, 2016.
2. Kuldeep Mathur : Public Policy and Politics in India, Oxford University Press, 2016.
3. Bidyutv Chakrabarty: Public Policy: Concept, Theory and Practice, 2015.
4. Pradeep Saxena : Public Policy Administration and Development
5. Sapru R.K. : Public Policy: Formulation, Implementation and Evaluation, Sterling Publishers, 2016.

**VERTICAL 4: BUSINESS DATA ANALYTICS****CMG349****STATISTICS FOR MANAGEMENT****L T P C  
3 0 0 3****OBJECTIVE:**

- To learn the applications of statistics in business decision making.

**UNIT I INTRODUCTION****9**

Basic definitions and rules for probability, Baye's theorem and random variables, Probability distributions: Binomial, Poisson, Uniform and Normal distributions.

**UNIT II SAMPLING DISTRIBUTION AND ESTIMATION****9**

Introduction to sampling distributions, Central limit theorem and applications, sampling techniques, Point and Interval estimates of population parameters.

**UNIT III TESTING OF HYPOTHESIS - PARAMETIRC TESTS****9**

Hypothesis testing: one sample and two sample tests for means of large samples (z-test), one sample and two sample tests for means of small samples (t-test), ANOVA one way.

**UNIT IV NON-PARAMETRIC TESTS****9**

Chi-square tests for independence of attributes and goodness of fit, Kolmogorov-Smirnov – test for goodness of fit, Mann – Whitney U test and Kruskal Wallis test.

**UNIT V CORRELATION AND REGRESSION****9**

Correlation –Rank Correlation – Regression – Estimation of Regression line – Method of Least Squares – Standard Error of estimate.

**TOTAL:45 PERIODS****OUTCOMES:**

- To facilitate objective solutions in business decision making.
- To understand and solve business problems
- To apply statistical techniques to data sets, and correctly interpret the results.
- To develop skill-set that is in demand in both the research and business environments
- To enable the students to apply the statistical techniques in a work setting.

**REFERENCES:**

1. Richard I. Levin, David S. Rubin, Masood H.Siddiqui, Sanjay Rastogi, Statistics for Management, Pearson Education, 8th Edition, 2017.
2. Prem. S. Mann, Introductory Statistics, Wiley Publications, 9th Edition, 2015.
3. T N Srivastava and Shailaja Rego, Statistics for Management, Tata McGraw Hill, 3rd Edition 2017.
4. Ken Black, Applied Business Statistics, 7th Edition, Wiley India Edition, 2012.
5. David R. Anderson, Dennis J. Sweeney, Thomas A.Williams, Jeffrey D.Camm, James J.Cochran, Statistics for business and economics, 13th edition, Thomson (South – Western) Asia, Singapore, 2016.
6. N. D. Vohra, Business Statistics, Tata McGraw Hill, 2017.

**CMG350****DATAMINING FOR BUSINESS INTELLIGENCE****L T P C  
3 0 0 3****OBJECTIVES :**

- To know how to derive meaning form huge volume of data and information.
- To understand how knowledge discovering process is used in business decision making.

**UNIT I INTRODUCTION**

Data mining, Text mining, Web mining, Data ware house.

**9****UNIT II DATA MINING PROCESS**Datamining process – KDD, CRISP-DM, SEMMA  
Prediction performance measures**9****UNIT III PREDICTION TECHNIQUES**

Data visualization, Time series – ARIMA, Winter Holts,

**9****UNIT IV CLASSIFICATION AND CLUSTERING TECHNIQUES**

Classification, Association, Clustering.

**9****UNIT V MACHINE LEARNING AND AI**

Genetic algorithms, Neural network, Fuzzy logic, Ant Colony optimization, Particle Swarm optimization

**9****TOTAL: 45 PERIODS****OUTCOMES:**

1. Learn to apply various data mining techniques into various areas of different domains.
2. Be able to interact competently on the topic of data mining for business intelligence.
3. Apply various prediction techniques.
4. Learn about supervised and unsupervised learning technique.
5. Develop and implement machine learning algorithms

**REFERENCES :**

1. Jaiwei Ham and Micheline Kamber, Data Mining concepts and techniques, Kauffmann Publishers 2006

2. Efraim Turban, Ramesh Sharda, Jay E. Aronson and David King, Business Intelligence, Prentice Hall, 2008.
3. W.H.Inmon, Building the Data Warehouse, fourth edition Wiley India pvt. Ltd. 2005.
4. Ralph Kimball and Richard Merz, The data warehouse toolkit, John Wiley, 3rd edition,2013.
5. Michel Berry and Gordon Linoff, Mastering Data mining, John Wiley and Sons Inc, 2nd Edition, 2011
6. Michel Berry and Gordon Linoff, Data mining techniques for Marketing, Sales and Customer support, John Wiley, 2011
7. G. K. Gupta, Introduction to Data mining with Case Studies, Prentice hall of India, 2011
8. Giudici, Applied Data mining – Statistical Methods for Business and Industry, John Wiley. 2009
9. Elizabeth Vitt, Michael Luckevich Stacia Misner, Business Intelligence, Microsoft, 2011
10. Michalewicz Z., Schmidt M. Michalewicz M and Chiriac C, Adaptive Business Intelligence, Springer – Verlag, 2007
11. GalitShmueli, Nitin R. Patel and Peter C. Bruce, Data Mining for Business Intelligence – Concepts, Techniques and Applications Wiley, India, 2010.

**CMG351**

**HUMAN RESOURCE ANALYTICS**

**L T P C  
3 0 0 3**

**OBJECTIVE:**

- To develop the ability of the learners to define and implement HR metrics that are aligned with the overall business strategy.
- To know the different types of HR metrics and understand their respective impact and application.
- To understand the impact and use of HR metrics and their connection with HR analytics.
- To understand common workforce issues and resolving them using people analytics.

**UNIT I INTRODUCTION TO HR ANALYTICS 9**

People Analytics - stages of maturity - Human Capital in the Value Chain : impact on business – HR metrics and KPIs.

**UNIT II HR ANALYTICS I: RECRUITMENT 9**

Recruitment Metrics : Fill-up ratio - Time to hire - Cost per hire - Early turnover - Employee referral hires - Agency hires - Lateral hires - Fulfillment ratio- Quality of hire.

**UNIT III HR ANALYTICS - TRAINING AND DEVELOPMENT 9**

Training & Development Metrics : Percentage of employees trained- Internally and externally trained -Training hours and cost per employee - ROI.

**UNIT IV HR ANALYTICS EMPLOYEE ENGAGEMENT AND CAREER PROGRESSION 9**

Employee Engagement Metrics :Talent Retention index - Voluntary and involuntary turnover-grades, performance, and service tenure - Internal hired index Career Progression Metrics: Promotion index - Rotation index - Career path index.

**UNIT V HR ANALYTICS IV: WORKFORCE DIVERSITY AND DEVELOPMENT 9**

Workforce Diversity and Development Metrics : Employees per manager – Workforce age profiling - Workforce service profiling - Churnover index - Workforce diversity index - Gender mix

**TOTAL: 45 PERIODS**

**OUTCOME:**

- The learners will be conversant about HR metrics and ready to apply at work settings.
- The learners will be able to resolve HR issues using people analytics.

**REFERENCES:**

1. JacFitzenz , The New HR Analytics, AMACOM , 2010.
2. Edwards M. R., & Edwards K, Predictive HR Analytics: Mastering the HR Metric.London: Kogan Page.2016.
3. Human Resources kit for Dummies – 3 rd edition – Max Messmer, 2003
4. Dipak Kumar Bhattacharyya, HR Analytics ,Understanding Theories and Applications, SAGE Publications India ,2017.
5. Sesil, J. C. , Applying advanced analytics to HR management decisions: Methods fo selection, developing incentives, and improving collaboration. Upper Saddle River,New Jersey: Pearson Education,2014.
6. Pease, G., & Beresford, B, Developing Human Capital: Using Analytics to Plan and Optimize Your Learning and Development Investments. Wiley ,2014.
7. Phillips, J., & Phillips, P.P, Making Human Capital Analytics Work: Measuring the ROI of Human Capital Processes and OUTCOME. McGraw-Hill,2014.
8. HR Scorecard and Metrices, HBR, 2001.

**CMG352**

**MARKETING AND SOCIAL MEDIA WEB ANALYTICS**

**L T P C  
3 0 0 3**

**OBJECTIVE:**

- To showcase the opportunities that exist today to leverage the power of the web and social media

**UNIT I MARKETING ANALYTICS**

**9**

Marketing Budget and Marketing Performance Measure, Marketing - Geographical Mapping, Data Exploration, Market Basket Analysis

**UNIT II COMMUNITY BUILDING AND MANAGEMENT**

**9**

History and Evolution of Social Media-Understanding Science of Social Media –Goals for using Social Media- Social Media Audience and Influencers - Digital PR- Promoting Social Media Pages-Linking Social Media Accounts-The Viral Impact of Social Media.

**UNIT III SOCIAL MEDIA POLICIES AND MEASUREMENTS**

**9**

Social Media Policies-Etiquette, Privacy- ethical problems posed by emerging social media technologies - The Basics of Tracking Social Media.

**UNIT IV WEB ANALYTICS**

**9**

Data Collection, Overview of Qualitative Analysis, Business Analysis, KPI and Planning, Critical Components of a Successful Web Analytics Strategy, Proposals & Reports, Web Data Analysis.

**UNIT V SEARCH ANALYTICS**

**9**

Search engine optimization (SEO), user engagement, user-generated content, web traffic analysis, online security, online ethics, data visualization.

**TOTAL: 45 PERIODS**





2. Michael Watson, Sara Lewis, Peter Cacioppi, Jay Jayaraman, Supply Chain Network Design: Applying Optimization and Analytics to the Global Supply Chain, Pearson Education, 2013.
3. Anna Nagurney, Min Yu, Amir H. Masoumi, Ladimer S. Nagurney, Networks Against Time: Supply Chain Analytics for Perishable Products, Springer, 2013.
4. Muthu Mathirajan, Chandrasekharan Rajendran, Sowmyanarayanan Sadagopan, Arunachalam Ravindran, Parasuram Balasubramanian, Analytics in Operations/Supply Chain Management , I.K. International Publishing House Pvt. Ltd., 2016.
5. Gerhard J. Plenert, Supply Chain Optimization through Segmentation and Analytics, CRC Press, Taylor & Francis Group, 2014.

**CMG354**

**FINANCIAL ANALYTICS**

**L T P C**

**3 0 0 3**

**OBJECTIVE:**

➤ This course introduces a core set of modern analytical tools that specifically target finance applications.

**UNIT I CORPORATE FINANCE ANALYSIS**

**9**

Basic corporate financial predictive modelling- Project analysis- cash flow analysis- cost of capital, Financial Break even modelling, Capital Budget model-Payback, NPV, IRR.

**UNIT II FINANCIAL MARKET ANALYSIS**

**9**

Estimation and prediction of risk and return ( bond investment and stock investment) –Time series-examining nature of data, Value at risk, ARMA, ARCH and GARCH.

**UNIT III PORTFOLIO ANALYSIS**

**9**

Portfolio Analysis – capital asset pricing model, Sharpe ratio, Option pricing models- binomial model for options, Black Scholes model and Option implied volatility.

**UNIT IV TECHNICAL ANALYSIS**

**9**

Prediction using charts and fundamentals – RSI, ROC, MACD, moving average and candle charts, simulating trading strategies. Prediction of share prices.

**UNIT V CREDIT RISK ANALYSIS**

**9**

Credit Risk analysis- Data processing, Decision trees, logistic regression and evaluating credit risk model.

**TOTAL: 45 PERIODS**

**OUTCOME**

➤ The learners should be able to perform financial analysis for decision making using excel, Python and R.

**REFERENCES:**

1. Financial analytics with R by Mark J. Bennett, Dirk L. Hugen, Cambridge university press.
2. Haskell Financial Data Modeling and Predictive Analytics Paperback – Import, 25 Oct 2013 by Pavel Ryzhov.
3. Quantitative Financial Analytics: The Path To Investment Profits Paperback – Import, 11 Sep 2017 by Edward E Williams (Author), John A Dobelman.
4. Python for Finance - Paperback – Import, 30 Jun 2017 by Yuxing Yan (Author).
5. Mastering Python for Finance Paperback – Import, 29 Apr 2015 by James Ma Weiming.

## VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY

CES331 SUSTAINABLE INFRASTRUCTURE DEVELOPMENT

L T P C  
3 0 0 3

### OBJECTIVE:

- To impart knowledge about sustainable Infrastructure development goals, practices and to understand the concepts of sustainable planning, design, construction, maintenance and decommissioning of infrastructure projects.

### UNIT I SUSTAINABLE DEVELOPMENT GOALS 9

Definitions, principles and history of Sustainable Development - Sustainable development goals (SDG): global and Indian – Infrastructure Demand and Supply - Environment and Development linkages - societal and cultural demands – Sustainability indicators - Performance indicators of sustainability and Assessment mechanism - Policy frameworks and practices: global and Indian – Infrastructure Project finance – Infrastructure project life cycle - Constraints and barriers for sustainable development - future directions.

### UNIT II SUSTAINABLE INFRASTRUCTURE PLANNING 9

Overview of Infrastructure projects: Housing sector, Power sector, Water supply, road, rail and port transportation sector, rural and urban infrastructure. Environmental Impact Assessment (EIA), Land acquisition -Legal aspects, Resettlement & Rehabilitation and Development - Cost effectiveness Analysis - Risk Management Framework for Infrastructure Projects, Economic, demand, political, socio-environmental and cultural risks. Shaping the Planning Phase of Infrastructure Projects to mitigate risks, Designing Sustainable Contracts, Negotiating with multiple Stakeholders on Infrastructure Projects. Use of ICT tools in planning – Integrated planning - Clash detection in construction - BIM (Building Information Modelling).

### UNIT III SUSTAINABLE CONSTRUCTION PRACTICES AND TECHNIQUES 9

Sustainability through lean construction approach - Enabling lean through information technology – Lean in planning and design - IPD (Integrated Project Delivery) - Location Based Management System - Geospatial Technologies for machine control, site management, precision control and real time progress monitoring - Role of logistics in achieving sustainable construction – Data management for integrated supply chains in construction - Resource efficiency benefits of effective logistics - Sustainability in geotechnical practice – Design considerations, Design Parameters and Procedures – Quality control and Assurance - Use of sustainable construction techniques: Precast concrete technology, Pre-engineered buildings.

### UNIT IV SUSTAINABLE CONSTRUCTION MATERIALS 9

Construction materials: Concrete, steel, glass, aluminium, timber and FRP - No/Low cement concrete - Recycled and manufactured aggregate - Role of QC and durability - Sustainable consumption – Eco-efficiency - green consumerism - product stewardship and green engineering - Extended producer responsibility – Design for Environment Strategies, Practices, Guidelines, Methods, And Tools. Eco-design strategies –Design for Disassembly - Dematerialization, rematerialization, transmaterialization – Green procurement and green distribution - Analysis framework for reuse and recycling – Typical constraints on reuse and recycling - Communication of Life Cycle Information - Indian Eco mark scheme - Environmental product declarations – Environmental marketing- Life cycle Analysis (LCA), Advances in LCA: Hybrid LCA, Thermodynamic LCA - Extending LCA - economic dimension, social dimension - Life cycle costing (LCC) - Combining LCA and LCC – Case studies

## **UNIT V SUSTAINABLE MAINTENANCE OF INFRASTRUCTURE PROJECTS**

**9**

Case Studies - Sustainable projects in developed countries and developing nations - An Integrated Framework for Successful Infrastructure Planning and Management - Information Technology and Systems for Successful Infrastructure Management, - Structural Health Monitoring for Infrastructure projects - Innovative Design and Maintenance of Infrastructure Facilities - Capacity Building and Improving the Governments Role in Infrastructure Implementation, Infrastructure Management Systems and Future Directions. – Use of Emerging Technologies – IoT, Big Data Analytics and Cloud Computing, Artificial Intelligences, Machine and Deep Learning, Fifth Generation (5G) Network services for maintenance .

**TOTAL: 45 PERIODS**

### **OUTCOME:**

On completion of the course, the student is expected to be able to

**CO1** Understand the environment sustainability goals at global and Indian scenario.

**CO2** Understand risks in development of projects and suggest mitigation measures.

**CO3** Apply lean techniques, LBMS and new construction techniques to achieve sustainability in infrastructure construction projects.

**CO4** Explain Life Cycle Analysis and life cycle cost of construction materials.

**CO5** Explain the new technologies for maintenance of infrastructure projects.

### **REFERENCES:**

1. Charles J Kibert, Sustainable Construction : Green Building Design & Delivery, 4th Edition , Wiley Publishers 2016.
2. Steve Goodhew, Sustainable Construction Process, Wiley Blackwell,UK, 2016.
3. Craig A. Langston & Grace K.C. Ding, Sustainable Practices in the Built Environment, Butterworth Heinemann Publishers, 2011.
4. William P Spence, Construction Materials, Methods & Techniques (3e), Yesdee Publication Pvt. Ltd, 2016.
5. New Building Materials and Construction World magazine
6. Kerry Turner. R, "Sustainable Environmental Management", Principles and Practice Publisher:Belhaven Press,ISBN:1852930039.
7. Munier N, "Introduction to Sustainability", Springer2005
8. Sharma, "Sustainable Smart Cities In India: Challenges And Future Perspectives", SPRINGER, 2022.
9. Ralph Horne, Tim Grant, KarliVerghese, Life Cycle Assessment: Principles, Practice and Prospects, Csiro Publishing,2009
10. European Commission - Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. Luxembourg. European Union;2010
11. Hudson, Haas, Uddin, Infrastructure management: integrating design, construction, maintenance, rehabilitation, and renovation, McGraw Hill, (1997).
12. GregerLundesjö, Supply Chain Management and Logistics in Construction: Delivering Tomorrow's Built Environment, Kogan Page Publishers, 2015.

### COs- POs & PSOs MAPPING

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2		1	1		2	3	1	1		2	1	1	2	1
2	3	1	3	2	1	2	2		1	1	1	2	2	2	2
3	2	2	3	1	1	1	1				1	1	1	3	1
4	3	1	3	2	2	1	3	1	1	1	1	2	2	2	2
5	3	1	2	2	2	2	3	1		1	1	2	2	3	2
<b>Avg.</b>	3	1	3	2	2	2	3	1	1	1	1	2	2	3	2

### CES332 SUSTAINABLE AGRICULTURE AND ENVIRONMENTAL MANAGEMENT L T P C 3 0 0 3

#### OBJECTIVES:

- To educate the students about the issues of sustainability in agroecosystems, introduce the concepts and principles of agroecology as applied to the design and management of sustainable agricultural systems for a changing world.

#### UNIT I AGROECOLOGY, AGROECOSYSTEM AND SUSTAINABLE AGRICULTURE CONCEPTS 9

Ecosystem definition - Biotic Vs. abiotic factors in an ecosystem - Ecosystem processes - Ecological services and agriculture - Problems associated with industrial agriculture/food systems - Defining sustainability - Characteristics of sustainable agriculture - Difference between regenerative and sustainable agriculture systems

#### UNIT II SOIL HEALTH, NUTRIENT AND PEST MANAGEMENT 9

Soil health definition - Factors to consider (physical, chemical and biological) - Composition of healthy soils - Soil erosion and possible control measures - Techniques to build healthy soil - Management practices for improving soil nutrient - Ecologically sustainable strategies for pest and disease control

#### UNIT III WATER MANAGEMENT 9

Soil water storage and availability - Plant yield response to water - Reducing evaporation in agriculture - Earthworks and tanks for rainwater harvesting - Options for improving the productivity of water - Localized irrigation - Irrigation scheduling - Fertigation - Advanced irrigation systems and agricultural practices for sustainable water use

#### UNIT IV ENERGY AND WASTE MANAGEMENT 9

Types and sources of agricultural wastes - Composition of agricultural wastes - Sustainable technologies for the management of agricultural wastes - Useful and high value materials produced using different processes from agricultural wastes - Renewable energy for sustainable agriculture

#### UNIT V EVALUATING SUSTAINABILITY IN AGROECOSYSTEMS 9

Indicators of sustainability in agriculture - On-farm evaluation of agroecosystem sustainability - Alternative agriculture approaches/ farming techniques for sustainable food production - Goals and components of a community food system - Case studies

**TOTAL: 45 PERIODS**

## OUTCOME

- On completion of the course, the student is expected to be able to
- CO1** Have an in-depth knowledge about the concepts, principles and advantages of sustainable agriculture
- CO2** Discuss the sustainable ways in managing soil health, nutrients, pests and diseases
- CO3** Suggest the ways to optimize the use of water in agriculture to promote an ecological use of resources
- CO4** Develop energy and waste management plans for promoting sustainable agriculture in non-sustainable farming areas
- CO5** Assess an ecosystem for its level of sustainability and prescribe ways of converting to a sustainable system through the redesign of a conventional agroecosystem

## REFERENCES:

1. Approaches to Sustainable Agriculture – Exploring the Pathways Towards the Future of Farming, Oberc, B.P. & Arroyo Schnell, A., IUCN, Belgium, 2020
2. Natural bioactive products in sustainable agriculture, Singh, J. & Yadav, A.N., Springer, 2020
3. Organic Farming for Sustainable Agriculture, Nandwani, D., Springer, 2016
4. Principles of Agronomy for Sustainable Agriculture, Villalobos, F.J. & Fereres, E., Springer, 2016
5. Sustainable Agriculture for Food Security: A Global Perspective, Balkrishna, A., CRC Press, 2021
6. Sustainable Energy Solutions in Agriculture, Bundschuh, J. & Chen, G., CRC Press, 2014

### CO – PO Mapping - SUSTAINABLE AGRICULTURE PRACTICES

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		2						2		2			2	2	
2		2		2	2	2							3	2	
3				2		2							3	2	3
4	3	2			2			2	2	2	2		3	2	3
5		2	3	2			1					1		2	
Avg.	3	2	3	2	2	2	1	2	2	2	2	1	3	2	3

1 - Low; 2 - Medium; 3 - High; '-' - No correlation

PROGRESS THROUGH KNOWLEDGE

**OBJECTIVES**

- To Impart knowledge of biomaterials and their properties
- To learn about Fundamentals aspects of Biopolymers and their applications
- To learn about bioceramics and biopolymers
- To introduce the students about metals as biomaterials and their usage as implants
- To make the students understand the significance of bionanomaterials and its applications.

**UNIT I INTRODUCTION TO BIOMATERIALS****9**

Introduction: Definition of biomaterials, requirements & classification of biomaterials- Types of Biomaterials- Degradable and resorbable biomaterials- engineered natural materials- Biocompatibility-Hydrogels-pyrolitic carbon for long term medical implants-textured and porous materials-Bonding types- crystal structure-imperfection in crystalline structure-surface properties and adhesion of materials –strength of biological tissues-performance of implants-tissue response to implants- Impact and Future of Biomaterials

**UNIT II BIO POLYMERS****9**

Molecular structure of polymers -Molecular weight - Types of polymerization techniques–Types of polymerization reactions- Physical states of polymers- Common polymeric biomaterials - Polyethylene -Polymethylmethacrylate (PMMA)-Polylactic acid (PLA) and polyglycolic acid (PGA) - Polycaprolactone (PCL) - Other biodegradable polymers –Polyurethan- reactions polymers for medical purposes - Collagens- Elastin- Cellulose and derivatives-Synthetic polymeric membranes and their biological applications

**UNIT III BIO CERAMICS AND BIOCOSITES****9**

General properties- Bio ceramics -Silicate glass - Alumina (Al<sub>2</sub>O<sub>3</sub>) -Zirconia (ZrO<sub>2</sub>)-Carbon-Calcium phosphates (CaP)- Resorbable Ceramics- surface reactive ceramics- Biomedical Composites-Polymer Matrix Composite(PMC)-Ceramic Matrix Composite(CMC)-Metal Matrix Composite (MMC)–glass ceramics - Orthopedic implants-Tissue engineering scaffolds

**UNIT IV METALS AS BIOMATERIALS****9**

Biomedical metals-types and properties-stainless steel-Cobalt chromium alloys-Titanium alloys-Tantalum-Nickel titanium alloy (Nitinol)- magnesium-based biodegradable alloys-surface properties of metal implants for osteointegration-medical application-corrosion of metallic implants – biological tolerance of implant metals

**UNIT V NANOBIMATERIALS****9**

Meatllcnanobiomaterials–Nanopolymers-Nanoceramics- Nanocomposites -Carbon based nanobiomaterials - transport of nanoparticles- release rate-positive and negative effect of nanosize-nanofibres-Nano and micro features and their importance in implant performance- Nanosurface and coats-Applications nanoantibiotics-Nanomedicines- Biochips – Biomimetics- BioNEMs -Biosensor-Bioimaging/Molecular Imaging- challenges and future perspective.

**TOTAL : 45 PERIODS****OUTCOMES**

- Students will gain familiarity with Biomaterials and they will understand their importance.
- Students will get an overview of different biopolymers and their properties
- Students gain knowledge on some of the important Bioceramics and Biocomposite materials
- Students gain knowledge on metals as biomaterials
- Student gains knowledge on the importance of nanobiomaterials in biomedical applications.

## REFERENCES

1. C. Mauli Agrawal, Joo L. Ong, Mark R. Appleford, Gopinath Mani "Introduction to Biomaterials Basic Theory with Engineering Applications" Cambridge University Press, 2014.
2. Donglu shi "Introduction to Biomaterials" Tsinghua University press, 2006.
3. Joon Park, R.S.Lakes "Biomaterials An Introduction" third edition, Springer 2007.
4. M.Jaffe,W.Hammond, P.Tolias and T.Arinzeh "Characterization of Biomaterials" Wood head publishing, 2013.
5. Buddy D.Ratner and Allan S.Hoffman Biomaterials Science "An Introduction to Material in Medicine" Third Edition, 2013.
6. VasifHasirci, NesrinHasirci "Fundamentals of Biomaterials" Springer, 2018
7. Leopoldo Javier Rios Gonzalez. "Handbook of Research on Bioenergy and Biomaterials: Consolidated and green process" Apple academic press, 2021.
8. Devarajan Thangadurai, Jeyabalan Sangeetha, Ram Prasad "Functional Bionanomaterials" springer, 2020.
9. Sujata.V.Bhat Biomaterials; Narosa Publishing house, 2002.

**CES334**

**MATERIALS FOR ENERGY SUSTAINABILITY**

**L T P C  
3 0 0 3**

### OBJECTIVES

- To familiarize the students about the challenges and demands of energy sustainability
- To provide fundamental knowledge about electrochemical devices and the materials used.
- To introduce the students to various types of fuel cell
- To enable students to appreciate novel materials and their usage in photovoltaic application
- To introduce students to the basic principles of various types Supercapacitors and the materials used.

### UNIT I SUSTAINABLE ENERGY SOURCES

**9**

Introduction to energy demand and challenges ahead – sustainable source of energy (wind, solar etc.) – electrochemical energy systems for energy harvesting and storage – materials for sustainable electrochemical systems building – India centric solutions based on locally available materials – Economics of wind and solar power generators vs. conventional coal plants – Nuclear energy

### UNIT II ELECTROCHEMICAL DEVICES

**9**

Electrochemical Energy – Difference between primary and secondary batteries – Secondary battery (Li-ion battery, Sodium-ion battery, Li-S battery, Li-O<sub>2</sub> battery, Nickel Cadmium, Nickel Metal Hydride) – Primary battery (Alkaline battery, Zinc-Carbon battery) – Materials for battery (Anode materials – Lithiated graphite, Sodiated hard carbon, Silicon doped graphene, Lithium Titanate) (Cathode Materials – S, LiCoO<sub>2</sub>, LiFePO<sub>4</sub>, LiMn<sub>2</sub>O<sub>4</sub>) – Electrolytes for Lithium-ion battery (ethylene carbonate and propylene carbonate based)



### UNIT III FUEL CELLS

9

Principle of operation of fuel cells – types of fuel cells (Proton exchange membrane fuel cells, alkaline fuel cell, direct methanol fuel cells, direct borohydride fuel cells, phosphoric acid fuel cells, solid oxide fuel cells, and molten carbonate fuel cells) – Thermodynamics of fuel cell – Fuel utilization – electrolyte membrane (proton conducting and anion conducting) – Catalysts (Platinum, Platinum alloys, carbon supported platinum systems and metal oxide supported platinum catalysts) – Anatomy of fuel cells (gas diffusion layer, catalyst layer, flow field plate, current conductors, bipolar plates and monopolar plates).

### UNIT IV PHOTOVOLTAICS

9

Physics of the solar cell – Theoretical limits of photovoltaic conversion – bulk crystal growth of Si and wafering for photovoltaic application - Crystalline silicon solar cells – thin film silicon solar cells – multijunction solar cells – amorphous silicon based solar cells – photovoltaic concentrators – Cu(InGa)Se<sub>2</sub> solar cells – Cadmium Telluride solar cells – dye sensitized solar cells – Perovskite solar cells – Measurement and characterization of solar cells - Materials used in solar cells (metallic oxides, CNT films, graphene, OD fullerenes, single-multi walled carbon nanotubes, two-dimensional Graphene, organic or Small molecule-based solar cells materials - copper-phthalocyanine and perylenetetracarboxylicbis - benzene – fullerenes - boron subphthalocyanine (II) phthalocyanine)

### UNIT V SUPERCAPACITORS

9

Supercapacitor –types of supercapacitors (electrostatic double-layer capacitors, pseudo capacitors and hybrid capacitors) - design of supercapacitor-three and two electrode cell-parameters of supercapacitor- Faradaic and non - Faradaic capacitance – electrode materials (transition metal oxides (MO), mixed metal oxides, conducting polymers (CP), Mxenes, nanocarbons, non-noble metal, chalcogenides, hydroxides and 1D-3D metal-organic frame work (MOF), activated carbon fibres (ACF)- Hydroxides-Based Materials - Polyaniline (PANI), a ternary hybrid composite-conductive polypyrrole hydrogels – Different types of nanocomposites for the SC electrodes (carbon-carbon composites, carbon-MOs composites, carbon-CPs composites and MOs-CPs composites) - Two-Dimensional (2D) Electrode Materials - 2D transition metal carbides, carbonitrides, and nitrides.

**TOTAL : 45 PERIODS**

### OUTCOMES

- Students will acquire knowledge about energy sustainability.
- Students understand the principles of different electrochemical devices.
- Students learn about the working of fuel cells and their application.
- Students will learn about various Photovoltaic applications and the materials used.
- The students gain knowledge on different types of supercapacitors and the performance of various materials

### REFERENCES

1. Functional materials for sustainable energy applications; John A. Kilner, Stephen J. Skinner, Stuart J. C. Irvine and Peter P. Edwards.
2. Hand Book of Fuel Cells: Fuel Cell Technology and Applications, Wolf Vielstich, Arnold Lamm, Hubert Andreas Gasteiger, Harumi Yokokawa, Wiley, London 2003.
3. B.E. Conway, Electrochemical supercapacitors: scientific fundamentals and technological applications, Kluwer Academic / Plenum publishers, New York, 1999.
4. T.R. Crompton, Batteries reference book, Newners, 3rd Edition, 2002.
5. Materials for Supercapacitor applications; B.Viswanathan. M.Aulice Scibioh
6. Electrode Materials for Supercapacitors: A Review of Recent Advances, Parnia Forouzandeh, Vignesh Kumaravel and Suresh C. Pillai, catalysts 2020.

7. Recent advances, practical challenges, and perspectives of intermediate temperature solid oxide fuel cell cathodes Amanda Ndubuisi, Sara Abouali, Kalpana Singh and VenkataramanThangadurai, J. Mater. Chem. A, 2022.
8. Review of next generation photovoltaic solar cell technology and comparative materialistic development Neeraj Kant, Pushpendra Singh, Materials Today: Proceedings, 2022.

**CES335**

**GREEN TECHNOLOGY**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVE:**

- To acquire knowledge on green systems and the environment, energy technology and efficiency, and sustainability.
- To provide green engineering solutions to energy demand, reduced energy footprint.

**UNIT I PRINCIPLES OF GREEN CHEMISTRY 9**

Historical Perspectives and Basic Concepts. The twelve Principles of Green Chemistry and green engineering. Green chemistry metrics- atom economy, E factor, reaction mass efficiency, and other green chemistry metrics, application of green metrics analysis to synthetic plans.

**UNIT II POLLUTION TYPES 9**

Pollution – types, causes, effects, and abatement. Waste – sources of waste, different types of waste, chemical, physical and biochemical methods of waste minimization and recycling.

**UNIT III GREEN REAGENTS AND GREEN SYNTHESIS 9**

Environmentally benign processes- alternate solvents- supercritical solvents, ionic liquids, water as a reaction medium, energy-efficient design of processes- photo, electro and sono chemical methods, microwave-assisted reactions

**UNIT IV DESIGNING GREEN PROCESSES 9**

Safe design, process intensification, in process monitoring. Safe product and process design – Design for degradation, Real-time Analysis for pollution prevention, inherently safer chemistry for accident prevention

**UNIT V GREEN NANOTECHNOLOGY 9**

Nanomaterials for water treatment, nanotechnology for renewable energy, nanotechnology for environmental remediation and waste management, nanotechnology products as potential substitutes for harmful chemicals, environmental concerns with nanotechnology

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

- CO1: To understand the principles of green engineering and technology  
 CO2: To learn about pollution using hazardous chemicals and solvents  
 CO3: To modify processes and products to make them green and safe.  
 CO4: To design processes and products using green technology  
 CO5 – To understand advanced technology in green synthesis

**TEXT BOOKS**

1. Green technology and design for the environment, Samir B. Billatos, Nadia A. Basaly, Taylor & Francis, Washington, DC, ©1997
2. Green Chemistry – An introductory text - M. Lancaster, RSC, 2016.
3. Green chemistry metrics - Alexi Lapkin and david Constable (Eds) , Wiley publications, 2008

## REFERENCE BOOKS

1. Environmental chemistry, Stanley E Manahan, Taylor and Francis, 2017

CES336

ENVIRONMENTAL QUALITY MONITORING AND ANALYSIS

L T P C  
3 0 0 3

### OBJECTIVES:

- to understand and study the complexity of the environment in relation to pollutants generated due to industrial activity.
- To analyze the quality of the environmental parameters and monitor the same for the purpose of environmental risk assessment.

### UNIT I ENVIRONMENTAL MONITORING AND STANDARDS

9

Introduction- Environmental Standards- Classification of Environmental Standards- Global Environmental Standards- Environmental Standards in India- Ambient air quality standards- water quality standard- Environmental Monitoring-Need for environmental monitoring- Concepts of environmental monitoring- Techniques of Environmental Monitoring.

### UNIT II MONITORING OF ENVIRONMENTAL PARAMETERS

9

Current Environmental Issues- Global Environmental monitoring programme-International conventions- Application of Environmental Monitoring- Atmospheric Monitoring - screening parameters – Significance of environmental sampling- sampling methods – water sampling - sampling of ambient air-sampling of flue gas.

### UNIT III ANALYTICAL METHODS FOR ENVIRONMENTAL MONITORING

9

Classification of Instrumental Method- Analysis of Organic Pollutants by Spectrophotometric methods -Determination of nitrogen, phosphorus and, chemical oxygen demand (COD) in sewage; Biochemical oxygen demand (BOD)- Sampling techniques for air pollution measurements; analysis of particulates and air pollutants like oxides of nitrogen, oxides of sulfur, carbon monoxide, hydrocarbon; Introduction to advanced instruments for environmental analysis

### UNIT IV ENVIRONMENTAL MONITORING PROGRAMME (EMP) & RISKASSESSMENT

9

Water quality monitoring programme- national water quality monitoring- Parameters for National Water Quality Monitoring- monitoring protocol; Process of risk assessment- hazard identification- exposure assessment- dose-response assessment; risk characterization.

### UNIT V AUTOMATED DATA ACQUISITION AND PROCESSING

9

Data Acquisition for Process Monitoring and Control - The Data Acquisition System - Online Data Acquisition, Monitoring, and Control - Implementation of a Data Management System - Review of Observational Networks -Sensors and transducers- classification of transducers- data acquisition system- types of data acquisition systems- data management and quality control; regulatory overview.

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES

After completion of this course, the students will know

- CO1 Basic concepts of environmental standards and monitoring.
- CO2 the ambient air quality and water quality standards;
- CO3 the various instrumental methods and their principles for environmental monitoring
- CO4 The significance of environmental standards in monitoring quality and sustainability of the environment.
- CO5 the various ways of raising environmental awareness among the people.
- CO6 Know the standard research methods that are used worldwide for monitoring the environment.

## TEXTBOOKS

1. Environmental monitoring Handbook, Frank R. Burden, © 2002 by The McGraw-Hill Companies, Inc.
2. Handbook of environmental analysis: chemical pollutants in the air, water, soil, and soil wastes / Pradyot Patnaik, © 1997 by CRC Press, Inc

## REFERENCES

1. Environmental monitoring / edited by G. Bruce Wiersma, © 2004 by CRC Press LLC.
2. H. H. Willard, L. L. Merit, J. A. Dean and F. A. Settle, Instrumental Methods of Analysis, CBP Publishers and Distributors, New Delhi, 1988.
3. Heaslip, G. (1975) Environmental Data Handling. John Wiley & Sons. New York.

## CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	1	1	1	-	-	-	-	-	-	-	-	-	3	-	-
CO2	1	1	1	1	1	-	-	-	1	-	2	2	2	1	1
CO3	1	1	2	1	1	-	-	-	2	-	1	1	1	-	-
CO4	1	2	3	3	1	-	-	-	2	-	3	3	1	-	-
CO5	1	1	3	2	1	-	-	-	3	-	3	1	2	-	-
CO6	3	2	3	3	2	-	-	-	3	-	3	3	3	1	1
Over all	3	2	3	3	2	-	-	-	3	-	3	3	3	1	1

PROGRESS THROUGH KNOWLEDGE

**COURSE OBJECTIVES:**

1. To create awareness on the energy scenario of India with respect to world
2. To understand the fundamentals of energy sources, energy efficiency and resulting environmental implications of energy utilisation
3. Familiarisation on the concept of sustainable development and its benefits
4. Recognize the potential of renewable energy sources and its conversion technologies for attaining sustainable development
5. Acquainting with energy policies and energy planning for sustainable development

**UNIT I ENERGY SCENARIO 9**

Comparison of energy scenario – India and World (energy sources, generation mix, consumption pattern, T&D losses, energy demand, per capita energy consumption) – energy pricing – Energy security.

**UNIT II ENERGY AND ENVIRONMENT 9**

Conventional Energy Sources - Emissions from fuels – Air, Water and Land pollution – Environmental standards - measurement and controls

**UNIT III SUSTAINABLE DEVELOPMENT 9**

Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG) - Social development: Poverty, conceptual issues and measures, impact of poverty. Globalization and Economic growth - Economic development: Economic inequalities, Income and growth.

**UNIT IV RENEWABLE ENERGY TECHNOLOGY 9**

Renewable Energy – Sources and Potential – Technologies for harnessing from Solar, Wind, Hydro, Biomass and Oceans – Principle of operation, relative merits and demerits

**UNIT V ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT 9**

National & State Energy Policy - National solar mission - Framework of Central Electricity Authority - National Hydrogen Mission - Energy and climate policy - State Energy Action Plan, RE integration, Road map for ethanol blending, Energy Efficiency and Energy Mix

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

1. Understand the world and Indian energy scenario
2. Analyse energy projects, its impact on environment and suggest control strategies
3. Recognise the need of Sustainable development and its impact on human resource development
4. Apply renewable energy technologies for sustainable development
5. Fathom Energy policies and planning for sustainable development.

**REFERENCES:**

1. Energy Manager Training Manual (4Volumes) available at <http://www.em-ea.org/gbook1.asp>, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004
2. Robert Ristirer and Jack P. Kraushaar, "Energy and the environment", Willey, 2005.
3. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012
4. Twidell, J.W. & Weir A., "Renewable Energy Resources", EFNSpon Ltd., UK, 2015.

5. Dhandapani Alagiri, Energy Security in India Current Scenario, The ICFAI University Press, 2006.
6. M.H. Fulekar, Bhawana Pathak, R K Kale, "Environment and Sustainable Development" Springer, 2016
7. <https://www.niti.gov.in/verticals/energy>

**CES338 ENERGY EFFICIENCY FOR SUSTAINABLE DEVELOPMENT L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

1. To understand the types of energy sources, energy efficiency and environmental implications of energy utilisation
2. To create awareness on energy audit and its impacts
3. To acquaint the techniques adopted for performance evaluation of thermal utilities
4. To familiarise on the procedures adopted for performance evaluation of electrical utilities
5. To learn the concept of sustainable development and the implication of energy usage

**UNIT I ENERGY AND ENVIRONMENT 9**

Primary energy sources - Coal, Oil, Gas – India Vs World with respect to energy production and consumption, Climate Change, Global Warming, Ozone Depletion, UNFCCC, COP

**UNIT II ENERGY AUDITING 9**

Need and types of energy audit. Energy management (audit) approach - understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments.

**UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES 9**

Energy conservation avenues in steam generation and utilisation, furnaces, Thermic Fluid Heaters. Insulation and Refractories - Commercial waste heat recovery devices: recuperator, regenerator, heat pipe, heat exchangers (Plate, Shell & Tube), heat pumps, and thermocompression

**UNIT IV ENERGY CONSERVATION IN ELECTRICAL UTILITIES 9**

Demand side management - Power factor improvement – Energy efficient transformers - Energy conservation avenues in Motors, HVAC, fans, blowers, pumps, air compressors, illumination systems and cooling towers

**UNIT V SUSTAINABLE DEVELOPMENT 9**

Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG). Globalization and Economic growth. Economic development: Economic inequalities, Income and growth. Social development: Poverty, conceptual issues and measures, impact of poverty,

**TOTAL: 45 PERIODS**

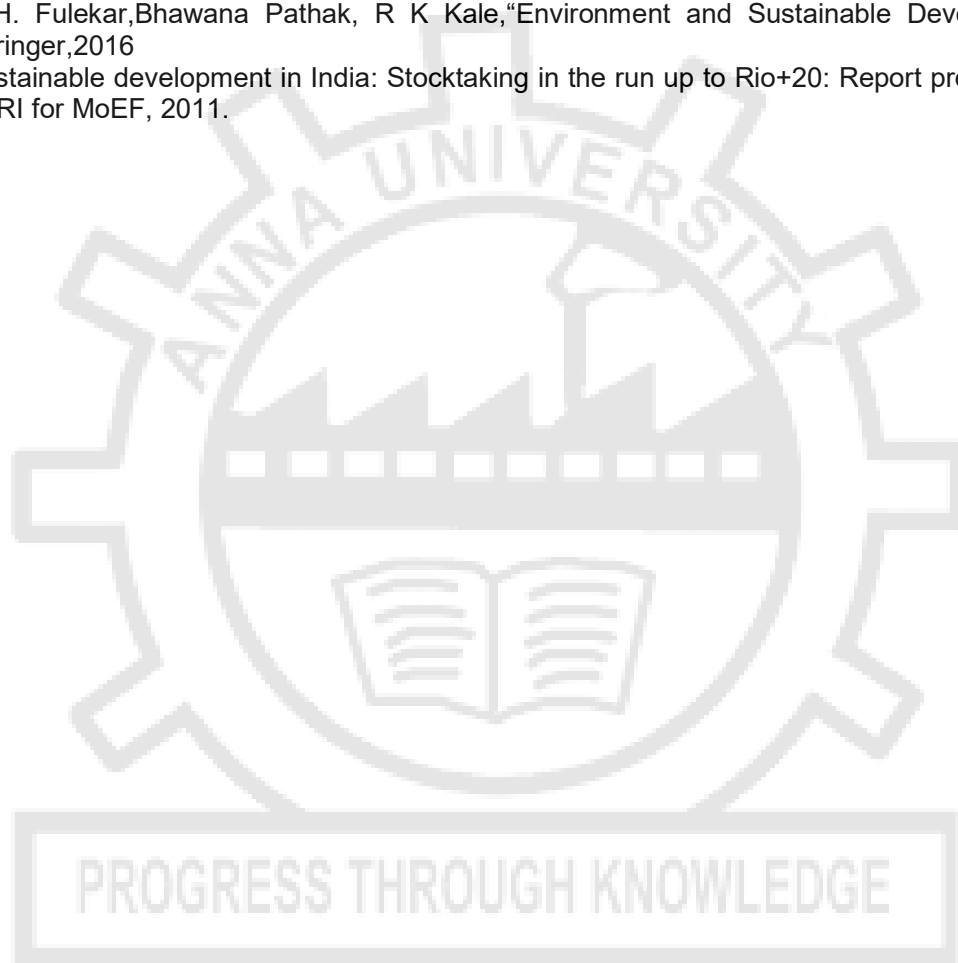
**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

1. Understand the prevailing energy scenario
2. Familiarise on energy audits and its relevance
3. Apply the concept of energy audit on thermal utilities
4. Employ relevant techniques for energy improvement in electrical utilities
5. Understand Sustainable development and its impact on human resource development

## REFERENCES:

1. Energy Manager Training Manual (4Volumes) available at [http://www.em-  
ea.org/gbook1.asp](http://www.em-<br/>ea.org/gbook1.asp), a website administered by Bureau of Energy Efficiency (BEE), a  
statutory body under Ministry of Power, Government of India.2004
2. Eastop.T.D& Croft D.R, "Energy Efficiency for Engineers and Technologists", Logman  
Scientific & Technical, ISBN-0-582-03184, 1990
3. W.R. Murphy and G. McKay "Energy Management" Butterworths, London 1987
4. Pratap Bhattacharyya, "Climate Change and Greenhouse Gas Emission", New India  
Publishing Agency- Nipa,2020
5. Matthew John Franchetti , Defne Apul "Carbon Footprint Analysis: Concepts, Methods,  
Implementation, and Case Studies" CRC Press,2012
6. Robert A. Ristinen, Jack J. Kraushaar, Jeffrey T. Brack, "Energy and the Environment", 4th  
Edition,Wiley,2022
7. M.H. Fulekar,Bhawana Pathak, R K Kale,"Environment and Sustainable Development"  
Springer,2016
8. Sustainable development in India: Stocktaking in the run up to Rio+20: Report prepared by  
TERI for MoEF, 2011.





**ANNA UNIVERSITY, CHENNAI**  
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**REGULATIONS 2021**  
**CHOICE BASED CREDIT SYSTEM**

**B. E. ELECTRONICS AND COMMUNICATION ENGINEERING**

**I. PROGRAM EDUCATIONAL OBJECTIVES (PEOs)**

1. To provide the students with a strong foundation in the required sciences in order to pursue studies in Electronics and Communication Engineering.
2. To gain adequate knowledge to become good professional in electronic and communication engineering associated industries, higher education and research.
3. To develop attitude in lifelong learning, applying and adapting new ideas and technologies as their field evolves.
4. To prepare students to critically analyze existing literature in an area of specialization and ethically develop innovative and research oriented methodologies to solve the problems identified.
5. To inculcate in the students a professional and ethical attitude and an ability to visualize the engineering issues in a broader social context.

**II. PROGRAM OUTCOMES (POs)**

- 1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- 2 **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- 4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- 5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- 6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.



7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12 **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**III. PROGRAM SPECIFIC OUTCOMES (PSOs)**

PSO1: Design, develop and analyze electronic systems through application of relevant electronics, mathematics and engineering principles

PSO2: Design, develop and analyze communication systems through application of fundamentals from communication principles, signal processing, and RF System Design & Electromagnetics.

PSO3: Adapt to emerging electronics and communication technologies and develop innovative solutions for existing and newer problems

**PEOs(1 to 5) mapped with POs and PSOs**

PEO	PO												PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
I.	3	3	2	2	2	2	-	-	-	-	-	3	3	2	3
II.	3	3	3	3	2	-	-	-	2	1	2	3	3	3	3
III.	3	2	3	3	3	-	-	-	2	2	-	3	3	3	3
IV.	3	3	3	3	2	-	-	3	-	-	-	2	2	2	2
V.	-	-	-	-	2	2	2	2	-	-	-	-	1	1	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

Mapping of Course Outcome and Programme Outcome																	
Year	Sem	Course name	PO												PSO		
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
I		Induction Programme															
		Professional English - I	1.6	2.2	1.8	2.2	1.5	3	3	3	1.6	3	3	3	-	-	
		Matrices and Calculus	3	3	1	1	0	0	0	0	2	0	2	3	-	-	
		Engineering Physics	3	3	1.6	1.2	1.8	1	-	-	-	-	-	1	-	-	
		Engineering Chemistry	2.8	1.3	1.6	1	-	1.5	1.8	-	-	-	-	1.5	-	-	
		Problem Solving and Python Programming	2	3	3	3	2	-	-	-	-	-	2	2	3	3	
		தமிழர் மரபு /Heritage of Tamils															
		Problem Solving and Python Programming Laboratory	2	3	3	3	2	-	-	-	-	-	2	2	3	3	
		Physics and Chemistry Laboratory	3	2.4	2.6	1	1										
			2.6	1.3	1.6	1	1	1.4	1.8	-	-	-	-	1.3	-	-	
English Laboratory §	3	3	3	3	1	3	3	3	3	3	3	3	3	-	-		
II		Professional English - II	3	3	3	3	2.75	3	3	3	2.2	3	3	3	-	-	-
		Statistics and Numerical Methods	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
		Physics for Electronics Engineering	3	2	1.4	1.5	2.5	2	3				1				
		Electrical and Instrumentation Engineering	2	1	1					1				-	-	-	
		Engineering Graphics	3	1	2	-	2	-	-	-	-	3	-	2	2	-	
		Circuit Analysis	3	3	3	2	-	-	-	1	-	1	-	-	-	-	
		தமிழரும் தொழில்நுட்பமும் /Tamils and Technology															
		Engineering Practices Laboratory	3	2			1	1	1				2	2	1	1	
		Circuits Analysis Laboratory	3	3	3	2	-	-	-	1	-	1	-	-	-	-	
		Communication Laboratory / Foreign Language §	2.4	2.8	3	3	1.8	3	3	3	3	3	3	-	-	-	
II	iii	Random Processes and Linear Algebra	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
		C Programming and Data Structures	2	2	1	2	2	1	1	-	1	1	1	2	2	2	2
		Signals and Systems	3	3	3	3	3	2	-	-	-	-	-	3	2	3	1
		Electronic Devices and Circuits	3	3	3	3	2	2	-	-	-	-	-	1	2	1	1

		Control Systems	3	3	3	3	2	2	-	-	-	-	2	3	3	3	3
		Digital Systems Design	3	2.6	2.6	2.3	-	2	-	-	-	-	2	2	3	3	2
		Electronic Devices and Circuits Laboratory	2	2	2.6	3	-	-	-	-	-	-	-	-	2	1	1
		C Programming and Data Structures Laboratory	2	2	1	2	2	1	1	-	1	1	1	2	2	2	2
		Professional Development <sup>s</sup>															
<b>IV</b>		Electromagnetic Fields	2	2	2	2	2	2	1	-	-	1	1	2			
		Embedded Systems and IOT Design	3	3	2.6	2.2	2.2	-	-	-	-	-	-	-	2.8	2.2	1.4
		Linear Integrated Circuits	1.4	2.5	3	2.2	-	-	-	-	-	-	1	3	2	1	1
		Digital Signal Processing	3	3	2	2	2	2	-	-	-	-	1	1	2	2	2
		Communication Systems	3	3	3	3	2.5	1	1	-	-	-	1	1			
		Environmental Sciences and Sustainability	2.8	1.8	1	1	-	2.2	2.4	-	-	-	-	1.8	-	-	-
		Communication Systems Laboratory	3	3	3	3	3	2.5	-	-	-	1	1	1			
		Linear Integrated Circuits Laboratory	2	3	3	3	2	-	-	-	-	-	1	1			
<b>III</b>	<b>V</b>	Wireless Communication	3	3	2	2	2	2	-	-	-	-	-	1	3	1	2
		VLSI and Chip Design	2	2	2	2	1	1.5	-	-	-	-	1	2	3	3	3
		Transmission lines and RF Systems	3	3	3	3	2	1	-	-	-	1	-	1	2	1	1
		VLSI Laboratory	2.2	2.2	2.2	2.2	1	-	-	-	-	-	1	1	2	2	2
<b>VI</b>		Telecommunication Switching and Transmission	3	2.6	2.8	2.2	1.2	-	-	-	-	-	-	2	2.8	2.4	2.2
		Artificial Intelligence and Machine Learning	2	1	2	2	1	-	-	-	2	2	2	3	2	2	2
<b>IV</b>	<b>VII</b>	Human Values and Ethics															
		Summer internship															
<b>VIII</b>		Project Work Internship															

1 - low, 2 - medium, 3 - high, '-' - no correlation

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**B. E. ELECTRONICS AND COMMUNICATION ENGINEERING**  
**CHOICE BASED CREDIT SYSTEM**  
**CURRICULUM AND SYLLABI FOR SEMESTERS I TO VIII**  
**SEMESTER I**

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IP3151	Induction Programme	-	-	-	-	-	0
<b>THEORY</b>								
2.	HS3152	Professional English - I	HSMC	3	0	0	3	3
3.	MA3151	Matrices and Calculus	BSC	3	1	0	4	4
4.	PH3151	Engineering Physics	BSC	3	0	0	3	3
5.	CY3151	Engineering Chemistry	BSC	3	0	0	3	3
6.	GE3151	Problem Solving and Python Programming	ESC	3	0	0	3	3
7.	GE3152	தமிழர் மரபு /Heritage of Tamils	HSMC	1	0	0	1	1
<b>PRACTICALS</b>								
8.	GE3171	Problem Solving and Python Programming Laboratory	ESC	0	0	4	4	2
9.	BS3171	Physics and Chemistry Laboratory	BSC	0	0	4	4	2
10.	GE3172	English Laboratory §	EEC	0	0	2	2	1
<b>TOTAL</b>				<b>16</b>	<b>1</b>	<b>10</b>	<b>27</b>	<b>22</b>

§ Skill Based Course

**SEMESTER II**

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	HS3252	Professional English - II	HSMC	2	0	0	2	2
2.	MA3251	Statistics and Numerical Methods	BSC	3	1	0	4	4
3.	PH3254	Physics for Electronics Engineering	BSC	3	0	0	3	3
4.	BE3254	Electrical and Instrumentation Engineering	ESC	3	0	0	3	3
5.	GE3251	Engineering Graphics	ESC	2	0	4	6	4
6.	EC3251	Circuit Analysis	PCC	3	1	0	4	4
7.	GE3252	தமிழரும் தொழில்நுட்பமும் /Tamils and Technology	HSMC	1	0	0	1	1
8.		NCC Credit Course Level 1#	-	2	0	0	2	2*
<b>PRACTICALS</b>								
9.	GE3271	Engineering Practices Laboratory	ESC	0	0	4	4	2
10.	EC3271	Circuits Analysis Laboratory	PCC	0	0	2	2	1
11.	GE3272	Communication Laboratory / Foreign Language §	EEC	0	0	4	4	2
<b>TOTAL</b>				<b>17</b>	<b>1</b>	<b>14</b>	<b>33</b>	<b>26</b>

# NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

§ Skill Based Course

**SEMESTER III**

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	MA3355	Random Processes and Linear Algebra	BSC	3	1	0	4	4
2.	CS3353	C Programming and Data Structures	ESC	3	0	0	3	3
3.	EC3354	Signals and Systems	PCC	3	1	0	4	4
4.	EC3353	Electronic Devices and Circuits	PCC	3	0	0	3	3
5.	EC3351	Control Systems	PCC	3	0	0	3	3
6.	EC3352	Digital Systems Design	PCC	3	0	2	5	4
<b>PRACTICALS</b>								
7.	EC3361	Electronic Devices and Circuits Laboratory	PCC	0	0	3	3	1.5
8.	CS3362	C Programming and Data Structures Laboratory	PCC	0	0	3	3	1.5
9.	GE3361	Professional Development <sup>§</sup>	EEC	0	0	2	2	1
<b>TOTAL</b>				<b>18</b>	<b>2</b>	<b>10</b>	<b>30</b>	<b>25</b>

<sup>§</sup> Skill Based Course

**SEMESTER IV**

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	EC3452	Electromagnetic Fields	PCC	3	0	0	3	3
2.	EC3401	Networks and Security	PCC	3	0	2	5	4
3.	EC3451	Linear Integrated Circuits	PCC	3	0	0	3	3
4.	EC3492	Digital Signal Processing	PCC	3	0	2	5	4
5.	EC3491	Communication Systems	PCC	3	0	0	3	3
6.	GE3451	Environmental Sciences and Sustainability	BSC	2	0	0	2	2
7.		NCC Credit Course Level 2 <sup>#</sup>		3	0	0	3	3 <sup>#</sup>
<b>PRACTICALS</b>								
8.	EC3461	Communication Systems Laboratory	PCC	0	0	3	3	1.5
9.	EC3462	Linear Integrated Circuits Laboratory	PCC	0	0	3	3	1.5
<b>TOTAL</b>				<b>17</b>	<b>0</b>	<b>10</b>	<b>27</b>	<b>22</b>

<sup>#</sup> NCC Credit Course level 2 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

**SEMESTER V**

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	EC3501	Wireless Communication	PCC	3	0	2	5	4
2.	EC3552	VLSI and Chip Design	PCC	3	0	0	3	3
3.	EC3551	Transmission lines and RF Systems	PCC	3	0	0	3	3
4.		Professional Elective I	PEC	-	-	-	-	3
5.		Professional Elective II	PEC	-	-	-	-	3
6.		Professional Elective III	PEC	-	-	-	-	3
7.		Mandatory Course-I <sup>&amp;</sup>	MC	3	0	0	3	0
<b>PRACTICALS</b>								
8.	EC3561	VLSI Laboratory	PCC	0	0	4	4	2
<b>TOTAL</b>				-	-	-	-	<b>21</b>

<sup>&</sup> Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under Mandatory Course-I)

**SEMESTER VI**

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	ET3491	Embedded Systems and IOT Design	PCC	3	0	2	5	4
2.	CS3491	Artificial Intelligence and Machine Learning	ESC	3	0	2	5	4
3.		Open Elective– I*	OEC	3	0	0	3	3
4.		Professional Elective V	PEC	-	-	-	-	3
5.		Professional Elective VI	PEC	-	-	-	-	3
6.		Professional Elective VII	PEC	-	-	-	-	3
7.		Mandatory Course-II <sup>&amp;</sup>	MC	3	0	0	3	0
8.		NCC Credit Course Level 3 <sup>#</sup>		3	0	0	3	3 <sup>#</sup>
<b>TOTAL</b>				-	-	-	-	<b>20</b>

<sup>\*</sup>Open Elective – I Shall be chosen from the list of open electives offered by other Programmes

<sup>&</sup> Mandatory Course-II is a Non-credit Course (Student shall select one course from the list given under Mandatory Course-II)

<sup>#</sup> NCC Credit Course level 3 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA

**SEMESTER VII / VIII\***

S. NO	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	GE3791	Human Values and Ethics	HSMC	2	0	0	2	2
2.		Elective - Management <sup>#</sup>	HSMC	3	0	0	3	3
3.		Open Elective – II**	OEC	3	0	0	3	3
4.		Open Elective – III**	OEC	3	0	0	3	3
5.		Open Elective – IV**	OEC	3	0	0	3	3
<b>PRACTICALS</b>								
6.	EC3711	Summer internship	EEC	0	0	0	0	2
<b>TOTAL</b>				<b>14</b>	<b>0</b>	<b>0</b>	<b>14</b>	<b>16</b>

\*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

\*\* Open Elective II - IV (Shall be chosen from the list of open electives offered by other Programmes).

# Elective - Management shall be chosen from the Elective Management courses.

**SEMESTER VIII /VII\***

S. NO	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>PRACTICALS</b>								
1.	EC3811	Project Work / Internship	EEC	0	0	20	20	10
<b>TOTAL</b>				<b>0</b>	<b>0</b>	<b>20</b>	<b>20</b>	<b>10</b>

\*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

**TOTAL CREDITS : 162**

**ELECTIVE – MANAGEMENT COURSES**

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	GE3751	Principles of Management	HSMC	3	0	0	3	3
2.	GE3752	Total Quality Management	HSMC	3	0	0	3	3
3.	GE3753	Engineering Economics and Financial Accounting	HSMC	3	0	0	3	3
4.	GE3754	Human Resource Management	HSMC	3	0	0	3	3
5.	GE3755	Knowledge Management	HSMC	3	0	0	3	3
6.	GE3792	Industrial Management	HSMC	3	0	0	3	3

### MANDATORY COURSES I

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3081	Introduction to Women and Gender Studies	MC	3	0	0	3	0
2.	MX3082	Elements of Literature	MC	3	0	0	3	0
3.	MX3083	Film Appreciation	MC	3	0	0	3	0
4.	MX3084	Disaster Risk Reduction and Management	MC	3	0	0	3	0

### MANDATORY COURSES II

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3085	Well Being with Traditional Practices - Yoga, Ayurveda and Siddha	MC	3	0	0	3	0
2.	MX3086	History of Science and Technology in India	MC	3	0	0	3	0
3.	MX3087	Political and Economic Thought for a Humane Society	MC	3	0	0	3	0
4.	MX3088	State, Nation Building and Politics in India	MC	3	0	0	3	0
5.	MX3089	Industrial Safety	MC	3	0	0	3	0



<b>Vertical I Semiconductor Chip Design and Testing</b>	<b>Vertical II Signal Processing</b>	<b>Vertical III RF Technologies</b>	<b>Vertical IV Bio Medical Technologies</b>	<b>Vertical V Underwater Technologies</b>	<b>Vertical VI Sensor Technologies and IoT</b>	<b>Vertical VII Space Technologies</b>	<b>Vertical VIII High Speed Communications</b>
Wide Bandgap Devices	Advanced Digital Signal Processing	RF Transceivers	Wearable Devices	Underwater Instrumentation System	IoT Processors	Radar Technologies	Optical Communication & Networks
Validation and Testing Technology	Image Processing	Signal Integrity	Human Assist Devices	Underwater Imaging Systems and Image Processing	IoT Based System Design	Avionics Systems	Wireless Broad Band Networks
Low Power IC Design	Speech Processing	Antenna Design	Therapeutic Equipment	Underwater Communication	Wireless Sensor Network Design	Positioning and Navigation Systems	4G/5G Communication Networks
VLSI Testing and Design For Testability	Software Defined Radio	MICs and RF System Design	Medical Imaging Systems	Ocean Observation Systems	Industrial IoT and Industry 4.0	Satellite Communication	Software Defined Networks
Mixed Signal IC Design Testing	DSP Architecture and Programming	EMI/EMC Pre Compliance Testing	Brain Computer Interface and Applications	Underwater Navigation Systems	MEMS Design	Remote Sensing	Massive MIMO Networks
Analog IC Design	Computer Vision	RF ID System Design & Testing	Body Area Networks	Ocean Acoustics	Fundamentals of Nanoelectronics	Rocketry and Space Mechanics	Advanced Wireless Communication Techniques

### **PROFESSIONAL ELECTIVE COURSES: VERTICALS**

#### **Registration of Professional Elective Courses from Verticals:**

Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E./B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to the Regulations 2021, Clause 4.10 (Amendments).

**PROFESSIONAL ELECTIVE COURSES: VERTICALS**

**VERTICAL 1: SEMICONDUCTOR CHIP DESIGN AND TESTING**

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CEC363	Wide Bandgap Devices	PEC	2	0	2	4	3
2.	CEC361	Validation and Testing Technology	PEC	2	0	2	4	3
3.	CEC370	Low Power IC Design	PEC	2	0	2	4	3
4.	CEC362	VLSI Testing and Design For Testability	PEC	2	0	2	4	3
5.	CEC342	Mixed Signal IC Design Testing	PEC	2	0	2	4	3
6.	CEC334	Analog IC Design	PEC	2	0	2	4	3

**VERTICAL 2: SIGNAL PROCESSING**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CEC332	Advanced Digital Signal Processing	PEC	2	0	2	4	3
2.	CEC366	Image Processing	PEC	3	0	0	3	3
3.	CEC356	Speech Processing	PEC	2	0	2	4	3
4.	CEC355	Software Defined Radio	PEC	2	0	2	4	3
5.	CEC337	DSP Architecture and Programming	PEC	2	0	2	4	3
6.	CCS338	Computer Vision	PEC	2	0	2	4	3

**VERTICAL 3: RF TECHNOLOGIES**

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CEC350	RF Transceivers	PEC	2	0	2	4	3
2.	CEC353	Signal Integrity	PEC	2	0	2	4	3
3.	CEC335	Antenna Design	PEC	2	0	2	4	3
4.	CEC341	MICs and RF System Design	PEC	2	0	2	4	3
5.	CEC338	EMI/EMC Pre Compliance Testing	PEC	2	0	2	4	3
6.	CEC349	RFID System Design and Testing	PEC	2	0	2	4	3

**VERTICAL 4: BIO MEDICAL TECHNOLOGIES**

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CBM370	Wearable Devices	PEC	3	0	0	3	3
2.	CBM352	Human Assist Devices	PEC	3	0	0	3	3
3.	CBM368	Therapeutic Equipment	PEC	3	0	0	3	3
4.	CBM355	Medical Imaging Systems	PEC	3	0	0	3	3
5.	CBM342	Brain Computer Interface and Applications	PEC	3	0	0	3	3
6.	CBM341	Body Area Networks	PEC	3	0	0	3	3

### VERTICAL 5: UNDERWATER TECHNOLOGIES

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CEC359	Underwater Instrumentation System	PEC	3	0	0	3	3
2.	CEC358	Underwater Imaging Systems and Image Processing	PEC	2	0	2	4	3
3.	CEC357	Underwater Communication	PEC	2	0	2	4	3
4.	CEC344	Ocean Observation Systems	PEC	2	0	2	4	3
5.	CEC360	Underwater Navigation Systems	PEC	3	0	0	3	3
6.	CEC343	Ocean Acoustics	PEC	2	0	2	4	3

### VERTICAL 6: SENSOR TECHNOLOGIES AND IOT

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CEC369	IoT Processors	PEC	2	0	2	4	3
2.	CEC368	IoT Based Systems Design	PEC	3	0	0	3	3
3.	CEC365	Wireless Sensor Network Design	PEC	3	0	0	3	3
4.	CEC367	Industrial IoT and Industry 4.0	PEC	2	0	2	4	3
5.	CEC340	MEMS Design	PEC	2	0	2	4	3
6.	CEC339	Fundamentals of Nanoelectronics	PEC	2	0	2	4	3

### VERTICAL 7: SPACE TECHNOLOGIES

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CEC347	Radar Technologies	PEC	3	0	0	3	3
2.	CEC336	Avionics Systems	PEC	3	0	0	3	3
3.	CEC346	Positioning and Navigation Systems	PEC	3	0	0	3	3
4.	CEC352	Satellite Communication	PEC	3	0	0	3	3
5.	CEC348	Remote Sensing	PEC	3	0	0	3	3
6.	CEC351	Rocketry and Space Mechanics	PEC	3	0	0	3	3

### VERTICAL 8: HIGH SPEED COMMUNICATIONS

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CEC345	Optical Communication & Networks	PEC	3	0	0	3	3
2.	CEC364	Wireless Broad Band Networks	PEC	3	0	0	3	3
3.	CEC331	4G/5G Communication Networks	PEC	2	0	2	4	3
4.	CEC354	Software Defined Networks	PEC	2	0	2	4	3
5.	CEC371	Massive MIMO Networks	PEC	2	0	2	4	3
6.	CEC333	Advanced Wireless Communication Techniques	PEC	3	0	0	3	3

**OPEN ELECTIVES**

(Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories).

**OPEN ELECTIVES – I**

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OAS351	Space Science	OEC	3	0	0	3	3
2.	OIE351	Introduction to Industrial Engineering	OEC	3	0	0	3	3
3.	OBT351	Food, Nutrition and Health	OEC	3	0	0	3	3
4.	OCE351	Environmental and Social Impact Assessment	OEC	3	0	0	3	3
5.	OEE351	Renewable Energy System	OEC	3	0	0	3	3
6.	OEI351	Introduction to Industrial Instrumentation and Control	OEC	3	0	0	3	3
7.	OMA351	Graph Theory	OEC	3	0	0	3	3
8.	CCS355	Neural Networks and Deep Learning	OEC	2	0	2	4	3
9.	CCW332	Digital Marketing	OEC	2	0	2	4	3

**OPEN ELECTIVES – II**

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OIE352	Resource Management Techniques	OEC	3	0	0	3	3
2.	OMG351	Fintech Regulation	OEC	3	0	0	3	3
3.	OFD351	Holistic Nutrition	OEC	3	0	0	3	3
4.	AI3021	IT in Agricultural System	OEC	3	0	0	3	3
5.	OEI352	Introduction to Control Engineering	OEC	3	0	0	3	3
6.	OPY351	Pharmaceutical Nanotechnology	OEC	3	0	0	3	3
7.	OAE351	Aviation Management	OEC	3	0	0	3	3
8.	CCS342	DevOps	OEC	2	0	2	4	3
9.	CCS361	Robotic Process Automation	OEC	2	0	2	4	3

**OPEN ELECTIVES – III**

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS351	English for Competitive Examinations	OEC	3	0	0	3	3
2.	OMG352	NGOs and Sustainable Development	OEC	3	0	0	3	3
3.	OMG353	Democracy and Good Governance	OEC	3	0	0	3	3
4.	CME365	Renewable Energy Technologies	OEC	3	0	0	3	3
5.	OME354	Applied Design Thinking	OEC	3	0	0	3	3
6.	MF3003	Reverse Engineering	OEC	3	0	0	3	3
7.	OPR351	Sustainable Manufacturing	OEC	3	0	0	3	3
8.	AU3791	Electric and Hybrid Vehicles	OEC	3	0	0	3	3
9.	OAS352	Space Engineering	OEC	3	0	0	3	3
10.	OIM351	Industrial Management	OEC	3	0	0	3	3
11.	OIE354	Quality Engineering	OEC	3	0	0	3	3
12.	OSF351	Fire Safety Engineering	OEC	3	0	0	3	3
13.	OML351	Introduction to Non-Destructive Testing	OEC	3	0	0	3	3
14.	OMR351	Mechatronics	OEC	3	0	0	3	3
15.	ORA351	Foundation of Robotics	OEC	3	0	0	3	3
16.	OAE352	Fundamentals of Aeronautical Engineering	OEC	3	0	0	3	3
17.	OGI351	Remote Sensing Concepts	OEC	3	0	0	3	3
18.	OAI351	Urban Agriculture	OEC	3	0	0	3	3
19.	OEN351	Drinking Water Supply and Treatment	OEC	3	0	0	3	3
20.	OEE352	Electric Vehicle Technology	OEC	3	0	0	3	3
21.	OEI353	Introduction to PLC Programming	OEC	3	0	0	3	3
22.	OCH351	Nano Technology	OEC	3	0	0	3	3
23.	OCH352	Functional Materials	OEC	3	0	0	3	3
24.	OFD352	Traditional Indian Foods	OEC	3	0	0	3	3
25.	OFD353	Introduction to Food Processing	OEC	3	0	0	3	3
26.	OPY352	IPR for Pharma Industry	OEC	3	0	0	3	3
27.	OTT351	Basics of Textile Finishing	OEC	3	0	0	3	3
28.	OTT352	Industrial Engineering for Garment Industry	OEC	3	0	0	3	3
29.	OTT353	Basics of Textile Manufacture	OEC	3	0	0	3	3
30.	OPE351	Introduction to Petroleum Refining and Petrochemicals	OEC	3	0	0	3	3
31.	CPE334	Energy Conservation and Management	OEC	3	0	0	3	3
32.	OPT351	Basics of Plastics Processing	OEC	3	0	0	3	3
33.	CBM348	Foundation Skills in Integrated Product Development	OEC	3	0	0	3	3
34.	CBM333	Assistive Technology	OEC	3	0	0	3	3
35.	OMA352	Operations Research	OEC	3	0	0	3	3
36.	OMA353	Algebra and Number Theory	OEC	3	0	0	3	3

37.	OMA354	Linear Algebra	OEC	3	0	0	3	3
38.	OCE353	Lean Concepts, Tools and Practices	OEC	3	0	0	3	3
39.	OBT352	Basics of Microbial Technology	OEC	3	0	0	3	3
40.	OBT353	Basics of Biomolecules	OEC	3	0	0	3	3
41.	OBT354	Fundamentals of Cell and Molecular Biology	OEC	3	0	0	3	3

#### OPEN ELECTIVES – IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS352	Project Report Writing	OEC	3	0	0	3	3
2.	OMA355	Advanced Numerical Methods	OEC	3	0	0	3	3
3.	OMA356	Random Processes	OEC	3	0	0	3	3
4.	OMA357	Queuing and Reliability Modelling	OEC	3	0	0	3	3
5.	OMG354	Production and Operations Management for Entrepreneurs	OEC	3	0	0	3	3
6.	OMG355	Multivariate Data Analysis	OEC	3	0	0	3	3
7.	OME352	Additive Manufacturing	OEC	3	0	0	3	3
8.	CME343	New Product Development	OEC	3	0	0	3	3
9.	OME355	Industrial Design & Rapid Prototyping Techniques	OEC	3	0	0	3	3
10.	MF3010	Micro and Precision Engineering	OEC	3	0	0	3	3
11.	OMF354	Cost Management of Engineering Projects	OEC	3	0	0	3	3
12.	AU3002	Batteries and Management system	OEC	3	0	0	3	3
13.	AU3008	Sensors and Actuators	OEC	3	0	0	3	3
14.	OAS353	Space Vehicles	OEC	3	0	0	3	3
15.	OIM352	Management Science	OEC	3	0	0	3	3
16.	OIM353	Production Planning and Control	OEC	3	0	0	3	3
17.	OIE353	Operations Management	OEC	3	0	0	3	3
18.	OSF352	Industrial Hygiene	OEC	3	0	0	3	3
19.	OSF353	Chemical Process Safety	OEC	3	0	0	3	3
20.	OML352	Electrical, Electronic and Magnetic materials	OEC	3	0	0	3	3
21.	OML353	Nanomaterials and applications	OEC	3	0	0	3	3
22.	OMR352	Hydraulics and Pneumatics	OEC	3	0	0	3	3
23.	OMR353	Sensors	OEC	3	0	0	3	3
24.	ORA352	Concepts in Mobile Robots	OEC	3	0	0	3	3
25.	MV3501	Marine Propulsion	OEC	3	0	0	3	3
26.	OMV351	Marine Merchant Vehicles	OEC	3	0	0	3	3
27.	OMV352	Elements of Marine Engineering	OEC	3	0	0	3	3
28.	CRA332	Drone Technologies	OEC	3	0	0	3	3



29.	OGI352	Geographical Information System	OEC	3	0	0	3	3
30.	OAI352	Agriculture Entrepreneurship Development	OEC	3	0	0	3	3
31.	OEN352	Biodiversity Conservation	OEC	3	0	0	3	3
32.	OEE353	Introduction to control systems	OEC	3	0	0	3	3
33.	OEI354	Introduction to Industrial Automation Systems	OEC	3	0	0	3	3
34.	OCH353	Energy Technology	OEC	3	0	0	3	3
35.	OCH354	Surface Science	OEC	3	0	0	3	3
36.	OFD354	Fundamentals of Food Engineering	OEC	3	0	0	3	3
37.	OFD355	Food Safety and Quality Regulations	OEC	3	0	0	3	3
38.	OPY353	Nutraceuticals	OEC	3	0	0	3	3
39.	OTT354	Basics of Dyeing and Printing	OEC	3	0	0	3	3
40.	FT3201	Fibre Science	OEC	3	0	0	3	3
41.	OTT355	Garment Manufacturing Technology	OEC	3	0	0	3	3
42.	OPE353	Industrial safety	OEC	3	0	0	3	3
43.	OPE354	Unit Operations in Petro Chemical Industries	OEC	3	0	0	3	3
44.	OPT352	Plastic Materials for Engineers	OEC	3	0	0	3	3
45.	OPT353	Properties and Testing of Plastics	OEC	3	0	0	3	3
46.	CBM370	Wearable Devices	OEC	3	0	0	3	3
47.	CBM356	Medical Informatics	OEC	3	0	0	3	3
48.	OCE354	Basics of Integrated Water Resources Management	OEC	3	0	0	3	3
49.	OBT355	Biotechnology for Waste Management	OEC	3	0	0	3	3
50.	OBT356	Lifestyle Diseases	OEC	3	0	0	3	3
51.	OBT357	Biotechnology in Health Care	OEC	3	0	0	3	3

## SUMMARY

Name of the Programme: B.E. Electronics and Communication Engineering										
S.No	Subject Area	Credits per Semester								Total Credits
		I	II	III	IV	V	VI	VII/VIII	VIII/VII	
1	HSMC	4	3					5		12
2	BSC	12	7	4	2					25
3	ESC	5	9	3			4			21
4	PCC		5	17	20	12	4			58
5	PEC					9	9			18
6	OEC						3	9		12
7	EEC	1	2	1				2	10	16
8	Non-Credit /(Mandatory)					√	√			
<b>Total</b>		<b>22</b>	<b>26</b>	<b>25</b>	<b>22</b>	<b>21</b>	<b>20</b>	<b>16</b>	<b>10</b>	<b>162</b>

### ENROLLMENT FOR B.E. / B. TECH. (HONOURS) / MINOR DEGREE (OPTIONAL)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor Degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes, Moreover, for minor degree the student can register for courses from any one of the following verticals also.

Complete details are available in clause 4.10 (Amendments) of Regulations 2021.

**VERTICALS FOR MINOR DEGREE**  
**(In addition to all the verticals of other programmes)**

<b>Vertical I Fintech and Block Chain</b>	<b>Vertical II Entrepreneurship</b>	<b>Vertical III Public Administration</b>	<b>Vertical IV Business Data Analytics</b>	<b>Vertical V Environment and Sustainability</b>
Financial Management	Foundations of Entrepreneurship	Principles of Public Administration	Statistics for Management	Sustainable infrastructure Development
Fundamentals of Investment	Team Building & Leadership Management for Business	Constitution of India	Datamining for Business Intelligence	Sustainable Agriculture and Environmental Management
Banking, Financial Services and Insurance	Creativity & Innovation in Entrepreneurship	Public Personnel Administration	Human Resource Analytics	Sustainable Bio Materials
Introduction to Blockchain and its Applications	Principles of Marketing Management For Business	Administrative Theories	Marketing and Social Media Web Analytics	Materials for Energy Sustainability
Fintech Personal Finance and Payments	Human Resource Management for Entrepreneurs	Indian Administrative System	Operation and Supply Chain Analytics	Green Technology
Introduction to Fintech	Financing New Business Ventures	Public Policy Administration	Financial Analytics	Environmental Quality Monitoring and Analysis
-	-	-	-	Integrated Energy Planning for Sustainable Development
-	-	-	-	Energy Efficiency for Sustainable Development

(choice of courses for Minor degree is to be made from any one vertical of other programmes or from anyone of the following verticals)

**VERTICAL 1: FINTECH AND BLOCK CHAIN**

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG331	Financial Management	PEC	3	0	0	3	3
2.	CMG332	Fundamentals of Investment	PEC	3	0	0	3	3
3.	CMG333	Banking, Financial Services and Insurance	PEC	3	0	0	3	3
4.	CMG334	Introduction to Blockchain and its Applications	PEC	3	0	0	3	3
5.	CMG335	Fintech Personal Finance and Payments	PEC	3	0	0	3	3
6.	CMG336	Introduction to Fintech	PEC	3	0	0	3	3

**VERTICAL 2: ENTREPRENEURSHIP**

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG337	Foundations of Entrepreneurship	PEC	3	0	0	3	3
2.	CMG338	Team Building & Leadership Management for Business	PEC	3	0	0	3	3
3.	CMG339	Creativity & Innovation in Entrepreneurship	PEC	3	0	0	3	3
4.	CMG340	Principles of Marketing Management For Business	PEC	3	0	0	3	3
5.	CMG341	Human Resource Management for Entrepreneurs	PEC	3	0	0	3	3
6.	CMG342	Financing New Business Ventures	PEC	3	0	0	3	3

**VERTICAL 3: PUBLIC ADMINISTRATION**

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG343	Principles of Public Administration	PEC	3	0	0	3	3
2.	CMG344	Constitution of India	PEC	3	0	0	3	3
3.	CMG345	Public Personnel Administration	PEC	3	0	0	3	3
4.	CMG346	Administrative Theories	PEC	3	0	0	3	3
5.	CMG347	Indian Administrative System	PEC	3	0	0	3	3
6.	CMG348	Public Policy Administration	PEC	3	0	0	3	3

**VERTICAL 4: BUSINESS DATA ANALYTICS**

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG349	Statistics for Management	PEC	3	0	0	3	3
2.	CMG350	Datamining for Business Intelligence	PEC	3	0	0	3	3
3.	CMG351	Human Resource Analytics	PEC	3	0	0	3	3
4.	CMG352	Marketing and Social Media Web Analytics	PEC	3	0	0	3	3
5.	CMG353	Operation and Supply Chain Analytics	PEC	3	0	0	3	3
6.	CMG354	Financial Analytics	PEC	3	0	0	3	3

**VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY**

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CES331	Sustainable infrastructure Development	PEC	3	0	0	3	3
2.	CES332	Sustainable Agriculture and Environmental Management	PEC	3	0	0	3	3
3.	CES333	Sustainable Bio Materials	PEC	3	0	0	3	3
4.	CES334	Materials for Energy Sustainability	PEC	3	0	0	3	3
5.	CES335	Green Technology	PEC	3	0	0	3	3
6.	CES336	Environmental Quality Monitoring and Analysis	PEC	3	0	0	3	3
7.	CES337	Integrated Energy Planning for Sustainable Development	PEC	3	0	0	3	3
8.	CES338	Energy Efficiency for Sustainable Development	PEC	3	0	0	3	3

This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

“Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed.”

“One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. “

Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

(i) Physical Activity

This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

(ii) Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

(iii) Universal Human Values

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and don't's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing.

Discussions would be conducted in small groups of about 20 students with a faculty

mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

(iv) Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

(v) Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

(vi) Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

(vii) Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

(viii) Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix) Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering / Technology / Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

**Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.**

References:

Guide to Induction program from AICTE



**COURSE OBJECTIVES:**

- To improve the communicative competence of learners
- To learn to use basic grammatic structures in suitable contexts
- To acquire lexical competence and use them appropriately in a sentence and understand their meaning in a text
- To help learners use language effectively in professional contexts
- To develop learners' ability to read and write complex texts, summaries, articles, blogs, definitions, essays and user manuals.

**UNIT I INTRODUCTION TO EFFECTIVE COMMUNICATION 1**

What is effective communication? (Explain using activities) Why is communication critical for excellence during study, research and work? What are the seven C's of effective communication? What are key language skills? What is effective listening? What does it involve? What is effective speaking? What does it mean to be an excellent reader? What should you be able to do? What is effective writing? How does one develop language and communication skills? What does the course focus on? How are communication and language skills going to be enhanced during this course? What do you as a learner need to do to enhance your English language and communication skills to get the best out of this course?

**INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 8**

Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails. Writing - Writing emails / letters introducing oneself. Grammar - Present Tense (simple and progressive); Question types: Wh/ Yes or No/ and Tags. Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).

**UNIT II NARRATION AND SUMMATION 9**

Reading - Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel & technical blogs. Writing - Guided writing-- Paragraph writing Short Report on an event (field trip etc.) Grammar –Past tense (simple); Subject-Verb Agreement; and Prepositions. Vocabulary - Word forms (prefixes& suffixes); Synonyms and Antonyms. Phrasal verbs.

**UNIT III DESCRIPTION OF A PROCESS / PRODUCT 9**

Reading – Reading advertisements, gadget reviews; user manuals. Writing - Writing definitions; instructions; and Product /Process description. Grammar - Imperatives; Adjectives; Degrees of comparison; Present & Past Perfect Tenses. Vocabulary - Compound Nouns, Homonyms; and Homophones, discourse markers (connectives & sequence words).

**UNIT IV CLASSIFICATION AND RECOMMENDATIONS 9**

Reading – Newspaper articles; Journal reports –and Non Verbal Communication ( tables, pie charts etc,. ). Writing – Note-making / Note-taking (\*Study skills to be taught, not tested); Writing recommendations; Transferring information from non verbal ( chart , graph etc, to verbal mode) Grammar – Articles; Pronouns - Possessive & Relative pronouns. Vocabulary - Collocations; Fixed / Semi fixed expressions.

**UNIT V EXPRESSION 9**

Reading – Reading editorials; and Opinion Blogs; Writing – Essay Writing (Descriptive or narrative). Grammar – Future Tenses, Punctuation; Negation (Statements & Questions); and Simple,

Compound & Complex Sentences. Vocabulary - Cause & Effect Expressions – Content vs Function words.

**TOTAL : 45 PERIODS**

**LEARNING OUTCOMES :**

At the end of the course, learners will be able

CO1:To use appropriate words in a professional context

CO2:To gain understanding of basic grammatic structures and use them in right context.

CO3:To read and infer the denotative and connotative meanings of technical texts

CO4:To write definitions, descriptions, narrations and essays on various topics

**TEXT BOOKS :**

1. English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition)  
English for Science & Technology Cambridge University Press, 2021.
2. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

**REFERENCES:**

1. Technical Communication – Principles And Practices By Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2. A Course Book On Technical English By Lakshminarayanan, Scitech Publications (India) Pvt. Ltd.
3. English For Technical Communication (With CD) By Aysha Viswamohan, Mcgraw Hill Education, ISBN : 0070264244.
4. Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.
5. Learning to Communicate – Dr. V. Chellammal, Allied Publishing House, New Delhi,2003.

**ASSESSMENT PATTERN**

Two internal assessments and an end semester examination to test students’ reading and writing skills along with their grammatical and lexical competence.

**CO’s-PO’s & PSO’s MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1	1	1	1	3	3	3	1	3	-	3	-	-	-
2	1	1	1	1	1	3	3	3	1	3	-	3	-	-	-
3	2	3	2	3	2	3	3	3	2	3	3	3	-	-	-
4	2	3	2	3	2	3	3	3	2	3	3	3	-	-	-
5	2	3	3	3	-	3	3	3	2	3	-	3	-	-	-
AVg.	1.6	2.2	1.8	2.2	1.5	3	3	3	1.6	3	3	3	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

MA3151

**MATRICES AND CALCULUS**

**L T P C**

**3 1 0 4**

**COURSE OBJECTIVES:**

- To develop the use of matrix algebra techniques that are needed by engineers for practical applications.
- To familiarize the students with differential calculus.

- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To make the students understand various techniques of integration.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

### **UNIT I            MATRICES**

**9 + 3**

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley - Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms – Applications : Stretching of an elastic membrane.

### **UNIT II            DIFFERENTIAL CALCULUS**

**9 + 3**

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum, product, quotient, chain rules) - Implicit differentiation - Logarithmic differentiation - Applications : Maxima and Minima of functions of one variable.

### **UNIT III          FUNCTIONS OF SEVERAL VARIABLES**

**9 + 3**

Partial differentiation – Homogeneous functions and Euler’s theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor’s series for functions of two variables – Applications : Maxima and minima of functions of two variables and Lagrange’s method of undetermined multipliers.

### **UNIT IV          INTEGRAL CALCULUS**

**9 + 3**

Definite and Indefinite integrals - Substitution rule - Techniques of Integration : Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals - Applications : Hydrostatic force and pressure, moments and centres of mass.

### **UNIT V            MULTIPLE INTEGRALS**

**9 + 3**

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals – Applications : Moments and centres of mass, moment of inertia.

**TOTAL: 60 PERIODS**

#### **COURSE OUTCOMES:**

At the end of the course the students will be able to

**CO1:**Use the matrix algebra methods for solving practical problems.

**CO2:**Apply differential calculus tools in solving various application problems.

**CO3:**Able to use differential calculus ideas on several variable functions.

**CO4:**Apply different methods of integration in solving practical problems.

**CO5:**Apply multiple integral ideas in solving areas, volumes and other practical problems.

#### **TEXT BOOKS:**

1. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10<sup>th</sup> Edition, New Delhi, 2016.
2. Grewal.B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44<sup>th</sup> Edition , 2018.
3. James Stewart, " Calculus : Early Transcendentals ", Cengage Learning, 8<sup>th</sup> Edition, New Delhi, 2015. [For Units II & IV - Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only),

2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8 ].

#### REFERENCES:

1. Anton. H, Bivens. I and Davis. S, " Calculus", Wiley, 10<sup>th</sup> Edition, 2016
2. Bali. N., Goyal. M. and Watkins. C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.), New Delhi, 7<sup>th</sup> Edition, 2009.
3. Jain . R.K. and Iyengar. S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 5<sup>th</sup> Edition, 2016.
4. Narayanan. S. and Manicavachagom Pillai. T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6. Srimantha Pal and Bhunia. S.C, "Engineering Mathematics" Oxford University Press, 2015.
7. Thomas. G. B., Hass. J, and Weir. M.D, " Thomas Calculus ", 14<sup>th</sup> Edition, Pearson India, 2018.

#### CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO2	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO3	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO4	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO5	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
Avg	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

PH3151

ENGINEERING PHYSICS

L T P C

3 0 0 3

#### COURSE OBJECTIVES:

- To make the students effectively achieve an understanding of mechanics.
- To enable the students to gain knowledge of electromagnetic waves and its applications.
- To introduce the basics of oscillations, optics and lasers.
- Equipping the students to successfully understand the importance of quantum physics.
- To motivate the students towards the applications of quantum mechanics.

#### UNIT I MECHANICS

9

Multi-particle dynamics: Center of mass (CM) – CM of continuous bodies – motion of the CM – kinetic energy of the system of particles. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy and moment of inertia - theorems of M.I –moment of inertia of continuous bodies – M.I of a diatomic molecule - torque – rotational dynamics of rigid bodies – conservation of angular momentum – rotational energy state of a rigid diatomic molecule - gyroscope - torsional pendulum – double pendulum –Introduction to nonlinear oscillations.

#### UNIT II ELECTROMAGNETIC WAVES

9

The Maxwell's equations - wave equation; Plane electromagnetic waves in vacuum, Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone

reception. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

### **UNIT III OSCILLATIONS, OPTICS AND LASERS**

**9**

Simple harmonic motion - resonance –analogy between electrical and mechanical oscillating systems - waves on a string - standing waves - traveling waves - Energy transfer of a wave - sound waves - Doppler effect. Reflection and refraction of light waves - total internal reflection - interference –Michelson interferometer –Theory of air wedge and experiment. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients - population inversion - Nd-YAG laser, CO<sub>2</sub> laser, semiconductor laser –Basic applications of lasers in industry.

### **UNIT IV BASIC QUANTUM MECHANICS**

**9**

Photons and light waves - Electrons and matter waves –Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization –Free particle - particle in a infinite potential well: 1D,2D and 3D Boxes- Normalization, probabilities and the correspondence principle.

### **UNIT V APPLIED QUANTUM MECHANICS**

**9**

The harmonic oscillator(qualitative)- Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope - Resonant diode - Finite potential wells (qualitative)- Bloch's theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.

**TOTAL : 45 PERIODS**

#### **COURSE OUTCOMES:**

After completion of this course, the students should be able to

**CO1:** Understand the importance of mechanics.

**CO2:** Express their knowledge in electromagnetic waves.

**CO3:** Demonstrate a strong foundational knowledge in oscillations, optics and lasers.

**CO4:** Understand the importance of quantum physics.

**CO5:** Comprehend and apply quantum mechanical principles towards the formation of energy bands.

#### **TEXT BOOKS:**

1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017.
2. E.M.Purcell and D.J.Morin, Electricity and Magnetism, Cambridge Univ.Press, 2013.
3. Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGraw-Hill (Indian Edition), 2017.

#### **REFERENCES:**

1. R.Wolfson. Essential University Physics. Volume 1 & 2. Pearson Education (Indian Edition), 2009.
2. Paul A. Tipler, Physic – Volume 1 & 2, CBS, (Indian Edition), 2004.
3. K.Thyagarajan and A.Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications, (Indian Edition), 2019.
4. D.Halliday, R.Resnick and J.Walker. Principles of Physics, Wiley (Indian Edition), 2015.
5. N.Garcia, A.Damask and S.Schwarz. Physics for Computer Science Students. Springer-Verlag, 2012.

**CO's-PO's & PSO's MAPPING**

CO	PO	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	1	1	1	-	-	-	-	-	-	-	-	-
2	3	3	2	1	2	1	-	-	-	-	-	-	-	-	-
3	3	3	2	2	2	1	-	-	-	-	-	1	-	-	-
4	3	3	1	1	2	1	-	-	-	-	-	-	-	-	-
5	3	3	1	1	2	1	-	-	-	-	-	-	-	-	-
AV	3	3	1.6	1.2	1.8	1	-	-	-	-	-	1	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

CY3151

ENGINEERING CHEMISTRY

L T P C

3 0 0 3

**COURSE OBJECTIVES:**

- To inculcate sound understanding of water quality parameters and water treatment techniques.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To introduce the basic concepts and applications of phase rule and composites.
- To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
- To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

**UNIT I WATER AND ITS TREATMENT**

9

Water: Sources and impurities, Water quality parameters: Definition and significance of-color, odour, turbidity, pH, hardness, alkalinity, TDS, COD and BOD, fluoride and arsenic. Municipal water treatment: primary treatment and disinfection (UV, Ozonation, break-point chlorination). Desalination of brackish water: Reverse Osmosis. Boiler troubles: Scale and sludge, Boiler corrosion, Caustic embrittlement, Priming & foaming. Treatment of boiler feed water: Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralization and zeolite process.

**UNIT II NANOCHEMISTRY**

9

Basics: Distinction between molecules, nanomaterials and bulk materials; Size-dependent properties (optical, electrical, mechanical and magnetic); Types of nanomaterials: Definition, properties and uses of – nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro spinning. Applications of nanomaterials in medicine, agriculture, energy, electronics and catalysis.

**UNIT III PHASE RULE AND COMPOSITES**

9

Phase rule: Introduction, definition of terms with examples. One component system - water system; Reduced phase rule; Construction of a simple eutectic phase diagram - Thermal analysis; Two component system: lead-silver system - Pattinson process.

Composites: Introduction: Definition & Need for composites; Constitution: Matrix materials (Polymer matrix, metal matrix and ceramic matrix) and Reinforcement (fiber, particulates, flakes and whiskers). Properties and applications of: Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. Hybrid composites - definition and examples.

## UNIT IV FUELS AND COMBUSTION

9

Fuels: Introduction: Classification of fuels; Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; Power alcohol and biodiesel.

Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; Ignition temperature: spontaneous ignition temperature, Explosive range; Flue gas analysis - ORSAT Method. CO<sub>2</sub> emission and carbon footprint.

## UNIT V ENERGY SOURCES AND STORAGE DEVICES

9

Stability of nucleus: mass defect (problems), binding energy; Nuclear energy: light water nuclear power plant, breeder reactor. Solar energy conversion: Principle, working and applications of solar cells; Recent developments in solar cell materials. Wind energy; Geothermal energy; Batteries: Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion-battery; Electric vehicles - working principles; Fuel cells: H<sub>2</sub>-O<sub>2</sub> fuel cell, microbial fuel cell; Supercapacitors: Storage principle, types and examples.

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:

At the end of the course, the students will be able:

**CO1:**To infer the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.

**CO2:**To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.

**CO3:**To apply the knowledge of phase rule and composites for material selection requirements.

**CO4:**To recommend suitable fuels for engineering processes and applications.

**CO5:**To recognize different forms of energy resources and apply them for suitable applications in energy sectors.

### TEXT BOOKS:

1. P. C. Jain and Monica Jain, "Engineering Chemistry", 17<sup>th</sup> Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2018.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3. S.S. Dara, "A Text book of Engineering Chemistry", S. Chand Publishing, 12<sup>th</sup> Edition, 2018

### REFERENCES:

1. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, "Text book of nanoscience and nanotechnology", Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2. O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2<sup>nd</sup> Edition, 2017.
3. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.
4. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, Second Edition, 2019.
5. O.V. Roussak and H.D. Gesser, Applied Chemistry-A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013.

### CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	1	-	1	1	-	-	-	-	1	-	-	-
2	2	-	-	1	-	2	2	-	-	-	-	-	-	-	-
3	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
4	3	1	1	-	-	1	2	-	-	-	-	-	-	-	-
5	3	1	2	1	-	2	2	-	-	-	-	2	-	-	-
<b>CO</b>	<b>2.8</b>	<b>1.3</b>	<b>1.6</b>	<b>1</b>	<b>-</b>	<b>1.5</b>	<b>1.8</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1.5</b>	<b>-</b>	<b>-</b>	<b>-</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation

GE3151

PROBLEM SOLVING AND PYTHON PROGRAMMING

L T P C  
3 0 0 3

#### COURSE OBJECTIVES:

- To understand the basics of algorithmic problem solving.
- To learn to solve problems using Python conditionals and loops.
- To define Python functions and use function calls to solve problems.
- To use Python data structures - lists, tuples, dictionaries to represent complex data.
- To do input/output with files in Python.

#### UNIT I COMPUTATIONAL THINKING AND PROBLEM SOLVING

9

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

#### UNIT II DATA TYPES, EXPRESSIONS, STATEMENTS

9

Python interpreter and interactive mode,debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

#### UNIT III CONTROL FLOW, FUNCTIONS, STRINGS

9

Conditionals:Boolean values and operators, conditional (if), alternative (if-else),chained conditional (if-elif-else);Iteration: state, while, for, break, continue, pass; Fruitful functions: return values,parameters, local and global scope, function composition, recursion; Strings: string slices,immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

#### UNIT IV LISTS, TUPLES, DICTIONARIES

9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.



**UNIT V FILES, MODULES, PACKAGES****9**

Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

**TOTAL : 45 PERIODS****COURSE OUTCOMES:**

**Upon completion of the course, students will be able to**

- CO1:** Develop algorithmic solutions to simple computational problems.
- CO2:** Develop and execute simple Python programs.
- CO3:** Write simple Python programs using conditionals and loops for solving problems.
- CO4:** Decompose a Python program into functions.
- CO5:** Represent compound data using Python lists, tuples, dictionaries etc.
- CO6:** Read and write data from/to files in Python programs.

**TEXT BOOKS:**

1. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.

**REFERENCES:**

1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1<sup>st</sup> Edition, 2021.
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1<sup>st</sup> Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press, 2021
4. Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2<sup>nd</sup> Edition, No Starch Press, 2019.
5. <https://www.python.org/>
6. Martin C. Brown, "Python: The Complete Reference", 4<sup>th</sup> Edition, Mc-Graw Hill, 2018.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	3	3	2	-	-	-	-	-	2	2	3	3
2	3	3	3	3	2	-	-	-	-	-	2	2	3	-
3	3	3	3	3	2	-	-	-	-	-	2	-	3	-
4	2	2	-	2	2	-	-	-	-	-	1	-	3	-
5	1	2	-	-	1	-	-	-	-	-	1	-	2	-
6	2	2	-	-	2	-	-	-	-	-	1	-	2	-
AVg.	2	3	3	3	2	-	-	-	-	-	2	2	3	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

**UNIT I LANGUAGE AND LITERATURE****3**

Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

**UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE****3**

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

**UNIT III FOLK AND MARTIAL ARTS****3**

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

**UNIT IV THINAI CONCEPT OF TAMILS****3**

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

**UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE****3**

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

**TOTAL : 15 PERIODS****TEXT-CUM-REFERENCE BOOKS**

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருறை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by:

Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation,  
Tamil Nadu)

10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay)  
(Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text  
Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference  
Book.

GE3152

தமிழர் மரபு

L T P C  
1 0 0 1

**அலகு I மொழி மற்றும் இலக்கியம்: 3**

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

**அலகு II மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை: 3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளூர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

**அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்: 3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஓயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

**அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள்: 3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

**அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு:**

**3**

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிக்கல்கள் - தமிழ்ப் புத்தகங்களின் அச்ச வரலாறு.

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருறை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

**GE3171 PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY L T P C  
0 0 4 2**

**COURSE OBJECTIVES:**

- To understand the problem solving approaches.
- To learn the basic programming constructs in Python.
- To practice various computing strategies for Python-based solutions to real world problems.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

**EXPERIMENTS:**

**Note: The examples suggested in each experiment are only indicative. The lab instructor is expected to design other problems on similar lines. The Examination shall not be restricted to the sample experiments listed here.**

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).
3. Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6. Implementing programs using Functions. (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings. (reverse, palindrome, character count, replacing characters)
8. Implementing programs using written modules and Python Standard Libraries (pandas, numpy. Matplotlib, scipy)
9. Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word)
10. Implementing real-time/technical applications using Exception handling. (divide by zero error, voter's age validity, student mark range validation)
11. Exploring Pygame tool.
12. Developing a game activity using Pygame like bouncing ball, car race etc.

**TOTAL: 60 PERIODS**

### **COURSE OUTCOMES:**

On completion of the course, students will be able to:

**CO1:** Develop algorithmic solutions to simple computational problems

**CO2:** Develop and execute simple Python programs.

**CO3:** Implement programs in Python using conditionals and loops for solving problems..

**CO4:** Deploy functions to decompose a Python program.

**CO5:** Process compound data using Python data structures.

**CO6:** Utilize Python packages in developing software applications.

### **TEXT BOOKS:**

1. Allen B. Downey, "Think Python : How to Think like a Computer Scientist", 2<sup>nd</sup> Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1<sup>st</sup> Edition, BCS Learning & Development Limited, 2017.

### **REFERENCES:**

1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1<sup>st</sup> Edition, 2021.
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1<sup>st</sup> Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press, 2021

4. Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2<sup>nd</sup> Edition, No Starch Press, 2019.
5. <https://www.python.org/>
6. Martin C. Brown, "Python: The Complete Reference", 4<sup>th</sup> Edition, Mc-Graw Hill, 2018.

#### CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	3	3	3	-	-	-	-	-	3	2	3	3
2	3	3	3	3	3	-	-	-	-	-	3	2	3	-
3	3	3	3	3	2	-	-	-	-	-	2	-	3	-
4	3	2	-	2	2	-	-	-	-	-	1	-	3	-
5	1	2	-	-	1	-	-	-	-	-	1	-	2	-
6	2	-	-	-	2	-	-	-	-	-	1	-	2	-
AVg.	2	3	3	3	2	-	-	-	-	-	2	2	3	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

BS3171

PHYSICS AND CHEMISTRY LABORATORY

L T P C  
0 0 4 2

#### PHYSICS LABORATORY : (Any Seven Experiments)

##### COURSE OBJECTIVES:

- To learn the proper use of various kinds of physics laboratory equipment.
  - To learn how data can be collected, presented and interpreted in a clear and concise manner.
  - To learn problem solving skills related to physics principles and interpretation of experimental data.
  - To determine error in experimental measurements and techniques used to minimize such error.
  - To make the student an active participant in each part of all lab exercises.
1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular and irregular objects.
  2. Simple harmonic oscillations of cantilever.
  3. Non-uniform bending - Determination of Young's modulus
  4. Uniform bending – Determination of Young's modulus
  5. Laser- Determination of the wavelength of the laser using grating
  6. Air wedge - Determination of thickness of a thin sheet/wire
  7. a) Optical fibre -Determination of Numerical Aperture and acceptance angle  
b) Compact disc- Determination of width of the groove using laser.
  8. Acoustic grating- Determination of velocity of ultrasonic waves in liquids.
  9. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids
  10. Post office box -Determination of Band gap of a semiconductor.
  11. Photoelectric effect
  12. Michelson Interferometer.

13. Melde's string experiment
14. Experiment with lattice dynamics kit.

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, the students should be able to

**CO1:** Understand the functioning of various physics laboratory equipment.

**CO2:** Use graphical models to analyze laboratory data.

**CO3:** Use mathematical models as a medium for quantitative reasoning and describing physical reality.

**CO4:** Access, process and analyze scientific information.

**CO5:** Solve problems individually and collaboratively.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-
2	3	3	2	1	1	-	-	-	-	-	-	-	-	-	-
3	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-
4	3	3	2	1	1	-	-	-	-	-	-	-	-	-	-
5	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-
<b>AVG</b>	3	2.4	2.6	1	1										

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CHEMISTRY LABORATORY: (Any seven experiments to be conducted)**

**COURSE OBJECTIVES:**

- To inculcate experimental skills to test basic understanding of water quality parameters, such as, acidity, alkalinity, hardness, DO, chloride and copper.
- To induce the students to familiarize with electroanalytical techniques such as, pH metry, potentiometry and conductometry in the determination of impurities in aqueous solutions.
- To demonstrate the analysis of metals and alloys.
- To demonstrate the synthesis of nanoparticles
  1. Preparation of  $\text{Na}_2\text{CO}_3$  as a primary standard and estimation of acidity of a water sample using the primary standard
  2. Determination of types and amount of alkalinity in a water sample.
    - Split the first experiment into two
  3. Determination of total, temporary & permanent hardness of water by EDTA method.
  4. Determination of DO content of water sample by Winkler's method.
  5. Determination of chloride content of water sample by Argentometric method.
  6. Estimation of copper content of the given solution by Iodometry.
  7. Estimation of TDS of a water sample by gravimetry.
  8. Determination of strength of given hydrochloric acid using pH meter.
  9. Determination of strength of acids in a mixture of acids using conductivity meter.
  10. Conductometric titration of barium chloride against sodium sulphate (precipitation titration)
  11. Estimation of iron content of the given solution using potentiometer.
  12. Estimation of sodium /potassium present in water using a flame photometer.
  13. Preparation of nanoparticles ( $\text{TiO}_2/\text{ZnO}/\text{CuO}$ ) by Sol-Gel method.
  14. Estimation of Nickel in steel
  15. Proximate analysis of Coal

**TOTAL : 30 PERIODS**

**COURSE OUTCOMES :**

**CO1:**To analyse the quality of water samples with respect to their acidity, alkalinity, hardness and DO.

**CO2:**To determine the amount of metal ions through volumetric and spectroscopic techniques

**CO3:**To analyse and determine the composition of alloys.

**CO4:**To learn simple method of synthesis of nanoparticles

**CO5:**To quantitatively analyse the impurities in solution by electroanalytical techniques

**TEXT BOOKS :**

1. J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas and B. Sivasankar, Vogel's Textbook of Quantitative Chemical Analysis (2009).

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	1	-	-	2	2	-	-	-	-	2	-	-	-
2	3	1	2	-	-	1	2	-	-	-	-	1	-	-	-
3	3	2	1	1	-	-	1	-	-	-	-	-	-	-	-
4	2	1	2	-	-	2	2	-	-	-	-	-	-	-	-
5	2	1	2	-	1	2	2	-	-	-	-	1	-	-	-
Avg.	2.6	1.3	1.6	1	1	1.4	1.8	-	-	-	-	1.3	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

**Note:** the average value of this course to be used for program articulation matrix.

**GE3172**

**ENGLISH LABORATORY**

**L T P C**

**0 0 2 1**

**COURSE OBJECTIVES:**

- To improve the communicative competence of learners
- To help learners use language effectively in academic /work contexts
- To develop various listening strategies to comprehend various types of audio materials like lectures, discussions, videos etc.
- To build on students' English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
- To use language efficiently in expressing their opinions via various media.

**UNIT I INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION**

**6**

Listening for general information-specific details- conversation: Introduction to classmates - Audio / video (formal & informal); Telephone conversation; Listening to voicemail & messages; Listening and filling a form. Speaking - making telephone calls-Self Introduction; Introducing a friend; - politeness strategies- making polite requests, making polite offers, replying to polite requests and offers- understanding basic instructions( filling out a bank application for example).

**UNIT II NARRATION AND SUMMATION**

**6**

Listening - Listening to podcasts, anecdotes / stories / event narration; documentaries and interviews with celebrities. Speaking - Narrating personal experiences / events-Talking about current and temporary situations & permanent and regular situations\* - describing experiences and feelings-engaging in small talk- describing requirements and abilities.



- UNIT III DESCRIPTION OF A PROCESS / PRODUCT 6**  
 Listening - Listen to product and process descriptions; a classroom lecture; and advertisements about products. Speaking – Picture description- describing locations in workplaces- Giving instruction to use the product- explaining uses and purposes- Presenting a product- describing shapes and sizes and weights- talking about quantities(large & small)-talking about precautions.
- UNIT IV CLASSIFICATION AND RECOMMENDATIONS 6**  
 Listening – Listening to TED Talks; Listening to lectures - and educational videos. Speaking – Small Talk; discussing and making plans-talking about tasks-talking about progress- talking about positions and directions of movement-talking about travel preparations- talking about transportation-
- UNIT V EXPRESSION 6**  
 Listening – Listening to debates/ discussions; different viewpoints on an issue; and panel discussions. Speaking –making predictions- talking about a given topic-giving opinions-understanding a website-describing processes

**TOTAL : 30 PERIODS**

**LEARNING OUTCOMES:**

At the end of the course, learners will be able

- CO1:**To listen to and comprehend general as well as complex academic information
- CO2:**To listen to and understand different points of view in a discussion
- CO3:**To speak fluently and accurately in formal and informal communicative contexts
- CO4:**To describe products and processes and explain their uses and purposes clearly and accurately
- CO5:**To express their opinions effectively in both formal and informal discussions

**ASSESSMENT PATTERN**

- One online / app based assessment to test listening /speaking
- End Semester **ONLY** listening and speaking will be conducted online.
- Proficiency certification is given on successful completion of listening and speaking internal test and end semester exam.

**CO's-PO's & PSO's MAPPING**

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
2	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
3	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
4	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
5	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
<b>AVg.</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	-	-	-

1-low, 2-medium, 3-high, ‘-‘- no correlation

**Note:** The average value of this course to be used for program articulation matrix.

**COURSE OBJECTIVES :**

- To engage learners in meaningful language activities to improve their reading and writing skills
- To learn various reading strategies and apply in comprehending documents in professional context.
- To help learners understand the purpose, audience, contexts of different types of writing
- To develop analytical thinking skills for problem solving in communicative contexts
- To demonstrate an understanding of job applications and interviews for internship and placements

**UNIT I MAKING COMPARISONS 6**

Reading - Reading advertisements, user manuals, brochures; Writing – Professional emails, Email etiquette - Compare and Contrast Essay; Grammar – Mixed Tenses, Prepositional phrases

**UNIT II EXPRESSING CAUSAL RELATIONS IN SPEAKING AND WRITING 6**

Reading - Reading longer technical texts– Cause and Effect Essays, and Letters / emails of complaint, Writing - Writing responses to complaints. Grammar - Active Passive Voice transformations, Infinitive and Gerunds

**UNIT III PROBLEM SOLVING 6**

Reading - Case Studies, excerpts from literary texts, news reports etc. Writing – Letter to the Editor, Checklists, Problem solution essay / Argumentative Essay. Grammar – Error correction; If conditional sentences

**UNIT IV REPORTING OF EVENTS AND RESEARCH 6**

Reading –Newspaper articles; Writing – Recommendations, Transcoding, Accident Report, Survey Report Grammar – Reported Speech, Modals Vocabulary – Conjunctions- use of prepositions

**UNIT V THE ABILITY TO PUT IDEAS OR INFORMATION COGENTLY 6**

Reading – Company profiles, Statement of Purpose, (SOP), an excerpt of interview with professionals; Writing – Job / Internship application – Cover letter & Resume; Grammar – Numerical adjectives, Relative Clauses.

**TOTAL : 30 PERIODS****COURSE OUTCOMES:**

At the end of the course, learners will be able

**CO1:**To compare and contrast products and ideas in technical texts.

**CO2:**To identify and report cause and effects in events, industrial processes through technical texts

**CO3:**To analyse problems in order to arrive at feasible solutions and communicate them in the written format.

**CO4:**To present their ideas and opinions in a planned and logical manner

**CO5:**To draft effective resumes in the context of job search.

**TEXT BOOKS :**

1. English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.
2. English for Science & Technology Cambridge University Press 2021.
3. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

## REFERENCE BOOKS:

1. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.
2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, NewDelhi.
3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.

## ASSESSMENT PATTERN

Two internal assessments and an end semester examination to test students' reading and writing skills along with their grammatical and lexical competence.

### CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	3	3	3	3	2	3	3	3	-	-	-
2	3	3	3	3	3	3	3	3	2	3	3	3	-	-	-
3	3	3	3	3	3	3	3	3	2	3	3	3	-	-	-
4	3	3	3	3	2	3	3	3	2	3	3	3	-	-	-
5	-	-	-	-	-	-	-	-	3	3	3	3	-	-	-
AVg.	3	3	3	3	2.75	3	3	3	2.2	3	3	3	-	-	-

1-low, 2-medium, 3-high, '-'- no correlation

**Note:** The average value of this course to be used for program articulation matrix.

MA3251

STATISTICS AND NUMERICAL METHODS

L T P C  
3 1 0 4

## COURSE OBJECTIVES:

- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

### UNIT I TESTING OF HYPOTHESIS

9 + 3

Sampling distributions - Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.

### UNIT II DESIGN OF EXPERIMENTS

9 + 3

One way and two way classifications - Completely randomized design – Randomized block design – Latin square design -  $2^2$  factorial design.

**UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9 + 3**

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.

**UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION 9 +3**

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

**UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 9 +3**

Single step methods: Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first order differential equations - Multi step methods: Milne's and Adams - Bash forth predictor corrector methods for solving first order differential equations.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

Upon successful completion of the course, students will be able to:

CO1:Apply the concept of testing of hypothesis for small and large samples in real life problems.

CO2:Apply the basic concepts of classifications of design of experiments in the field of agriculture.

CO3:Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.

CO4:Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.

CO5:Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

**TEXT BOOKS:**

1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10<sup>th</sup> Edition, New Delhi, 2015.
2. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8<sup>th</sup> Edition, 2015.

**REFERENCES:**

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9<sup>th</sup> Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8<sup>th</sup> Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7<sup>th</sup> Edition, 2007.
4. Gupta S.C. and Kapoor V. K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 12<sup>th</sup> Edition, 2020.
5. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics ", Tata McGraw Hill Edition, 4<sup>th</sup> Edition, 2012.
6. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", 9<sup>th</sup> Edition, Pearson Education, Asia, 2010.

### CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO2	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO3	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO4	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO5	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
Avg	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

PH3254

PHYSICS FOR ELECTRONICS ENGINEERING

L T P C

3 0 0 3

#### COURSE OBJECTIVES:

- To make the students to understand the basics of crystallography and its importance in studying materials properties.
- To understand the electrical properties of materials including free electron theory, applications of quantum mechanics and magnetic materials.
- To instil knowledge on physics of semiconductors, determination of charge carriers and device applications
- To establish a sound grasp of knowledge on different optical properties of materials, optical displays and applications
- To inculcate an idea of significance of nano structures, quantum confinement and ensuing nano device applications.

#### UNIT I CRYSTALLOGRAPHY

9

Crystal structures: Crystal lattice – basis - unit cell and lattice parameters – crystal systems and Bravais lattices – Structure and packing fractions of SC, BCC, FCC, diamond cubic, NaCl, ZnS structures – crystal planes, directions and Miller indices – distance between successive planes – linear and planar densities – crystalline and noncrystalline materials – Example use of Miller indices: wafer surface orientation – wafer flats and notches – pattern alignment - imperfections in crystals.

#### UNIT II ELECTRICAL AND MAGNETIC PROPERTIES OF MATERIALS

9

Classical free electron theory - Expression for electrical conductivity – Thermal conductivity, expression - Quantum free electron theory : Tunneling – degenerate states – Fermi- Dirac statistics – Density of energy states – Electron in periodic potential – Energy bands in solids – tight binding approximation - Electron effective mass – concept of hole. Magnetic materials: Dia, para and ferromagnetic effects – paramagnetism in the conduction electrons in metals – exchange interaction and ferromagnetism – quantum interference devices – GMR devices.

#### UNIT III SEMICONDUCTORS AND TRANSPORT PHYSICS

9

Intrinsic Semiconductors – Energy band diagram – direct and indirect band gap semiconductors – Carrier concentration in intrinsic semiconductors – extrinsic semiconductors - Carrier concentration in N-type & P-type semiconductors – Variation of carrier concentration with temperature – Carrier transport in Semiconductors: Drift, mobility and diffusion – Hall effect and devices – Ohmic contacts – Schottky diode.

**UNIT IV OPTICAL PROPERTIES OF MATERIALS****9**

Classification of optical materials – Optical processes in semiconductors: optical absorption and emission, charge injection and recombination, optical absorption, loss and gain. Optical processes in quantum wells – Optoelectronic devices: light detectors and solar cells – light emitting diode – laser diode - optical processes in organic semiconductor devices –excitonic state – Electro-optics and nonlinear optics: Modulators and switching devices – plasmonics.

**UNIT V NANO DEVICES****9**

Density of states for solids - Significance between Fermi energy and volume of the material – Quantum confinement – Quantum structures – Density of states for quantum wells, wires and dots – Band gap of nanomaterials – Tunneling – Single electron phenomena – Single electron Transistor. Conductivity of metallic nanowires – Ballistic transport – Quantum resistance and conductance – Carbon nanotubes: Properties and applications - Spintronic devices and applications – Optics in quantum structures – quantum well laser.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

At the end of the course, the students should be able to

**CO1:** know basics of crystallography and its importance for varied materials properties

**CO2:** gain knowledge on the electrical and magnetic properties of materials and their applications

**CO3:** understand clearly of semiconductor physics and functioning of semiconductor devices

**CO4:** understand the optical properties of materials and working principles of various optical devices

**CO5:** appreciate the importance of nanotechnology and nanodevices.

**TEXT BOOKS:**

1. S.O. Kasap. Principles of Electronic Materials and Devices, McGraw Hill Education (Indian Edition), 2020.
2. R.F.Pierret. Semiconductor Device Fundamentals. Pearson (Indian Edition), 2006.
3. G.W.Hanson. Fundamentals of Nanoelectronics. Pearson Education (Indian Edition), 2009.

**REFERENCES:**

1. Laszlo Solymar, Walsh, Donald, Syms and Richard R.A., Electrical Properties of Materials, Oxford Univ. Press (Indian Edition) 2015.
2. Jasprit Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Education (Indian Edition), 2019.
3. Charles Kittel, Introduction to Solid State Physics, Wiley India Edition, 2019.
4. Mark Fox, Optical Properties of Solids, Oxford Univ.Press, 2001.
5. N.Gershenfeld. The Physics of Information Technology. Cambridge University Press, 2011.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-
2	3	2	1	2	-	2	-	-	-	-	-	-	-	-	-
3	3	2	2	-	2	-	-	-	-	-	-	-	-	-	-
4	3	-	1	-	3	2	3	-	-	-	-	1	-	-	-
5	3	-	2	1	-	2	-	-	-	-	-	1	-	-	-
<b>AVG</b>	3	2	1.4	1.5	2.5	2	3					1			

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES :**

- To impart knowledge in types, construction and working of transformers
- To impart knowledge in types, construction and working of DC machines
- To impart knowledge in types, construction and working of AC rotating machines
- To introduce the functional elements and working of measuring instruments.
- To introduce the basics of power system and protection schemes

**UNIT I TRANSFORMER****9**

Introduction - Ideal and Practical Transformer – Phasor diagram-- Per Unit System – Equivalent circuit- Testing- Efficiency and Voltage Regulation– Three Phase Transformers –Applications- Auto Transformers, Advantages- Harmonics.

**UNIT II DC MACHINES****9**

Introduction – Constructional Features– Motor and Generator mode - EMF and Torque equation – Circuit Model – Methods of Excitation- Characteristics – Starting and Speed Control – Universal Motor- Stepper Motors – Brushless DC Motors- Applications

**UNIT III AC ROTATING MACHINES****9**

Principle of operation of three-phase induction motors – Construction –Types – Equivalent circuit, Speed Control - Single phase Induction motors -Construction– Types–starting methods. Alternator: Working principle–Equation of induced EMF – Voltage regulation, Synchronous motors- working principle-starting methods – Torque equation.

**UNIT IV MEASUREMENTS AND INSTRUMENTATION****9**

Functional elements of an instrument , Standards and calibration, Operating Principle , types - Moving Coil and Moving Iron meters, Measurement of three phase power, Energy Meter, Instrument Transformers-CT and PT,DSO- Block diagram- Data acquisition.

**UNIT V BASICS OF POWER SYSTEMS****9**

Power system structure -Generation , Transmission and distribution , Various voltage levels, Earthing – methods of earthing, protective devices- switch fuse unit- Miniature circuit breaker- moulded case circuit breaker- earth leakage circuit breaker, safety precautions and First Aid

**TOTAL: 45 PERIODS****COURSE OUTCOMES :**

After completing this course, the students will be able to

- CO1:** Explain the working principle of electrical machines
- CO2:** Analyze the output characterizes of electrical machines
- CO3:** Choose the appropriate electrical machines for various applications
- CO4:** Explain the types and operating principles of measuring instruments
- CO5:** Explain the basic power system structure and protection schemes

**TEXT BOOKS:**

1. Kothari DP and I.J Nagrath, “Basic Electrical and Electronics Engineering”, Second Edition, McGraw Hill Education, 2020
2. S. K, Bhattacharya, “Basic Electrical and Electronics Engineering”, Second Edition, Pearson Education, 2017.
3. A.K. Sawhney, Puneet Sawhney ‘A Course in Electrical & Electronic Measurements &

Instrumentation', Dhanpat Rai and Co, New Delhi, 2015.

4. C.L.Wadhwa, "Generation, Distribution and Utilisation of Electrical Energy", New Age International pvt.ltd.,2003

#### REFERENCES:

1. Kothari DP and I.J Nagrath, "Basic Electrical Engineering", Fourth Edition, McGraw Hill Education, 2019
2. Mahmood Nahvi and Joseph A. Edminister, "Electric Circuits", Schaum' Outline Series, McGraw Hill, 2002.
3. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010

#### CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	-	-	-	-	1	-	-	-	-	-	-	-
2	2	1	1	-	-	-	-	1	-	-	-	-	-	-	-
3	2	1	1	-	-	-	-	1	-	-	-	-	-	-	-
4	2	1	1	-	-	-	-	1	-	-	-	-	-	-	-
5	2	1	1	-	-	-	-	1	-	-	-	-	-	-	-
<b>CO</b>	<b>2</b>	<b>1</b>	<b>1</b>	-	-	-	-	<b>1</b>	-	-	-	-	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

**GE3251**

**ENGINEERING GRAPHICS**

**L T P C**

**2 0 4 4**

#### COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Drawing engineering curves.
- Drawing freehand sketch of simple objects.
- Drawing orthographic projection of solids and section of solids.
- Drawing development of solids
- Drawing isometric and perspective projections of simple solids.

#### CONCEPTS AND CONVENTIONS (Not for Examination)

Importance of graphics in engineering applications — Use of drafting instruments — BIS conventions and specifications — Size, layout and folding of drawing sheets — Lettering and dimensioning.

#### UNIT I PLANE CURVES

**6+12**

Basic Geometrical constructions, Curves used in engineering practices: Conics — Construction of ellipse, parabola and hyperbola by eccentricity method — Construction of cycloid — construction of involutes of square and circle — Drawing of tangents and normal to the above curves.

#### UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE

**6+12**

Orthographic projection - principles - Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.



**UNIT III PROJECTION OF SOLIDS AND FREEHAND SKETCHING 6+12**

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method. Visualization concepts and Free Hand sketching: Visualization principles —Representation of Three Dimensional objects — Layout of views- Freehand sketching of multiple views from pictorial views of objects.

Practicing three dimensional modeling of simple objects by CAD Software (Not for examination)

**UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 6 +12**

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other — obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids — Prisms, pyramids cylinders and cones.

Practicing three dimensional modeling of simple objects by CAD Software (Not for examination)

**UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 6+12**

Principles of isometric projection — isometric scale —Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

Practicing three dimensional modeling of isometric projection of simple objects by CAD Software (Not for examination)

**TOTAL: (L=30+P=60) 90 PERIODS**

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1:**Use BIS conventions and specifications for engineering drawing.

**CO2:**Construct the conic curves, involutes and cycloid.

**CO3:**Solve practical problems involving projection of lines.

**CO4:**Draw the orthographic, isometric and perspective projections of simple solids.

**CO5:**Draw the development of simple solids.

**TEXT BOOKS:**

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 53<sup>rd</sup> Edition, 2019.
2. Natrajan K.V., "A Text Book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2018.
3. Parthasarathy, N. S. and Vela Murali, "Engineering Drawing", Oxford University Press, 2015

**REFERENCES:**

1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill, 2<sup>nd</sup> Edition, 2019.
2. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Publications, Bangalore, 27<sup>th</sup> Edition, 2017.
3. Luzzader, Warren.J. and Duff, John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4. Parthasarathy N. S. and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.
5. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson Education India, 2<sup>nd</sup> Edition, 2009.
6. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.

**Publication of Bureau of Indian Standards:**

1. IS 10711 — 2001: Technical products Documentation — Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) — 2001: Technical products Documentation — Lettering.
3. IS 10714 (Part 20) — 2001 & SP 46 — 2003: Lines for technical drawings.
4. IS 11669 — 1986 & SP 46 — 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) — 2001: Technical drawings — Projection Methods.

**Special points applicable to University Examinations on Engineering Graphics:**

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
2	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
3	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
4	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
5	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
<b>CO</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>-</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>3</b>	<b>-</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>-</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation

EC3251

CIRCUIT ANALYSIS

L T P C  
3 1 0 4

**COURSE OBJECTIVES:**

- To learn the basic concepts and behaviour of DC and AC circuits.
- To understand various methods of circuit/ network analysis using network theorems.
- To understand the transient and steady state response of the circuits subjected to DC excitations and AC with sinusoidal excitations.
- To learn the concept of coupling in circuits and topologies.

**UNIT I DC CIRCUIT ANALYSIS**

12

Basic Components of electric Circuits, Charge, current, Voltage and Power, Voltage and Current Sources, Ohms Law, Kirchoff's Current Law, Kirchoff's voltage law, The single Node – Pair Circuit, series and Parallel Connected Independent Sources, Resistors in Series and Parallel, voltage and current division, Nodal analysis, Mesh analysis.

**UNIT II NETWORK THEOREM AND DUALITY**

12

Useful Circuit Analysis techniques - Linearity and superposition, Thevenin and Norton Equivalent Circuits, Maximum Power Transfer, Delta-Wye Conversion. Duals, Dual circuits. Analysis using dependent current sources and voltage sources

**UNIT III SINUSOIDAL STEADY STATE ANALYSIS**

12

Sinusoidal Steady – State analysis , Characteristics of Sinusoids, The Complex Forcing Function, The Phasor, Phasor relationship for R, L, and C, impedance and Admittance, Nodal and Mesh Analysis, Phasor Diagrams, AC Circuit Power Analysis, Instantaneous Power, Average Power, apparent Power and Power Factor, Complex Power.

**UNIT IV TRANSIENTS AND RESONANCE IN RLC CIRCUITS****12**

Basic RL and RC Circuits, The Source- Free RL Circuit, The Source-Free RC Circuit, The Unit-Step Function, Driven RL Circuits, Driven RC Circuits, RLC Circuits, Frequency Response, Parallel Resonance, Series Resonance, Quality Factor.

**UNIT V COUPLED CIRCUITS AND TOPOLOGY****12**

Magnetically Coupled Circuits, mutual Inductance, the Linear Transformer, the Ideal Transformer, An introduction to Network Topology, Trees and General Nodal analysis, Links and Loop analysis.

**SUGGESTED ACTIVITIES:**

- Practice solving variety of problems

**COURSE OUTCOMES**

**On successful completion of this course, the student will be able to**

**CO1:** Apply the basic concepts of circuit analysis such as Kirchoff's laws, mesh current and node voltage method for analysis of DC and AC circuits.

**CO2:** Apply suitable network theorems and analyze AC and DC circuits

**CO3:** Analyze steady state response of any R, L and C circuits

**CO4:** Analyze the transient response for any RC, RL and RLC circuits and frequency response of parallel and series resonance circuits.

**CO5:** Analyze the coupled circuits and network topologies

**TOTAL: 60 PERIODS****TEXT BOOKS:**

1. Hayt Jack Kemmerly, Steven Durbin, "Engineering Circuit Analysis", Mc Graw Hill education, 9th Edition, 2018.
2. Charles K. Alexander & Mathew N.O.Sadiku, "Fundamentals of Electric Circuits", Mc Graw-Hill, 2nd Edition, 2003.
3. Joseph Edminister and Mahmood Nahvi, —Electric Circuits, Schaum's Outline Series, Tata McGraw Hill Publishing Company, New Delhi, Fifth Edition Reprint 2016.

**REFERENCES:**

1. Robert.L. Boylestead, "Introductory Circuit Analysis", Pearson Education India, 12th Edition, 2014. David Bell, "Fundamentals of Electric Circuits", Oxford University press, 7th Edition, 2009.
2. John O Mallay, Schaum's Outlines "Basic Circuit Analysis", The Mc Graw Hill companies, 2nd Edition, 2011
3. Allan H.Robbins, Wilhelm C.Miller, "Circuit Analysis Theory and Practice", Cengage Learning, Fifth Edition, 1st Indian Reprint 2013

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1	1	-	-	-	1		1	-	-	-	-	-
2	3	3	2	2	-	-	-	1		1	-	-	-	-	-
3	3	3	3	3	-	-	-	1		1	-	-	-	-	-
4	3	3	3	3	-	-	-	1		1	-	-	-	-	-
5	3	3	3	2	-	-	-	1		1	-	-	-	-	-
<b>CO</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1</b>		<b>1</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation

**UNIT I WEAVING AND CERAMIC TECHNOLOGY****3**

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

**UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY****3**

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

**UNIT III MANUFACTURING TECHNOLOGY****3**

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold-Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

**UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY****3**

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

**UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING****3**

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

**TOTAL : 15 PERIODS****TEXT-CUM-REFERENCE BOOKS**

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருறை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies).
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation,

Tamil Nadu)

10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

GE3252

**தமிழரும் தொழில்நுட்பமும்**

L T P C

1 0 0 1

**அலகு I நெசவு மற்றும் பானைத் தொழில்நுட்பம்: 3**  
சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

**அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்: 3**  
சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

**அலகு III உற்பத்தித் தொழில் நுட்பம்: 3**  
கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

**அலகு IV வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்: 3**  
அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குழுவித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

**அலகு V அறிவியல் தமிழ் மற்றும் கணித்தமிழ்: 3**  
அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

**TOTAL : 15 PERIODS**

## TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருதை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

**NX3251      NCC Credit Course Level 1\*  
(ARMY WING)**

NCC Credit Course Level 1

**L   T   P   C  
2   0   0   2**

**NCC GENERAL**

**6**

NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2

**NATIONAL INTEGRATION AND AWARENESS**

**4**

NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1

**PERSONALITY DEVELOPMENT**

**7**

PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2

**LEADERSHIP**

**5**

L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2

**SOCIAL SERVICE AND COMMUNITY DEVELOPMENT**

**8**

SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

**TOTAL: 30 PERIODS**

NX3252

**NCC Credit Course Level 1\*  
(NAVAL WING)**

NCC Credit Course Level - I

**L T P C**  
**2 0 0 2**

**NCC GENERAL**

**6**

NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2

**NATIONAL INTEGRATION AND AWARENESS**

**4**

NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1

**PERSONALITY DEVELOPMENT**

**7**

PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2

**LEADERSHIP**

**5**

L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2

**SOCIAL SERVICE AND COMMUNITY DEVELOPMENT**

**8**

SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

**TOTAL : 30 PERIODS**



**NX3253**

**NCC Credit Course Level 1\*  
(AIR FORCE WING)**

NCC Credit Course Level - I

**L T P C**  
**2 0 0 2**

**NCC GENERAL**

**6**

NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2

**NATIONAL INTEGRATION AND AWARENESS**

**4**

NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1

**PERSONALITY DEVELOPMENT**

**7**

PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2

**LEADERSHIP**

**5**

L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2

**SOCIAL SERVICE AND COMMUNITY DEVELOPMENT**

**8**

SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

**TOTAL : 30 PERIODS**

**COURSE OBJECTIVES:**

The main learning objective of this course is to provide hands on training to the students in:

- Drawing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planing; making joints in wood materials used in commonhousehold wood work.
- Wiring various electrical joints in common household electrical wire work.
- Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts; Assembling simple mechanical assembly of common household equipments; Making a tray out of metal sheet using sheet metal work.
- Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.

**GROUP – A (CIVIL & ELECTRICAL)****PART I CIVIL ENGINEERING PRACTICES 15****PLUMBING WORK:**

- a) Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
- b) Preparing plumbing line sketches.
- c) Laying pipe connection to the suction side of a pump
- d) Laying pipe connection to the delivery side of a pump.
- e) Connecting pipes of different materials: Metal, plastic and flexible pipes used inhousehold appliances.

**WOOD WORK:**

- a) Sawing,
- b) Planing and
- c) Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.

Wood Work Study:

- a) Studying joints in door panels and wooden furniture
- b) Studying common industrial trusses using models.

**PART II ELECTRICAL ENGINEERING PRACTICES 15**

- a) Introduction to switches, fuses, indicators and lamps - Basic switch board wiring with lamp, fan and three pin socket
- b) Staircase wiring
- c) Fluorescent Lamp wiring with introduction to CFL and LED types.
- d) Energy meter wiring and related calculations/ calibration
- e) Study of Iron Box wiring and assembly
- f) Study of Fan Regulator (Resistor type and Electronic type using Diac/Triac/quadrac)
- g) Study of emergency lamp wiring/Water heater

## GROUP – B (MECHANICAL AND ELECTRONICS)

### PART III MECHANICAL ENGINEERING PRACTICES

15

#### WELDING WORK:

- a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
- b) Practicing gas welding.

#### BASIC MACHINING WORK:

- a) (simple)Turning.
- b) (simple)Drilling.
- c) (simple)Tapping.

#### ASSEMBLY WORK:

- a) Assembling a centrifugal pump.
- b) Assembling a household mixer.
- c) Assembling an airconditioner.

#### SHEET METAL WORK:

- a) Making of a square tray

#### FOUNDRY WORK:

- a) Demonstrating basic foundry operations.

### PART IV ELECTRONIC ENGINEERING PRACTICES

15

#### SOLDERING WORK:

- a) Soldering simple electronic circuits and checking continuity.

#### ELECTRONIC ASSEMBLY AND TESTING WORK:

- a) Assembling and testing electronic components on a small PCB.

#### ELECTRONIC EQUIPMENT STUDY:

- a) Study an elements of smart phone..
- b) Assembly and dismantle of LED TV.
- c) Assembly and dismantle of computer/ laptop

**TOTAL: 60 PERIODS**

#### COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

**CO1:**Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.

**CO2:**Wire various electrical joints in common household electrical wire work.

**CO3:**Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical assembly of common household equipments; Make a tray out of metal sheet using sheet metal work.

**CO4:**Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

### CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1
2	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1
3	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1
CO	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

EC3271

CIRCUIT ANALYSIS LABORATORY

L T P C

0 0 2 1

#### COURSE OBJECTIVES:

- To gain hands- on experience in Thevenin & Norton theorem, KVL & KCL, and Superposition Theorems.
- To understand the working of RL,RC and RLC circuits

#### List of Experiments:

1. Verifications of KVL & KCL.
2. Verifications of Thevenin & Norton theorem.
3. Verification of Superposition Theorem.
4. Verification of maximum power transfer Theorem
5. Determination of Resonance Frequency of Series & Parallel RLC Circuits.
6. Transient analysis of RL and RC circuits.

**TOTAL : 30 PERIODS**

#### COURSE OUTCOMES:

**At the end of the course, the student will be able to**

- Design RL and RC circuits.
- Verify Thevinin & Norton theorem KVL & KCL, and Super Position Theorems.

#### TEXT BOOKS

1. Hayt JackKemmerly, Steven Durbin, "Engineering Circuit Analysis", McGraw Hill education, 9<sup>th</sup> Edition, 2018.
2. Charles K. Alexander & Mathew N.O.Sadiku, "Fundamentals of Electric Circuits", McGraw- Hill, 2<sup>nd</sup> Edition, 2003.
3. Joseph Edminister and Mahmood Nahvi, "Electric Circuits, Schaum's Outline Series", Tata McGraw Hill Publishing Company, New Delhi, Fifth Edition Reprint 2016.

#### REFERENCES

1. David Bell, "Fundamentals of Electric Circuits", Oxford University press, 7<sup>th</sup> Edition, 2009
2. John O Mallay, Schaum's Outlines "Basic Circuit Analysis", The Mc Graw Hill companies, 2<sup>nd</sup> Edition, 2011.
3. A.Bruce Carlson, "Cicuits: Engineering Concepts and Analysis of Linear Electric Circuits, Cengage Learning, India Edition 2nd Indian Reprint 2009.
4. Allan H.Robbins, Wilhelm C.Miller, "Circuit Analysis Theory and Practice", Cengage Learning, Fifth Edition, 1st Indian Reprint 2013

### CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1	1	-	-	-	1	-	1	-	-	-	-	-
2	3	3	2	2	-	-	-	1	-	1	-	-	-	-	-
3	3	3	3	3	-	-	-	1	-	1	-	-	-	-	-
4	3	3	3	3	-	-	-	1	-	1	-	-	-	-	-
5	3	3	3	2	-	-	-	1	-	1	-	-	-	-	-
CO	3	3	3	2	-	-	-	1	-	1	-	-	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

GE3272

COMMUNICATION LABORATORY

L T P C  
0 0 4 2

#### COURSE OBJECTIVES:

- To identify varied group discussion skills and apply them to take part in effective discussions in a professional context.
- To analyse concepts and problems and make effective presentations explaining them clearly and precisely.
- To be able to communicate effectively through formal and informal writing.
- To be able to use appropriate language structures to write emails, reports and essays
- To give instructions and recommendations that are clear and relevant to the context

#### UNIT I

12

Speaking-Role Play Exercises Based on Workplace Contexts, - talking about competition-discussing progress toward goals-talking about experiences- talking about events in life- discussing past events-Writing: writing emails ( formal & semi-formal).

#### UNIT II

12

Speaking: discussing news stories-talking about frequency-talking about travel problems- discussing travel procedures- talking about travel problems- making arrangements-describing arrangements-discussing plans and decisions- discussing purposes and reasons- understanding common technology terms-Writing: - writing different types of emails.

#### UNIT III

12

Speaking: discussing predictions-describing the climate-discussing forecasts and scenarios- talking about purchasing-discussing advantages and disadvantages- making comparisons- discussing likes and dislikes- discussing feelings about experiences-discussing imaginary scenarios Writing: short essays and reports-formal/semi-formal letters.

#### UNIT IV

12

Speaking: discussing the natural environment-describing systems-describing position and movement- explaining rules-( example- discussing rental arrangements)- understanding technical instructions-Writing: writing instructions-writing a short article.

#### UNIT V

12

Speaking: describing things relatively-describing clothing-discussing safety issues( making recommendations) talking about electrical devices-describing controlling actions- Writing: job application( Cover letter + Curriculum vitae)-writing recommendations.

**TOTAL: 60 PERIODS**

## LEARNING OUTCOMES

**CO1:**Speak effectively in group discussions held in formal/semi formal contexts.

**CO2:**Discuss, analyse and present concepts and problems from various perspectives to arrive at suitable solutions

**CO3:**Write emails, letters and effective job applications.

**CO4:**Write critical reports to convey data and information with clarity and precision

**CO5:**Give appropriate instructions and recommendations for safe execution of tasks

## Assessment Pattern

- One online / app based assessment to test speaking and writing skills
- Proficiency certification is given on successful completion of speaking and writing.

### CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	3	3	1	3	3	3	3	3	3	3	-	-	-
2	2	3	3	3	1	3	3	3	3	3	3	3	-	-	-
3	2	2	3	3	1	3	3	3	3	3	3	3	-	-	-
4	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
5	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
AVg.	2.4	2.8	3	3	1.8	3	3	3	3	3	3	3	-	-	-

1-low, 2-medium, 3-high, '-'- no correlation

- **Note:** The average value of this course to be used for program articulation matrix.

MA3355

RANDOM PROCESSES AND LINEAR ALGEBRA

L T P C

3 1 0 4

## COURSE OBJECTIVES :

- To introduce the basic notions of vector spaces which will then be used to solve related problems.
- To understand the concepts of vector space, linear transformations , inner product spaces and orthogonalization..
- To provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems in communication engineering.
- To provide necessary basics in probability that are relevant in applications such as random signals, linear systems in communication engineering.
- To understand the basic concepts of probability, one and two dimensional random
- variables and to introduce some standard distributions applicable to engineering which can describe real life phenomenon.

### UNIT - I PROBABILITY AND RANDOM VARIABLES

9 + 3

Axioms of probability – Conditional probability – Baye's theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions - Functions of a random variable.

### UNIT - II TWO - DIMENSIONAL RANDOM VARIABLES

9 + 3

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

**UNIT – III RANDOM PROCESSES****9 + 3**

Classification – Stationary process – Markov process - Poisson process - Discrete parameter Markov chain – Chapman Kolmogorov equations (Statement only) - Limiting distributions .

**UNIT - IV VECTOR SPACES****9 + 3**

Vector spaces – Subspaces – Linear combinations and linear system of equations – Linear independence and linear dependence – Bases and dimensions.

**UNIT - V LINEAR TRANSFORMATION AND INNER PRODUCT SPACES****9 + 3**

Linear transformation - Null spaces and ranges - Dimension theorem - Matrix representation of a linear transformations - Inner product - Norms - Gram Schmidt orthogonalization process - Adjoint of linear operations - Least square approximation.

**TOTAL: 60 PERIODS****COURSE OUTCOMES :**

Upon successful completion of the course, students will be able to:

- CO1:** Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.
- CO2:** Demonstrate accurate and efficient use of advanced algebraic techniques.
- CO3:** Apply the concept of random processes in engineering disciplines.
- CO4:** Understand the fundamental concepts of probability with a thorough knowledge of standard distributions that can describe certain real-life phenomenon.
- CO5:** Understand the basic concepts of one and two dimensional random variables and apply them to model engineering problems.

**TEXTBOOKS :**

1. Gross, D., Shortle, J.F, Thompson, J.M and Harris. C.M., "Fundamentals of Queueing Theory", Wiley Student 4th Edition, 2014.
2. Ibe, O.C., "Fundamentals of Applied Probability and Random Processes", Elsevier, 1st Indian Reprint, 2007.
3. Friedberg. A.H., Insel. A.J. and Spence. L., "Linear Algebra", Prentice Hall of India, New Delhi, 4<sup>th</sup> Edition, 2004.

**REFERENCES :**

1. Hsu, "Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes", Tata McGraw Hill Edition, New Delhi, 2004.
2. Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications", 2nd Edition, John Wiley and Sons, 2002.
3. Yates, R.D. and Goodman. D. J., "Probability and Stochastic Processes", 2nd Edition, Wiley India Pvt. Ltd., Bangalore, 2012.
4. Kolman. B. Hill. D.R., "Introductory Linear Algebra", Pearson Education, New Delhi, First Reprint, 2009.
5. Kumaresan. S., "Linear Algebra – A Geometric Approach", Prentice – Hall of India, New Delhi, Reprint, 2010.
6. Strang. G., "Linear Algebra and its applications", Thomson (Brooks/Cole), New Delhi, 2005.

### CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO2	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO3	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO4	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO5	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO6	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CS3353**

**C PROGRAMMING AND DATA STRUCTURES**

**L T P C**

**3 0 0 3**

#### **COURSE OBJECTIVES:**

- To introduce the basics of C programming language.
- To learn the concepts of advanced features of C.
- To understand the concepts of ADTs and linear data structures.
- To know the concepts of non-linear data structure and hashing.
- To familiarize the concepts of sorting and searching techniques.

#### **UNIT I C PROGRAMMING FUNDAMENTALS (8+1 SKILL)**

**9**

Data Types – Variables – Operations – Expressions and Statements – Conditional Statements – Functions – Recursive Functions – Arrays – Single and Multi-Dimensional Arrays.

#### **UNIT II C PROGRAMMING - ADVANCED FEATURES (8+1 SKILL)**

**9**

Structures – Union – Enumerated Data Types – Pointers: Pointers to Variables, Arrays and Functions – File Handling – Preprocessor Directives.

#### **UNIT III LINEAR DATA STRUCTURES (8+1 SKILL)**

**9**

Abstract Data Types (ADTs) – List ADT – Array-Based Implementation – Linked List – Doubly-Linked Lists – Circular Linked List – Stack ADT – Implementation of Stack – Applications – Queue ADT – Priority Queues – Queue Implementation – Applications.

#### **UNIT IV NON-LINEAR DATA STRUCTURES (8+1 SKILL)**

**9**

Trees – Binary Trees – Tree Traversals – Expression Trees – Binary Search Tree – Hashing - Hash Functions – Separate Chaining – Open Addressing – Linear Probing– Quadratic Probing – Double Hashing – Rehashing.

#### **UNIT V SORTING AND SEARCHING TECHNIQUES (8+1 SKILL)**

**9**

Insertion Sort – Quick Sort – Heap Sort – Merge Sort –Linear Search – Binary Search.

**TOTAL: 45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)**

**5**

#### **COURSE OUTCOMES:**

**CO1:**Develop C programs for any real world/technical application.

**CO2:**Apply advanced features of C in solving problems.

**CO3:**Write functions to implement linear and non-linear data structure operations.



**CO4:**Suggest and use appropriate linear/non-linear data structure operations for solving a given problem.

**CO5:**Appropriately use sort and search algorithms for a given application.

**CO6:**Apply appropriate hash functions that result in a collision free scenario for data storage and retrieval.

**TEXT BOOKS:**

1. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", Second Edition, Pearson Education, 1997.
2. ReemaThareja, "Programming in C", Second Edition, Oxford University Press, 2016.

**REFERENCES:**

1. Brian W. Kernighan, Rob Pike, "The Practice of Programming", Pearson Education, 1999.
2. Paul J. Deitel, Harvey Deitel, "C How to Program", Seventh Edition, Pearson Education, 2013.
3. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, 1983.
4. Ellis Horowitz, SartajSahni and Susan Anderson, "Fundamentals of Data Structures", Galgotia, 2008.

**List of Open Source Software/ Learning website:**

<https://www.coursera.org/specializations/data-structures-algorithms>

<https://nptel.ac.in/courses/112107243>

<https://nptel.ac.in/courses/112105598>

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	1	2	2	1	1	-	1	2	1	3	2	1	3
2	1	2	1	2	2	-	-	-	1	1	1	2	2	2	2
3	2	3	1	2	3	-	-	-	1	1	1	2	2	1	2
4	2	1	-	1	1	-	-	-	2	1	1	2	2	3	1
5	1	2	1	2	2	1	1	-	1	2	1	3	2	2	3
<b>CO</b>	2	2	1	2	2	1	1	-	1	1	1	2	2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**EC3354**

**SIGNALS AND SYSTEMS**

**L T P C**

**3 1 0 4**

**COURSE OBJECTIVES :**

- To understand the basic properties of signal & systems
- To know the methods of characterization of LTI systems in time domain
- To analyze continuous time signals and system in the Fourier and Laplace domain
- To analyze discrete time signals and system in the Fourier and Z transform domain

**UNIT I CLASSIFICATION OF SIGNALS AND SYSTEMS**

**6+6**

Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids\_Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals - Classification of systems- CT systems and DT systems- – Linear & Nonlinear, Time-variant& Time-invariant,Causal & Non-causal, Stable & Unstable.

**UNIT II ANALYSIS OF CONTINUOUS TIME SIGNALS 6+6**  
 Fourier series for periodic signals - Fourier Transform – properties- Laplace Transforms and Properties

**UNIT III LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS 6+6**  
 Impulse response - convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems - Systems connected in series / parallel.

**UNIT IV ANALYSIS OF DISCRETE TIME SIGNALS 6+6**  
 Baseband signal Sampling–Fourier Transform of discrete time signals (DTFT)– Properties of DTFT - Z Transform & Properties

**UNIT V LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS 6+6**  
 Impulse response–Difference equations-Convolution sum- Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.

**TOTAL: 30+30 PERIODS**

**COURSE OUTCOMES:**

**At the end of the course, the student will be able to:**

- CO1:determine if a given system is linear/causal/stable
- CO2: determine the frequency components present in a deterministic signal
- CO3:characterize continuous LTI systems in the time domain and frequency domain
- CO4:characterize discrete LTI systems in the time domain and frequency domain
- CO5:compute the output of an LTI system in the time and frequency domains

**TEXT BOOKS:**

1. Oppenheim, Willsky and Hamid, “Signals and Systems”, 2nd Edition, Pearson Education, New Delhi, 2015.(Units I - V)
2. Simon Haykin, Barry Van Veen, “Signals and Systems”, 2nd Edition, Wiley, 2002

**REFERENCES :**

1. B. P. Lathi, “Principles of Linear Systems and Signals”, 2<sup>nd</sup> Edition, Oxford, 2009.
2. M. J. Roberts, “Signals and Systems Analysis using Transform methods and MATLAB”, McGraw- Hill Education, 2018.
3. John Alan Stuller, “An Introduction to Signals and Systems”, Thomson, 2007.

**CO’s-PO’s & PSO’s MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	3	-	3	2	-	-	-	-	-	3	-	-	1
2	3	-	3	-	-	2	-	-	-	-	-	3	-	3	-
3	3	3	-	-	3	2	-	-	-	-	-	3	2	-	-
4	3	3	-	-	3	2	-	-	-	-	-	3	-	3	1
5	3	3	-	3	3	2	-	-	-	-	-	3	-	3	1
<b>CO</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>1</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES :**

- To give a comprehensive exposure to all types of devices and circuits constructed with discrete components. This helps to develop a strong basis for building linear and digital integrated circuits
- To analyze the frequency response of small signal amplifiers
- To design and analyze single stage and multistage amplifier circuits
- To study about feedback amplifiers and oscillators principles
- To understand the analysis and design of multi vibrators

**UNIT I SEMICONDUCTOR DEVICES****9**

PN junction diode, Zener diode, BJT, MOSFET, UJT –structure, operation and V-I characteristics, diffusion and transition capacitance - Rectifiers – Half Wave and Full Wave Rectifier, Zener as regulator

**UNIT II AMPLIFIERS****9**

Load line, operating point, biasing methods for BJT and MOSFET, BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response –MOSFET small signal model– Analysis of CS, CG and Source follower – Gain and frequency response- High frequency analysis.

**UNIT III MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER****9**

Cascode amplifier, Differential amplifier – Common mode and Difference mode analysis – MOSFET input stages – tuned amplifiers – Gain and frequency response – Neutralization methods.

**UNIT IV FEEDBACK AMPLIFIERS AND OSCILLATORS****9**

Advantages of negative feedback – Voltage / Current, Series , Shunt feedback Amplifiers – positive feedback–Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.

**UNIT V POWER AMPLIFIERS AND DC/DC CONVERTERS****9**

Power amplifiers- class A-Class B-Class AB-Class C-Power MOSFET-Temperature Effect- Class AB Power amplifier using MOSFET –DC/DC convertors – Buck, Boost, Buck-Boost analysis and design.

**TOTAL: 45 PERIODS****COURSE OUTCOMES :**

At the end of the course the students will be able to

**CO1:** Explain the structure and working operation of basic electronic devices.

**CO2:** Design and analyze amplifiers.

**CO3:** Analyze frequency response of BJT and MOSFET amplifiers

**CO4:** Design and analyze feedback amplifiers and oscillator principles.

**CO5:** Design and analyze power amplifiers and supply circuits

**TEXT BOOKS :**

1. David A. Bell, "Electronic Devices and Circuits", Oxford Higher Education press, 5 th Edition, 2010.
2. Robert L. Boylestad and Louis Nasheresky, "Electronic Devices and Circuit Theory", 10th Edition, Pearson Education / PHI, 2008.
3. Adel .S. Sedra, Kenneth C. Smith, "Micro Electronic Circuits", Oxford University Press, 7 th Edition, 2014.

**REFERENCES :**

1. Donald.A. Neamen, "Electronic Circuit Analysis and Design", Tata McGraw Hill, 3 rd Edition, 2010.
2. D.Schilling and C.Belove, "Electronic Circuits", McGraw Hill, 3 rd Edition, 1989
3. Muhammad H.Rashid, "Power Electronics", Pearson Education / PHI , 2004.

**CO's-PO's & PSO's MAPPING**

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
1	3	3	3	3	2	1	-	-	-	-	-	1	2	1	1
2	3	2	2	3	2	2	-	-	-	-	-	1	2	1	1
3	3	3	3	2	1	2	-	-	-	-	-	1	2	1	1
4	3	3	2	3	2	2	-	-	-	-	-	1	2	1	1
5	3	2	3	2	2	1	-	-	-	-	-	1	2	1	1
CO	3	3	3	3	2	2	-	-	-	-	-	1	2	1	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

**EC3351**

**CONTROL SYSTEMS**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES :**

- To introduce the components and their representation of control systems
- To learn various methods for analyzing the time response, frequency response and stability of the systems.
- To learn the various approach for the state variable analysis.

**UNIT I SYSTEMS COMPONENTS AND THEIR REPRESENTATION 9**

Control System: Terminology and Basic Structure-Feed forward and Feedback control theory- Electrical and Mechanical Transfer Function Models-Block diagram Models-Signal flow graphs models-DC and AC servo Systems-Synchronous -Multivariable control system

**UNIT II TIME RESPONSE ANALYSIS 9**

Transient response-steady state response-Measures of performance of the standard first order and second order system-effect on an additional zero and an additional pole-steady error constant and system- type number-PID control-Analytical design for PD, PI,PID control systems

**UNIT III FREQUENCY RESPONSE AND SYSTEM ANALYSIS 9**

Closed loop frequency response-Performance specification in frequency domain-Frequency response of standard second order system- Bode Plot - Polar Plot- Nyquist plots-Design of compensators using Bode plots-Cascade lead compensation-Cascade lag compensation-Cascade lag-lead compensation

**UNIT IV CONCEPTS OF STABILITY ANALYSIS 9**

Concept of stability-Bounded - Input Bounded - Output stability-Routh stability criterion-Relative stability-Root locus concept-Guidelines for sketching root locus-Nyquist stability criterion.

**UNIT V CONTROL SYSTEM ANALYSIS USING STATE VARIABLE METHODS 9**

State variable representation-Conversion of state variable models to transfer functions-Conversion of transfer functions to state variable models-Solution of state equations-Concepts of Controllability and Observability-Stability of linear systems-Equivalence between transfer function and state variable representations-State variable analysis of digital control system-Digital control design using state feedback.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES :**

**Upon successful completion of the course the student will be able to**

- CO1:** Compute the transfer function of different physical systems.
- CO2:** Analyse the time domain specification and calculate the steady state error.
- CO3:** Illustrate the frequency response characteristics of open loop and closed loop system response.
- CO4:** Analyse the stability using Routh and root locus techniques.
- CO5:** Illustrate the state space model of a physical system and discuss the concepts of sampled data control system.

**TEXT BOOK:**

1. M.Gopal,“Control System – Principles and Design”, Tata McGraw Hill, 4<sup>th</sup> Edition, 2012.

**REFERENCE:**

1. J.Nagrath and M.Gopal, “Control System Engineering”, New Age International Publishers, 5<sup>th</sup> Edition, 2007.
2. K.Ogata, “Modern Control Engineering”, PHI, 5<sup>th</sup> Edition, 2012.
3. S.K.Bhattacharya, “Control System Engineering”, Pearson, 3<sup>rd</sup> Edition, 2013.
4. Benjamin.C.Kuo, “Automatic Control Systems”, Prentice Hall of India, 7<sup>th</sup> Edition,1995.

**CO’s-PO’s & PSO’s MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	2	2	2	-	-	-	-	2	3	3	3	3
2	3	3	3	3	2	3	-	-	-	-	2	2	3	3	3
3	3	2	3	3	2	2	-	-	-	-	2	3	3	2	3
4	3	3	3	2	2	2	-	-	-	-	2	2	3	3	3
5	2	2	3	3	2	3	-	-	-	-	2	3	2	2	3
CO	3	3	3	3	2	2	-	-	-	-	2	3	3	3	3

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

**EC3352**

**DIGITAL SYSTEMS DESIGN**

**L T P C**

**3 0 2 4**

**COURSE OBJECTIVES :**

- To present the fundamentals of digital circuits and simplification methods
- To practice the design of various combinational digital circuits using logic gates
- To bring out the analysis and design procedures for synchronous and asynchronous Sequential circuits
- To learn integrated circuit families.
- To introduce semiconductor memories and related technology

<b>UNIT I</b>	<b>BASIC CONCEPTS</b>	<b>9</b>
Review of number systems-representation-conversions, Review of Boolean algebra- theorems, sum of product and product of sum simplification, canonical forms min term and max term, Simplification of Boolean expressions-Karnaugh map, completely and incompletely specified functions, Implementation of Boolean expressions using universal gates ,Tabulation methods.		
<b>UNIT II</b>	<b>COMBINATIONAL LOGIC CIRCUITS</b>	<b>9</b>
Problem formulation and design of combinational circuits - Code-Converters, Half and Full Adders, Binary Parallel Adder – Carry look ahead Adder, BCD Adder, Magnitude Comparator, Decoder, Encoder, Priority Encoder, Mux/Demux, Case study: Digital trans-receiver / 8 bit Arithmetic and logic unit, Parity Generator/Checker, Seven Segment display decoder		
<b>UNIT III</b>	<b>SYNCHRONOUS SEQUENTIAL CIRCUITS</b>	<b>9</b>
Latches, Flip flops – SR, JK, T, D, Master/Slave FF, Triggering of FF, Analysis and design of clocked sequential circuits – Design - Moore/Mealy models, state minimization, state assignment,lock - out condition circuit implementation - Counters, Ripple Counters, Ring Counters, Shift registers, Universal Shift Register. Model Development: Designing of rolling display/real time clock		
<b>UNIT IV</b>	<b>ASYNCHRONOUS SEQUENTIAL CIRCUITS</b>	<b>9</b>
Stable and Unstable states, output specifications, cycles and races, state reduction, race free assignments, Hazards, Essential Hazards, Fundamental and Pulse mode sequential circuits, Design of Hazard free circuits.		
<b>UNIT V</b>	<b>LOGIC FAMILIES AND PROGRAMMABLE LOGIC DEVICES</b>	<b>9</b>
Logic families- Propagation Delay, Fan - In and Fan - Out - Noise Margin - RTL ,TTL,ECL, CMOS - Comparison of Logic families - Implementation of combinational logic/sequential logic design using standard ICs, PROM, PLA and PAL, basic memory, static ROM,PROM,EPROM,EEPROM EAPROM.		

**45 PERIODS**  
**30 PERIODS**

**PRACTICAL EXERCISES :**

1. Design of adders and subtractors & code converters.
2. Design of Multiplexers & Demultiplexers.
3. Design of Encoders and Decoders.
4. Design of Magnitude Comparators
5. Design and implementation of counters using flip-flops
6. Design and implementation of shift registers.

**COURSE OUTCOMES :**

At the end of the course the students will be able to

**CO1:** Use Boolean algebra and simplification procedures relevant to digital logic.

**CO2:** Design various combinational digital circuits using logic gates.

**CO3:**Analyse and design synchronous sequential circuits.

**CO4:** Analyse and design asynchronous sequential circuits. .

**CO5:** Build logic gates and use programmable devices

**TOTAL:75 PERIODS**

**TEXTBOOKS :**

1. M. Morris Mano and Michael D. Ciletti, 'Digital Design', Pearson, 5th Edition, 2013.(Unit - I - V)

## REFERENCES :

1. Charles H. Roth, Jr, 'Fundamentals of Logic Design', Jaico Books, 4th Edition, 2002.
2. William I. Fletcher, "An Engineering Approach to Digital Design", Prentice- Hall of India, 1980.
3. Floyd T.L., "Digital Fundamentals", Charles E. Merrill publishing company, 1982.
4. John. F. Wakerly, "Digital Design Principles and Practices", Pearson Education, 4 th Edition, 2007.

## CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	2	-	2	-	-	-	-	3	3	3	3	2
2	-	-	-	-	-	-	-	-	-	-	2	1	2	3	2
3	-	3	3	2	-	2	-	-	-	-	2	2	3	3	2
4	-	-	-	-	-	-	-	-	-	-	3	2	2	3	1
5	-	3	3	3	-	-	-	-	-	-	2	2	3	3	2
CO	3	2.6	2.6	2.3	-	2	-	-	-	-	2	2	3	3	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

EC3361

ELECTRONIC DEVICES AND CIRCUITS LABORATORY

L T P C  
0 0 3 1.5

## COURSE OBJECTIVES

- To learn the characteristics of PN Junction diode and Zener diode.
- To understand the operation of rectifiers and filters.
- To study the characteristics of amplifier.

## LIST OF EXPERIMENTS

1. Characteristics of PN Junction Diode and Zener diode.
2. Full Wave Rectifier with Filters.
3. Design of Zener diode Regulator.
4. Common Emitter input-output Characteristics.
5. MOSFET Drain current and Transfer Characteristics.
6. Frequency response of CE and CS amplifiers.
7. Frequency response of CB and CC amplifiers.
8. Frequency response of Cascode Amplifier
9. CMRR measurement of Differential Amplifier
10. Class A Transformer Coupled Power Amplifier.

## COURSE OUTCOMES

At the end of the laboratory course, the student will be able to understand the

**CO1:**Characteristics of PN Junction Diode and Zener diode.

**CO2:**Design and Testing of BJT and MOSFET amplifiers.

**CO3:**Operation of power amplifiers.

**TOTAL:45 PERIODS**

## REFERENCE :

XYZ of Oscilloscope – Application note: Tektronix USA.

## CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	3	3	2	1	-	-	-	-	-	1	2	1	1
2	2	2	3	3	2	1	-	-	-	-	-	1	2	1	1
3	2		2		1	1	-	-	-	-	-	1	2	1	1
4	-	-	-	-	3	1	-	-	-	-	-	1	2	1	1
5	-	-	-	-	2	1	-	-	-	-	-	1	2	1	1
CO	2	2	2.6	3	2	1	-	-	-	-	-	1	2	1	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

### CS3362 C PROGRAMMING AND DATA STRUCTURES LABORATORY

L T P C  
0 0 3 1.5

#### COURSE OBJECTIVES:

- To develop applications in C
- To implement linear and non-linear data structures
- To understand the different operations of search trees
- To get familiarized to sorting and searching algorithms

#### LIST OF EXPERIMENTS

1. Practice of C programming using statements, expressions, decision making and iterative statements
2. Practice of C programming using Functions and Arrays
3. Implement C programs using Pointers and Structures
4. Implement C programs using Files
5. Development of real time C applications
6. Array implementation of List ADT
7. Array implementation of Stack and Queue ADTs
8. Linked list implementation of List, Stack and Queue ADTs
9. Applications of List, Stack and Queue ADTs
10. 10. Implementation of Binary Trees and operations of Binary Trees
11. Implementation of Binary Search Trees
12. Implementation of searching techniques
13. Implementation of Sorting algorithms : Insertion Sort, Quick Sort, Merge Sort
14. Implementation of Hashing – any two collision techniques

**TOTAL: 45 PERIODS**

#### COURSE OUTCOMES:

At the end of the course, the students will be able to:

- CO1:** Use different constructs of C and develop applications
- CO2:** Write functions to implement linear and non-linear data structure operations
- CO3:** Suggest and use the appropriate linear / non-linear data structure operations for a given problem
- CO4:** Apply appropriate hash functions that result in a collision free scenario for data storage and Retrieval
- CO5:** Implement Sorting and searching algorithms for a given application



### CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	1	2	2	1	1	-	1	2	1	3	2	1	3
2	1	2	1	2	2	-	-	-	1	1	1	2	2	2	2
3	2	3	1	2	3	-	-	-	1	1	1	2	2	1	2
4	2	1	-	1	1	-	-	-	2	1	1	2	2	3	1
5	1	2	1	2	2	1	1	-	1	2	1	3	2	2	3
<b>Avg</b>	2	2	1	2	2	1	1	-	1	1	1	2	2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**GE3361**

**PROFESSIONAL DEVELOPMENT**

**L T P C**  
**0 0 2 1**

#### **COURSE OBJECTIVES:**

To be proficient in important Microsoft Office tools: MS WORD, EXCEL, POWERPOINT.

- To be proficient in using MS WORD to create quality technical documents, by using standard templates, widely acceptable styles and formats, variety of features to enhance the presentability and overall utility value of content.
- To be proficient in using MS EXCEL for all data manipulation tasks including the common statistical, logical, mathematical etc., operations, conversion, analytics, search and explore, visualize, interlink, and utilizing many more critical features offered
- To be able to create and share quality presentations by using the features of MS PowerPoint, including: organization of content, presentability, aesthetics, using media elements and enhance the overall quality of presentations.

#### **MS WORD:**

**10 Hours**

Create and format a document

Working with tables

Working with Bullets and Lists

Working with styles, shapes, smart art, charts

Inserting objects, charts and importing objects from other office tools

Creating and Using document templates

Inserting equations, symbols and special characters

Working with Table of contents and References, citations

Insert and review comments

Create bookmarks, hyperlinks, endnotes footnote

Viewing document in different modes

Working with document protection and security

Inspect document for accessibility

**MS EXCEL:****10 Hours**

Create worksheets, insert and format data

Work with different types of data: text, currency, date, numeric etc.

Split, validate, consolidate, Convert data

Sort and filter data

Perform calculations and use functions: (Statistical, Logical, Mathematical, date, Time etc.)

Work with Lookup and reference formulae

Create and Work with different types of charts

Use pivot tables to summarize and analyse data

Perform data analysis using own formulae and functions

Combine data from multiple worksheets using own formulae and built-in functions to generate results

Export data and sheets to other file formats

Working with macros

Protecting data and Securing the workbook

**MS POWERPOINT:****10 Hours**

Select slide templates, layout and themes

Formatting slide content and using bullets and numbering

Insert and format images, smart art, tables, charts

Using Slide master, notes and handout master

Working with animation and transitions

Organize and Group slides

Import or create and use media objects: audio, video, animation

Perform slideshow recording and Record narration and create presentable videos

**TOTAL: 30 PERIODS****COURSE OUTCOMES:**

On successful completion the students will be able to

**CO1:**Use MS Word to create quality documents, by structuring and organizing content for their day to day technical and academic requirements

**CO2:**Use MS EXCEL to perform data operations and analytics, record, retrieve data as per requirements and visualize data for ease of understanding

**CO3:**Use MS PowerPoint to create high quality academic presentations by including common tables, charts, graphs, interlinking other elements, and using media objects.

**COURSE OBJECTIVES :**

- To impart knowledge on the basics of static electric field and the associated laws
- To impart knowledge on the basics of static magnetic field and the associated laws
- To give insight into coupling between electric and magnetic fields through Faraday's law, displacement current and Maxwell's equations
- To gain the behaviour of the propagation of EM waves
- To study the significance of Time varying fields.

**UNIT I INTRODUCTION****9**

Electromagnetic model, Units and constants, Review of vector algebra, Rectangular, cylindrical and spherical coordinate systems, Line, surface and volume integrals, Gradient of a scalar field, Divergence of a vector field, Divergence theorem, Curl of a vector field, Stoke's theorem, Null identities, Helmholtz's theorem, Verify theorems for different path, surface and volume.

**UNIT II ELECTROSTATICS****9**

Electric field, Coulomb's law, Gauss's law and applications, Electric potential, Conductors in static electric field, Dielectrics in static electric field, Electric flux density and dielectric constant, Boundary conditions, Electrostatics boundary value problems, Capacitance, Parallel, cylindrical and spherical capacitors, Electrostatic energy, Poisson's and Laplace's equations, Uniqueness of electrostatic solutions, Current density and Ohm's law, Electromotive force and Kirchhoff's voltage law, Equation of continuity and Kirchhoff's current law

**UNIT III MAGNETOSTATICS****9**

Lorentz force equation, Ampere's law, Vector magnetic potential, Biot-Savart law and applications, Magnetic field intensity and idea of relative permeability, Calculation of magnetic field intensity for various current distributions Magnetic circuits, Behaviour of magnetic materials, Boundary conditions, Inductance and inductors, Magnetic energy, Magnetic forces and torques

**UNIT IV TIME-VARYING FIELDS AND MAXWELL'S EQUATIONS****9**

Faraday's law, Displacement current and Maxwell-Ampere law, Maxwell's equations, Potential functions, Electromagnetic boundary conditions, Wave equations and solutions, Time-harmonic fields, Observing the Phenomenon of wave propagation with the aid of Maxwell's equations

**UNIT V PLANE ELECTROMAGNETIC WAVES****9**

Plane waves in lossless media, Plane waves in lossy media (low-loss dielectrics and good conductors), Group velocity, Electromagnetic power flow and Poynting vector, Normal incidence at a plane conducting boundary, Normal incidence at a plane dielectric boundary

**COURSE OUTCOMES :**

At the end of the course the students will be able to

- CO1:** Relate the fundamentals of vector, coordinate system to electromagnetic concepts
- CO2:** Analyze the characteristics of Electrostatic field
- CO3:** Interpret the concepts of Electric field in material space and solve the boundary conditions
- CO4:** Explain the concepts and characteristics of Magneto Static field in material space and solve boundary conditions.
- CO5:** Determine the significance of time varying fields

**TOTAL:45 PERIODS**

## TEXT BOOKS

1. D.K. Cheng, Field and wave electromagnetics, 2nd ed., Pearson (India), 2002
2. M.N.O.Sadiku and S.V. Kulkarni, Principles of electromagnetics, 6th ed., Oxford(Asian Edition), 2015

## REFERENCES

1. Edward C. Jordan & Keith G. Balmain, Electromagnetic waves and Radiating Systems, Second Edition, Prentice-Hall Electrical Engineering Series, 2012.
2. W.H. Hayt and J.A. Buck, Engineering electromagnetics, 7th ed., McGraw-Hill (India), 2006
3. B.M. Notaros, Electromagnetics, Pearson: New Jersey, 2011

### CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO12
1	2	1	1	1	-	2	1	-	-	1	-	2
2	2	2	3	3	2	2	2	-	-	1	1	2
3	2	2	3	2	2	2	1	-	-	1	1	2
4	2	2	3	2	2	2	1	-	-	1	1	2
5	2	2	2	2	2	2	1	-	-	2	2	1
CO	2	2	2	2	2	2	1	-	-	1	1	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

EC3401

NETWORKS AND SECURITY

L T P C  
3 0 2 4

### COURSE OBJECTIVES:

- To learn the Network Models and datalink layer functions.
- To understand routing in the Network Layer.
- To explore methods of communication and congestion control by the Transport Layer.
- To study the Network Security Mechanisms.
- To learn various hardware security attacks and their countermeasures.

### UNIT I NETWORK MODELS AND DATALINK LAYER

9

Overview of Networks and its Attributes – Network Models – OSI, TCP/IP, Addressing – Introduction to Datalink Layer – Error Detection and Correction – Ethernet(802.3)- Wireless LAN – IEEE 802.11, Bluetooth – Flow and Error Control Protocols – HDLC – PPP.

### UNIT II NETWORK LAYER PROTOCOLS

9

Network Layer – IPv4 Addressing – Network Layer Protocols(IP,ICMP and Mobile IP) Unicast and Multicast Routing – Intradomain and Interdomain Routing Protocols – IPv6 Addresses – IPv6 – Datagram Format - Transition from IPv4 to IPv6.

### UNIT III TRANSPORT AND APPLICATION LAYERS

9

Transport Layer Protocols – UDP and TCP Connection and State Transition Diagram - Congestion Control and Avoidance(DEC bit, RED)- QoS - Application Layer Paradigms – Client – Server Programming – Domain Name System – World Wide Web, HTTP, Electronic Mail.

### UNIT IV NETWORK SECURITY

9

OSI Security Architecture – Attacks – Security Services and Mechanisms – Encryption –Advanced Encryption Standard – Public Key Cryptosystems – RSA Algorithm – Hash Functions – Secure Hash Algorithm – Digital Signature Algorithm.

## UNIT V                    **HARDWARE SECURITY**

**9**

Introduction to hardware security, Hardware Trojans, Side – Channel Attacks – Physical Attacks and Countermeasures – Design for Security. Introduction to Blockchain Technology.

**45 PERIODS**

### **PRACTICAL EXERCISES:**

**30 PERIODS**

#### **Experiments using C**

1. Implement the Data Link Layer framing methods,
  - i) Bit stuffing, (ii) Character stuffing
2. Implementation of Error Detection / Correction Techniques
  - i) LRC, (ii) CRC, (iii) Hamming code
3. Implementation of Stop and Wait, and Sliding Window Protocols
4. Implementation of Go back-N and Selective Repeat Protocols.
5. Implementation of Distance Vector Routing algorithm (Routing Information Protocol) (Bellman-Ford).
6. Implementation of Link State Routing algorithm (Open Shortest Path First) with 5 nodes (Dijkstra's).
7. Data encryption and decryption using Data Encryption Standard algorithm.
8. Data encryption and decryption using RSA (Rivest, Shamir and Adleman) algorithm.
9. Implement Client Server model using FTP protocol.

#### **Experiments using Tool Command Language**

1. Implement and realize the Network Topology - Star, Bus and Ring using NS2.
2. Implement and perform the operation of CSMA/CD and CSMA/CA using NS2.

### **COURSE OUTCOMES:**

**Upon successful completion of the course the student will be able to**

- CO1:** Explain the Network Models, layers and functions.
- CO2:** Categorize and classify the routing protocols.
- CO3:** List the functions of the transport and application layer.
- CO4:** Evaluate and choose the network security mechanisms.
- CO5:** Discuss the hardware security attacks and countermeasures.

**TOTAL:75 PERIODS**

### **TEXTBOOKS**

1. Behrouz.A.Forouzan, Data Communication and Networking, Fifth Edition, TMH, 2017.(Unit – I,II,III)
2. William Stallings, Cryptography and Network Security, Seventh Edition, Pearson Education, 2017(Unit- IV)
3. Bhunia Swarup, Hardware Security –A Hands On Approach,Morgan Kaufmann, First edition, 2018.(Unit – V).

### **REFERENCES**

1. James.F.Kurose and Keith.W.Ross, Computer Networking – A Top – Down Approach, Sixth Edition, Pearson, 2017.
2. Douglas .E.Comer, Computer Networks and Internets with Internet Applications, Fourth Edition, Pearson Education, 2008.

**COURSE OBJECTIVES:**

- To introduce the basic building blocks of linear integrated circuits
- To learn the linear and non-linear applications of operational amplifiers
- To introduce the theory and applications of analog multipliers and PLL
- To learn the theory of ADC and DAC
- To introduce the concepts of waveform generation and introduce some special function ICs

**UNIT I BASICS OF OPERATIONAL AMPLIFIERS 9**

Current mirror and current sources, Current sources as active loads, Voltage sources, Voltage References, BJT Differential amplifier with active loads, Basic information about op-amps – Ideal Operational Amplifier - General operational amplifier stages -and internal circuit diagrams of IC 741, DC and AC performance characteristics, slew rate, Open and closed loop configurations – MOSFET Operational Amplifiers – LF155 and TL082.

**UNIT II APPLICATIONS OF OPERATIONAL AMPLIFIERS 9**

Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-I and I-to-V converters, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic amplifier, Comparators, Schmitt trigger, Precision rectifier, peak detector, clipper and clamper, Low-pass, high-pass and band-pass Butterworth filters.

**UNIT III ANALOG MULTIPLIER AND PLL 9**

Analog Multiplier using Emitter Coupled Transistor Pair - Gilbert Multiplier cell – Variable transconductance technique, analog multiplier ICs and their applications, Operation of the basic PLL, Closed loop analysis, Voltage controlled oscillator, Monolithic PLL IC 565, application of PLL for AM detection, FM detection, FSK modulation and demodulation and Frequency synthesizing and clock synchronization

**UNIT IV ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS 9**

Analog and Digital Data Conversions, D/A converter – specifications - weighted resistor type, R-2R Ladder type, Voltage Mode and Current-Mode  $R - 2R$  Ladder types - switches for D/A converters, high speed sample-and-hold circuits, A/D Converters – specifications - Flash type - Successive Approximation type - Single Slope type – Dual Slope type - A/D Converter using Voltage-to-Time Conversion - Over-sampling A/D Converters, Sigma – Delta converters.

**UNIT V WAVEFORM GENERATORS AND SPECIAL FUNCTION ICs 9**

Sine-wave generators, Multivibrators and Triangular wave generator, Saw-tooth wave generator, ICL8038 function generator, Timer IC 555, IC Voltage regulators – Three terminal fixed and adjustable voltage regulators - IC 723 general purpose regulator - Monolithic switching regulator, Low Drop – Out(LDO) Regulators - Switched capacitor filter IC MF10, Frequency to Voltage and Voltage to Frequency converters, Audio Power amplifier, Video Amplifier, Isolation Amplifier, Opto-couplers and fibre optic IC

**COURSE OUTCOMES:**

At the end of the course the students will be able to

**CO1** : Design linear and nonlinear applications of OP – AMPS

**CO2** : Design applications using analog multiplier and PLL

**CO3** : Design ADC and DAC using OP – AMPS

**CO4** : Generate waveforms using OP – AMP Circuits

**CO5** : Analyze special function ICs

**TOTAL:45 PERIODS**

**TEXT BOOK**

1. 1.D.Roy Choudhry, Shail Jain, “Linear Integrated Circuits”, New Age International Pvt. Ltd., 2018, Fifth Edition. (Unit I – V)
2. 2.Sergio Franco, “Design with Operational Amplifiers and Analog Integrated Circuits”, 4th Edition, Tata Mc Graw-Hill, 2016 (Unit I – V)

**REFERENCES**

1. Ramakant A. Gayakwad, “OP-AMP and Linear ICs”, 4th Edition, Prentice Hall / Pearson Education, 2015
2. Robert F.Coughlin, Frederick F.Driscoll, “Operational Amplifiers and Linear Integrated Circuits”, Sixth Edition, PHI, 2001.
3. S.Salivahanan & V.S. Kanchana Bhaskaran, “Linear Integrated Circuits”, TMH,2nd Edition, 4th Reprint, 2016.

**CO’s-PO’s & PSO’s MAPPING**

C	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1	PSO	PSO	PSO	
1	2	-	-	-	-	-	-	-	-	-	1	-	2	1	1	
2	2	3	3	2	-	-	-	-	-	-	-	-	2	1	1	
3	1	-	-	2	-	-	-	-	-	-	-	-	2	1	1	
4	1	-	-	2	-	-	-	-	-	-	-	-	2	1	1	
5	1	2	3	3	-	-	-	-	-	-	-	3	2	1	1	
<b>C</b>	<b>1.4</b>	<b>2.5</b>	<b>3</b>	<b>2.2</b>	-	-	-	-	-	-	-	<b>1</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation

**EC3492**

**DIGITAL SIGNAL PROCESSING**

**L T P C**  
**3 0 2 4**

**COURSE OBJECTIVES:**

- To learn discrete fourier transform, properties of DFT and its application to linear filtering
- To understand the characteristics of digital filters, design digital IIR and FIR filters and apply these filters to filter undesirable signals in various frequency bands
- To understand the effects of finite precision representation on digital filters
- To understand the fundamental concepts of multi rate signal processing and its applications
- To introduce the concepts of adaptive filters and its application to communication engineering

**UNIT I DISCRETE FOURIER TRANSFORM**

**9**

Sampling Theorem, concept of frequency in discrete-time signals, summary of analysis & synthesis equations for FT & DTFT, frequency domain sampling, Discrete Fourier transform (DFT) - deriving DFT from DTFT, properties of DFT - periodicity, symmetry, circular convolution. Linear filtering using DFT. Filtering long data sequences - overlap save and overlap add method. Fast computation of DFT - Radix-2 Decimation-in-time (DIT) Fast Fourier transform (FFT), Decimation-in-frequency (DIF) Fast Fourier transform (FFT). Linear filtering using FFT.

**UNIT II INFINITE IMPULSE RESPONSE FILTERS**

**9**

Characteristics of practical frequency selective filters. characteristics of commonly used analog filters - Butterworth filters, Chebyshev filters. Design of IIR filters from analog filters (LPF, HPF, BPF, BRF) - Approximation of derivatives, Impulse invariance method, Bilinear transformation. Frequency

transformation in the analog domain. Structure of IIR filter - direct form I, direct form II, Cascade, parallel realizations.

**UNIT III                      FINITE IMPULSE RESPONSE FILTERS                      9**

Design of FIR filters - symmetric and Anti-symmetric FIR filters - design of linear phase FIR filters using Fourier series method - FIR filter design using windows (Rectangular, Hamming and Hanning window), Frequency sampling method. FIR filter structures - linear phase structure, direct form realizations

**UNIT IV                      FINITE WORD LENGTH EFFECTS                      9**

Fixed point and floating point number representation - ADC - quantization - truncation and rounding - quantization noise - input / output quantization - coefficient quantization error - product quantization error - overflow error - limit cycle oscillations due to product quantization and summation - scaling to prevent overflow.

**UNIT V                      DSP APPLICATIONS                      9**

Multirate signal processing: Decimation, Interpolation, Sampling rate conversion by a rational factor – Adaptive Filters: Introduction, Applications of adaptive filtering to equalization-DSP Architecture- Fixed and Floating point architecture principles

**45 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

**MATLAB / EQUIVALENT SOFTWARE PACKAGE/ DSP PROCESSOR BASED IMPLEMENTATION**

1. Generation of elementary Discrete-Time sequences
2. Linear and Circular convolutions
3. Auto correlation and Cross Correlation
4. Frequency Analysis using DFT
5. Design of FIR filters (LPF/HPF/BPF/BSF) and demonstrates the filtering operation
6. Design of Butterworth and Chebyshev IIR filters (LPF/HPF/BPF/BSF) and demonstrate the filtering operations
7. Study of architecture of Digital Signal Processor
8. Perform MAC operation using various addressing modes
9. Generation of various signals and random noise
10. Design and demonstration of FIR Filter for Low pass, High pass, Band pass and Band stop filtering
11. Design and demonstration of Butter worth and Chebyshev IIR Filters for Low pass, High pass, Band pass and Band stop filtering
12. Implement an Up-sampling and Down-sampling operation in DSP Processor

**COURSE OUTCOMES:**

At the end of the course students will be able to:

**CO1:**Apply DFT for the analysis of digital signals and systems

**CO2:**Design IIR and FIR filters

**CO3:** Characterize the effects of finite precision representation on digital filters

**CO4:**Design multirate filters

**CO5:**Apply adaptive filters appropriately in communication systems

**TOTAL:75 PERIODS**



**TEXT BOOKS:**

1. John G. Proakis and Dimitris G. Manolakis, Digital Signal Processing – Principles, Algorithms and Applications, Fourth Edition, Pearson Education / Prentice Hall, 2007.
2. A. V. Oppenheim, R.W. Schaffer and J.R. Buck, —Discrete-Time Signal Processing”, 8th Indian Reprint, Pearson, 2004.

**REFERENCES**

1. Emmanuel C. Ifeakor & Barrie. W. Jervis, “Digital Signal Processing”, Second Edition, Pearson Education / Prentice Hall, 2002.
2. Sanjit K. Mitra, “Digital Signal Processing – A Computer Based Approach”, Tata Mc Graw Hill, 2007.
3. Andreas Antoniou, “Digital Signal Processing”, Tata Mc Graw Hill, 2006.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	2	2	-	-	-	-	1	1	3	3	2
2	3	3	3	3	2	2	-	-	-	-	1	1	2	2	2
3	3	3	2	2	2	2	-	-	-	-	1	1	1	2	2
4	3	3	2	2	3	1	-	-	-	-	1	1	2	2	3
5	3	2	2	2	3	2	-	-	-	-	1	1	2	2	1
<b>CO</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	-	-	-	-	<b>1</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>2</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation

EC3491

COMMUNICATION SYSTEMS

L T P C

3 0 0 3

**COURSE OBJECTIVES:**

- To introduce Analog Modulation Schemes
- To impart knowledge in random process
- To study various Digital techniques
- To introduce the importance of sampling & quantization
- To impart knowledge in demodulation techniques
- To enhance the class room teaching using smart connectivity instruments

**UNIT I AMPLITUDE MODULATION**

9

Review of signals and systems, Time and Frequency domain representation of signals, Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations. Angle Modulation, Representation of FM and PM signals, Spectral characteristics of angle modulated signals. SSB Generation – Filter and Phase Shift Methods, VSB Generation – Filter Method, Hilbert Transform, Pre-envelope & complex envelope AM techniques, Superheterodyne Receiver.

**UNIT II RANDOM PROCESS & SAMPLING**

9

Review of probability and random process. Gaussian and white noise characteristics, Noise in amplitude modulation systems, Noise in Frequency modulation systems. Pre-emphasis and De-emphasis, Threshold effect in angle modulation.

Low pass sampling – Aliasing- Signal Reconstruction-Quantization - Uniform & non-uniform quantization - quantization noise - Nyquist criterion- Logarithmic Companding –PAM, PPM, PWM, PCM – TDM, FDM

**UNIT III DIGITAL TECHNIQUES 9**

Pulse modulation Differential pulse code modulation. Delta modulation, Noise considerations in PCM,, Digital Multiplexers, Channel coding theorem - Linear Block codes - Hamming codes - Cyclic codes - Convolutional codes - Viterbi Decoder

**UNIT IV DIGITAL MODULATION SCHEME 9**

Geometric Representation of signals - Generation, detection, IQ representation, PSD & BER of Coherent BPSK, BFSK, & QPSK - QAM - Carrier Synchronization - Structure of Non-coherent Receivers Synchronization and Carrier Recovery for Digital modulation, Spectrum Analysis – Occupied bandwidth – Adjacent channel power, EVM, Principle of DPSK

**UNIT V DEMODULATION TECHNIQUES 9**

Elements of Detection Theory, Optimum detection of signals in noise, Coherent communication with waveforms- Probability of Error evaluations. Baseband Pulse Transmission- Inter symbol Interference, Optimum demodulation of digital signals over band-limited channels.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course students will be able to

**CO1:** Gain knowledge in amplitude modulation techniques

**CO2:** Understand the concepts of Random Process to the design of communication systems

**CO3:** Gain knowledge in digital techniques

**CO4:** Gain knowledge in sampling and quantization

**CO5:** Understand the importance of demodulation techniques

**TEXTBOOKS :**

1. Simon Haykins, "Communication Systems", Wiley, 5th Edition, 2009.(Unit I - V)
2. B.P.Lathi, "Modern Digital and Analog Communication Systems", 4th Edition, Oxford University Press, 2011.

**REFERENCES :**

1. Wayner Tomasi, Electronic Communication System, 5th Edition, Pearson Education,2008.
2. D.Roody, J.Coolen, Electronic Communications, 4th edition PHI 2006
3. A.Papoulis, "Probability, Random variables and Stochastic Processes", McGraw Hill, 3<sup>rd</sup> edition, 1991.
4. B.Sklar, "Digital Communications Fundamentals and Applications", 2nd Edition Pearson Education 2007
5. H P Hsu, Schaum Outline Series - "Analog and Digital Communications" TMH 2006
6. Couch.L., "Modern Communication Systems", Pearson, 2001

**CO's-PO's & PSO's MAPPING**

CO	Pos											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	3	3	3	2	1	1	-	-	-	1	1
2	3	3	3	3	2	1	1	-	-	-	1	1
3	3	3	3	3	3	1	1	-	-	-	1	1
4	3	3	3	3	3	1	1	-	-	-	1	1

5	3	3	3	3	2	1	1	-	-	-	1	1
Avg	3	3	3	3	2.5	1	1	-	-	-	1	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

**GE3451 ENVIRONMENTAL SCIENCES AND SUSTAINABILITY**

**L T P C  
2 0 0 2**

**COURSE OBJECTIVES:**

- To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation.
- To impart knowledge on the causes, effects and control or prevention measures of environmental pollution and natural disasters.
- To facilitate the understanding of global and Indian scenario of renewable and nonrenewable resources, causes of their degradation and measures to preserve them.
- To familiarize the concept of sustainable development goals and appreciate the interdependence of economic and social aspects of sustainability, recognize and analyze climate changes, concept of carbon credit and the challenges of environmental management.
- To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles and analyze the role of sustainable urbanization.

**UNIT I ENVIRONMENT AND BIODIVERSITY 6**

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

**UNIT II ENVIRONMENTAL POLLUTION 6**

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts .

**UNIT III RENEWABLE SOURCES OF ENERGY 6**

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

**UNIT IV SUSTAINABILITY AND MANAGEMENT 6**

Development , GDP ,Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols-Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

**UNIT V SUSTAINABILITY PRACTICES 6**

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economical and technological change.

**TOTAL:30 PERIODS**

**COURSE OUTCOMES:**

**CO1:**To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.

**CO2:**To identify the causes, effects of environmental pollution and natural disasters and contribute to the preventive measures in the society.

**CO3:**To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.

**CO4:**To recognize the different goals of sustainable development and apply them for suitable technological advancement and societal development.

**CO5:**To demonstrate the knowledge of sustainability practices and identify green materials, energy cycles and the role of sustainable urbanization.

**TEXT BOOKS :**

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

**REFERENCES :**

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 . edition 2010.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, Third Edition, 2015.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

**CO's-PO's & PSO's MAPPING**

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	-	-	-	2	3	-	-	-	-	2	-	-	-
2	3	2	-	-	-	3	3	-	-	-	-	2	-	-	-
3	3	-	1	-	-	2	2	-	-	-	-	2	-	-	-
4	3	2	1	1	-	2	2	-	-	-	-	2	-	-	-
5	3	2	1	-	-	2	2	-	-	-	-	1	-	-	-
<b>Avg.</b>	<b>2.8</b>	<b>1.8</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>2.2</b>	<b>2.4</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1.8</b>	<b>-</b>	<b>-</b>	<b>-</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES :**

- To study the AM & FM Modulation and Demodulation.
- To learn and realize the effects of sampling and TDM.
- To understand the PCM & Digital Modulation.
- To Simulate Digital Modulation Schemes.
- To Implement Equalization Algorithms and Error Control Coding Schemes.

**LIST OF EXPERIMENTS**

1. AM- Modulator and Demodulator
2. FM - Modulator and Demodulator
3. Pre-Emphasis and De-Emphasis.
4. Signal sampling and TDM.
5. Pulse Code Modulation and Demodulation.
6. Pulse Amplitude Modulation and Demodulation.
7. Pulse Position Modulation and Demodulation and Pulse Width Modulation and Demodulation.
8. Digital Modulation – ASK, PSK, FSK.
9. Delta Modulation and Demodulation.
10. Simulation of ASK, FSK, and BPSK Generation and Detection Schemes.
11. Simulation of DPSK, QPSK and QAM Generation and Detection Schemes.
12. Simulation of Linear Block and Cyclic Error Control coding Schemes.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:****At the end of the laboratory course, the student will be able to understand the:****CO1:**Design AM, FM & Digital Modulators for specific applications.**CO2:**Compute the sampling frequency for digital modulation.**CO3:**Simulate & validate the various functional modules of Communication system.**CO4:**Demonstrate their knowledge in base band signaling schemes through implementation of digital modulation schemes.**CO5:**Apply various channel coding schemes & demonstrate their capabilities towards the improvement of the noise performance of Communication system.**CO's-PO's & PSO's MAPPING**

CO	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	3	3	3	3	3	-	-	-	1	1	1
2	3	3	3	3	3	2	-	-	-	1	1	1
3	3	3	3	3	3	2	-	-	-	1	1	1
4	3	3	3	3	3	3	-	-	-	1	1	1
5	3	3	3	3	3	2	-	-	-	1	1	1
Avg	3	3	3	3	3	2.5	-	-	-	1	1	1

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

**COURSE OBJECTIVES:**

- To gain hands on experience in designing electronic circuits
- To learn simulation software used in circuit design
- To learn the fundamental principles of amplifier circuits
- To differentiate feedback amplifiers and oscillators.
- To differentiate the operation of various multivibrators

**LIST OF EXPERIMENTS:****DESIGN AND ANALYSIS OF THE FOLLOWING CIRCUITS**

1. Series and Shunt feedback amplifiers-Frequency response, Input and output impedance
2. RC Phase shift oscillator and Wien Bridge Oscillator
3. Hartley Oscillator and Colpitts Oscillator
4. RC Integrator and Differentiator circuits using Op-Amp
5. Clippers and Clampers
6. Instrumentation amplifier
7. Active low-pass, High pass & Band pass filters
8. PLL Characteristics and its use as frequency multiplier, clock synchronization
9. R-2R ladder type D-A converter using Op-Amp

**SIMULATION USING SPICE (Using Transistor):**

1. Tuned Collector Oscillator
2. Twin -T Oscillator / Wein Bridge Oscillator
3. Double and Stagger tuned Amplifiers
4. Bistable Multivibrator
5. Schmitt Trigger circuit with Predictable hysteresis
6. Analysis of power amplifier

**Components and Accessories:**

Transistors, Resistors, Capacitors, Inductors, diodes, Zener Diodes, Bread Boards, Transformers.  
SPICE Circuit Simulation Software: (any public domain or commercial software)

**Note:** Op-Amps uA741, LM 301, LM311, LM 324, LM317, LM723, 7805, 7812, 2N3524, 2N3525, 2N3391, AD 633, LM 555, LM 565 may be used

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course the students will be able to

**CO1:**Analyze various types of feedback amplifiers

**CO2:**Design oscillators, tuned amplifiers, wave-shaping circuits and multivibrators

**CO3:**Design and simulate feedback amplifiers,oscillators, tuned amplifiers, wave- shaping circuits and multivibrators, filters using SPICE Tool.

**CO4:**Design amplifiers, oscillators, D-A converters using operational amplifiers.

**CO5:**Design filters using op-amp and perform an experiment on frequency response

## CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	3	-	-	-	-	-	-	1	1
CO2	2	3	3	3	-	-	-	-	-	-	1	1
CO3	2	3	3	3	-	-	-	-	-	-	1	1
CO4	2	3	3	3	2	-	-	-	-	-	1	1
CO5	-	-	-	-	-	-	-	-	-	-	-	-
Avg	2	3	3	3	2	-	-	-	-	-	1	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

EC3501

WIRELESS COMMUNICATION

L T P C

3 0 2 4

### COURSE OBJECTIVES:

- To study and understand the concepts and design of a Cellular System.
- To Study And Understand Mobile Radio Propagation And Various Digital Modulation Techniques.
- To Understand The Concepts Of Multiple Access Techniques And Wireless Networks

### UNIT-I THE CELLULAR CONCEPT-SYSTEM DESIGN FUNDAMENTALS 9

Introduction-Frequency Reuse-Channel Assignment Strategies-**Handoff Strategies**: Prioritizing Handoffs, Practical Handoff Considerations. **Interference And System Capacity**: Co-Channel Interference And System Capacity-Channel Planning For Wireless Systems, Adjacent Channel Interference, Power Control For Reducing Interference, Trunking And Grade Of Service. **Improving Coverage And Capacity In Cellular Systems**: Cell Splitting, Sectoring.

### UNIT-II MOBILE RADIO PROPAGATION 9

**Large Scale Path Loss**: Introduction To Radio Wave Propagation - Free Space Propagation Model – **Three Basic Propagation Mechanism**: Reflection – Brewster Angle- Diffraction- Scattering. **Small Scale Fading And Multipath**: Small Scale Multipath Propagation, Factors Influencing Small-Scale Fading, Doppler Shift, Coherence Bandwidth, Doppler Spread And Coherence Time. **Types Of Small- Scale Fading**: Fading Effects Due To Multipath Time Delay Spread, Fading Effects Due To Doppler Spread.

### UNIT- III MODULATION TECHNIQUES AND EQUALIZATION AND DIVERSITY 9

**Digital Modulation – An Overview**: Factors That Influence The Choice Of Digital Modulation, **Linear Modulation Techniques**: Minimum Shift Keying (MSK), Gaussian Minimum Shift Keying (GMSK), **Spread Spectrum Modulation Techniques**: Pseudo- Noise (PN) Sequences, Direct Sequence Spread Spectrum (DS-SS)- Modulation Performance In Fading And Multipath Channels- **Equalization, Diversity And Channel Coding**: Introduction-Fundamentals Of Equalization- **Diversity Techniques**: Practical Space Diversity Considerations, Polarization Diversity, Frequency Diversity, Time Diversity.

### UNIT- IV MULTIPLE ACCESS TECHNIQUES 9

**Introduction**: Introduction To Multiple Access- Frequency Division Multiple Access (FDMA)- Time Division Multiple Access (TDMA)- Spread Spectrum Multiple Access- Code Division Multiple Access (CDMA)- Space Division Multiple Access (SDMA)- **Capacity Of Cellular Systems**: Capacity Of Cellular CDMA, Capacity Of CDMA With Multiple Cells.

**UNIT- V WIRELESS NETWORKING****9**

**Introduction:** Difference Between Wireless And Fixed Telephone Networks, The Public Switched Telephone Network(PSTN), **Development Of Wireless Networks:** First Generation Wireless Networks, Second Generation Wireless Networks, Third Generation Wireless Networks, Fixed Network Transmission Hierarchy, **Traffic Routing In Wireless Networks:** Circuit Switching, Packet Switching- **Personal Communication Services/ Networks(PCS/PCNs):** Packet Vs Circuit Switching For PCN, Cellular Packet- Switched Architecture- Packet Reservation Multiple Access(PRMA)- **Network Databases:** Distributed Database For Mobility Management- Universal Mobile Telecommunication Systems(UMTS).

**45 PERIODS****PRACTICAL EXERCISES:****30 PERIODS**

1. Modeling of wireless communication systems using Matlab(Two ray channel and Okumura –Hata model)
2. Modeling and simulation of Multipath fading channel
3. Design, analyze and test Wireless standards and evaluate the performance measurements such as BER, PER, BLER, throughput, capacity, ACLR, EVM for 4G and 5G using Matlab
4. Modulation: Spread Spectrum – DSSS Modulation & Demodulation
5. Wireless Channel equalization: Zero-Forcing Equalizer (ZFE), MMSE Equalizer(MMSEE), Adaptive Equalizer (ADE), Decision Feedback Equalizer (DFE)
6. Modeling and simulation of TDMA, FDMA and CDMA for wireless communication

**TOTAL:75 PERIODS****COURSE OUTCOMES :****Upon successful completion of the course the student will be able to:****CO1:** Understand The Concept And Design Of A Cellular System.**CO2:** Understand Mobile Radio Propagation And Various Digital Modulation Techniques.**CO3:** Understand The Concepts Of Multiple Access Techniques And Wireless Networks**CO4:** Characterize a wireless channel and evolve the system design specifications**CO5:** Design a cellular system based on resource availability and traffic demands.**TEXT BOOK :**

1. Rappaport, T.S., -"Wireless communications", Pearson Education, Second Edition, 2010.

**REFERENCES :**

1. Wireless Communication –Andrea Goldsmith, Cambridge University Press, 2011
2. Van Nee, R. and Ramji Prasad, —OFDM for wireless multimedia communications, Artech House, 2000
3. David Tse and Pramod Viswanath, —Fundamentals of Wireless Communication, Cambridge University Press, 2005.
4. Upena Dalal, —"Wireless Communication", Oxford University Press, 2009.
5. Andreas.F. Molisch, —"Wireless Communications", John Wiley – India, 2006.
6. Wireless Communication and Networks –William Stallings ,Pearson Education, Second Edition 2002.

**CO's-PO's & PSO's MAPPING**

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
1	3	2	2	3	3	1	-	-	-	-	-	1	3	1	1
2	3	3	2	1	3	2	-	-	-	-	-	-	3	1	2
3	3	3	3	3	2	2	-	-	-	-	-	1	3	1	2
4	2	3	2	2	2	2	-	-	-	-	-	1	2	1	1
5	2	-	3	3	2	1	-	-	-	-	-	1	2	2	2



CO	3	3	2	2	2	2	-	-	-	-	-	1	3	1	2
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1 - low, 2 - medium, 3 - high, '-' - no correlation

EC3552

VLSI AND CHIP DESIGN

L T P C

3 0 0 3

**COURSE OBJECTIVES:**

- Understand the fundamentals of IC technology components and their characteristics.
- Understand combinational logic circuits and design principles.
- Understand sequential logic circuits and clocking strategies.
- Understand ASIC Design functioning and design.
- Understand Memory Architecture and building blocks

**UNIT I MOS TRANSISTOR PRINCIPLES 9**

MOS logic families (NMOS and CMOS), Ideal and Non Ideal IV Characteristics, CMOS devices. MOS(FET) Transistor Characteristic under Static and Dynamic Conditions, Technology Scaling, power consumption

**UNIT II COMBINATIONAL LOGIC CIRCUITS 9**

Propagation Delays, stick diagram, Layout diagrams, Examples of combinational logic design, Elmore's constant, Static Logic Gates, Dynamic Logic Gates, Pass Transistor Logic, Power Dissipation, Low Power Design principles.

**UNIT III SEQUENTIAL LOGIC CIRCUITS AND CLOCKING STRATEGIES 9**

Static Latches and Registers, Dynamic Latches and Registers, Pipelines, Nonbistable Sequential Circuits. Timing classification of Digital Systems, Synchronous Design, Self-Timed Circuit Design .

**UNIT IV INTERCONNECT , MEMORY ARCHITECTURE AND ARITHMETIC CIRCUITS 9**

Interconnect Parameters – Capacitance, Resistance, and Inductance, Electrical Wire Models, Sequential digital circuits: adders, multipliers, comparators, shift registers. Logic Implementation using Programmable Devices (ROM, PLA, FPGA), Memory Architecture and Building Blocks, Memory Core and Memory Peripherals Circuitry

**UNIT V ASIC DESIGN AND TESTING 9**

Introduction to wafer to chip fabrication process flow. Microchip design process & issues in test and verification of complex chips, embedded cores and SOCs, Fault models, Test coding. ASIC Design Flow, Introduction to ASICs, Introduction to test benches, Writing test benches in Verilog HDL, Automatic test pattern generation, Design for testability, Scan design: Test interface and boundary scan.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**Upon successful completion of the course the student will be able to**

**CO1:** In depth knowledge of MOS technology

**CO2:** Understand Combinational Logic Circuits and Design Principles

**CO3:** Understand Sequential Logic Circuits and Clocking Strategies

**CO4:** Understand Memory architecture and building blocks

**CO5:** Understand the ASIC Design Process and Testing.

**TEXTBOOKS**

1. Jan D Rabaey, Anantha Chandrakasan, “ Digital Integrated Circuits: A Design Perspective”, PHI, 2016.(Units II, III and IV).
2. Neil H E Weste, Kamran Eshranghian, “ Principles of CMOS VLSI Design: A System Perspective,” Addison Wesley, 2009.( Units - I, IV).
3. Michael J Smith ,” Application Specific Integrated Circuits, Addison Wesley, (Unit - V)
4. Samir Palnitkar,” Verilog HDL:A guide to Digital Design and Synthesis”, Second Edition, Pearson Education,2003.(Unit - V)
5. Parag K.Lala,” Digital Circuit Testing and Testability”, Academic Press, 1997, (Unit - V)

**REFERENCES**

1. D.A. Hodges and H.G. Jackson, Analysis and Design of Digital Integrated Circuits, International Student Edition, McGraw Hill 1983
2. P. Rashinkar, Paterson and L. Singh, "System-on-a-Chip Verification-Methodology and Techniques", Kluwer Academic Publishers,2001
3. SamihaMourad and YervantZorian, “Principles of Testing Electronic Systems”, Wiley 2000
4. M. Bushnell and V. D. Agarwal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers,2000

**CO’s-PO’s & PSO’s MAPPING**

C	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1	PSO	PSO	PSO
1	1	1	-	-	-	-	-	-	-	-	-	-	3	3	3
2	3	2	3	2	-	-	-	-	-	-	-	1	3	3	3
3	2	3	2	3	1	1	-	-	-	-	-	2	3	2	3
4	-	-	1	1	-	-	-	-	-	-	-	3	3	3	2
5	-	-	-	-	-	2	-	-	-	-	1	-	3	2	2
<b>C</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>1.5</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation

**EC3551**

**TRANSMISSION LINES AND RF SYSTEMS**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce the various types of transmission lines and its characteristics
- To understand high frequency line, power and impedance measurements
- To impart technical knowledge in impedance matching using Smith Chart.
- To introduce passive filters and basic knowledge of active RF components
- To learn the concepts of a RF system transceiver design.

**UNIT I TRANSMISSION LINE THEORY**

**9**

General theory of Transmission lines - the transmission line - general solution - The infinite line - Wavelength, velocity of propagation - Waveform distortion - the distortion less line - Loading and different methods of loading - Line not terminated in Z 0 - Reflection coefficient - calculation of current, voltage, power delivered and efficiency of transmission - Input and transfer impedance - Open and short circuited lines - reflection factor and reflection loss.

**UNIT II HIGH FREQUENCY TRANSMISSION LINES**

**9**

Transmission line equations at radio frequencies - Line of Zero dissipation - Voltage and current on the dissipation less line, Standing Waves, Nodes, Standing Wave Ratio - Input impedance of the

dissipation less line - Open and short circuited lines - Power and impedance measurement on lines - Reflection losses - Measurement of VSWR and wavelength.

**UNIT III IMPEDANCE MATCHING IN HIGH FREQUENCY LINE 9**

Impedance matching: Quarter wave transformer ,One Eighth wave line, Half wave line- Impedance matching by stubs- Single stub and double stub matching - Smith chart – Application of Smith chart, Solutions of problems using Smith chart - Single and double stub matching using Smith chart.

**UNIT IV WAVEGUIDES 9**

Waves between parallel planes of perfect conductors- Transverse Electric waves and Transverse Magnetic waves, Characteristics of TE and TM waves, Transverse Electromagnetic waves, TM and TE waves in Rectangular waveguides, TM and TE waves in Circular waveguides.

**UNIT V RF SYSTEM DESIGN CONCEPTS 9**

Active RF components: Semiconductor basics in RF, bipolar junction transistors, RF field effect transistors, High electron mobility transistors, Fundamentals of MMIC, Basic concepts of RF design: Filters, couplers, power dividers, Amplifier power relations, Low noise amplifiers, Power amplifiers.

**COURSE OUTCOMES:**

- CO1:** Explain the characteristics of transmission lines and its losses.
- CO2:** Calculate the standing wave ratio and input impedance in high frequency transmission lines.
- CO3:** Analyze impedance matching by stubs using Smith Charts.
- CO4:** Comprehend the characteristics of TE and TM waves.
- CO5:** Design a RF transceiver system for wireless communication

**TOTAL:45 PERIODS**

**TEXTBOOKS**

1. John D Ryder, “Networks lines and fields”,Prentice Hall of India,New Delhi,2005.(Unit I–IV)
2. Mathew M. Radmanesh, “Radio Frequency & Microwave Electronics”, Pearson Education Asia, Second Edition, 2002 (Unit – V)
3. Annapurna Das, Sisir K. Das, “Microwave Engineering”, McGraw Hill Education (India) private limited, Third edition,2000.(Unit – V)

**REFERENCES**

1. Reinhold Ludwig and Powel Bretchko, “RF Circuit Design” – Theory and Applications”, Pearson Education Asia, First Edition, 2001.
2. D. K. Misra, “Radio Frequency and Microwave Communication Circuits”- Analysis and Design, John Wiley & Sons, 2004.
3. Richard Chi-Hsi Li - , “RF Circuit Design” – A John Wiley & Sons, Inc, Publications
4. W.Alan Davis, Krishna Agarwal, “Radio Frequency Circuit Design”, John willy & Sons,2001

**CO’s-PO’s & PSO’s MAPPING**

CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	2	1	-	-	-	1	-	1	2	1	1
2	3	2	2	3	2	1	-	-	-	1	-	1	2	1	1
3	3	3	3	2	1	2	-	-	-	1	-	1	2	1	1
4	3	3	2	3	2	1	-	-	-	1	-	1	2	1	1
5	3	2	3	2	2	1	-	-	-	1	-	1	2	1	1
CO	3	3	3	3	2	1	-	-	-	1	-	1	2	1	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES:**

- To learn Hardware Descriptive Language (Verilog/VHDL).
- To learn the fundamental principles of Digital System Desing using HDL and FPGA.
- To learn the fundamental principles of VLSI circuit design in digital domain
- To learn the fundamental principles of VLSI circuit design in analog domain
- To provide hands on design experience with EDA platforms.

**LIST OF EXPERIMENTS:**

1. Design of basic combinational and sequential (Flip-flops) circuits using HDL. Simulate it using Xilinx/Altera Software and implement by Xilinx/Altera FPGA
2. Design an Adder ; Multiplier (Min 8 Bit) using HDL. Simulate it using Xilinx/Altera Software and implement by Xilinx/Altera FPGA
3. Design and implement Universal Shift Register using HDL. Simulate it using Xilinx/Altera Software
4. Design Memories using HDL. Simulate it using Xilinx/Altera Software and implement by Xilinx/Altera FPGA
5. Design Finite State Machine (Moore/Mealy) using HDL. Simulate it using Xilinx/Altera Software and implement by Xilinx/Altera FPGA
6. Design 3-bit synchronous up/down counter using HDL. Simulate it using Xilinx/Altera Software and implement by Xilinx/Altera FPGA
7. Design 4-bit Asynchronous up/down counter using HDL. Simulate it using Xilinx/Altera Software and implement by Xilinx/Altera FPGA
8. Design and simulate a CMOS Basic Gates & Flip-Flops. Generate Manual/Automatic Layout .
9. Design and simulate a 4-bit synchronous counter using a Flip-Flops. Generate Manual/Automatic Layout
10. Design and Simulate a CMOS Inverting Amplifier.
11. Design and Simulate basic Common Source, Common Gate and Common Drain Amplifiers.
12. Design and simulate simple 5 transistor differential amplifier.

**COURSE OUTCOMES:**

**On completion of the course, students will be able to:**

**CO1:** Write HDL code for basic as well as advanced digital integrated circuit

**CO2:** Import the logic modules into FPGA Boards

**CO3:** Synthesize Place and Route the digital Ips

**CO4:** Design, Simulate and Extract the layouts of Digital & Analog IC Blocks using EDA tools

**CO5:** Test and Verification of IC design

**TOTAL: 60 PERIODS**

**CO's-PO's & PSO's MAPPING**

C	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1	PSO	PSO	PSO
1	2	-	-	-	-	-	-	-	-	-	-	-	2	3	2
2	3	3	1	1	-	-	-	-	-	-	-	-	2	1	2
3	1	2	2	2	-	-	-	-	-	-	1	1	2	2	2
4	-	1	3	3	1	-	-	-	-	-	1	1	2	2	2
5	3	3	3	3	1	-	-	-	-	-	1	1	2	2	2
<b>C</b>	<b>2.2</b>	<b>2.2</b>	<b>2.2</b>	<b>2.2</b>	<b>1</b>	-	-	-	-	-	<b>1</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>2</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES :**

- Learn the architecture and features of 8051.
- Study the design process of an embedded system.
- Understand the real – time processing in an embedded system.
- Learn the architecture and design flow of IoT.
- Build an IoT based system.

**UNIT I 8051 MICROCONTROLLER****9**

Microcontrollers for an Embedded System – 8051 – Architecture – Addressing Modes – Instruction Set – Program and Data Memory – Stacks – Interrupts – Timers/Counters – Serial Ports – Programming.

**UNIT II EMBEDDED SYSTEMS****9**

Embedded System Design Process – Model Train Controller – ARM Processor – Instruction Set Preliminaries – CPU – Programming Input and Output – Supervisor Mode – Exceptions and Trap – Models for programs – Assembly, Linking and Loading – Compilation Techniques – Program Level Performance Analysis.

**UNIT III PROCESSES AND OPERATING SYSTEMS****9**

Structure of a real – time system – Task Assignment and Scheduling – Multiple Tasks and Multiple Processes – Multirate Systems – Pre emptive real – time Operating systems – Priority based scheduling – Interprocess Communication Mechanisms – Distributed Embedded Systems – MPSoCs and Shared Memory Multiprocessors – Design Example – Audio Player, Engine Control Unit and Video Accelerator.

**UNIT IV IOT ARCHITECTURE AND PROTOCOLS****9**

Internet – of – Things – Physical Design, Logical Design – IoT Enabling Technologies – Domain Specific IoTs – IoT and M2M – IoT System Management with NETCONF – YANG – IoT Platform Design – Methodology – IoT Reference Model – Domain Model – Communication Model – IoT Reference Architecture – IoT Protocols - MQTT, XMPP, Modbus, CANBUS and BACNet.

**UNIT V IOT SYSTEM DESIGN****9**

Basic building blocks of an IoT device – Raspberry Pi – Board – Linux on Raspberry Pi – Interfaces – Programming with Python – Case Studies: Home Automation, Smart Cities, Environment and Agriculture.

**45 PERIODS****PRACTICAL EXERCISES****30 PERIODS**

Experiments using 8051.

1. Programming Arithmetic and Logical Operations in 8051.
2. Generation of Square waveform using 8051.
3. Programming using On – Chip ports in 8051.
4. Programming using Serial Ports in 8051.
5. Design of a Digital Clock using Timers/Counters in 8051.

Experiments using ARM

Interfacing ADC and DAC

Blinking of LEDs and LCD

Interfacing keyboard and Stepper Motor.

Miniprojects for IoT  
 Garbage Segregator and Bin Level Indicator  
 Colour based Product Sorting  
 Image Processing based Fire Detection  
 Vehicle Number Plate Detection  
 Smart Lock System

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

- CO1:** Explain the architecture and features of 8051.
- CO2:** Develop a model of an embedded system.
- CO3:** List the concepts of real time operating systems.
- CO4:** Learn the architecture and protocols of IoT.
- CO5:** Design an IoT based system for any application.

**TEXTBOOKS :**

1. Mohammed Ali Mazidi, Janice Gillispie Mazidi, Rolin D.McKinlay, The 8051 Microcontroller and Embedded Systems Using Assembly and C, Second Edition, Pearson Education, 2008.(Unit – I)
2. Marilyn Wolf, Computers as Components – Principles of Embedded Computing System Design, Third Edition, Morgan Kaufmann, 2012.(Unit – II,III)
3. Arshdeep Bahga, Vijay Madisetti, Internet – of- Things – A Hands on Approach, Universities Press, 2015.(Unit – IV,V)

**REFERENCES :**

1. Mayur Ramgir, Internet – of – Things, Architecture, Implementation and Security, First Edition, Pearson Education, 2020.
2. Lyla B.Das, Embedded Systems: An Integrated Approach, Pearson Education 2013.
3. Jane.W.S .Liu, Real – Time Systems, Pearson Education, 2003.

**CO's-PO's & PSO's MAPPING**

C	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1	PSO	PSO	PSO
1	3	3	3	2	2	-	-	-	-	-	-	-	3	2	1
2	3	3	3	2	2	-	-	-	-	-	-	-	3	2	1
3	3	3	2	2	2	-	-	-	-	-	-	-	2	1	1
4	3	3	2	2	2	-	-	-	-	-	-	-	3	3	2
5	3	3	3	3	3	-	-	-	-	-	-	-	3	3	2
<b>C</b>	<b>3</b>	<b>3</b>	<b>2.6</b>	<b>2.2</b>	<b>2.2</b>	-	-	-	-	-	-	-	<b>2.8</b>	<b>2.2</b>	<b>1.4</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CS3491**

**ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING**

**L T P C**  
**3 0 2 4**

**COURSE OBJECTIVES:**

The main objectives of this course are to:

- Study about uninformed and Heuristic search techniques.
- Learn techniques for reasoning under uncertainty
- Introduce Machine Learning and supervised learning algorithms
- Study about ensembling and unsupervised learning algorithms
- Learn the basics of deep learning using neural networks

<b>UNIT I</b>	<b>PROBLEM SOLVING</b>	<b>9</b>
Introduction to AI - AI Applications - Problem solving agents – search algorithms – uninformed search strategies – Heuristic search strategies – Local search and optimization problems – adversarial search – constraint satisfaction problems (CSP)		
<b>UNIT II</b>	<b>PROBABILISTIC REASONING</b>	<b>9</b>
Acting under uncertainty – Bayesian inference – naïve bayes models. Probabilistic reasoning – Bayesian networks – exact inference in BN – approximate inference in BN – causal networks.		
<b>UNIT III</b>	<b>SUPERVISED LEARNING</b>	<b>9</b>
Introduction to machine learning – Linear Regression Models: Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function – Probabilistic discriminative model - Logistic regression, Probabilistic generative model – Naive Bayes, Maximum margin classifier – Support vector machine, Decision Tree, Random forests		
<b>UNIT IV</b>	<b>ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING</b>	<b>9</b>
Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization		
<b>UNIT V</b>	<b>NEURAL NETWORKS</b>	<b>9</b>
Perceptron - Multilayer perceptron, activation functions, network training – gradient descent optimization – stochastic gradient descent, error backpropagation, from shallow networks to deep networks –Unit saturation (aka the vanishing gradient problem) – ReLU, hyperparameter tuning, batch normalization, regularization, dropout.		

**45 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

1. Implementation of Uninformed search algorithms (BFS, DFS)
2. Implementation of Informed search algorithms (A\*, memory-bounded A\*)
3. Implement naïve Bayes models
4. Implement Bayesian Networks
5. Build Regression models
6. Build decision trees and random forests
7. Build SVM models
8. Implement ensembling techniques
  1. Implement clustering algorithms
  2. Implement EM for Bayesian networks
  3. Build simple NN models
  4. Build deep learning NN models

**OUTCOMES:**

- At the end of this course, the students will be able to:
- CO1:** Use appropriate search algorithms for problem solving
  - CO2:** Apply reasoning under uncertainty
  - CO3:** Build supervised learning models
  - CO4:** Build ensembling and unsupervised models
  - CO5:** Build deep learning neural network models

**TOTAL:75 PERIODS**

**TEXT BOOKS:**

1. Stuart Russell and Peter Norvig, "Artificial Intelligence – A Modern Approach", Fourth Edition, Pearson Education, 2021.
2. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Fourth Edition, 2020.

**REFERENCES**

1. Dan W. Patterson, "Introduction to AI and ES", Pearson Education, 2007
2. Kevin Night, Elaine Rich, and Nair B., "Artificial Intelligence", McGraw Hill, 2008
3. Patrick H. Winston, "Artificial Intelligence", Third Edition, Pearson Education, 2006
4. Deepak Khemani, "Artificial Intelligence", Tata McGraw Hill Education, 2013 (<http://nptel.ac.in/>)
5. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
6. Tom Mitchell, "Machine Learning", McGraw Hill, 3rd Edition, 1997.
7. Charu C. Aggarwal, "Data Classification Algorithms and Applications", CRC Press, 2014
8. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, "Foundations of Machine Learning", MIT Press, 2012.
9. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	3	1	3	2	-	-	-	-	1	3	3	3
2	3	2	2	3	1	3	2	-	-	-	-	1	3	3	3
3	1	2	1	3	2	3	2	-	-	-	-	1	3	3	3
4	1	2	3	1	3	3	2	-	-	-	-	1	3	3	3
5	2	2	2	-	3	3	2	-	-	-	-	1	3	3	3
CO	2	2	2	2	2	3	2	-	-	-	-	1	3	3	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

EC3711

SUMMER INTERNSHIP

L T P C  
0 0 0 2

**COURSE OBJECTIVES:**

To enable the students to

- Get connected with industry/ laboratory/research institute
- Get practical knowledge on production process in the industry and develop skills to solve related problems
- Develop skills to carry out research in the research institutes/laboratories

The students individually undergo training in reputed firms/ research institutes / laboratories for the specified duration. After the completion of training, a detailed report should be submitted within ten days from the commencement of next semester. The students will be evaluated as per the Regulations.

**No. of Weeks: 04**

**COURSE OUTCOMES:**

On completion of the course, the student will know about

- CO1: System-level design processes, verification and validation techniques, manufacturing and production processes in the firm or research facilities in the laboratory/research institute
- CO2: Analysis of industrial / research problems and their solutions
- CO3: Documentation of system specifications, design methodologies, process parameters, testing parameters and results
- CO4: Preparing of technical report and presentation



**COURSE OBJECTIVES:**

To train the students in

- Identifying problem and developing the structured methodology to solve the identified problem in the industry or research problem at research Institution or college.
- Conducting experiments, analyze and discuss the test results, and make conclusions.
- Preparing project reports and presentation

The students shall individually / or as group work on a specific topic approved by the Department. The student can select any topic which is relevant to his/her specialization of the programme. The student should continue the work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work, results and discussion, conclusion and references should be prepared as per the format prescribed by the University and submitted to the Head of the department. The students will be evaluated based on the report and viva-voce examination by a panel of examiners as per the Regulations.

**TOTAL: 300 PERIODS**

**COURSE OUTCOMES:**

At the end of the project, the student will be able to

CO1: Formulate and analyze problem / create a new product/ process.

CO2: Design and conduct experiments to find solution

CO3: Analyze the results and provide solution for the identified problem, prepare project report and make presentation.

## VERTICALS

**CEC363**

**WIDE BANDGAP DEVICES**

**L T P C**  
**2 0 2 3**

**COURSE OBJECTIVES:**

- Introduce the concept of wide band gap (WBG) devices and its application in real world
- Advantages and disadvantages of WBG devices
- Provide an introduction to basic operation of WBG power devices
- Learn Design principles of modern power devices
- Ability to deal high frequency design complexity

**UNIT I                      WBG DEVICES AND THEIR APPLICATION IN REAL WORLD                      6**

Review of semiconductor basics, Operation and characteristics of the SiC Schottky Barrier Diode, SiC DMOSFET and GaN HEMT, Review of Wide bandgap semiconductor technology -Advantages and disadvantages

**UNIT II                      SWITCHING CHARACTERIZATION OF WBG                      6**

Turn-on and Turn-off characteristics of the device, Hard switching loss analysis, Double pulse test set-up

**UNIT III                      DRIVERS FOR WIDE BAND GAP DEVICES                      6**

Gate driver, Impact of gate resistance, Gate drivers for wide bandgap power devices , Transient immunity integrated gate drivers

**UNIT IV                      HIGH FREQUENCY DESIGN COMPLEXITY AND PCB DESIGNING                      6**

Effects of parasitic inductance, Effects of parasitic capacitance , EMI filter design for high frequency power converters High frequency PCB design, Conventional power loop design, High frequency power loop optimization, Separation of power from signal PCB

**UNIT V                      APPLICATIONS OF WIDE BANDGAP DEVICES                      6**

Consumer electronics applications, Wireless power transfer applications, Electric vehicle applications , Renewable energy sources applications

**30 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

1. Conduct switching loss and Magnetic loss on Low side
2. Conduct Double pulse test (DPT) and learn IEC 60747 -8/9 standards
3. Conduct experiments for Diode reverse recovery on High side
4. Conduct Power analysis and harmonic measurement
5. Measure Turn on /off delay , . Calculate recovery softness factor , measure reverse recovery energy.

**List of Equipments needed for 30 students in a batch (6 students in bench)**

1. 1GHz Flexi channel oscilloscope with 6 channels - #5
2. 2ch AFG with 9inch touchscreen and built-in Double Pulse Test application to generate atleast 2 varying pulse widths, 16Mpts memory - #1
3. Power supplies - Programmable DC Power Supply, 720W (for High Voltage side) and Programmable Single Channel DC Power Supply, 192W (to drive Gate drive circuit) - #1
4. Voltage Probes to measure Vgs (low side) – passive probe or differential probe 200MHz - #15

5. Voltage Probes to measure Vgs (high side) – 1GHz, isolated probes with MMCX adapter tips – #1 nos
6. Current Probes to measure drain current – 30A with 120Mz BW - #5

**COURSE OUTCOMES:**

**Upon successful completion of the course the student will be able to**

**CO1:** Students master design principles of power devices

**CO2:** Students become familiar with reliability issues and testing methods

**CO3:** An ability to design and conduct experiments, as well as to analyze and interpret data

**CO4:** Student to get real life experience and to know practical applications of WBG

**CO5:** Indepth knowledge on practical usage of this technology

**TOTAL:60 PERIODS**

**TEXT BOOKS**

1. A. Lidow, J. Strydom, M. D. Rooij, D. Reusch, GaN Transistors for Efficient Power Conversion, Wiley, 2014, ISBN-13: 978-1118844762.
2. G. Meneghesso, M. Meneghini, E. Zanoni, “Gallium Nitride-enabled High Frequency and High Efficiency Power Conversion,” Springer International Publishing, 2018, ISBN: 978-3-319-77993-5.

**REFERENCES**

1. F. Wang, Z. Zhang and E. A. Jones, Characterization of Wide Bandgap Power Semiconductor Devices, IET, ISBN-13: 978-1785614910 (2018).
2. B.J.Baliga, “Gallium Nitride and Silicon Carbide Power Devices,” World Scientific Publishing Company (3 Feb. 2017).
3. L. Corradini, D. Maksimovic, P. Mattavelli, R. Zane, “Digital Control of HighFrequency Switched-Mode Power Converters”, Wiley, ISBN-13: 978-1118935101 (9th June, 2015).

**CO’s-PO’s & PSO’s MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	3	2	-	-	-	-	-	-	-	1	1	3
2	3	3	3	2	2	-	-	-	-	-	-	-	1	1	2
3	3	3	2	2	2	-	-	-	-	-	-	-	2	2	2
4	3	3	3	3	2	-	-	-	-	-	-	-	3	2	2
5	3	2	3	3	2	-	-	-	-	-	-	-	2	2	2
CO	3	3	2.6	2.6	2	-	-	-	-	-	-	-	2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CEC361**

**VALIDATION AND TESTING TECHNOLOGY**

**L T P C**

**2 0 2 3**

**COURSE OBJECTIVES:**

- Getting familiar with various IC technology.
- Learn MOS theory and testing
- Learn CMOS circuit theory and testing
- Getting expertise on CMOS characterization.
- Explore circuit and device level testing methods

**UNIT I TECHNOLOGY INTRODUCTION: 6**  
Introduction to IC Technology – MOS, PMOS, NMOS, CMOS & BiCMOS Technologies. VLSI Fabrication, Oxidation, Lithography, Diffusion, Ion Implantation, Metallization, Integrated Resistors and Capacitors.

**UNIT II MOS THEORY ANALYSIS-I 6**  
Basic Electrical Properties of MOS Circuits:  $I_{ds}$ - $V_{ds}$  Relationships, MOS Transistor Threshold Voltage  $V_{th}$ ,  $g_m$ ,  $g_{ds}$ , Figure of Merit  $\omega_0$ , Short Channel and Narrow Channel Width Effects.

**UNIT III MOS THEORY ANALYSIS- II 6**  
Pass Transistor, Transmission Gate, NMOS Inverter, Various Pull-ups, CMOS Inverter Analysis and Design, Bi-CMOS Inverters, Latch up in CMOS Circuits.

**UNIT IV CMOS CIRCUIT CHARACTERISATION AND PERFORMANCE ESTIMATION 6**  
Sheet Resistance  $R_S$ , conductivity and its Concept to MOS, Area Capacitance Units, Calculations - Delays, Driving Large Capacitive Loads, Delay Estimation, Logical Effort and Transistor Sizing, Power Dissipation, Reliability.

**UNIT V BASIC OF SILICON VALIDATION 6**  
Need for Testing, Testing at Various Levels, Objectives of Testing - VLSI Test process and Test Equipment - Types of Testing: Functionality Tests, Silicon Debug, Manufacturing Tests, Defect during manufacturing - Fault Modelling, Observability and Controllability, Fault Coverage, Fault Sampling - ATE, Test economics.

**30 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

1. MOS TESTING for  $I_{ds}$ - $V_{ds}$  Relationships
2. MOSFET testing for threshold voltage like  $V_{th}$ , gate breakdown voltage.
3. Sheet resistivity measurement.
4. Conductivity measurement.
5. Inverter testing
6. Designing of CMOS inverter/ logic gate and testing of delay estimation.

List of equipment needed for a batch of 30 students (3 in a bench):

- Dual channel SMU for MOSFET testing with Test script processor and IV software: 2 nos (one setup for three students)
- Resistivity and Conductivity Setup – #2 setups
- I-V SMU analyser
- Four Point Collinear Resistivity Measurement Setup
- Resistivity samples #2
- Conductivity Samples #2
- Inverter testing setup: power supply #1, Scope with AFG and power application: #1no
- Xilinx /CAD: 5 no.

**COURSE OUTCOMES:**

**Upon successful completion of the course the student will be able to**

**CO1:** Complete overview to CMOS fabrication process.

**CO2:** Understand the fundamental concept of MOS FET and testing.

**CO3:** Explain the concept of MOS theory and analysis.

**CO4:** To give the student an understanding of CMOS performance testing and estimation.

**CO5:** Explain the basics of Testing and Fault Modeling

**TEXT BOOKS:**

1. Kamran Ehraghian, Dauglas A. Pucknell and Sholeh Eshraghiam, “Essentials of VLSI Circuits and Systems” – PHI, EEE, 2005 Edition.
2. Neil H. E. Weste and David. Harris Ayan Banerjee,, “CMOS VLSI Design” - Pearson Education, 1999.

**REFERENCES**

1. M.L. Bushnell and V.D. Agrawal, “Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits”, Kluwer Academic Publishers, 2004
2. N.K. Jha and S.G. Gupta, “Testing of Digital Systems”, Cambridge University Press, 2003
3. Etienne Sicard, Sonia Delmas Bendhia, “Basics of CMOS Cell Design”, TMH, EEE, 2005

**CO’s-PO’s & PSO’s MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	2	2	1	-	-	-	2	2	3	2	3
2	2	3	3	3	2	1	1	-	-	-	2	2	3	3	2
3	3	2	2	3	2	3	3	-	-	-	3	2	2	2	2
4	3	3	2	3	2	3	3	-	-	-	2	2	1	2	1
5	3	2	3	3	3	3	2	-	-	-	2	2	1	2	1
CO	2.8	2.6	2.6	3	2.2	2.4	2	-	-	-	2	2	2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CEC370**

**LOW POWER IC DESIGN**

**L T P C  
2 0 2 3**

**COURSE OBJECTIVES:**

- To learn the fundamentals of low power low voltage VLSI design.
- To understand the impact of power on system performances.
- To understand the different design approaches.
- To develop the low power low voltage memories

**UNIT I FUNDAMENTALS OF LOW POWER CIRCUITS**

**6**

Need for Low Power Circuit Design, Sources of Power Dissipation – Switching Power Dissipation, Short Circuit Power Dissipation, Leakage Power Dissipation, Glitching Power Dissipation, Short Channel Effects –Drain Induced Barrier Lowering and Punch Through, Surface Scattering, Velocity Saturation, Impact Ionization, Hot Electron Effect.

**UNIT II LOW-POWER DESIGN APPROACHES**

**6**

Low-Power Design through Voltage Scaling: VTCMOS circuits, MTCMOS circuits, Architectural Level Approach –Pipelining and Parallel Processing Approaches. Switched Capacitance Minimization Approaches: System Level Measures, Circuit Level Measures, Mask level Measures.

**UNIT III LOW-VOLTAGE LOW-POWER ADDERS**

**6**

Introduction, Standard Adder Cells, CMOS Adder’s Architectures – Ripple Carry Adders, Carry Look-Ahead Adders, Carry Select Adders, Carry Save Adders, LowVoltage Low Power Design Techniques –Trends of Technology and Power Supply Voltage, LowVoltage Low-Power Logic Styles.

**UNIT IV                      LOW-VOLTAGE LOW-POWER MULTIPLIERS                      6**

Introduction, Overview of Multiplication, Types of Multiplier Architectures, Braun Multiplier, Baugh-Wooley Multiplier, Booth Multiplier, Introduction to Wallace Tree Multiplier

**UNIT V                      LOW-VOLTAGE LOW-POWER MEMORIES                      6**

Basics of ROM, Low-Power ROM Technology, Future Trend and Development of ROMs, Basics of SRAM, Memory Cell, Precharge and Equalization Circuit, LowPower SRAM Technologies, Basics of DRAM, Self-Refres Circuit, Future Trend and Development of DRAM.

**30 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

1. Modeling and sources of power consumption
2. Power estimation at different design levels (mainly circuit, transistor, and gate)
3. Power optimization for combinational circuits
4. Power optimization for sequential circuits
5. Power optimization for RT and algorithmic levels.

**TOTAL:60 PERIODS**

**COURSE OUTCOMES:**

**Upon successful completion of the course the student will be able to**

**CO1:** Understand the fundamentals of Low power circuit design.

**CO2:** Attain the knowledge of architectural approaches.

**CO3:** Analyze and design Low-Voltage Low-Power combinational circuits.

**CO4:** Learn the design of Low-Voltage Low-Power Memories

**CO5:** Design and develop Low Power, Low Voltage Circuits

**TEXT BOOKS:**

1. Sung-Mo Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits – Analysis and Design", TMH, 2011.
2. Kiat-Seng Yeo, Kaushik Roy, "Low-Voltage, Low-Power VLSI Subsystems", TMH Professional Engineering, 2004.

**REFERENCES**

1. Ming-BO Lin, "Introduction to VLSI Systems: A Logic, Circuit and System Perspective", CRC Press, 2012.
2. Anantha Chandrakasan, "Low Power CMOS Design", IEEE Press, /Wiley International, 1998
3. Kaushik Roy, Sharat C. Prasad, "Low Power CMOS VLSI Circuit Design", John Wiley, & Sons, 2000.
4. Gary K. Yeap, "Practical Low Power Digital VLSI Design", Kluwer Academic Press, 2002
5. Bellamour, M. I. Elamasri, "Low Power CMOS VLSI Circuit Design", A Kluwer Academic Press, 1995.
6. Siva G. Narendran, Anatha Chandrakasan, "Leakage in Nanometer CMOS Technologies", Springer, 2005

## CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	3	2	-	-	-	-	-	-	2	2	2	2
2	3	2	1	2	3	-	-	-	-	-	-	1	2	2	1
3	3	3	3	2	2	-	-	-	-	-	-	1	2	2	2
4	2	3	3	3	3	-	-	-	-	-	-	1	2	3	3
5	3	3	3	2	2	-	-	-	-	-	-	2	2	2	3
CO	2.8	2.8	2.4	2.4	2.4	-	-	-	-	-	-	1.8	2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CEC362**

**VLSI TESTING AND DESIGN FOR TESTABILITY**

**L T P C**

**3 0 0 3**

### COURSE OBJECTIVES:

- To introduce logic and fault simulation and testability measures.
- To study the design for testability.
- To know about interfacing and testing of memory
- To introduce power management techniques in testing
- To study testability in analog circuits

### UNIT I TEST REQUIREMENTS AND METRICS

**9**

Validation platforms- SOC design methodology, IP components, Integration, Clocking, I/Os and interfaces, Device modes, Logic, memories, analog, I/Os, power management; Test requirements- Test handoffs, Testers Where DUT and DFT fit into design / framework; Test- ATPG, DFT, BIST, COF, TTR; Test cost metrics and test economics; Logic fault models- SAF, TDF, PDF, Iddq, St-BDG, Dy-BDG, SDD; Basics of test generation and fault simulation- Combinational circuits, Sequential; Specific algorithmic approaches, CAD framework, Optimisations.

### UNIT II SCAN DESIGN AND BIST

**9**

Scan Design- Scan design requirements, Types of scan and control mechanisms, Test pattern construction for scan, Managing scan in IPs and SOCs, Scan design optimisations, Partitioning, Clocking requirements for scan and delay fault testing, Speed of operation; BIST – Framework, Controller configurations, FSMs, LFSRs, STUMPS architecture, Scan compression and bounds, Test per cycle, Test per scan, Self-testing and self-checking circuits, Online test.

### UNIT III MEMORY TEST AND TEST INTERFACES

**9**

Memory Test -Memory fault models, Functional architecture as applicable to test, Test of memories, Test of logic around memories, BIST controller configuration, Test of logic around memories, DFT and architecture enhancements, Algorithmic optimisations; Test Interfaces-Test control requirements, Test interfaces - 1500, JTAG, Hierarchical, serial control, Module / IP test, SOC test, Board test, System test, Boundary scan.

### UNIT IV DESIGN CONSIDERATIONS AND POWER MANAGEMENT DURING TEST

**9**

Design Considerations- Design considerations, Physical design congestion, Partitioning, Clocks, Test modes, Pins, Test scheduling, Embedded test, Architecture improvements, Test in the presence of security; Power management during test- Methods for low power test, ATPG methods,

DFT methods, Scan methods, Low power compression, Test of power management, Implications of power excursions, Optimisations.

## **UNIT V ANALOG TEST**

**9**

Test requirements. DFT methods. BIST methods. Test versus measurement. Defect tests versus performance tests. Tests for specific modules - PLL, I/Os, ADC, DAC, SerDes, etc. RF test requirements.

### **COURSE OUTCOMES:**

At the end of this course, the students will be able to:

CO1:Understand logic and fault simulation requirements and testability measures.

CO2:Understand the Design for Testability.

CO3:Develop interfacing and memory testing.

CO4:Perform testing with power management techniques.

CO5 :Carry-out fault Detection in analog circuits.

### **TEXT BOOK:**

1. Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits, Vishwani Agrawal and Michael Bushnell, Springer, 2002.

**CEC342**

## **MIXED SIGNAL IC DESIGN TESTING**

**L T P C**

**2 0 2 3**

### **COURSE OBJECTIVES:**

- To know about mixed-signal devices and the need for testing these devices.
- To study the various techniques for testing.
- To learn about ADC and DAC based testing.
- To understand the Clock and Serial Data Communications Channels
- To study the general purpose measuring devices.

## **UNIT I MIXED – SIGNAL TESTING**

**6**

Common Types of Analog and Mixed- Signal Circuits – Applications of Mixed-Signal Circuits - Post-Silicon Production Flow - Test and Packing – Characterization versus Production Testing - Test and Diagnostic Equipment - Automated Test Equipments – Wafer Probers – Handlers – E-Beam Probers – Focused Ion Beam Equipments – Forced –Temperature

## **UNIT II YIELD, MEASUREMENT ACCURACY, AND TEST TIME**

**6**

Yield - Measurement Terminology - Repeatability, Bias, and Accuracy - Calibrations and Checkers - Tester Specifications - Reducing Measurement Error with Greater Measurement Time – Guardbands - Effects of Measurement Variability on Test Yield - Effects of Reproducibility and Process Variation on Yield - Statistical Process Control

## **UNIT III DAC TESTING**

**6**

Basics of Data Converters -Principles of DAC and ADC Conversion, Data Formats, Comparison of DACs and ADCs, DAC Failure Mechanisms - Basic DC Tests - Transfer Curve Tests - Dynamic DAC Tests - Tests for Common DAC Applications

## **UNIT IV ADC TESTING**

**6**

ADC Testing Versus DAC Testing - ADC Code Edge Measurements - Edge Code Testing Versus Center Code Testing, Step Search and Binary Search Methods, Servo Method, Linear Ramp



Histogram Method, Histograms to Code Edge Transfer Curves, Rising Ramps Versus Falling Ramps, Sinusoidal Histogram Method - DC Tests and Transfer Curve Tests - Dynamic ADC Tests - Tests for Common ADC Applications

**UNIT V CLOCK AND SERIAL DATA COMMUNICATIONS CHANNEL MEASUREME 6**

Synchronous and Asynchronous Communications - Time-Domain Attributes of a Clock Signal - Frequency-Domain Attributes of a Clock Signal - Communicating Serially Over a Channel - Bit Error Rate Measurement - Methods to Speed Up BER Tests in Production - Deterministic Jitter Decomposition - Jitter Transmission Tests.

**30 PERIODS**

**COURSE OUTCOMES:**

**Upon successful completion of the course the student will be able to**

**CO1:** Learn the fundamentals of mixed signal circuits.

**CO2:** Define the various measurement terminologies.

**CO3:** Acquire knowledge of Analog to Digital Converters.

**CO4:** Learn testing of Analog to Digital Converters.

**CO5:** Comprehend the attributes of a clock signal.

**TEXTBOOK:**

1. Gordon W.Roberts, Friedrich Taenzler, Mark Burns, "An Introduction to Mixed-signal IC Test and Measurement" Oxford University Press, Inc.2012 (Unit I - V)
2. M.L.Bushnell and V.D.Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers, 2002. (Unit - III)
3. BapirajuVinnakota, "Analog and mixed-signal test", Prentice Hall, 1998.(Unit - II)
4. Digital and Analogue Instrumentation: Testing and Measurement by NihalKularatna

**PRACTICAL EXERCISES:**

**30 PERIODS**

DESIGN AND TESTING OF THE FOLLOWING CIRCUITS

1. PLL characteristics and its use as Frequency Multiplier, Clock synchronization
2. R-2R Ladder Type and Flash Type ADC.
3. DC power supply using LM317 and LM723.
4. Design of asynchronous counter
5. Design of synchronous counter
6. Implementation and Testing of RS Latch and Flip-flops

**TOTAL : 60 PERIODS**

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	2	2	-	-	-	-	-	2	3	3	3
2	3	3	2	2	1	2	-	-	-	-	-	2	3	2	3
3	3	3	2	2	2	2	-	-	-	-	-	2	3	2	3
4	3	3	3	2	2	1	-	-	-	-	-	2	1	2	2
5	3	3	3	2	2	2	-	-	-	-	-	3	2	1	2
CO	3	3	2.8	2.2	1.8	1.8	-	-	-	-	-	2.2	3	2	2

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

**COURSE OBJECTIVES:**

- To study the basics of MOS Circuits.
- To analyse the noise characteristics of amplifiers.
- To study the performance parameters of amplifiers.
- To comprehend the compensation techniques
- To understand the detection and testing of faults.

**UNIT I SINGLE STAGE AMPLIFIERS 6**

Basic MOS physics and equivalent circuits and models, CS, CG and Source Follower, differential amplifier with active load, Cascode and Folded Cascode configurations with active load, design of Differential and Cascode Amplifiers – to meet specified SR, noise, gain, BW, ICMR and power dissipation, voltage swing, high gain amplifier structures.

**UNIT II HIGH FREQUENCY AND NOISE CHARACTERISTICS OF AMPLIFIERS 6**

Miller effect, association of poles with nodes, frequency response of CS, CG and Source Follower, Cascode and Differential Amplifier stages, statistical characteristics of noise, noise in Single Stage amplifiers, noise in Differential Amplifiers.

**UNIT III FEEDBACK AND SINGLE STAGE OPERATIONAL AMPLIFIERS 6**

Properties and types of negative feedback circuits, effect of loading in feedback networks, operational amplifier performance parameters, single stage Op Amps, two-stage Op Amps, input range limitations, gain boosting, slew rate, power supply rejection, noise in Op Amps.

**UNIT IV STABILITY , FREQUENCY COMPENSATION 6**

Multipole Systems, Phase Margin, Frequency Compensation, Compensation Of Two Stage Op Amps, Slewing In Two Stage Op Amps, Other Compensation Techniques.

**UNIT V LOGIC CIRCUIT TESTING 6**

Faults in Logic Circuits- Basic Concepts of Fault Detection- Design for Testability- Ad Hoc Techniques, Level-Sensitive Scan Design, Partial Scan, Built-in Self-Test.

**30 PERIODS**  
**30 PERIODS**

**PRACTICAL EXERCISES:**

1. Design a CMOS inverter and analyze its characteristics.
2. Design a Common source amplifier and analyze its performance.
3. Design a Common drain amplifier and analyze its performance.
4. Design a Common gate amplifier and analyze its performance.
5. Design a differential amplifier with resistive load using transistors.
6. Design three stage and five stage ring oscillator circuit and compare its frequencies.

List of equipment needed for a batch of 30 students (3 in a bench):

- Cadence/Tanner/equivalent EDA Tools -10 User License

**COURSE OUTCOMES:**

**Upon successful completion of the course the student will be able to**

**CO1:** Design amplifiers to meet user specifications.

**CO2:** Analyse the frequency and noise performance of amplifiers.

**CO3:** Design and analyse feedback amplifiers and one stage op amps .

**CO4:** Analyse stability of op amp.

**CO5:** Testing experience of logic circuits.

**TOTAL:60 PERIODS**

**TEXTBOOKS :**

1. Behzad Razavi, "Design Of Analog Cmos Integrated Circuits", Tata Mcgraw Hill, 2001.(Unit –I,II,III,IV)
2. Parag K.Lala, "An Introduction to Logic Circuit Testing",Morgan & Claypool Publishers,2009.(Unit V)

**REFERENCES :**

1. Willey M.C. Sansen, "Analog Design Essentials", Springer, 2006.
2. Grebene, "Bipolar And Mos Analog Integrated Circuit Design", John Wiley & Sons,Inc.,2003. Phillip E.Allen, Douglas R .Holberg, "Cmos Analog Circuit Design", Oxford University Press, 2nd Edition, 2002.
3. Recorded Lecture Available at [http://www.ee.iitm.ac.in/vlsi/courses/ee5320\\_2021/start](http://www.ee.iitm.ac.in/vlsi/courses/ee5320_2021/start)
4. Jacob Baker "CMOS: Circuit Design, Layout, And Simulation, Wiley IEEE Press, 3rd Edition, 2010.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	2	2	-	-	-	-	-	2	3	3	3
2	3	3	2	2	1	2	-	-	-	-	-	2	3	2	3
3	3	3	2	2	2	2	-	-	-	-	-	2	3	2	3
4	3	3	3	2	2	1	-	-	-	-	-	2	1	2	2
5	3	3	3	2	2	2	-	-	-	-	-	3	2	1	2
CO	3	3	2.6	2.2	1.8	1.8	-	-	-	-	-	2.2	2.4	2	2

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

**CEC332**

**ADVANCED DIGITAL SIGNAL PROCESSING**

**L T P C  
2 0 2 3**

**COURSE OBJECTIVES:**

- To introduce the concepts of discrete time random signal processing
- To know about multirate signal processing and its applications
- To understand the spectrum estimation techniques
- To learn the concept of prediction theory and filtering

**UNIT I MULTIRATE SIGNAL PROCESSING**

**6**

Review of Convolution, DFT and ZT, Multirate Signal Processing - Decimation, Interpolation, Sampling Rate Conversion by a rational factor – digital filter banks, sub band coding, Quadrature Mirror Filter.

**UNIT II DISCRETE TIME RANDOM PROCESSES**

**6**

Stationary random processes, Autocorrelation, Rational Power Spectra, Filters for generating random Processes from white noise and inverse filter – AR, MA and ARMA processes – relationship between autocorrelation and the filter parameters.

**UNIT III LINEAR PREDICTION AND FILTERING**

**6**

Linear Prediction – Forward and Backward - Wiener filters for filtering and prediction – FIR Wiener Filter – IIR Wiener Filter – Kalman Filter.

**UNIT IV ADAPTIVE FILTERING****6**

FIR adaptive filters – adaptive filters based on steepest descent method – LMS algorithm – Variants of LMS algorithm – adaptive echo cancellation – adaptive channel equalization – RLS Algorithm.

**UNIT V SPECTRUM ESTIMATION****6**

Estimation of power spectra from finite duration observations of signals – Non parametric methods of spectrum estimation – the Bartlett and the Welch method – Parametric spectrum estimation – AR, MA and ARMA.

**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS**

1. Study of autocorrelation and Cross Correlation of random signals
2. Design and Implementation of Multirate Systems.
3. Design and Implementation of Wiener Filter
4. Design and Implementation of FIR Linear Predictor
5. Design of adaptive filters using LMS algorithm
6. Spectrum Estimation using Bartlett and Welch Methods

**COURSE OUTCOMES:**

**Upon successful completion of the course the student will be able to**

**CO1:** Comprehend multirate signal processing and demonstrate its applications

**CO2:** Demonstrate an understanding of the power spectral density and apply to discrete random signals and systems

**CO3:** Apply linear prediction and filtering techniques to discrete random signals for signal detection and estimation.

**CO4:** Analyze adaptive filtering problems and demonstrate its application

**CO5:** Apply power spectrum estimation techniques to random signals.

**TOTAL:60 PERIODS****TEXT BOOKS :**

1. John G. Proakis & Dimitris G. Manolakis, —Digital Signal Processing – Principles, Algorithms & Applications, Fourth Edition, Pearson Education / Prentice Hall, 2007.
2. P. Vaidyanathan, "Multirate systems and filter banks", Prentice Hall Inc. 1993.

**REFERENCES :**

1. Monson H. Hayes, "Statistical digital signal processing and modeling", John Wiley and Sons Inc. New York, Indian reprint 2008.
2. Haykin, Adaptive Filter Theory, 4th Edition, Pearson Education, New Delhi, 2006.
3. Sophocles J. Orfanidis, "Optimum Signal Processing ", McGraw Hill, 2000.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	2	2	2	-	-	-	-	-	1	2	3	3
2	3	3	3	2	2	2	-	-	-	-	-	2	3	2	2
3	3	3	3	2	2	2	-	-	-	-	-	2	2	2	1
4	3	3	3	2	2	2	-	-	-	-	-	2	3	2	2
5	3	3	2	2	1	1	-	-	-	-	-	1	2	3	1
CO	3	3	3	2	2	2	-	-	-	-	-	2	3	2	2

**1 - low, 2 - medium, 3 - high, '-' - no correlation**



**CO4:** Learn the basics of segmentation, features extraction, compression and recognition methods for color models.

**CO5:** Comprehend image compression concepts.

**TEXT BOOKS:**

1. Rafael C. Gonzalez, Richard E. Woods, 'Digital Image Processing', Pearson, Third Edition, 2010.
2. Anil K. Jain, 'Fundamentals of Digital Image Processing', Pearson, 2002.

**REFERENCES**

1. Kenneth R. Castleman, 'Digital Image Processing', Pearson, 2006.
2. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, 'Digital Image Processing using MATLAB', Pearson Education, Inc., 2011.
3. D.E. Dudgeon and R.M. Mersereau, 'Multidimensional Digital Signal Processing', Prentice Hall Professional Technical Reference, 1990.
4. William K. Pratt, 'Digital Image Processing', John Wiley, New York, 2002
5. Milan Sonka et al 'Image processing, analysis and machine vision', Brookes/Cole, Vikas Publishing House, 2nd edition, 1999.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	2	2	2	-	-	-	-	-	3	2	3	2
2	3	3	3	2	2	2	-	-	-	-	-	2	2	3	2
3	3	3	2	2	2	2	-	-	-	-	-	2	2	2	1
4	3	3	3	2	2	2	-	-	-	-	-	2	2	2	1
5	3	3	3	3	2	2	-	-	-	-	-	2	2	2	1
CO	3	3	3	2	2	2	-	-	-	-	-	2	2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CEC356**

**SPEECH PROCESSING**

**L T P C  
2 0 2 3**

**COURSE OBJECTIVES:**

- Study the fundamentals of speech signal and extracts various speech features
- Understand different speech coding techniques for speech compression applications
- Learn to build speech enhancement, text-to-speech synthesis system

**UNIT I FUNDAMENTALS OF SPEECH**

**6**

The Human speech production mechanism, Discrete-Time model of speech production, Speech perception - human auditory system, Phonetics - articulatory phonetics, acoustic phonetics, and auditory phonetics, Categorization of speech sounds, Spectrographic analysis of speech sounds, Pitch frequency, Pitch period measurement using spectral and cepstral domain, Formants, Evaluation of Formants for voiced and unvoiced speech.

**UNIT II SPEECH FEATURES AND DISTORTION MEASURES**

**6**

Significance of speech features in speech-based applications, Speech Features – Cepstral Coefficients, Mel Frequency Cepstral Coefficients (MFCCs), Perceptual Linear Prediction (PLP), Log Frequency Power Coefficients (LFPCs), Speech distortion measures–Simplified distance measure, LPC-based distance measure, Spectral distortion measure, Perceptual distortion measure.

**UNIT III SPEECH CODING****6**

Need for speech coding, Waveform coding of speech – PCM, Adaptive PCM, DPCM, ADPCM, Delta Modulation, Adaptive Delta Modulation, G.726 Standard for ADPCM, Parametric Speech Coding – Channel Vocoders, Linear Prediction Based Vocoders, Code Excited Linear Prediction (CELP) based Vocoders, Sinusoidal speech coding techniques, Hybrid coder, Transform domain coding of speech

**UNIT IV SPEECH ENHANCEMENT****6**

Classes of Speech Enhancement Algorithms, **Spectral-Subtractive Algorithms** - Multiband Spectral Subtraction, MMSE Spectral Subtraction Algorithm, Spectral Subtraction Based on Perceptual Properties, **Wiener Filtering** - Wiener Filters in the Time Domain, Wiener Filters in the Frequency Domain, Wiener Filters for Noise Reduction, Maximum-Likelihood Estimators, Bayesian Estimators, MMSE and Log-MMSE Estimator, **Subspace Algorithms**.

**UNIT V SPEECH SYNTHESIS AND APPLICATION****6**

A Text-to-Speech systems (TTS), Synthesizers technologies – Concatenative synthesis, Use of Formants for concatenative synthesis, Use of LPC for concatenative synthesis, HMM-based synthesis, Sinewave synthesis, Speech transformations, Watermarking for authentication of a speech, Emotion recognition from speech.

**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS**

1. Write a MATLAB Program to classify voiced and unvoiced segment of speech using various time-domain measures
2. Write a MATLAB Program to calculate the MFCC for a speech signal
3. Implement ITU-T G.722 Speech encoder in MATLAB
4. Write a MATLAB Program to implement Wiener Filters for Noise Reduction
5. Design a speech emotion recognition system using DCT and WPT in MATLAB

**HARDWARE & SOFTWARE SUPPORT TOOLS:**

- Personal Computer with MATLAB
- Microphone and Speakers

**COURSE OUTCOMES:**

**At the end of this course, the students will be able to:**

**CO1:** Understand the fundamentals of speech.

**CO2:** Extract various speech features for speech related applications

**CO3:** Choose an appropriate speech coder for a given application.

**CO4:** Build a speech enhancement system.

**CO5:** Build a text-to-speech synthesis system for various applications

**TOTAL:60 PERIODS****TEXT BOOKS :**

1. Shaila D. Apte, Speech and Audio Processing, Wiley India (P) Ltd, New Delhi, 2012
2. Philipos C. Loizou, Speech Enhancement Theory and Practice, Second Edition, CRC Press, Inc., United States, 2013

**REFERENCES:**

1. Rabiner L. R. and Juang B. H, Fundamentals of speech recognition, Pearson Education, 2003
2. Thomas F. Quatieri, Discrete-time speech signal processing - Principles and practice, Pearson, 2012.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	1	1	2	1	-	-	-	-	-	2	3	3	3
2	1	2	1	1	2	1	-	-	-	-	-	2	2	2	2
3	1	2	1	1	2	1	-	-	-	-	-	1	1	2	2
4	3	-	3	3	-	3	-	-	-	-	-	2	2	3	3
5	3	-	3	3	-	3	-	-	-	-	-	2	2	2	2
CO	1.8	2	1.8	1.8	2	1.8						1.8	2	2.4	2.4

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CEC355**

**SOFTWARE DEFINED RADIO**

**L T P C  
2 0 2 3**

**COURSE OBJECTIVES:**

- To introduce the concepts of software radios
- To know about RF implementation challenges for software defined radios
- To understand the digital generation of signals
- To learn the software and hardware requirements for software defined radios.

**UNIT I INTRODUCTION TO SOFTWARE RADIO 6**

The Need for Software Radios. Characteristics and Benefits of a Software Radio. Design Principles of a Software Radio.

**UNIT II RF IMPLEMENTATION 6**

Purpose of RF front – end, Dynamic range, RF receiver front – end topologies, Enhanced flexibility of the RF chain with software radios, Importance of the components to overall performance, Transmitter architectures and their issues, Noise and distortion in the RF chain, Hybrid DDS – PLL systems, Applications of Direct Digital Synthesis.

**UNIT III DIGITAL GENERATION OF SIGNALS 6**

Comparison of direct digital synthesis with analog signal synthesis, Approaches to direct digital synthesis, Analysis of spurious signals, Performance of direct digital synthesis systems, Applications of direct digital synthesis.

**UNIT IV SMART ANTENNAS 6**

Benefits of smart antennas, Structures for beamforming systems, Smart antenna algorithms, Hardware implementation of smart antennas, Digital Hardware Choices-Key hardware elements.

**UNIT V HARDWARE AND SOFTWARE FOR SDR & CASE STUDIES 6**

DSP Processors, FPGA, ASICs. Trade-offs, Object oriented programming, Object Brokers, GNU Radio-USRP. Case Studies: SPEAK easy, JRTS, SDR-3000.

**30 PERIODS**



**PRACTICAL EXERCISES:****30 PERIODS**

1. Study of SDR hardware kit
2. Design and Implementation of digital modulation schemes using SDR
3. Implementation of synchronization techniques using SDR
4. Channel Coding Techniques using SDR
5. Study of channel estimation techniques using SDR
6. Study of MIMO concepts using SDR

**COURSE OUTCOMES :****At the end of this course, the students will be able to:****CO1:** Demonstrate an understanding in the evolving paradigm of Software defined radio and technologies for its implementation.**CO2:** Analyse Radio frequency implementation issues**CO3:** Implement Smart antenna techniques for software defined radio.**CO4:** Compare various digital synthesis procedures.**CO5:** Comprehend various hardware and software requirements for software defined radios.**TOTAL:60 PERIODS****TEXT BOOKS :**

1. Jeffrey Hugh Reed, "Software Radio: A Modern Approach to Radio Engineering," Prentice Hall Professional, 2002.
2. Tony J Roupael, "RF and DSP for SDR," Elsevier Newnes Press, 2008.

**REFERENCES**

1. P. Kenington, "RF and Baseband Techniques for Software Defined Radio," Artech House, 2005.
2. Paul Burns, "Software Defined Radio for 3G," Artech House, 2002.
3. Behrouz. F. Bourjney " Signal Processing for Software defined Radios", Lulu 2008.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	2	2	2	-	-	-	1	-	3	3	2	2
2	3	3	3	2	2	2	-	-	-	1	-	2	3	2	2
3	3	3	3	2	2	2	-	-	-	1	-	2	3	2	3
4	3	3	3	2	2	2	-	-	-	1	-	2	2	2	2
5	3	3	3	3	2	2	-	-	-	1	-	2	2	2	2
CO	3	3	3	2	2	2	-	-	-	1	-	2	2	2	2

**1 - low, 2 - medium, 3 - high, '-' - no correlation****CEC337****DSP ARCHITECTURE AND PROGRAMMING****L T P C****2 0 2 3****COURSE OBJECTIVES:**

- Study the architecture of programmable DSP processors
- Learn to implement various standard DSP algorithms in DSP Processors
- Use the Programmable DSP Processors to build real-time DSP systems

**UNIT I ARCHITECTURES FOR PROGRAMMABLE DSP PROCESSORS 6**

Basic Architectural features, DSP Computational building blocks, Bus architecture and memory, Data addressing capabilities, Address generation Unit, Programmability and program execution, Speed issues, Features for external interfacing

**UNIT II TMS320C5X PROGRAMMABLE DSP PROCESSOR 6**

Architecture of TMS320C54xx DSP processors, Addressing modes – Assembly language Instructions -Memory space, interrupts, and pipeline operation of TMS320C54xx DSP Processor, On-Chip peripherals, Block Diagram of TMS320C54xx DSP starter kit

**UNIT III TMS320C6X PROGRAMMABLE DSP PROCESSOR 6**

Commercial TI DSP processors, Architecture of TMS320C6x DSP Processor, Linear and Circular addressing modes, TMS320C6x Instruction Set, Assembler directives, Linear Assembly, Interrupts, Multichannel buffered serial ports, Block diagram of TMS320C67xx DSP Starter Kit and Support Tools

**UNIT IV IMPLEMENTATION OF DSP ALGORITHMS 6**

DSP Development system, On-chip, and On-board peripherals of C54xx and C67xx DSP development boards, Code Composer Studio (CCS) and support files, Implementation of Conventional FIR, IIR, and Adaptive filters in TMS320C54xx/TMS320C67xx DSP processors for real-time DSP applications, Implementation of FFT algorithm for frequency analysis in real-time.

**UNIT V APPLICATIONS OF DSP PROCESSORS 6**

Voice scrambling using filtering and modulation, Voice detection and reverse playback, Audio effects, Graphic Equalizer, Adaptive noise cancellation, DTMF signal detection, Speech thesis using LPC, Automatic speaker recognition

**30 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

1. Real-Time Sine Wave Generation
2. Programming examples using C, Assembly and linear assembly
3. Implementation of moving average filter
4. FIR implementation with a Pseudorandom noise sequence as input to a filter
5. Fixed point implementation of IIR filter
6. FFT of Real-Time input signal

**HARDWARE & SOFTWARE SUPPORT TOOLS:**

- TMS320C54xx/TMS320C67xx DSP Development board
- Code Composer Studio (CCS)
- Function Generator and Digital Storage Oscilloscope
- Microphone and speaker

**TOTAL:60 PERIODS**

**COURSE OUTCOMES**

**At the end of this course, the students will be able to:**

- CO1:** Understand the architectural features of DSP Processors.
- CO2:** Comprehend the organization of TMS320C54xx DSP processors
- CO3:** Build solutions using TMS320C6x DSP Processor
- CO4:** Implement DSP Algorithms
- CO5:** Study the applications of DSP Processors.

## TEXT BOOKS

1. Avtar Singh and S. Srinivasan, Digital Signal Processing – Implementations using DSP Microprocessors with Examples from TMS320C54xx, Cengage Learning India Private Limited, Delhi 2012
2. RulphChassaing and Donald Reay, Digital Signal Processing and Applications with the TMS320C6713 and TMS320C6416 DSK, Second Edition, Wiley India (P) Ltd, New Delhi, 2008

## REFERENCES

1. B.Venkataramani and M.Bhaskar, "Digital Signal Processors – Architecture, Programming and Applications", Tata McGraw – Hill Publishing Company Limited. New Delhi, 2003.
2. TMS320C5416/6713 DSK user manual at <https://www.ti.com>

### CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	2	2	2	-	-	-	1	-	3	3	3	3
2	3	3	2	2	2	2	-	-	-	1	-	2	3	3	3
3	3	3	3	2	2	2	-	-	-	1	-	2	2	2	2
4	3	3	3	3	2	2	-	-	-	1	-	2	2	3	2
5	3	3	3	2	2	2	-	-	-	1	-	2	2	3	2
CO	3	3	3	2	2	2	-	-	-	1	-	2	2	3	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS338

COMPUTER VISION

L T P C

2 0 2 3

### COURSE OBJECTIVES:

- To understand the fundamental concepts related to Image formation and processing.
- To learn feature detection, matching and detection
- To become familiar with feature based alignment and motion estimation
- To develop skills on 3D reconstruction
- To understand image based rendering and recognition

### UNIT I INTRODUCTION TO IMAGE FORMATION AND PROCESSING 6

Computer Vision - Geometric primitives and transformations - Photometric image formation - The digital camera - Point operators - Linear filtering - More neighborhood operators - Fourier transforms - Pyramids and wavelets - Geometric transformations - Global optimization.

### UNIT II FEATURE DETECTION, MATCHING AND SEGMENTATION 6

Points and patches - Edges - Lines - Segmentation - Active contours - Split and merge - Mean shift and mode finding - Normalized cuts - Graph cuts and energy-based methods.

### UNIT III FEATURE-BASED ALIGNMENT & MOTION ESTIMATION 6

2D and 3D feature-based alignment - Pose estimation - Geometric intrinsic calibration - Triangulation - Two-frame structure from motion - Factorization - Bundle adjustment - Constrained structure and motion - Translational alignment - Parametric motion - Spline-based motion - Optical flow - Layered motion.

**UNIT IV 3D RECONSTRUCTION****6**

Shape from X - Active rangefinding - Surface representations - Point-based representations- Volumetric representations - Model-based reconstruction - Recovering texture maps and albedosos.

**UNIT V IMAGE-BASED RENDERING AND RECOGNITION****6**

View interpolation Layered depth images - Light fields and Lumigraphs - Environment mattes - Video-based rendering-Object detection - Face recognition - Instance recognition - Category recognition - Context and scene understanding- Recognition databases and test sets.

**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS****LABORATORY EXPERIMENTS:****Software needed:**

OpenCV computer vision Library for OpenCV in Python / PyCharm or C++ / Visual Studio or or equivalent

- OpenCV Installation and working with Python
- Basic Image Processing - loading images, Cropping, Resizing, Thresholding, Contour analysis, Bolb detection
- Image Annotation – Drawing lines, text circle, rectangle, ellipse on images
- Image Enhancement - Understanding Color spaces, color space conversion, Histogram equalization, Convolution, Image smoothing, Gradients, Edge Detection
- Image Features and Image Alignment – Image transforms – Fourier, Hough, Extract ORB Image features, Feature matching, cloning, Feature matching based image alignment
- Image segmentation using Graphcut / Grabcut
- Camera Calibration with circular grid
- Pose Estimation
- 3D Reconstruction – Creating Depth map from stereo images
- Object Detection and Tracking using Kalman Filter, Camshift

1. docs.opencv.org

2. <https://opencv.org/opencv-free-course/>

**TOTAL : 60 PERIODS****COURSE OUTCOMES:**

**At the end of this course, the students will be able to:**

**CO1:**To understand basic knowledge, theories and methods in image processing and computer vision.

**CO2:**To implement basic and some advanced image processing techniques in OpenCV.

**CO3:**To apply 2D a feature-based based image alignment, segmentation and motion estimations.

**CO4:**To apply 3D image reconstruction techniques

**CO5:**To design and develop innovative image processing and computer vision applications.

**TEXT BOOKS:**

1. Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer- Texts in Computer Science, Second Edition, 2022.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, Second Edition, 2015.

## REFERENCES:

1. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
2. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006
3. E. R. Davies, Computer and Machine Vision, Fourth Edition, Academic Press, 2012.

## CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	1	1	1	-	-	-	2	1	3	2	2	1	1
2	3	3	3	2	3	-	1	-	2	1	2	2	3	1	2
3	3	3	2	2	3	-	-	-	1	1	2	2	3	2	2
4	2	3	3	2	3	-	-	-	2	1	2	3	2	2	3
5	2	3	3	2	2	2	-	-	3	1	2	3	3	3	3
<b>AVg.</b>	2.6	2.6	2.4	1.8	2.4	0.4	0.25	0	2	1	2.2	2.4	2.6	1.8	2.2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CEC350**

**RF TRANSCEIVERS**

**LT P C**  
**2 0 2 3**

## COURSE OBJECTIVES:

- To understand the fundamentals of RF system design
- To acquaint with the various components of RF system for wireless communications
- To know the basic techniques needed for analysis of RF systems
- To enable the students to verify the basic principles and design aspects involved in RF systems components
- To conduct experiments to analyze and interpret data to produce meaningful conclusion and match with theoretical concepts

### **UNIT I CMOS PHYSICS, TRANSCEIVER SPECIFICATIONS AND ARCHITECTURES**

**6**

CMOS: Introduction to MOSFET Physics - Noise: Thermal, shot, flicker, popcorn noise - Transceiver Specifications: Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR - Phase noise - Transceiver Architectures: Receiver: Homodyne, Heterodyne, Image reject, Low-IF Architectures - Transmitter: Direct-up conversion, Two-step up conversion schemes

### **UNIT II IMPEDANCE MATCHING NETWORKS AND AMPLIFIERS**

**6**

Review of S-parameters and Smith chart - Passive IC components - Impedance matching networks - Amplifiers: Common Gate, Common Source Amplifiers - OC Time constants in bandwidth estimation and enhancement - High frequency amplifier design - Low Noise Amplifiers: Power match and Noise match, single-ended and differential LNAs

### **UNIT III FEEDBACK SYSTEMS AND POWER AMPLIFIERS**

**6**

Feedback Systems: Stability of feedback systems, Gain and phase margin, Root-locus techniques, Time and Frequency domain considerations, Compensation - Power Amplifiers: General model - Class A, AB, B, C, D, E and F amplifiers - Linearization Techniques - Efficiency boosting techniques - ACPR metric

**UNIT IV FILTERS, OSCILLATORS AND MIXERS****6**

Overview - basic resonator and filter configuration, special filter realizations, filter implementation - Basic oscillator model, high-frequency oscillator configuration, Colpitt's oscillator - basic characteristics of mixers, single and double-balanced mixers

**UNIT V PLL AND FREQUENCY SYNTHESIZERS****6**

PLL: Linearized Model, Noise properties, Phase detectors, Loop filters and Charge pumps- Frequency Synthesizers: Integer-N frequency synthesizers - Direct Digital Frequency Synthesizers

**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS**

1. Measurement of S-parameters for impedance matching circuits, and RF filters using network analyzer
2. Design of RF inductor and capacitor
3. Design and characterization of LNA
4. Design of impedance matching network
5. Design of low-pass and band-pass filter at RF
6. Design and characterization of mixer

**TOTAL:60 PERIODS****COURSE OUTCOMES:**

**At the end of this course, the students will be able to:**

**CO1:** Interpret the nonlinear effects in RF circuits

**CO2:** Design RF circuits

**CO3:** Analyze the performance of RF circuits

**CO4:** Apply knowledge to identify a suitable architecture and systematically design an RF System

**CO5:** Comprehensively record and report the measured data, and would be capable analyzing, interpreting the experimentally measured data and produce the conclusions

**TEXTBOOKS**

1. Lee T, Design of CMOS RF Integrated Circuits, Cambridge, Second Edition, 2004
2. Razavi B, RF Microelectronics, Pearson Education, Second Edition, 2012

**REFERENCES**

1. Ludwig R, and Bretchko P, RF Circuit Design Theory and Applications, Prentice Hall, 2000
2. Razavi B, Design of Analog CMOS Integrated Circuits, McGraw Hill, Second Edition, 2017
3. Kyung-WhanYeom, Microwave Circuit Design - A Practical Approach using ADS, Pearson Education, 2015

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	3	2	-	-	-	-	1	-	2	1	1	3
2	3	3	3	2	2	-	-	-	-	1	-	2	1	1	2
3	3	3	2	2	2	-	-	-	-	1	-	2	2	2	2
4	3	3	3	3	2	-	-	-	-	1	-	2	3	2	2
5	3	2	3	3	2	-	-	-	-	1	-	2	2	2	2
CO	3	3	3	3	2	-	-	-	-	1	-	2	2	2	2

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

**COURSE OBJECTIVES:**

- Understand characteristic impedance of transmission line and impedance matching techniques.
- Understand plain signal reflection and cross talk noise in the transmission line, and also explain the mathematical analysis method.
- Understand Eye diagram and related measurement to test quality of Signal
- Learn Jitter analysis and jitter decomposition
- Work with high frequency differential signal and its applications

**UNIT I SIGNAL REFLECTION AND IMPEDANCE MATCHING TECHNIQUE 6**

Phenomenon of signal reflection. Signal reflection at transmitting end.  
Signal reflection at branch point. Multiple reflection in transmission line.  
Prevention of signal reflection by using impedance matching technique.

**UNIT II CROSSTALK NOISE 6**

Crosstalk definition and classification. Crosstalk mechanism. Analysis of crosstalk noise in transmission line. Main factor of causing crosstalk noise.

**UNIT III DIFFERENTIAL SIGNAL TRANSMISSION CIRCUIT. 6**

Pros and cons of using differential signaling compared with that of single-ended signaling.  
High-speed differential interfaces. Theory of differential signaling.  
Differential signal termination techniques.

**UNIT IV FREQUENCY RESPONSE OF A CIRCUIT 6**

Frequency response of transmission line and circuit. Inter-symbol interference (ISI) and eye-pattern.  
Deterioration of a signal waveform due to ISI. Circuit techniques to prevent the deterioration. Linear time-invariant systems. Frequency response of pulse.

**UNIT V EYE DIAGRAM AND JITTER 6**

Jitter Definition and Types of Jitter; Jitter decomposition; Eye diagram analysis and related measurement

**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS**

1. Generating 1GHz Differential signal from AWG
2. Getting Eye on oscilloscope and conduct various measurement on Eye as well Timing parametric such as rise/fall times, pulse width, and duty cycle Programmable software clock recovery including software PLL .
3. Accurate jitter analysis using the spectral and Q-scale methods for detailed decomposition of jitter components, including the extraction of industry standard dual-dirac model parameters
4. Generate LVDS signal and conduct signal integrity measurement

**List of Equipments needed:**

- 2Ch 1 GHz Arbitrary waveform generator
- 2GHz 4 flex channel scope with automated jitter and eye diagram measurement
- LVDS measurement suite

**COURSE OUTCOMES:****At the end of this course, the students will be able to:****CO1:** Familiarity with High speed design and related issues**CO2:** Understanding on critical design aspect**CO3:** Know about Jitter and related measurements which is critical for design**CO4:** Practical application of high speed differential signals**CO5:** Measurement expertise up to industry expectations**TOTAL:60 PERIODS****TEXT BOOKS**

1. Signal and Power integrity Simplified -Eric Bogatin, Pearson, 3rd Edition
2. High Speed Digital Design by Howard Johnson and Martin Graham, Prentice Hall,1st Edition

**REFERENCES**

1. High Speed Signal Propagation and Howard Johnson,Prentice Hall,1st Edition

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	2	2	2	-	-	-	-	-	3	3	2	2
2	3	3	3	2	2	2	-	-	-	-	-	2	3	2	2
3	3	3	3	2	2	2	-	-	-	-	-	2	3	2	3
4	3	3	3	2	2	2	-	-	-	-	-	2	2	2	2
5	3	3	3	3	2	2	-	-	-	-	-	2	2	2	2
CO	3	3	3	2	2	2	-	-	-	-	-	2	2	2	2

**1 - low, 2 - medium, 3 - high, '-' - no correlation****CEC335****ANTENNA DESIGN****L T P C  
2 0 2 3****COURSE OBJECTIVES:**

- To introduce the basic concepts of antenna arrays for smart antenna design
- To discuss the random variables and processes for angle of arrival (AOA) estimation
- To describe different algorithms used for AOA estimation
- To introduce the concepts of fixed weight beamforming
- To introduce the concept of adaptive beamforming

**UNIT I ANTENNA ARRAY FUNDAMENTALS****6**

Linear arrays: Two element and Uniform N element array – Array weighting: Beam steered and weighted arrays – Circular arrays – Rectangular planar arrays – Fixed beam arrays – Butler Matrices – Fixed sidelobe cancelling – Retrodirective arrays: Passive and active retrodirective arrays.

**UNIT II PRINCIPLES OF RANDOM VARIABLES AND PROCESSES****6**

Definition of Random Variables - Probability Density Functions - Expectation and Moment - Common Probability Density Functions - Stationarity and Ergodicity - Autocorrelation and Power Spectral Density - Correlation Matrix

**UNIT III ANGLE OF ARRIVAL ESTIMATION****6**

Fundamentals of Matrix Algebra: Vector basics - Matrix basics - Array Correlation Matrix - AOA Estimation Methods: Bartlett AOA estimate, Capon AOA estimate, Linear prediction AOA estimate,



Maximum entropy AOA estimate, Pisarenko harmonic decomposition AOA estimate, Min-norm AOA estimate, MUSIC AOA estimate, Root-MUSIC AOA estimate, ESPRIT AOA estimate

**UNIT IV SMART ANTENNAS: FIXED WEIGHT BEAMFORMING 6**

Introduction - Historical Development of Smart Antennas - Fixed Weight Beamforming Basics: Maximum signal-to-interference ratio, Minimum mean-square error, Maximum likelihood, Minimum variance

**UNIT V SMART ANTENNAS: ADAPTIVE BEAMFORMING 6**

Adaptive Beamforming: Least mean squares, Sample matrix inversion, Recursive least squares, Constant modulus, Least squares constant modulus, Conjugate gradient method, Spreading sequence array weights, Description of the new SDMA receiver.

**30 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

1. Write a MATLAB code to estimate the radiation pattern of a linear array and N element uniform array
2. Write a MATLAB code to estimate the AOA using MUSIC and ESPRIT algorithm
3. Write a MATLAB code to estimate the weights of the array. Using the final weights estimate the array factor and the mean square error.
4. Write a MATLAB code to dynamically alter the main lobe direction based on the information of AOA.

**COURSE OUTCOMES:**

**At the end of this course, the students will be able to:**

**CO1:** Describe the basics of phased array antennas

**CO2:** Understand random process and its application in Smart antennas

**CO3:** Estimate the weights of the antenna array based on the angle of arrival

**CO4:** Analyze the fixed weight beamforming in smart antennas

**CO5:** Analyze adaptive beamforming in smart antennas

**TOTAL 60 PERIODS**

**TEXT BOOKS**

1. Frank Gross, Smart antennas for wireless communications, McGra-Hill, 2006.
2. S. Chandran, Adaptive antenna arrays, trends and applications, Springer, 2009.

**REFERENCES**

1. T. S. Rappaport, Smart antennas: Adaptive arrays, algorithms and wireless position location, IEEE Press, 1998.
2. Robert A. Monzingo, Randy L. Haupt and Thomas W. Miller, Introduction to Adaptive arrays, 2nd Edition, IET, 2011.
3. Thomas Kaiser, Smart Antennas: State of the Art, Hindawi, 2005

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	2	1	-	-	-	1	-	2	3	2	2
2	3	2	2	2	2	1	-	-	-	1	-	2	3	2	2
3	3	3	2	2	1	2	-	-	-	1	-	2	3	2	2
4	3	3	2	3	2	1	-	-	-	1	-	2	3	2	2
5	3	2	3	2	2	1	-	-	-	1	-	2	3	2	2
CO	3	3	2	2	2	1	-	-	-	1	-	2	3	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES:**

- To study the characteristics of Active components and applications.
- To design the RF filter and analyze the circuits operated at millimeter wavelength
- To understand the basics of Microwave integrated circuits
- To learn the concepts of non reciprocal components for MICs
- To design the antenna and analyze its performance using measurement techniques

**UNIT I ACTIVE RF COMPONENTS AND APPLICATIONS 6**

RF diodes, BJT, RF FET'S, High electron mobility transistors, matching and biasing networks-impedance matching using discrete components, microstripline matching networks, amplifier classes of operation and biasing networks.

**UNIT II RF FILTER DESIGN 6**

Overview, Basic resonator and filter configuration, special filter realizations, smith chart based filter design, coupled filter.

**UNIT III INTRODUCTION TO MICROWAVE INTEGRATED CIRCUITS 6**

Overview of ABCD and S parameters - Overview of Planar transmission lines (Stripline, Microstripline, Slotline, CPW, Finline)-Design Parameters for Strip Line And Microstripline- Active Device Technologies- Design ApproachesMultichip Module Technology- Substrates

**UNIT IV NON RECIPROCAL COMPONENTS FOR MICs 6**

Microstrip on Ferrimagnetic substrates, Microstrip circulators. Isolators and phase shifters, Design of microstrip circuits – high power and low power circuits.

**UNIT V INTEGRATED ANTENNA DESIGN AND MEASUREMENTS 6**

Integrated Antenna Design- Photonic Band Gap Antennas - Micro Machined Antenna - Micro Electro Mechanical System Antennas - Test Fixture Measurements - Probe Station Measurements - Thermal and Cryogenic Measurements- Experimental Field Probing Techniques.

**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS**

1. Design of low pass, high pass, band pass and band stop filter at RF using any software tool
2. Design of low pass, high pass, band pass and band stop filter at RFDesign of low pass, high pass, band pass and band stop filter at RF
3. Design of low pass, high pass, band pass and band stop filter at RF
4. Design of low pass, high pass, band pass and band stop filter at RF
5. Measurement of S parameters for a) Inductor b) Capacitor c) impedance matching circuits, filters using network analyzer
6. Design a microstrip circuits

**COURSE OUTCOMES:**

**Upon successful completion of the course the student will be able to**

**CO1:** Apply knowledge of S parameter theory to any RF active component design circuit for obtaining performance measure.

**CO2:** Analyze microwave circuits for filters design.

**CO3**Evaluate the performance of any practical Microwave integrated circuits

**CO4:** Create communication circuits and subsystems with practical design parameters for non-reciprocal components in MICs.

**CO5:** Design microwave integrated antenna design circuit for the required Performance using professional software tools.

**TOTAL:60 PERIODS**

**TEXTBOOKS**

1. Reinhold Ludwig and Powel Bretchko, RF Circuit Design – Theory and Applications, Pearson Education Asia, First Edition, 2001.(Unit – I, II)
2. Bharathi Bhat, Shiban K. Koul, “Stripline-like Transmission Lines for Microwave Integrated Circuits”, New Age International Pvt Ltd Publishers, 2007.(Unit –III ,V)
3. Gupta KC and Amarjit Singh, “Microwave Integrated circuits”, Wiley Eastern, 1974.(Unit – IV)

**REFERENCES**

1. Mathew M. Radmanesh, Radio Frequency & Microwave Electronics, Pearson Education Asia, Second Edition, 2002.
2. Ulrich L. Rohde and David P. NewKirk, RF / Microwave Circuit Design, John Wiley & Sons USA 2000.
3. Roland E. Best, Phase – Locked Loops: Design, simulation and applications, McGraw Hill Publishers 5TH edition 2003
4. David Pozar ,Microwave Engineering, Addison Wesley 3rd Edition
5. Ravender Goyal, “Monolithic MIC; Technology & Design”, Artech House, First Edition 1989.

**CO’s-PO’s & PSO’s MAPPING**

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO3
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2	3	3	3	2	3	2	2	-	2	1	-	1	3	2	2
3	3	3	2	2	3	2	2	-	2	1	-	1	3	2	2
4	3	3	2	2	3	2	2	-	2	1	-	1	3	2	2
5	3	3	1	2	3	2	2	-	2	1	-	1	3	2	2
CO	3	3	2	2	3	2	2	-	2	1	-	1	3	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CEC338**

**EMI / EMC PRE COMPLIANCE TESTING**

**L T P C  
2 0 2 3**

**COURSE OBJECTIVES:**

- To introduce the basic concepts of Electromagnetic Interference
- To teach the importance of measurement device for EMI.
- To explain the EMI coupling & control principles
- To understand receivers & Analyzer functionalities
- To impart knowledge on design issues in EMI/EMC

**UNIT I NATURE AND ORIGINS OF ELECTROMAGNETIC COMPATIBILITY**

**6**

Introduction-Visualising the EMI problem-Source of EMI,EMI coupling to victim equipment, Intersystem and Intrasystem EMI, EMC standards and specifications

**UNIT II**                    **TYPES of EMI COUPLING**                    **6**  
Conducted, radiated and transient coupling; Common ground impedance coupling; Common mode and ground loop coupling; Differential mode coupling, Near field cable to cable coupling; Field to cable coupling, Power mains and Power supply coupling; Transient EMI

**UNIT III**                    **MEASUREMENT DEVICES FOR EMI**                    **6**  
Introduction – Measurement by direct connection, Inductively coupled devices, EMC antennas – Basic antenna parameters, Antennas for radiated emission testing, Wideband antennas - Magnetic field antennas, Type of antennas used in susceptibility testing

**UNIT IV**                    **RECEIVERS, ANALYSERS AND MEASUREMENT EQUIPMENT**                    **6**  
EMI receiver, Spectrum Analyzers, RF power meter Frequency meters. Standards requiring immunity tests, Automatic EMC tests, Electromagnetic transient testing, Transient types, Continuous and transient signal, ESD-electrostatic discharge

**UNIT V**                    **PRE-COMPLIANCE TESTING TO AVOID EMC PROBLEMS**                    **6**  
Need for Pre-Compliance Testing; Intersystem and Intrasystem EMC - Developing an approach to EMC design - Process flow chart, - EMC strategy – Self certification; Solutions to avoid EMC: ESD Shielding, EMI Filters; Grounding; Bonding, Isolation transformer, Transient suppressors; EMI Suppression Cables.

**30 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

1. Basic spectrum measurement and power measurement with markers
2. Perform environment scan and detect various signals available
3. DPX, Spectrogram and transient capture with mask test and act on violation
4. EMI spurious detection and measurement against EMI limit lines
5. Use of LISN and measurement concept of Conducted emission

**List of equipments for needed for a batch of 30 students (3 in a bench):**

1. Real Time Spectrum Analyser upto atleast 6.2GHz and 40MHz BW – 10 nos
2. Near Field Probes kit – 10 nos
3. 25MHz to 300 MHz Biconical antenna – 10 nos
4. 300 MHz to 1GHz Compact Log Periodic Antenna – 10 nos
5. line impedance stabilization network (LISN) - 3
6. EMI EMC Test Software – 10 nos
7. Tripod Stand – 10 nos

**COURSE OUTCOMES:**

**At the end of this course, the students will be able to:**

- CO1:** Perceive the various types and mechanisms of Electromagnetic Interference
- CO2:** Propose a suitable EMI mitigation technique.
- CO3:** Evaluate EMI coupling & control principles
- CO4:** Explain the importance receivers & Analyzer functionalities
- CO5:** Inspect the design issues in EMI/EMC

**TOTAL:60 PERIODS**

**TEXTBOOKS**

1. David Morgan , "A Handbook for EMC Testing and Measurement", IET Electrical Measurement, 2012
2. Tim Williams , "EMC for Product Designers", 5th Edition, Newnes Elsevier, 2017

## REFERENCES

1. V.P.Kodali, "Engineering EMC Principles, Measurements and Technologies", IEEE Press, Newyork, 1996
2. Paul, C.R., "Introduction to Electromagnetic Compatibility", 2nd ed., Wiley (2010)
3. David K. Cheng, "Field and Wave Electromagnetics", 2nd ed. Pearson Education, 2009

### CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	3	3	1	1	-	-	1	-	1	2	1	2
2	3	3	2	1	3	2	1	-	-	1	-	2	2	2	2
3	3	3	3	3	2	2	1	-	-	1	-	2	2	2	2
4	3	3	2	2	2	2	1	-	-	1	-	2	2	1	2
5	3	-	3	3	2	2	1	-	-	1	-	2	2	2	2
CO	3	3	2	2	2	2	1	-	-	1	-	2	2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CEC349**

**RFID SYSTEM DESIGN AND TESTING**

**L T P C**

**2 0 2 3**

### COURSE OBJECTIVES:

- To discuss the fundamentals of near field and far field RFID communications
- To articulate the standards and protocols used in RFID systems
- To describe the operating principles of RFID tag and reader
- To introduce the security aspects and system architecture of RFID systems
- To illustrate the industrial and scientific applications of RFID systems

### UNIT I INTRODUCTION

**6**

RFID Principles: Near-field based RFID – Properties of Magnetic field – Far-field based RFID – Properties of Backscatter RF Systems – Modulation techniques – Frequency based property comparison of RFID Systems

### UNIT II RFID STANDARDS AND PROTOCOLS

**6**

RFID Industry standards: EPC global – ISO15693 Vicinity cards and RFID – ISO14443 Proximity cards and RFID – The NFC forum – Reading collocated RFID tags: Query Tree protocol – Query Slot protocol

### UNIT III OPERATING PRINCIPLES

**6**

RFID Tag components: RFID tag types – the 1-Bit Transponder and Chipless Tags – RFID readers and middleware component – Communication fundamentals: Coupling, Data encoding, multi-path effect – Tag, Reader and sensor communication.

### UNIT IV DATA INTEGRITY AND SECURITY

**6**

The checksum procedure – Multiaccess procedures – Attacks on RFID Systems – Protection by Cryptographic measures

### UNIT V RFID ENABLED SENSORS AND APPLICATIONS

**6**

RFID enabled Sensors: Antenna design challenges – IC design – Integration of sensors and RFID – Power consumption and Link budget.

Applications: Contactless smart cards – Access control – Electronic passport – Industrial Automation – Medical applications – Challenges and opportunities.

**30 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

1. Design of a passive RFID Tag Antenna
2. Design of an RFID reader antenna
3. Determination of read range of the RFID tag at UHF and Microwave frequencies
4. Determination of RFID tag performance for different standards

**COURSE OUTCOMES:**

**At the end of this course, the students will be able to:**

**CO1:** Classify RFID systems based on frequency, architecture and performance

**CO2:** Define standards for RFID technology

**CO3:** Illustrate the operation of various components of RFID systems

**CO4:** Describe the privacy and security issues in RFID Systems

**CO5:** Discuss the construction and applications of RFID enabled sensor

**TOTAL:60 PERIODS**

**TEXTBOOKS**

1. Roy Want, RFID Explained, Springer 2022.
2. Amin Rida, Li Yang, Manos M. Tentzeris, RFID Enabled Sensor Design and Applications, Artech House, 2010

**REFERENCES**

1. Klaus Finkenzeller, RFID Handbook, 3rd Edition, Wiley, 2010
2. Syed Ahson, Mohammad Ilyas, RFID Handbook, CRC Press, 2008
3. Paris Kitsos, Security in RFID and Sensor Networks, CRC Press, 2016.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	2	2	3	1	-	-	1	-	3	2	3	2
2	3	2	3	2	2	2	1	-	-	1	-	3	3	2	2
3	3	3	3	2	3	2	1	-	-	1	-	3	2	3	2
4	3	3	3	2	2	2	1	-	-	1	-	2	3	2	2
5	3	3	2	2	2	2	2	-	-	1	-	3	2	2	2
CO	3	3	3	2	3	3	1	-	-	1	-	2	3	3	2

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

**CBM370**

**WEARABLE DEVICES**

**L T P C**

**3 0 0 3**

**OBJECTIVES:**

**The student should be made to:**

- To know the hardware requirement of wearable systems
- To understand the communication and security aspects in the wearable devices
- To know the applications of wearable devices in the field of medicine

**UNIT I INTRODUCTION TO WEARABLE SYSTEMS AND SENSORS**

**9**

Wearable Systems- Introduction, Need for Wearable Systems, Drawbacks of Conventional Systems for Wearable Monitoring, Applications of Wearable Systems, Types of Wearable Systems, Components of wearable Systems. Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor.

**UNIT II SIGNAL PROCESSING AND ENERGY HARVESTING FOR WEARABLE DEVICES 9**

Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, sampling frequency for reduced energy consumption, Rejection of irrelevant information. Power Requirements- Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.

**UNIT III WIRELESS HEALTH SYSTEMS 9**

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication Techniques.

**UNIT IV SMART TEXTILE 9**

Introduction to smart textile- Passive smart textile, active smart textile. Fabrication Techniques- Conductive Fibres, Treated Conductive Fibres, Conductive Fabrics, Conductive Inks. Case study- smart fabric for monitoring biological parameters - ECG, respiration.

**UNIT V APPLICATIONS OF WEARABLE SYSTEMS 9**

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, neural recording, Gait analysis, Sports Medicine.

**OUTCOMES:**

On successful completion of this course, the student will be able to

- CO1: Describe the concepts of wearable system.
- CO2: Explain the energy harvestings in wearable device.
- CO3: Use the concepts of BAN in health care.
- CO4: Illustrate the concept of smart textile
- CO5: Compare the various wearable devices in healthcare system

**TOTAL PERIODS:45**

**TEXT BOOKS**

1. Annalisa Bonfiglio and Danilo De Rossi, Wearable Monitoring Systems, Springer, 2011
2. Zhang and Yuan-Ting, Wearable Medical Sensors and Systems, Springer, 2013
3. Edward Sazonov and Micheal R Neuman, Wearable Sensors: Fundamentals, Implementation and Applications, Elsevier, 2014
4. Mehmet R. Yuce and Jamil Y. Khan, Wireless Body Area Networks Technology, Implementation applications, Pan Stanford Publishing Pte.Ltd, Singapore, 2012

**REFERENCES**

1. Sandeep K.S, Gupta, Tridib Mukherjee and Krishna Kumar Venkatasubramanian, Body Area Networks Safety, Security, and Sustainability, Cambridge University Press, 2013.
2. Guang-Zhong Yang, Body Sensor Networks, Springer, 2006.

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
2	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
3	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
4	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1

5	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
AVg.	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CBM352**

**HUMAN ASSIST DEVICES**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- To study the role and importance of machines that takes over the functions of the heart and lungs,
- To study various mechanical techniques that help a non-functioning heart.
- To learn the functioning of the unit which does the clearance of urea from the blood
- To understand the tests to assess the hearing loss and development of electronic devices to compensate for the loss.
- To study about recent techniques used in modern clinical applications

**UNIT I HEART LUNG MACHINE AND ARTIFICIAL HEART**

**9**

Condition to be satisfied by the H/L System. Different types of Oxygenators, Pumps, Pulsatile and Continuous Types, Monitoring Process, Shunting, The Indication for Cardiac Transplant, Driving Mechanism, Blood Handling System, Functioning and different types of Artificial Heart, Schematic for temporary bypass of left ventricle.

**UNIT II CARDIAC ASSIST DEVICES**

**9**

Assisted through Respiration, Right and left Ventricular Bypass Pump, Auxiliary ventricle, Open Chest and Closed Chest type, Intra Aortic Balloon Pumping, Prosthetic Cardiac valves, Principle of External Counter pulsation techniques.

**UNIT III ARTIFICIAL KIDNEY**

**9**

Indication and Principle of Haemodialysis, Membrane, Dialysate, types of filter and membranes, Different types of hemodialyzers, Monitoring Systems, Wearable Artificial Kidney, Implanting Type.

**UNIT IV RESPIRATORY AND HEARING AIDS**

**9**

Ventilator and its types-Intermittent positive pressure, Breathing Apparatus Operating Sequence, Electronic IPPB unit with monitoring for all respiratory parameters. Types of Deafness, Hearing Aids, SISI, masking techniques, wearable devices for hearing correction.

**UNIT V RECENT TRENDS**

**9**

Transcutaneous electrical nerve stimulator, bio-feedback, Diagnostic and point-of-care platforms.

**COURSE OUTCOMES:**

At the end of this course the students will be able to:

**CO1:** Explain the principles and construction of artificial heart

**CO2:** Understand various mechanical techniques that improve therapeutic technology

**CO3:** Explain the functioning of the membrane or filter that cleanses the blood.

**CO4:** Describe the tests to assess the hearing loss and development of wearable devices for the same.

**CO5:** Analyze and research on electrical stimulation and biofeedback techniques in rehabilitation and physiotherapy.



**TEXT BOOKS:**

1. Gray E Wnek, Gray L Browlin – Encyclopedia of Biomaterials and Biomedical Engineering –Marcel Dekker Inc New York 2004.
2. John. G . Webster – Bioinstrumentation - John Wiley & Sons (Asia) Pvt Ltd - 2004
3. Joseph D.Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press, 2006

**REFERENCES:**

1. Andreas.F. Von racum, “Hand book of bio material evaluation”, Mc-Millan publishers, 1980.
2. Gray E Wnek, Gray L Browlin, “Encyclopedia of Biomaterials and Biomedical Engineering” Marcel Dekker Inc New York 2004.
3. D.S. Sunder, “Rehabilitation Medicine”, 3rd Edition, Jaypee Medical Publication, 2010

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	3	2	-	-	-	-	-	3	3	1	2
2	3	3	3	2	2	3	-	-	-	-	-	2	2	2	2
3	3	3	3	3	3	2	-	-	-	-	-	3	3	3	2
4	3	3	1	1	3	2	-	-	-	-	-	2	3	1	3
5	3	3	3	3	3	3	-	-	-	-	-	2	3	3	2
CO	3	3	2.6	2.4	2.8	2.4	-	-	-	-	-	2.4	2.8	2	2.2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CBM368****THERAPEUTIC EQUIPMENT**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To learn the principles of cardiac assist devices.
- To understand the need and use of extracorporeal devices, and the use of lasers in medicine.
- To enable the students to gain knowledge on the working of therapeutic clinical equipment.

**UNIT I CARDIAC AND RESPIRATORY THERAPY EQUIPMENT****9**

Cardiac Pacemaker: Internal and External Pacemaker– Programmable pacemakers. Cardiac Defibrillators: AC and DC Defibrillator- Internal and External Defibrillators - Protection Circuit, Defibrillator analyzers. Cardiac ablation catheter.

Types of Ventilators – Pressure, Volume, and Time controlled. Basic principles of electromechanical, pneumatic and electronic ventilators, Patient Cycle Ventilators, Ventilator testing. Humidifiers, Nebulizers, Inhalators.

**UNIT II BIOMECHANICAL THERAPEUTIC EQUIPMENT****9**

Electrodiagnosis, Therapeutic radiation, Electrotherapy, Electrodes, Stimulators for Nerve and Muscle, Functional Electrical Stimulation. peripheral nerve stimulator, ultrasonic stimulators, Stimulators for pain and relief - Inferential Therapy Unit, TENS. GAIT Assessment and Therapy. Continuous Passive Motion unit, Cervical / Lumber Traction Machine -Traction Table.

**UNIT III BODY CARE EQUIPMENT****9**

Skin Treatment: Ultrasonic spot remove, vacuum therapy unit, Skin tightening, Wrinkle Reduction, Facial and Rejuvenation. Laser hair therapy machine. Body Slimmer/Shaper – Deep Heat Therapy, Massager, Fitness – Treadmill, Bike.

**UNIT IV DENTAL CARE EQUIPMENT****9**

Dental Chair - Dental Hand pieces and Accessories: Evolution of rotary equipment, Low-speed handpiece, High-speed handpiece, Hand piece maintenance. Vacuum and Pneumatic techniques: Vacuum techniques, Oral evacuation systems, Vacuum pump, Pneumatic techniques, Dental compressor. Decontamination Unit and constant fumigation unit. Dental Radiography: Dental X-ray Machine.

**UNIT V HEAT & PHOTON THERAPY EQUIPMENT****9**

High frequency heat therapy, Principle, Short wave diathermy, Microwave diathermy, Ultrasonic therapy, Lithotripsy. Therapeutic UV and IR Lamps. Basic principles of Biomedical LASERS: Applications of lasers in medicine, CO<sub>2</sub>laser, He-Ne laser, Nd-YAG and Ruby laser.

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

- CO1:** Suggest suitable therapeutic devices for ailments related to cardiology, pulmonology, neurology, etc
- CO2:** Comprehend the principles of bodycare equipment
- CO3:** Understand the operation of dental care equipment.
- CO4:** Analyze the different types of therapies for suitable applications.
- CO5:** Appreciate the application of lasers in biomedical applications.

**TOTAL:45 PERIODS****TEXT BOOKS**

1. Khandpur. R.S., "Handbook of Biomedical Instrumentation". Second Edition. Tata McGrawHill Pub. Co., Ltd. 2003.
2. John.G.Webster. "Medical Instrumentation, Application and Design". Fourth Edition. Wiley & sons, Inc., NewYork. 2009.

**REFERENCES**

1. Leslie Cromwell, Fred. J. Weibell & Erich. A.Pfeiffer. "Biomedical Instrumentation and Measurements". Second Edition. Prentice Hall Inc.2000.
2. John Low & Ann Reed. "Electrotherapy Explained, Principles and Practice". Second Edition. Butterworth Heinemann Ltd. 2000.
3. Joseph. J. Carr, John Michael Brown, "Introduction to Biomedical Equipment Technology", Prentice Hall and Technology, 2008.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	2	3	2	-	-	-	-	2	3	3	3
2	3	3	3	3	2	3	2				-	2	3	2	2
3	3	3	3	3	2	3	2	-	-	-	-	2	3	2	2
4	3	2	2	3	2	3	2	-	-	-	-	2	2	3	2
5	3	3	2	3	2	3	2	-	-	-	-	2	2	3	3
CO	3	2.8	2.6	3	2.5	3	2	-	-	-	-	2	2.6	2.6	2.4

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CBM355****MEDICAL IMAGING SYSTEMS****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- To understand the generation of X-ray and its uses in Medical imaging
- To describe the principle of Computed Tomography.

- To know the techniques used for visualizing various sections of the body.
- To learn the principles of different radio diagnostic equipment in Imaging.
- To discuss the radiation therapy techniques and radiation safety

**UNIT I X RAYS 9**

Nature of X-rays- X-Ray absorption – Tissue contrast. X- Ray Equipment (Block Diagram) – X-Ray Tube, the collimator, Bucky Grid, power supply, Digital Radiography - discrete digital detectors, storage phosphor and film scanning, X-ray Image Intensifier tubes – Fluoroscopy – Digital Fluoroscopy. Angiography, cine Angiography. Digital subtraction Angiography. Mammography.

**UNIT II COMPUTED TOMOGRAPHY 9**

Principles of tomography, CT Generations, X- Ray sources- collimation- X- Ray detectors – Viewing systems – spiral CT scanning – Ultra fast CT scanners. Image reconstruction techniques – back projection and iterative method.

**UNIT III MAGNETIC RESONANCE IMAGING 9**

Fundamentals of magnetic resonance- properties of electromagnetic waves : speed , amplitude, phase, orientation and waves in matter - Interaction of Nuclei with static magnetic field and Radio frequency wave- rotation and precession – Induction of magnetic resonance signals – bulk magnetization – Relaxation processes T1 and T2. Block Diagram approach of MRI system – system magnet (Permanent, Electromagnet and Superconductors), generations of gradient magnetic fields, Radio Frequency coils (sending and receiving), shim coils, Electronic components, fMRI.

**UNIT IV NUCLEAR IMAGING 9**

Radioisotopes- alpha, beta, and gamma radiations. Radio Pharmaceuticals. Radiation detectors – gas filled, ionization chambers, proportional counter, GM counter and scintillation Detectors, Gamma camera – Principle of operation, collimator, photomultiplier tube, X-Y positioning circuit, pulse height analyzer. Principles of SPECT and PET

**UNIT V RADIATION THERAPY AND RADIATION SAFETY 9**

Radiation therapy – linear accelerator, Telegamma Machine. SRS – SRT – Recent Techniques in radiation therapy – 3D CRT – IMRT – IGRT and Cyber knife – radiation measuring instruments Dosimeter, film badges, Thermo Luminescent dosimeters – electronic dosimeter – Radiation protection in medicine – radiation protection principles

**TOTAL 45 PERIODS**

**COURSE OUTCOMES:**

**At the end of the course the student will be able to:**

- CO1:** Describe the working principle of the X-ray machine and its application.
- CO2:** Illustrate the principle computed tomography
- CO3:** Interpret the technique used for visualizing various sections of the body using Magnetic Resonance Imaging.
- CO4:** Demonstrate the applications of radionuclide imaging.
- CO5:** Analyze different imaging techniques and choose appropriate imaging equipment for better diagnosis and outline the methods of radiation safety.

**TEXT BOOKS:**

1. Isaac Bankman, I. N. Bankman , Handbook Of Medical Imaging: Processing and Analysis(Biomedical Engineering),Academic Press,2000

- Jacob Beutel (Editor), M. Sonka (Editor), Handbook of Medical Imaging, Volume 2. Medical Image Processing and Analysis , SPIE Press 2000
- Khin Wee Lai, DyahEkashantiOctorinaDewi “Medical Imaging Technology”, Springer Singapore, 2015

## REFERENCE BOOKS

- Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw – Hill, New Delhi, 2003.
- Dougherty, Geoff (Ed.), “Medical Image Processing - Techniques and Applications”, Springer-Verlag New York, 2011

## CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	2	2	2	-	-	-	-	-	3	2	3	2
2	3	3	3	2	2	1	-	-	-	-	-	2	2	3	2
3	3	3	2	2	2	2	-	-	-	-	-	2	2	2	1
4	3	3	3	2	2	1	-	-	-	-	-	2	2	2	1
5	3	3	3	3	2	2	-	-	-	-	-	1	2	2	1
CO	3	3	2.8	2.2	2	1.6	-	-	-	-	-	2	2	2.4	1.4

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CBM342**

**BRAIN COMPUTER INTERFACE AND APPLICATIONS**

**L T P C**

**3 0 0 3**

## COURSE OBJECTIVES:

The student should be made to:

- To understand the basic concepts of brain computer interface
- To study the various signal acquisition methods
- To study the signal processing methods used in BCI

## UNIT I INTRODUCTION TO BCI

**9**

Fundamentals of BCI – Structure of BCI system – Classification of BCI – Invasive, Non-invasive and Partially invasive BCI – EEG signal acquisition - Signal Preprocessing – Artifacts removal.

## UNIT II ELECTROPHYSIOLOGICAL SOURCES

**9**

Sensorimotor activity – Mu rhythm, Movement Related Potentials – Slow Cortical Potentials-P300 - Visual Evoked Potential - Activity of Neural Cells - Multiple Neuromechanisms.

## UNIT III FEATURE EXTRACTION METHODS

**9**

Time/Space Methods – Fourier Transform, PSD – Wavelets – Parametric Methods – AR,MA,ARMA models – PCA – Linear and Non-Linear Features.

## UNIT IV FEATURE TRANSLATION METHODS

**9**

Linear Discriminant Analysis – Support Vector Machines - Regression – Vector Quantization– Gaussian Mixture Modeling – Hidden Markov Modeling – Neural Networks.

## UNIT V APPLICATIONS OF BCI

**9**

Functional restoration using Neuroprosthesis - Functional Electrical Stimulation, Visual Feedback and control - External device control, Case study: Brain actuated control of mobile Robot.

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1:** Describe BCI system and its potential applications.

**CO2:** Analyze event related potentials and sensory motor rhythms.

**CO3:** Compute features suitable for BCI.

**CO4:** Design classifier for a BCI system.

**CO5:** Implement BCI for various applications.

**TOTAL:45 PERIODS**

**TEXTBOOKS**

1. Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010.

**REFERENCES**

1. R. Spehlmann, "EEG Primer", Elsevier Biomedical Press, 1981.
2. Arnon Kohen, "Biomedical Signal Processing", Vol I and II, CRC Press Inc, Boca Rato, Florida, 1986.
3. Bishop C.M., "Neural Networks for Pattern Recognition", Oxford, Clarendon Press, 1995.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	2	2	2	-	-	-	-	-	2	3	3	3
2	3	3	3	2	2	1	-	-	-	-	-	2	2	2	2
3	3	3	3	2	2	1	-	-	-	-	-	1	1	2	2
4	3	3	3	1	3	2	-	-	-	-	-	2	2	3	3
5	3	3	3	3	3	2	-	-	-	-	-	2	2	2	2
CO	3	3	3	2	2.4	1.6	-	-	-	-	-	1.8	2	2.4	2.4

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CBM341**

**BODY AREA NETWORKS**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

**The student should be made to:**

- To know the hardware requirement of BAN
- To understand the communication and security aspects in the BAN
- To know the applications of BAN in the field of medicine

**UNIT I INTRODUCTION**

**9**

Definition, BAN and Healthcare, Technical Challenges- Sensor design, biocompatibility, Energy Supply, optimal node placement, number of nodes, System security and reliability, BAN Architecture – Introduction.

**UNIT II HARDWARE FOR BAN**

**9**

Processor-Low Power MCUs, Mobile Computing MCUs ,Integrated processor with radio transceiver, Memory ,Antenna-PCB antenna, Wire antenna, Ceramic antenna, External antenna, Sensor Interface, Power sources- Batteries and fuel cells for sensor nodes.

**UNIT III WIRELESS COMMUNICATION AND NETWORK 9**

RF communication in Body, Antenna design and testing, Propagation, Base Station-Network topology-Stand –Alone BAN, Wireless personal Area Network Technologies-IEEE 802.15.1,IEEE P802.15.13, IEEE 802.15.14, Zigbee.

**UNIT IV COEXISTENCE ISSUES WITH BAN 9**

Interferences – Intrinsic - Extrinsic, Effect on transmission, Counter measures- on physical layer and data link layer, Regulatory issues-Medical Device regulation in USA and Asia, Security and Self-protection-Bacterial attacks, Virus infection, Secured protocols, Self-protection.

**UNIT V APPLICATIONS OF BAN 9**

Monitoring patients with chronic disease, Hospital patients, Elderly patients, Cardiac arrhythmias monitoring, Multi patient monitoring systems, Multichannel Neural recording, Gait analysis, Sports Medicine, Electronic pill.

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1:** Comprehend and appreciate the significance and role of this course in the present contemporary world.

**CO2:** Design a BAN for appropriate application in medicine.

**CO3:** Assess the efficiency of communication and the security parameters.

**CO4:** Understand the need for medical device regulation and regulations followed in various regions

**CO5:** Extend the concepts of BAN for medical applications.

**TOTAL:45 PERIODS****TEXT BOOKS**

1. Sandeep K.S. Gupta, Tridib Mukherjee, Krishna Kumar Venkata Subramanian, "Body Area Networks Safety, Security, and Sustainability", Cambridge University Press, 2013
2. Mehmet R. Yuce, Jamil Y.Khan, "Wireless Body Area Networks Technology, Implementation, and Applications", Pan Stanford Publishing Pte. Ltd., Singapore, 2012

**REFERENCES**

1. Zhang, Yuan-Ting, "Wearable Medical Sensors and Systems", Springer, 2013.
2. Guang-Zhong Yang(Ed.), "Body Sensor Networks", Springer, 2006.
3. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	1	1	1	1	1	-	-	-	-	1	3	3	3
2	3	3	3	3	1	2	2	-	-	-	-	1	3	3	3
3	3	2	1	1	1	1	1	-	-	-	-	1	3	3	3
4	2	2	1	1	1	1	1	-	-	-	-	1	3	3	3
5	2	2	1	1	1	2	2	-	-	-	-	1	3	3	3
CO	2.4	2.2	1.4	1.4	1	1.4	1.4	-	-	-	-	1	3	3	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES:**

- To learn basics of underwater vehicle control system
- To know the basic sensors and transducers used in underwater vehicles
- To learn the types of communication systems
- To learn different types of underwater vehicles and their applications.
- To learn about subsea battery and power management system

**UNIT I INTRODUCTION ON DATA ACQUISITION AND CONTROL SYSTEM 9**

Introduction on PLC & various Input / Output modules, SCADA and HMI, Real time Controller, Signal conditioning circuits and associated components: Ethernet Modem, SMPS, Media converters, Ethernet switches, Fuses & Fuse holders, Power supply units, Power management system, Pressure Compensator, Pressure compensated batteries, Valve amplifiers, Actuators, Types of valves- proportional valves and solenoid valves, Types of relays- Solid State Relay and Electromagnetic relay, Pressure casing for underwater DACS,

**UNIT II UNDERWATER SENSORS AND TRANSDUCERS 9****Navigation and Auxiliary sensors and Transducers**

Inertial Navigation System, FOG/RLG, GPS, DGPS, Gyroscope, Motion Reference Unit, Doppler Velocity Log, Acoustic Transponder, Beacon, Positioning System- LBL, SBL, SSBL, Underwater Encoder, Proximity switches, Conductivity sensor, Temperature sensor, Depth sensor, Accelerometer, Tilt sensor, LVDT, Vacuum sensor, Current meters.

**Scientific Instruments**

Acoustic Doppler Current Profiler, Echosounder, Hydrophones, SONAR- Forward looking SONAR, Bottom Looking SONAR, Altimeter, Swell and wave sensor, PH sensor, Turbidity sensor, Oxygen sensor, Water samplers, Nitrogen sensor, CTD

**UNIT III TELEMETRY SYSTEM 9**

Telemetry system for tethered vehicles, Fiber optic communication, Single mode fiber, Multimode fiber, Fiber optics in oceanographic applications, Basis of optical fiber transmission, Fiber losses and signal attenuation, Slip rings, Umbilical cables, Underwater cables and connectors, Field installable Termination Assembly

Acoustic communication: Acoustic wave propagation, Optical communication, Satellite communication- Iridium, Inmarsat, Argos for surface Tracking.

**UNIT IV TYPES OF UNDERWATER VEHICLES 9**

Type of vehicles, manned and unmanned vehicles, Tethered and untethered vehicles, Remotely Operable Vehicle (ROV), Autonomous Underwater vehicle (AUV), Gliders, Solar powered Gliders, Manned submersible, Submarines, Deep Sea Rescue vehicle (DSRV), Various Propulsion systems.

**UNIT V CASE STUDY 9**

Design of low power DAC system for portable instrument,  
Design of power module for autonomous system,  
Design consideration on wireless sensor network and its important,  
MEMS systems used in underwater systems and its merits and demerits.

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:

On successful completion of this course, the student will be able to

**CO1:** Design of DAC system for various underwater Applications

**CO2:** Knowledge about sensors used underwater and their working principle

**CO3:** Underwater communication system and their application

**CO4:** Knowledge about different types of underwater vehicles

**CO5:** Subsea battery and Battery Management System

### BOOK REFERENCES

1. The Ocean engineering Handbook, Ferial El- Hawary
2. Guidance and control of Ocean Vehicles, Thor I Fossen
3. Instrumentation and metrology in Oceanography by Marc Le mann
4. Jane's Underwater technology,, Technology and applications of AUV by Gwyn Griffiths
5. Fundamentals of Marine Vehicle Control, Karl Von Ellenrieder
6. Instrumentation & control G J Roy
7. Handbook of ocean and underwater engineering, Myers, J J; Holm, C H; McAllister, R F
8. Underwater communication and Network, Yi Lou, Niaz Ahmed

### CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	2	2	3	-	-	-	-	-	3	2	3	2
2	3	2	3	2	2	2	-	-	-	-	-	3	3	2	2
3	3	3	3	2	3	2	-	-	-	-	-	3	2	3	2
4	3	3	3	2	2	2	-	-	-	-	-	2	3	2	2
5	3	3	2	2	2	2	-	-	-	-	-	3	2	2	2
CO	3	3	3	2	3	3	-	-	-	-	-	2	3	3	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

### CEC358 UNDERWATER IMAGING SYSTEMS AND IMAGE PROCESSING

L T P C  
2 0 2 3

### COURSE OBJECTIVES:

- To learn the fundamental components of optical imaging
- To understand the challenges involved in Underwater imaging
- To understand the fundamental of Ocean Acoustics
- To Understand the principle of image processing techniques
- To Learn the SONAR Systems and various applications

### UNIT I FUNDAMENTAL COMPONENTS OF OPTICAL IMAGE PROCESSING SYSTEM6

Fundamentals and application of image processing, Human and Computer Vision, Introduction on Digital Camera:Focal length, Aperture, Shutter Speed, Spatial Resolution, Underwater lights and its importance, Halogen, LED, Colour Temperature, lumens, Beam angle. Image File format: JPEG, PNG, TIFF, BMP, GIF.

### UNIT II OPTICAL IMAGE PROCESSING

6

Image Formation, Digitization, Sampling and Quantization, Geometric Transformation, Interpolation, Image Reconstruction, Spatial Filtering, Histogram, Binary Image, Color Fundamentals, Color transformations, Color Interpolation, Morphology, Image segmentation, Pattern Recognition. Challenges involved in underwater optical imaging



**UNIT III                      FUNDAMENTALS OF UNDERWATER ACOUSTICS                      6**

Acoustic waves, Acoustic pressure, Velocity and density, Frequency and wavelength, Intensity and power, Logarithmic notation- Decibels, absolute references and levels, Source Level, Basics of propagation losses, Target Strength, Back scattering, Acoustic noise, Multiple paths, Doppler effect, Time characteristics of echoes, Active and passive sonar equations, Underwater electro acoustic transducers- projectors and hydrophones, General Structure of SONAR systems

**UNIT IV                      SONAR SIGNAL PROCESSING                      6**

Spatial signals-Signals in space and time, Co-ordinate systems, Propagating waves, Wave number- frequency space, Finite continuous apertures, Spatial sampling, Directivity, Beamforming, Time and frequency domain beamforming, Array gain, Angular resolution, Transmitting signals- Narrowband Vs Chirp, Matched filtering, Range resolution, Time Varying Gain (TVG), Signal intensity to image conversion

**UNIT V                      DIFFERENT TYPES OF SONAR SYSTEMS                      6**

Passive and active sonars, Single beam echo sounder, Multi beam echo sounder, Sub-bottom profiler, Sediment profiler, Side scan sonar, Synthetic aperture sonar, Forward looking sonar.

**30 PERIODS**

**PRACTICALEXERCISES:**

**30 PERIODS**

1. Generation of discrete time signals and finding its frequency components
2. Generation of Chirp signals and understanding its time-frequency characteristics
3. Delaying and summing of signals in time and frequency domain for narrow band signals
4. Delaying and summing of signals in time and frequency domain for wide band signals
5. Matched filtering

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1:** Understand the techniques for underwater imaging

**CO2:** Understand the fundamentals of underwater acoustics and ambient noise

**CO3:** Exposer for array processing techniques for underwater imaging applications

**CO4:** Design of Filter and impedance matching circuits

**CO5:** Know about SONAR system and its applications

**TOTAL:60 PERIODS**

**TEXT BOOKS**

1. Bernd Jahne, "Digital Image processing, Sixth Edition, Springer,2005
2. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, "Digital Image Processing using MATLAB, Third Edition, Gatesmark Publishing,2020
3. P.K. Thiruvikraman,"A Course on Digital Image processing with MATLAB, First Edition, IOP Publishing,2020

**REFERENCES**

1. Tinku & Ajoy K. Ray,"Image Processing principles & Applications, First Edition, Wiley-Interscience,2005
2. Xavier Lurton,"An Introduction to Underwater Acoustics (Principles and applications), Second Edition, Springer,2010
3. Don H. Johnson and Dan E. Dudgeon,"Array Signal Processing: Concepts and Techniques, First Edition, Prentice Hall,1993
4. Harry L. Van Trees,"Optimum Array Processing, First Edition, Wiley-Interscience,2002

5. Richard O. Nielsen, "Sonar Signal Processing, First Edition, Artech House, 1991

6. A. D. Waite, "SONAR for Practicing Engineers, Third Edition, Wiley, 2002

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	2	2	2	-	-	-	-	-	3	2	3	2
2	3	3	3	2	2	1	-	-	-	-	-	2	2	3	2
3	3	3	2	2	2	2	-	-	-	-	-	2	2	2	1
4	3	3	3	2	2	1	-	-	-	-	-	2	2	2	1
5	3	3	3	3	2	2	-	-	-	-	-	1	2	2	1
CO	3	3	3	2	2	2	-	-	-	-	-	2	2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CEC357**

**UNDERWATER COMMUNICATION**

**L T P C**  
**2 0 2 3**

**COURSE OBJECTIVES:**

- To learn about fiber optic communication for underwater application
- To learn underwater MI communication and sensor networking
- To understand underwater acoustic communication
- To understand the challenges in underwater communication
- To learn underwater cables and handling system for various application

**UNIT I UNDERWATER FIBRE OPTICS COMMUNICATION**

**6**

Basics of Fibre Optics communication: Working Principle, Single Mode, Multi-Mode, Effect on Fibre bending, Standard FO Connectors, Cable Requirement for Underwater Application, Cable Characteristics, Basic design for Electro-Optical(E-O) Underwater Cable, Handling system for E-O cables, Optical slip ring and its application, An insight into Fibre Optic Telemetry.

**UNIT II UNDERWATER OPTICAL COMMUNICATION**

**6**

Introduction, Classification of Underwater Wireless Optical Communication Links, Underwater Optical Communication (UWOC) System: Modulation, Coding, Light Source Technology, Common Lasers in UWOC, Signal Detectors and its merits and demerits, Alignment and Compensation, UWC Network, Absorption and Scattering Losses, UWOC Channel Modeling, UWOC Link Turbulence, Noise in the UWOC Channel. UWOC Networks.

**UNIT III UNDERWATER MI COMMUNICATION & SENSOR NETWORKS**

**6**

Fundamental Principles of Magnetic Induction, Basic Element of Magnetism, Magnetic Induction, Lenz's Law, Mutual and Self Induction, Inductive and Capacitive Reactance of the coil, MI Communication System: MI Coil, Matching Network, Communication Block:  
MI Wireless Sensor Networks: UW sensor network Application and Its Architecture, Localization, Medium Access protocols, Routing Protocols, Cross-layer Protocols, Recent trend on MI communication.

**UNIT IV BASIC PRINCIPLES OF UNDERWATER ACOUSTIC COMMUNICATION**

**6**

Ocean Acoustic environment; Measuring sound levels and relevant units; Sound propagation in the ocean – sound velocity profiles in the deep water and shallow water Speed of underwater sound, Underwater Sound Transmission Loss, Acoustic Field Model: Ray Theory Model, Structure and Performance of UWAC System: Basic Structure of UWAC System, Performance Indicators of UWAC System, Characteristics of the UWA Channel.

**UNIT V UNDERWATER ACOUSTIC NETWORK TECHNOLOGY****6**

Basics on Underwater Acoustic Modem and its construction, Bandwidth and its limitations, Characteristics of UWA Network, Topology of UWA Network, Network Protocol Architecture of UWA Network, UWAC Challenges and Research Trends, Comparison study on RF, Optical and Acoustic Communication in Underwater. Underwater telephone, Acoustic Positioning System, Underwater beacon.

**30 PERIODS****PRACTICALEXERCISES:****30 PERIODS**

1. Conducting an experiment for testing of optical communication in water tank with clear and turbid water.
2. Measure the insertion loss of different FO connectors, bending loos using optical power meter.
3. Testing of MI communication and Sensor network
4. Testing of hydrophone and acoustic communication with different operating frequency and
5. Design a MI coil and testing it for Inductive communication

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1:** To get an explore to different underwater communication system

**CO2:** Design of MI coil for

**CO3:** To know the important of underwater communication and its challenges

**CO4:** To understand the strength of Underwater acoustic communication

**CO5:** To understand the sensor network concepts and its application

**TOTAL:60 PERIODS****TEXTBOOKS**

1. Yi Lou, NiAx Ahmed, Underwater Communications and Networks, First Edition, Springer,2021

**REFERENCES**

1. Ferial El-Hawary, The Ocean Engineering Hand book, First Edition, CRC Press, 2001
2. L.M. Brekhovskikh and Yu. P. Lysanov, Fundamentals of ocean acoustics, Third Edition, Springer,2003
3. Robert J Urick, Principles of underwater sound, Third Edition, Peninsula Publishing,2013
4. Rahul Sharma, Deep Sea Mining Handbook, First Edition, Springer,2017

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	3	1	3	2	-	-	-	-	1	3	3	3
2	3	2	2	3	1	3	2	-	-	-	-	1	3	3	3
3	3	3	3	3	2	3	2	-	-	-	-	1	3	3	3
4	3	2	3	1	3	3	2	-	-	-	-	1	3	3	3
5	2	2	2	3	3	3	2	-	-	-	-	1	3	3	3
CO	2	2	2	2	2	3	2	-	-	-	-	1	3	3	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES:**

- To learn the important variables of ocean
- To learn the sensors used for ocean observation and its interfaces
- To study about various platforms used for ocean observation
- To understand data telemetry system for real time observation of Ocean.
- To study about data handling and processing techniques.

**UNIT I INTRODUCTION TO ESSENTIAL OCEAN VARIABLES****6**

Ocean – Dynamics of upper ocean, Air sea interaction, Waves, Currents, Tides, Salinity, Conductivity, Pressure, Temperature, Wind amplitude & Direction, Humidity, Ocean circulation, Sea states, Importance of Ocean observation: Coastal Zones-Cyclones-Tsunami.

**UNIT II INSTRUMENTATION AND OBSERVATION SYSTEMS****6**

General measurement system, Principles, Measurement of Meteorological and Oceanographic Surface & Sub Surface Parameters, Remote measurements. Measurement Techniques, Sensors and instruments: Oceanic Parameters and their conversion to Electrical signals. Sensors for wave, Salinity, Temperature, Rainfall, Water current & Direction. Pressure sensors for Tide and Waves. Acoustic sensors for measurement of Current speed & Direction, Platform Speed Correction-GPS/DGPS.

**UNIT III OCEAN OBSERVATION PLATFORMS****6**

Eulerian-Lagrangian - Ship Based Observations, Surface Drifters, Moored Data Buoys, Tsunami Buoys, Argo float, Gliders, Satellite Based Observations, Challenges Associated with Underwater Measurements, Fouling-Corrosion.

**UNIT IV OCEAN DATA TELEMETRY****6**

Data telemetry, Wire telemetry, Modems, Wireless telemetry- Acoustic communications- Underwater Optic communication - Satellite Telemetry-LEO-GEO-MEO, GSM-GPRS, Inmarsat, INSAT, Iridium. ARGOS

**UNIT V OCEAN DATA PROCESSING****6**

Data processing and storage: Raw and processed data. Storage systems and methods- Data presentation, charts, electronic and graphic presentation, Data exchange, data formats

**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS**

1. Interface of Analog /Serial sensor with Data Acquisition System
2. Calculating co-efficients, Drift for sensors
3. Data plotting and presentation exercise
4. Experiment on rail fall sensor interface and data telemetry through IoT
5. Circuit design for RS232/RS485/RS422/TTL Interface and testing of half and full duplex communication and sensor network

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1:** Get an Explore on Ocean Dynamics and parameters

**CO2:** Different sensor interface for marine applications

**CO3:** Identification of suitable platform for various measurement & applications

**CO4:** To Know about various telemetries for ocean data transfer

**CO5:** Apply data processing and plotting methods for ocean parameters

**TOTAL:60 PERIODS**

**TEXT BOOKS**

1. James Irish, and Albert Williams III. 2.693, —Principles of Oceanographic Instrument Systems – Sensors and Measurements (13.998), Springer, 2004.
2. Observing the Oceans in Real Time, —R. Venkatesan and Amit Tandon, Springer, 2017.

**REFERENCES**

1. Ocean Instrumentation, Electronics, and Energy, — S. R. Vijayalakshmi and S. Muruganand, Mercury Learning & Information, 2016.
2. Data analysis methods in Physical Oceanography, —Richard E. Thomson and William J. Emery, Elsevier Science,2014.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	3	3	1	-	-	-	-	-	1	2	1	2
2	3	3	2	1	3	2	-	-	-	-	-	2	2	2	2
3	3	3	3	3	2	2	-	-	-	-	-	2	2	2	2
4	3	3	2	2	2	2	-	-	-	-	-	2	2	1	2
5	3	2	3	3	2	2	-	-	-	-	-	2	2	2	2
CO	3	3	2	2	2	2	-	-	-	-	-	2	2	2	2

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

**CEC360**

**UNDERWATER NAVIGATION SYSTEMS**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- To Understand the relationship between autonomy, sensing, navigation and control on an un-manned marine subsea vehicle.
- To understand about various types of navigational equipment & sensors
- To understand the basic communication methods and signal losses, attenuation.
- To understand the types of Acoustic transponders, Beacon and Responder

**UNIT I BASICS OF UNDERWATER COMMUNICATION**

**9**

Introduction to underwater acoustics, Understanding Thermoclines in Ocean Waters, subsea communication sensors, Instruments and applications, Sound propagation in the ocean – Sound Velocity Profiles (SVP) in the deep water and shallow water; Sound attenuation in the sea – absorption, scattering, transmission loss, reverberation, Snell’s law, target strength; Laser communication and limitations.

**UNIT II UNDERWATER NAVIGATION & ITS AIDING SENSOR AND DEVICES**

**9**

Different types of navigational sensors, Accelerometers, Fiber Optic Gyroscopes (FOGs), Ring Laser Gyroscope (RLG) types and Working principles, and their applications, Doppler Velocity Log, Error sources in subsea navigation, Calibration overview for subsea navigation. Attitude Heading and Reference Systems (AHRS) & IMU

**UNIT III ACOUSTIC POSITIONING SYSTEMS**

**9**

Subsea navigation possible solutions, Vehicle positioning, Acoustic Positioning systems, Short Base

Line (SBL), Super Short Base Line (SSBL), Long Base line (LBL) Configurations and Positioning overview.

**UNIT IV SUBSEA VEHICLE NAVIGATION**

**9**

Subsea navigation, Uses of subsea navigation, challenges of subsea navigation. Basics of underwater navigation, Types of underwater Navigations, Aided navigational systems, Inertial Navigational systems. role of dead-reckoning navigation in subsea navigation, Kalman filters (XKF) and Invariant extended Kalman filters for navigation.

**UNIT V CASE STUDY**

**9**

- Tethered vehicle deployment guidelines and preparedness.
- AUV /ROV based search operation requirements and planning.
- Tethered crawling vehicle sensors, data acquisition and maneuvering.
- Acoustic positioning system transponder deployment and recovery
- Aided and unaided navigation system study.
- Understand the basic tools needed to effectively develop software for robotic platforms in a group environment, and resolve conflicts and adhere to group goals in the software cycle.

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able

**CO1:** To know about the Underwater Navigation System

**CO2:** To know about the INS and its aiding sensor

**CO3:** To know about the challenges involved in underwater navigation

**CO4:** To study about how navigation system is integrated with manned and unmanned underwater vehicles

**CO5:** To know about underwater positioning system

**TOTAL:45 PERIODS**

**TEXT BOOKS**

1. Fundamentals of ocean acoustics by L.M.Brekhovskikh and Yu. P. Lysanov
2. An Underwater Vehicle Navigation System Using Acoustic and Inertial Sensors by Norvald Kjerstad
3. Underwater Acoustic Positioning Systems by P. H. Milne

**REFERENCES BOOKS**

1. Electronic and Acoustic Navigation systems for Maritime Studies by Norvald Kjerstad
2. Guidance & Control of Ocean Vehicles by TT Fossen
3. Dynamic Positioning of Offshore Vessels. By Morgan, M.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	2	2	-	-	-	-	-	2	3	3	3
2	3	3	2	2	2	2	-	-	-	-	-	2	3	2	3
3	3	3	2	2	2	2	-	-	-	-	-	2	3	2	3
4	3	3	3	2	2	1	-	-	-	-	-	2	1	2	2
5	3	3	3	2	2	2	-	-	-	-	-	3	2	1	2
CO	3	3	3	2	2	2	-	-	-	-	-	2	3	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES:**

- To enable the student to understand the importance of ocean acoustics for marine applications.
- To understand the physics of sound propagation and the factors affecting sound signal in the ocean
- To study the types and characteristics of acoustic transducers and arrays
- To understand the sources of ambient noise present in the sea and impacts of sound on marine diversity
- To expose the student in the basics of underwater acoustic signal processing and image processing

**UNIT I FUNDAMENTALS OF UNDERWATER ACOUSTICS 6**

Ocean Acoustic environment; Measuring sound levels and relevant units; Sound propagation in the ocean – sound velocity profiles in the deep water and shallow water; Sound attenuation in the sea – absorption, scattering, transmission loss, reverberation, Snell's law, target strength; SONAR systems- active, passive SONAR equations and system parameters.

**UNIT II UNDERWATER ACOUSTIC TRANSDUCERS AND DEVICES 6**

Principles of transduction and SONAR transducer design; Electromechanical Analog circuits, coupling coefficient, efficiency, Directivity characteristics of receivers, frequency response characteristics of transducers, Transducer measurement techniques; Physical geometry of arrays - linear, planar, cylindrical, spherical, beam patterns, array gain.

**UNIT III AMBIENT NOISE IN THE OCEAN 6**

Sources of noise, Natural and Physical sounds - Seismic, Wind, Wave, Rain and Turbulence; Biological sounds - Dolphin, Whales, Fishes; Man made Noises- Shipping Machinery noises, Pile driving, Wind Mills; Variability of Ambient noises; Frequency Bands, Noise levels of all above; Impacts of Sound on Marine Animals.

**UNIT IV PROCESSING OF UNDERWATER ACOUSTIC SIGNALS AND IMAGES 6**

Representations of the signals – Fourier representations, Spatial filtering; Matched filters and Autocorrelations, Temporal resolution; Signal to Noise Ratio, Estimation of Auto Covariance, Cross Covariance; Power spectra of different Underwater Signals, Classification of signals; Concept and Types of beamforming techniques; Image segmentation, Filtering, Equalization and Restoration

**UNIT V UNDERWATER ACOUSTIC INSTRUMENTS AND ITS APPLICATION 6**

Principles of Sonar systems, Echosounder – single beam, multi beam; Side scan sonars – Imaging, Underwater acoustic camera; Sub bottom profilers –Sediment classification; Acoustic modem – Tsunami systems; Acoustic Positioning system- Transponders, USBL, SSBL systems, HiPAP; Underwater telephone; Underwater noise recorders; Underwater Beacons.

**30 PERIODS  
30 PERIODS****PRACTICAL EXERCISES:**

1. Applying sonar equations in the design of ocean instruments
2. Auto correlation and Cross Correlation of underwater signals
3. Simulation of transmission loss in the ocean
4. Frequency Analysis of underwater ambient noise data

5. Comparison of sound velocity gradients for different ocean depths
6. Applying digital filters to underwater signal
7. Beamforming of vertical linear array data
8. Characterization of hydrophones for receiving and transmitting responses
9. Acoustic characterization of ship machinery noises
10. Acoustic characterization of whale / any marine animal sound
11. Underwater image enhancement - filtering
12. Underwater image enhancement – color enhancement

### COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- CO1:** Understand the basics of underwater sound and its propagation in ocean  
**CO2:** To simulate / design any underwater SONAR systems for ocean application  
**CO3:** To identify different kinds of noises present in the ocean and its impacts on the marine biodiversity  
**CO4:** Ability to get exposure in analyzing and applying suitable techniques for underwater acoustic signals and images  
**CO5:** To recognize different types of SONAR systems used practically

**TOTAL:60 PERIODS**

### TEXTBOOKS

1. Robert J Urick,—Principles of underwater sound, Third Edition, Peninsula Publishing,2013
2. Herman Medwin and Clarence S. Clay, —Fundamental of acoustical oceanography, First Edition, Academic Press,1998.

### REFERENCES

1. L.M. Brekhovskikh and Yu. P. Lysanov,—Fundamentals of ocean acoustics, Third Edition, Springer,2003
2. John G Proakis and Manolakis, —Digital Signal Processing Principles Algorithms and Applications, Fourth Edition, Pearson, 2006.
3. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, —Digital Image Processing using MATLAB, Third Edition, Gatesmark Publishing,2020.

### CO's-PO's & PSO's MAPPING

CO	P O1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO3
1	3	3	3	2	2	2	-	-	-	-	-	2	3	3	3
2	3	3	3	2	2	1	-	-	-	-	-	2	2	2	2
3	3	3	3	2	2	2	-	-	-	-	-	2	1	2	2
4	3	3	3	2	3	2	-	-	-	-	-	2	2	3	3
5	3	3	3	3	3	2	-	-	-	-	-	2	2	2	2
CO	3	3	3	2	2	2	-	-	-	-	-	2	2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CEC369**

**IOT PROCESSORS**

**L T P C**  
**2 0 2 3**

### COURSE OBJECTIVES:

- Learn the architecture and features of ARM.
- Study the exception handling and interrupts in CORTEX M3
- Program the CORTEX M3
- Learn the architecture of STM 32L15XXX ARM CORTEX M3/M4 microcontroller.



- Understand the concepts of System – On – Chip(SoC)

**UNIT I OVERVIEW OF ARM AND CORTEX-M3 6**

ARM Architecture – Versions, Instruction Set Development, Thumb 2 and Instruction Set Architecture, Cortex M3 Basics: Registers, Stack Pointer, Link Register, Program Counter, Special Registers, Operation Mode, Exceptions and Interrupts, Vector Tables, Stack Memory Operations, Reset Sequence , CORTEX M3 Instruction Sets: Assembly Basics, Instruction List, Instruction Descriptions, CORTEX M3 – Implementation Overview: Pipeline, Block Diagram. Bus Interfaces, I – Code Bus, D – Code Bus, System Bus- External PPB and DAP Bus.

**UNIT II CORTEX EXCEPTION HANDLING AND INTERRUPTS 6**

Exception Types, Priority, Vector Tables, Interrupt Inputs and Pending behaviour, Fault Exceptions, Supervisor Call and Pendable Service Call, NVIC: Nested Vector Interrupt Controller, Overview, Basic Interrupts, SYSTICK Time, Interrupt Behaviourm Interrupt/Exception Sequences, Exception Exits, Nested Interrupts, Tail – Chaining Interrupts, Late Arrivals and Interrupt Latency.

**UNIT III CORTEX M3/M4 PROGRAMMING 6**

Cortex M3/M4 Programming: Overview, Typical Development Flow, Using C, CMSIS Using Assembly, Excepton Programming Using Interrupts, Exception/Interrupt Handlers, Software Interrupts, Vector Table Relocation, Memory Protection Unit and other CORTEX M3 Features, MPU Registers, Setting up the MPU, Power Management, Multiprocessor Configuration.

**UNIT IV STM32L15XXX ARMCORTEX M3/M4 MICROCONTROLLER AND DEBUGGING TOOLS 6**

STM32L15XXX ARM CORTEX M3/M4 Microcontroller: Memory and Bus Architecture, Power Control, Reset and Clock Control, STM32L15XXX Peripherals: GPIOs, System Configuration Controller, NVIC, ADC, Comparators, GP Timers, USART Development and Debugging Tools: Software and Hardware tools like Cross Assemblerm Compiler, Debugger, Simulator, In – Circuit Emulator(ICE), Logic Analyser.

**UNIT V INTRODUCTION TO SYSTEM – ON – CHIP 6**

System Architecture: An Overview, Components of the System Processors, Memories and Interconnects, Processor Architectures, Memory and Addressing, System Level Interconnection – An Approach for SOC Design – Chip basics – Cycle Time – Die Area – Power and Cost – Area, Power and Time Trade – Offs in Processor Design – Reliability and Configurability – SOC Design Approach – Application Studies – AES, 3D Graphics Processor. Image Compression and Video Compression.

**30 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

**ARM Assembly Programming**

1. Write a program to add two 32-bit numbers stored in r0 and r1 registers and write the result to r2. The result is stored to a memory location. a) Run the program with breakpoint and verify the result b) Run the program with stepping and verify the content of registers at each stage.
2. Write ARM assembly to perform the function of division. Registers r1 and r2 contain the dividend and divisor, r3 contains the quotient, and r5 contains the remainder.

**Embedded C Programming on ARM Cortex M3/M4 Microcontroller**

1. Write a program to turn on green LED (Port B.6) and Blue LED (Port B.7) on STM32L-Discovery by configuring GPIO.

2. Transmit a string "Programming with ARM Cortex" to PC by configuring the registers of USART2. Use polling method.

### ARM Cortex M3/M4 Programming with CMSIS

1. Write a program to toggle the LEDs at the rate of 1 sec using standard peripheral library. Use Timer3 for Delay.
2. Transmit a string "Programming with ARM Cortex" to PC by using standard peripheral library with the help of USART3. Use polling method.

### COURSE OUTCOMES:

On successful completion of this course, the student will be able to

**CO1:** Explain the architecture and features of ARM.

**CO2:** List the concepts of exception handling.

**CO3:** Write a program using ARM CORTEX M3/M4.

**CO4:** Learn the architecture of STM32L15XXX ARM CORTEX M3/M4.

**CO5:** Design an SoC for any application.

**TOTAL:60 PERIODS**

### TEXTBOOKS

1. Joseph Yiu, The Definitive Guide to the ARM CORTEX M3/M4, Second Edition, Elsevier, 2010.(Unit – I, II)
2. Andrew N Sloss, Dominic Symes, Chris Wright, ARM System Developers Guide Designing and Optimising System Software, Elsevier, 2006 (Unit – III, IV)
3. Michael J Flynn and Wayne Luk, Computer System Design, System On Chip, Wiley India 2011.(Unit – V)

### REFERENCES

Steve Furber, ARM System – on – Chip Architecture, 2<sup>nd</sup> Edition, Pearson, 2015.

CORTEX M Series ARM Reference Manual

CORTEX M3 Technical Reference Manual

STM32L152XX ARM CORTEX M3 Microcontroller Reference Manual 5/97

### CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	2	2	2	-	-	-	-	-	3	3	3	3
2	3	3	3	3	2	2	-	-	-	-	-	2	3	3	3
3	3	3	3	3	2	2	-	-	-	-	-	2	2	2	2
4	3	3	2	2	2	2	-	-	-	-	-	2	2	2	2
5	3	3	2	2	2	1	-	-	-	-	-	3	3	2	2
CO	3	3	2.6	2.4	2	1.8	-	-	-	-	-	2.4	2.6	2.4	2.4

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CEC368**

**IOT BASED SYSTEMS DESIGN**

**L T P C**

**3 0 0 3**

### COURSE OBJECTIVES:

- To understand the basics of IoT.
- To get knowledge about the various services provided by IoT.
- To familiarize themselves with various communication techniques and networking.
- To know the implementation of IoT with different tools.
- To understand the various applications in IoT.

**UNIT I INTRODUCTION TO INTERNET OF THINGS 9**

Rise of the machines – Evolution of IoT – Web 3.0 view of IoT – Definition and characteristics of IoT – IoT Enabling Technologies – IoT Architecture -- Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects - IoT levels and deployment templates – A panoramic view of IoT applications.

**UNIT II MIDDLEWARE AND PROTOCOLS OF IOT 9**

Middleware technologies for IoT system (IoT Ecosystem Overview – Horizontal Architecture Approach for IoT Systems – SOA based IoT Middleware) Middleware architecture of RFID,WSN,SCADA,M2M –Interoperability challenges of IoT-Protocols for RFID,WSN,SCADA,M2M- Zigbee, KNX,BACNet,MODBUS - Challenges Introduced by 5G in IoT Middleware(Technological Requirements of 5G Systems - Perspectives and a Middleware Approach Toward 5G (COMPaaS Middleware) – Resource management in IoT.

**UNIT III COMMUNICATION AND NETWORKING 9**

IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition –Application Layer Protocols: CoAP and MQTT- Data aggregation & dissemination.

**UNIT IV IOT IMPLEMENTATION TOOLS 9**

Introduction to Python, Introduction to different IoTtools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python, Implementation of IoT with Raspberry Pi.

**UNIT V APPLICATIONS AND CASE STUDIES: 9**

Home automations - Smart cities – Environment – Energy – Retail – Logistics – Agriculture – Industry - Health and life style – Case study.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

**CO1:** Articulate the main concepts, key technologies, strength and limitations of IoT.

**CO2:** Identify the architecture, infrastructure models of IoT.

**CO3:** Analyze the networking and how the sensors are communicated in IoT .

**CO4:** Analyze and design different models for IoT implementation.

**CO5:** Identify and design the new models for market strategic interaction.

**TEXT BOOKS:**

1. Honbo Zhou, "Internet of Things in the cloud:A middleware perspective", CRC press, 2012.
2. Vijay Madiseti and Arshdeep Bahga, "Internet of Things (A Hands-onApproach)", VPT, 1<sup>st</sup> Edition, 2014.

**REFERENCES:**

1. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 2017.
2. Constandinos X. Mavromoustakis, George Mastorakis, Jordi MongayBatalla, "Internet of Things (IoT) in 5G Mobile Technologies" Springer International Publishing Switzerland 2016.

3. Dieter Uckelmann, Mark Harrison, Florian Michahelles, “Architecting the Internet of Things” Springer-Verlag Berlin Heidelberg, 2011.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	2	1	3	-	-	-	-	2	3	3	3	3
2	3	3	2	2	1	-	-	-	-	-	1	2	3	3	3
3	3	3	3	2	1	2	-	-	-	-	3	2	3	2	3
4	3	3	2	2	3	-	-	-	-	-	-	1	3	3	2
5	3	2	3	3	2	1	-	-	-	-	2	1	3	2	2
CO	<b>3</b>	<b>2.8</b>	<b>2.4</b>	<b>2.2</b>	<b>1.6</b>	<b>2</b>	-	-	-	-	<b>2</b>	<b>1.8</b>	<b>3</b>	<b>2.6</b>	<b>2.6</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CEC365**

**WIRELESS SENSOR NETWORK DESIGN**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES :**

- To understand the fundamentals of wireless sensor network
- To gain knowledge on the MAC and Routing Protocols of WSN
- To get exposed to 6LOWPAN technology
- To acquire knowledge on the protocols required for developing real time applications using WSN and 6LOWPAN.
- To gain knowledge about operating system related to WSN and 6LOWPAN

**UNIT I INTRODUCTION**

**9**

Principle of Wireless Sensor Network -Introduction to wireless sensor networks- Challenges, Comparison with ad hoc network, Node architecture and Network architecture, design principles, Service interfaces, Gateway, Short range radio communication standards-IEEE 802.15.4, Zigbee and Bluetooth. Physical layer and transceiver design considerations.

**UNIT II MAC AND ROUTING PROTOCOLS**

**9**

MAC protocols – fundamentals, low duty cycle protocols and wakeup concepts, contention and Schedule-based protocols - SMAC, BMAC,TRAMA, Routing protocols – Requirements, Classification -SPIN, Directed Diffusion, COUGAR, ACQUIRE, LEACH, PEGASIS.

**UNIT III 6LOWPAN**

**9**

6LoWPAN Architecture - protocol stack, Adaptation Layer, Link layers – Addressing, Routing - Mesh-Under - Route-Over, Header Compression - Stateless header compression - Context- based header compression, Fragmentation and Reassembly , Mobility – types, Mobile IPv6, Proxy Home Agent, Proxy MIPv6, NEMO –Routing – MANET, ROLL, Border routing.

**UNIT IV APPLICATION**

**9**

Design Issues, Protocol Paradigms -End-to-end, Real-time streaming and sessions, Publish/subscribe, Web service paradigms, Common Protocols -Web service protocols, MQ telemetry transport for sensor networks (MQTT-S), ZigBee compact application protocol (CAP),Service discovery, Simple network management protocol (SNMP), Real-time transport and sessions, Industry- Specific protocols.

**UNIT V TOOLS****9**

TinyOS – Introduction, NesC, Interfaces, modules, configuration, Programming in TinyOS using NesC, TOSSIM, Contiki – Structure, Communication Stack, Simulation environment – Cooja simulator, Programming

**TOTAL: 45 PERIODS****COURSE OUTCOMES:****CO1:** To be able to design solutions for WSNs applications**CO2:** To be able to develop efficient MAC and Routing Protocols**CO3:** To be able to design solutions for 6LOWPAN applications**CO4:** To be able to develop efficient layered protocols in 6LOWPAN**CO5:** To be able to use Tiny OS and Contiki OS in WSNs and 6LOWPAN applications**REFERENCES:**

1. Holger Karl , Andreas willig, “Protocol and Architecture for Wireless Sensor Networks”, John Wiley Publication, 2006.
2. Anna Forster, “Introduction to Wireless Sensor Networks”, Wiley, 2017.
3. Zach Shelby Sensinode and Carsten Bormann, “ 6LoWPAN: The Wireless Embedded Internet” John Wiley and Sons, Ltd, Publication, 2009.
4. Philip Levis, “TinyOS Programming”, 2006 –[www.tinyos.net](http://www.tinyos.net).
5. The Contiki Operating System.<http://www.sics.se/contiki>.

**CO’s-PO’s & PSO’s MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	2	2	1	-	-	-	-	2	2	3	1	1
2	3	3	2	2	2	1	-	-	-	-	-	2	3	2	2
3	3	3	3	2	2	1	-	-	-	-	-	3	3	2	2
4	3	3	3	3	2	2	-	-	-	-	-	2	2	1	2
5	2	-	1	1	3	2	-	-	-	-	-	2	2	2	1
CO	<b>2.8</b>	<b>3</b>	<b>2.2</b>	<b>2</b>	<b>2.2</b>	<b>1.4</b>	-	-	-	-	<b>2</b>	<b>2.2</b>	<b>2.6</b>	<b>1.6</b>	<b>1.6</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CEC367****INDUSTRIAL IOT AND INDUSTRY 4.0****L T P C****2 0 2 3****COURSE OBJECTIVES:**

- IoT Nodes & Sensors
- IoT Gateways
- IoT Cloud Systems
- IoT Cloud Dashboards
- Challenges in IoT system Design – Hardware & Software

**UNIT I UNDERSTANDING IOT CONCEPT AND DEVELOPMENT PLATFORM****6**

IOT Definition, Importance of IoT, Applications of IOT, IoT architecture, Understanding working of Sensors, Actuators, Sensor calibration, Study of Different sensors and their characteristics

**UNIT II ANALYZING & DECODING OF COMMUNICATION PROTOCOL USED IN IOT DEVELOPMENT PLATFORM 6**

UART Communication Protocol, I2C Protocol device interfacing and decoding of signal, SPI Protocol device interfacing and decoding of signal, WIFI and Router interfacing, Ethernet Configuration, Bluetooth study and analysis of data flow, Zigbee Interfacing and study of signal flow

**UNIT III IOT PHYSICAL DEVICES AND ENDPOINTS AND CONTROLLING HARDWARE AND SENSORS 6**

IoT Physical Devices and Endpoints- Introduction to Arduino and Raspberry Pi- Installation, Interfaces (serial, SPI, I2C), Programming – Python program with Raspberry PI with focus on interfacing external gadgets, controlling output, reading input from pins.

Controlling Hardware- Connecting LED, Buzzer, Switching High Power devices with transistors, Controlling AC Power devices with Relays, Controlling servo motor, speed control of DC Motor, unipolar and bipolar Stepper motors;

Sensors- Light sensor, temperature sensor with thermistor, voltage sensor, ADC and DAC, Temperature and Humidity Sensor DHT11, Motion Detection Sensors, Wireless Bluetooth Sensors, Level Sensors, USB Sensors, Embedded Sensors, Distance Measurement with ultrasound sensor.

**UNIT IV CLOUD SERVICES USED IN IOT DEVELOPMENT PLATFORM 6**

Configuration of the cloud platform, Sending data from the IOT nodes to the gateways using different communication options; Transferring data from gateway to the cloud; Exploring the web services like mail, Messaging (SMS) and Twitter etc.; Tracking of cloud data as per the requirement; Google Cloud service architect; AWS cloud Services architect; Microsoft Azure cloud services Architect; OEN source Cloud Services; Initial State IoT Dashboard & Cloud Services

**UNIT V CHALLENGES IN IOT SYSTEM DESIGN – HARDWARE & SOFTWARE 6**

Antenna design and placement, Chip-package system development, Power electronics, electromagnetic interference/compatibility (EMI/EMC), Electronics reliability; Battery simulation.

**30 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

**Study and Program different Sensors for IoT applications**

- LDR sensor, IR sensor, Temperature Sensor, Ultrasound Sensor, Gas sensor
- Write a program using IR sensor for working morning alarm and night lamp
- Write a program using Temperature sensor for detecting heat / fire
- Write a program using Gas sensor for detecting LPG gas leak
- Write a program using Ultrasound sensor for range detection
- Write a program using sensors for carparking assist
- Write a program using sensors for water level indicator and overflow detection

**2. Designing and debugging complex mixed signal devices (analog, digital, and RF)**

- Write a program to interface Bluetooth and implement DC Motor.
- Write a program to control LEDs using Alexa Echo Dot.
- Write a program to control Buzzer using Alexa Echo Dot.
- Write a program to control DC motor using Google Assistance.
- Write a program to control Stepper motor using Google Assistance
- Studying and decoding Computer Bus (RS-232, UART).
- Studying Bluetooth analysis and measurement of Signals
- studying WLAN analysis of 802.11a/b/g/j/p, 802.11n, 802.11ac Signals

### 3. Understanding battery requirements

- Determining ultra-low deep sleep current of Node
- Measuring Transmit and Receive current signals of Node
- Capturing short transients and fast transients signals of node
- Recording Device(node) operations over extended states.
- Create stable low noise voltage supply for every state of your IOT devices, from sleep to transmit .
- Record and Generate Battery sources with the battery simulation options

### 4. Understanding Modulation techniques –

- Understanding of ASK, FSK Modulation and measurements
- Capturing the live ASK Signal and decoding it.
- Understanding the BPSK, QPSK & QAM Modulation Techniques and analysis.
- Understanding the APSK & APCO modulation & analysis.

### List of equipment for a batch of 30 students (3 in a bench):

- Real time Spectrum Analyser upto atleast 6.2GHz and 40MHz bandwidth – Qty #1
- DC Power supply - 120W with Battery simulation – Qty #1
- Graphical Digital Multimeter with built-in digitizer and datalogging for 20 channels – Qty #1
- 200MHz 6 channel scope with Serial trigger & decode capability for I2C, SPI, RS-232/422/485/UART buses, and built-in 50MHz AFG and 8 digital channel analysis – Qty #1
- AI Node with pre-configured SSD, USB Camera, USB Hub, USB Mouse, and USB Keyboard. – Qty 1no
- Sensor IOT Application Board with built-in 7 sensors (LDR #2, IR #2, Temperature #1, Ultrasound #1 and LPG Gas sensors #1); Embedded uC mother board, LCD display, Buzzer, Power supply (12V,1A) with adaptor and PCB Base plate; - Qty 5 nos
- All in One General Purpose Board
- IOT Gateway – Qty 1no
- Bluetooth Module– Qty 1no
- Router – Qty 1no
- Portable Sensor Kit – Qty 1no
- IOT sensor kit – Qty 1no
- RFID Module – Qty 1no
- Finger Print Module – Qty 1no
- Stepper Motor – Qty 1no
- DC Motor – Qty 1no
- Amazon Echo device – Qty 2nos

### COURSE OUTCOMES:

Upon completion of this course, the students will be able to

**CO1:** Understand the building blocks of IoT technology and explore the vast spectrum of IoT applications

**CO2:** Use processors & peripherals to design & build IoT hardware

**CO3:** Assess, select and customize technologies for IoT applications

**CO4:** Connect numerous IOT applications with the physical world of humans and real life problem solving.

**CO5:** Design and implement IOT applications that manage big data

**TOTAL:60 PERIODS**

## TEXT BOOKS

1. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madiseti, Universities Press, 2015, ISBN: 9788173719547
2. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759

## REFERENCES

1. Raspberry Pi Cookbook, Software and Hardware Problems and solutions, Simon Monk, O'Reilly (SPD), 2016, ISBN 7989352133895
2. N. Ida, Sensors, Actuators and Their Interfaces, SciTech Publishers, 2014.
3. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015 3. Editors Ovidiu Vermesan

## CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
1	3	2	2	2	1	2	-	-	-	-	-	2	3	2	2
2	3	2	2	2	1	2	-	-	-	-	-	2	3	3	2
3	3	2	2	2	2	2	-	-	-	-	-	2	3	3	2
4	3	2	3	2	3	2	-	-	-	-	-	2	3	3	2
5	3	3	3	3	3	3	-	-	-	-	-	1	3	2	3
CO	3	2.25	2.4	2.2	2	2.2	-	-	-	-	-	1.8	3	2.6	2.2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CEC340**

**MEMS DESIGN**

**L T P C**

**2 0 2 3**

### COURSE OBJECTIVES:

- To understand the basic electrical and mechanical concepts of MEMS design
- To understand the design aspects of electrostatic sensors and actuators
- To understand the design aspects of thermal sensors and actuators
- To understand the design aspects of piezoelectric sensors and actuators
- To understand the design aspects of magnetic sensors and actuators

### UNIT I ESSENTIAL ELECTRIC AND MECHANICAL CONCEPTS

**6**

Conductivity of semiconductors, Crystal planes and orientations, stress and strain, flexural beam bending analysis under simple loading conditions, Dynamic system, resonant frequency and quality factor

### UNIT II ELECTRO STATIC SENSING AND ACTUATION

**6**

Parallel plate capacitor, Applications of parallel plate capacitors- inertial sensor, pressure sensor, flow sensor, tactile sensor, parallel plate actuators, interdigitated finger capacitors, applications of comb drive devices.

### UNIT III THERMAL SENSING AND ACTUATION

**6**

Fundamentals of thermal transfer, Sensors and actuators based on thermal expansion, Thermal couples, Thermal resistors, Applications- Infrared sensors, flow sensors, Inertial sensors, other sensors



**UNIT IV           PIEZOELECTRIC SENSING AND ACTUATION****6**

Mathematical description of piezoelectric effects, Cantilever piezoelectric actuator model, properties of piezoelectric materials –Quartz, PZT,PVDF, ZnO , Applications – Acoustic sensors, Tactile sensors

**UNIT V           MAGNETIC SENSING AND ACTUATION****6**

Concepts and principles- magnetization and nomenclatures, principles of micromagnetic actuators, fabrication of micro magnetic components- deposition, design and fabrication of magnetic coil, MEMS magnetic actuators

**30 PERIODS  
30 PERIODS****PRACTICAL EXERCISES:**

1. Design and simulation of piezoelectric cantilever
2. Design and simulation of thermo couples
3. Design and simulation of comb drive actuators

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

**CO1:** Understand the basics of MEMS design aspects.

**CO2:** Apply the knowledge in the development of electro static sensors and actuators.

**CO3:** Apply the knowledge in the development of thermal sensors and actuators.

**CO4:** Apply the knowledge in the development of piezoelectric sensors and actuators.

**CO5:** Apply the knowledge in the development of magnetic sensors and actuators.

**TOTAL:60PERIODS****TEXTBOOKS**

- 1.Chang Liu, “Foundations of MEMS”, Pearson education India limited, 2006

**REFERENCES**

1. Murty B.S, Shankar P, Raj B, Rath, B.B, Murday J, Textbook of Nanoscience and Nanotechnology, Springer publishing, 2013.
2. Sergey Edward Lyshevski, “MEMS and NEMS: Systems, Devices, and Structures”, CRC Press, 2002
3. Tai Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata Mcgraw Hill, 2002
4. Vinod Kumar Khanna Nanosensors: Physical, Chemical, and Biological, CRC press,2012.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	2	2	2	-	-	-	-	-	1	3	2	2
2	3	3	3	2	2	2	-	-	-	-	-	2	3	2	2
3	3	3	3	2	2	2	-	-	-	-	-	2	3	2	2
4	3	3	3	2	2	2	-	-	-	-	-	2	3	2	2
5	3	3	3	2	2	2	-	-	-	-	-	2	3	2	2
CO	<b>3</b>	<b>3</b>	2.8	2	2	2	-	-	-	-	-	<b>1.8</b>	<b>3</b>	<b>2</b>	<b>2</b>

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

**COURSE OBJECTIVES:**

- To understand the concepts of nano electronics and quantum electronics
- To understand the concepts of nano electronic devices, transistors, tunneling devices and superconducting devices
- To understand the basics of nanotube devices

**UNIT I INTRODUCTION TO NANO ELECTRONICS 6**

Scaling to nano - Light as a wave and particle- Electrons as waves and particles- origin of quantum mechanics - General postulates of quantum mechanics - Time independent Schrodinger wave equation- Electron confinement - Quantum dots, wires and well-Spin and angular momentum

**UNIT II QUANTUM ELECTRONICS 6**

Quantum electronic devices - Short channel MOS transistor - Split gate transistor - Electron wave transistor - Electron wave transistor - Electron spin transistor - Quantum cellular automata - Quantum dot array, Quantum memory.

**UNIT III NANO ELECTRONIC TRANSISTORS 6**

Coulomb blockade - Coulomb blockade in Nano capacitors - Coulomb blockade in tunnel junctions - Single electron transistors, Semiconductor nanowire FETs and SETs, Molecular SETs and molecular electronics - Memory cell.

**UNIT IV NANO ELECTRONIC TUNNELING AND SUPER CONDUCTING DEVICES 6**

Tunnel effect -Tunneling element -Tunneling diode - Resonant tunneling diode - Three terminal resonant tunneling devices- Superconducting switching devices- Cryotron- Josephson tunneling device.

**UNIT V NANOTUBES AND NANOSTRUCTURE DEVICES 6**

Carbon Nanotube - Fullerenes - Types of nanotubes – Formation of nanotubes –Assemblies – Purification of carbon nanotubes – Electronic properties – Synthesis of carbon nanotubes – Carbon nanotube interconnects – Carbon nanotube FETs and SETs –Nanotube for memory applications- Nano structures and nano structured devices.

**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS**

T-CAD/ Any other relevant software based Simulations

1. Field Effect Transistors
2. Single Electron Transistors
3. Tunneling devices

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

**CO1:** Understand the basics of nano electronics including quantum wires, dots and wells

**CO2:** Use the mechanism behind quantum electronic devices

**CO3 :** Analyze the key performance aspects of tunneling and superconducting nano electronic devices

**CO4:** Apply the knowledge in the development of nanotubes and nanostructure devices

**TOTAL:60 PERIODS**

**TEXTBOOKS**

1. Hanson, Fundamentals of Nanoelectronics, Pearson education, 2009.

**REFERENCES**

1. Jan Dienstuhl, Karl Goser, and Peter Glösekötter, Nanoelectronics and Nanosystems: From Transistors to Molecular and Quantum Devices, Springer-Verlag, 2004.
2. Mircea Dragoman and Daniela Dragoman, Nanoelectronics: Principles and Devices, Artech House, 2009.
3. Robert Puers, Livio Baldi, Marcel Van de Voorde and Sebastiaan E. Van Nooten, Nanoelectronics: Materials, Devices, Applications, Wiley, 2017.
4. Brajesh Kumar Kaushik, Nanoelectronics: Devices, Circuits and Systems, Elsevier science, 2018

**CO's-PO's & PSO's MAPPING**

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
1	3	3	2	2	2	1	-	-	-	-	-	2	2	1	1
2	3	3	3	2	2	2	-	-	-	-	-	2	3	1	1
3	3	3	3	2	2	2	-	-	-	-	-	2	3	1	1
4	3	3	2	2	2	2	-	-	-	-	-	2	3	1	1
5	3	3	3	3	3	3	-	-	-	-	-	2	3	1	2
<b>CO</b>	<b>3</b>	<b>3</b>	<b>2.6</b>	<b>2.2</b>	<b>2.2</b>	<b>2</b>	-	-	-	-	-	<b>2</b>	<b>2.8</b>	<b>1</b>	<b>1.2</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CEC347**

**RADAR TECHNOLOGIES**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

The student should be made to:

- Understand the basics of Radar and Radar equation
- Understand the types of Radar
- understand tracking Radar
- Understand the various signal processing in Radar
- Understand the Subsystems in Radar

**UNIT I INTRODUCTION TO RADAR EQUATION**

**9**

The Origins of Radar ,Radar principles, Basic Block Diagram, Radar classifications based on Frequencies, Wave form and application,Radar Fundamentals: Detection, Range, velocity, The simple form of the Radar Equation, Pulsed Radar equation, Detection of Signals in Noise- Receiver Noise, Signal-to-Noise Ratio, Probabilities of Detection and False Alarm, Integration of Radar Pulses, Radar Cross Section of Targets,Transmitter Power,Pulse Repetition Frequency,Antenna Parameters, System losses.

**UNIT II CW, MTI AND PULSE DOPPLER RADAR**

**9**

CW and Frequency Modulated Radar, Doppler and MTI Radar- Delay Line Cancellers, Staggered Pulse Repetition Frequencies, Doppler Filter Banks, Digital MTI Processing, Moving Target

Detector, Limitations to MTI Performance, MTI from a Moving Platform (AMIT), Pulse Doppler Radar.

**UNIT III TRACKING RADAR 9**

Tracking with Radar, Monopulse Tracking, Conical Scan, Sequential Lobing, Limitations to Tracking Accuracy, Low-Angle Tracking - Comparison of Trackers, Track while Scan (TWS) Radar- Target prediction, state estimation, Measurement models, alpha – beta tracker, Kalman Filtering, Extended Kalman filtering.

**UNIT IV RADAR SIGNAL PROCESSING 9**

Radar Signal Processing Fundamentals, Detection strategies, Optimal detection, Threshold detection, Constant False alarm rate detectors, Adaptive CFAR, pulse compression waveforms, compression gain, LFM waveforms matched filtering, radar ambiguity functions, radar resolution, Detection of radar signals in Noise and clutter, detection of non fluctuating target in noise, Doppler spectrum of fluctuating targets, Range Doppler spectrum of stationary and moving radar.

**UNIT V RADAR TRANSMITTERS AND RECEIVERS 9**

Radar Transmitter, Linear Beam Power Tubes, Solid State RF Power Sources, Magnetron, Crossed Field Amplifiers, Other RF Power Sources. The Radar Receiver, Receiver noise power, Super heterodyne Receiver, Duplexers and Receiver Protectors- Radar Displays. Radar Antenna - Reflector Antennas - Electronically Steered Phased Array Antennas – Phase Shifters

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the student will be able to:

- CO1:**Identify the Radar parameters
- CO2:**Differentiate various radar types
- CO3:**Evaluate different tracking and filtering schemes
- CO4:**Apply signal processing in target detection
- CO5:**Design Radar transmitter and receiver blocks

**TEXT BOOKS**

1. Habibur Rahman, Fundamental Principles of Radar, CRC press, Taylor and Francis, 2019.
2. M. R. Richards, J. A. Scheer, W. A. Holm, Editors “Principles of Modern Radar, Basic Principles”, SciTech Publishing, 2012

**REFERENCES**

1. 1.Nathansan, “Radar design principles-Signal processing and environment”, PHI, 2nd Edition,2007.
2. 2.M.I.Skolnik , “Introduction to Radar Systems”, Tata McGraw Hill 2006.
3. Mark A. Richards, “Fundamentals of Radar Signal Processing”, McGraw-Hill, 2005.

**CO’s-PO’s & PSO’s MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	-	-	-	-	2	2	3	3	2
CO2	3	3	3	3	2	2	-	-	-	-	2	2	2	2	2
CO3	3	3	3	3	2	2	-	-	-	-	2	2	1	2	3
CO4	3	3	3	2	3	2	-	-	-	-	1	2	2	1	2
CO5	3	2	2	2	3	2	-	-	-	-	1	2	2	2	1
<b>CO</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES:**

- To impart knowledge on the needs for avionics for both Civil and military aircraft.
- To impart knowledge on avionics architecture and Avionics data bus.
- To impart knowledge understand the various cockpit displays and human interfaces.
- To impart knowledge on the concepts of flight control systems, FMS and their importance
- To impart knowledge on different navigation aids and need for certification

**UNIT I INTRODUCTION TO AVIONICS 9**

Basics of Avionics-Basics of Cockpits – Need for Avionics in civil and military aircraft and space systems – Integrated Avionics Architecture –Military and Civil system – Typical avionics System and Sub systems – Design and Technologies – Requirements and Importance of illities of Avionic Systems.

**UNIT II DIGITAL AVIONICS BUS ARCHITECTURE 9**

Evolution of Avionics architecture– Avionics Data buses MIL-STD-1553, MIL-STD-1773, ARINC-429, ARINC-629, AFDX/ARINC-664, ARINC-818 – Aircraft system Interface

**UNIT III COCKPIT DISPLAYS AND MAN-MACHINE INTERACTION 9**

Trends in display technology- CRT, LED, LCD, EL and plasma panel - Touch screen - Direct voice input (DVI) –Civil cockpit and military cockpit: MFD, MFK, HUD, HDD, HMD, HOTAS – Glass cockpit.

**UNIT IV FLIGHT CONTROL SYSTEMS 9**

Introduction to Flight control systems and FMS– Longitudinal control – Lateral Control –Autopilot – Flight planning – Radar Electronic Warfare - Certification-Military and civil aircrafts.

**UNIT V NAVIGATION SYSTEMS 9**

Overview of navigation systems - Communication Systems – Radio navigation – Types & Principles – Fundamentals of Inertial Sensors – INS – GNSS -- GPS – Approach and Landing Aids – ILS & MLS – Hybrid Navigation

**COURSE OUTCOMES:****TOTAL: 45 PERIODS**

Upon completion of the course, students will be able to:

**CO1:** Explain the different of Avionics Systems and its need for civil and military aircrafts considering the reliability and safety aspects

**CO2:** Select a suitable architecture and data bus based on the requirements

**CO3:** Compare the different display technologies used in cockpit

**CO4:** Explain the principles of flight control systems and the importance of FMS

**CO5:** Explain the communication and navigation techniques used in aircrafts

**TEXT BOOK:**

1. R.P.G. Collinson, "Introduction to Avionics", Springer Publications, Third Edition, 2011.

**REFERENCES:**

1. Cary R .Spitzer, "The Avionics Handbook", CRC Press, 2000.
2. Middleton, D.H. "Avionics Systems", Longman Scientific and Technical, Longman Group UK Ltd., England, 1989.

3. Spitzer, C.R. "Digital Avionics Systems", Prentice Hall, Englewood Cliffs, N.J., U.S.A., 1987.
4. Myron Kayton , Walter R. Fried "Avionics Navigation Systems" 2nd Edition, Wiley Publication, 2008.
5. Jim Curren, "Trend in Advanced Avionics", IOWA State University, 1992.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	3	2	-	-	-	-	-	3	3	3	2
2	3	3	3	2	2	2	-	-	-	-	-	3	3	2	2
3	3	3	3	3	1	2	-	-	-	-	-	3	2	3	2
4	2	3	3	2	2	1	-	-	-	-	-	2	2	1	2
5	3	3	2	2	2	1	-	-	-	-	-	2	2	2	2
CO	3	3	3	2	2	2	-	-	-	-	-	2	2	2	2

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

**CEC346**

**POSITIONING AND NAVIGATION SYSTEMS**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES**

- To explain the fundamentals of navigation systems.
- To understand the inertial navigation systems
- To acquire knowledge on radio navigation.
- To have an overview of global positioning systems
- To learn the hybrid navigation systems.

**UNIT I**

**NAVIGATION CONCEPTS**

**9**

Fundamentals of navigation systems and Position Fixing – Categories of navigation - Geometric concepts of Navigation – The Earth in inertial space - Different Coordinate Systems – Coordinate Transformation - Euler angle formulations - Direction cosine matrices formulation - Quaternion formulation.

**UNIT II**

**INERTIAL NAVIGATION SYSTEMS**

**9**

Inertial sensors - Gyroscopes -Types - Mechanical - Electromechanical-Optical Gyro -Ring Laser gyro- Fiber optic gyro- Accelerometers – Pendulous type – Force Balance type – MEMs - Basic Principles of Inertial Navigation – Types - Platform and Strap down - Mechanization INS system - Rate Corrections - Acceleration errors – Schuler Tuning.

**UNIT III**

**RADIO NAVIGATION & AIR TRAFFIC MANAGEMENT**

**9**

Different types of radio navigation- ADF, VOR, DME, TACAN,VORTAC - Doppler – Hyperbolic Navigations – Air Traffic Management – RADAR Surveillance - Airborne Collision Avoidance Systems

**UNIT IV**

**GLOBAL POSITIONING SYSTEM**

**9**

Overview of GPS: Basic concept, system architecture, , GPS Signals Signal structure, anti-spoofing (AS), selective availability, GPS for position and velocity determination, GPS aided Geo-augmented navigation (GAGAN) architecture -GPS error sources-clock error, ionospheric error, tropospheric error, multipath, ionospheric error estimation using dual frequency GPS receiver

**UNIT V HYBRID NAVIGATION & RELATIVE NAVIGATION SYSTEMS 9**

Hybrid Navigation - Introduction to Kalman filtering – Case Studies -Integration of GPS and INS using Kalman Filter - Relative Navigation – fundamentals – Equations of Relative Motion for circular orbits (Clohessy\_Wiltshire Equations) - Sensors for Rendezvous Navigation - Relative positioning - Point positioning and differential positioning - Differential GPS (DGPS) and Space based Augmentation system (SBAS)- Concepts - Relative GPS -Formation Flying - Figure of Merit (FOM)

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

Upon completion of the course, students will be able to

**CO1** : Understand the advanced concepts of Positioning and Navigation systems and exposure on various Navigation systems

**CO2** : Know about Gyroscopes and accelerometers and Inertial Navigation systems and its types and Mechanisation

**CO3** : Explain the different Radio Navigation aids and its usage for civil and military aircrafts and satellites

**CO4** : Explain the Satellite Navigation – GPS and its usage in aircraft and spacecraft applications

**CO5**: Deploy these skills effectively in the analysis and understanding of hybrid navigation systems and Relative navigation in a spacecraft.

**TEXT BOOKS:**

1. Myron Kyton, Walfred Fried, 'Avionics Navigation Systems', John Wiley & Sons,2 edition,1997.
2. Nagaraja, N.S. "Elements of Electronic Navigation", Tata McGraw-Hill Pub. Co., New Delhi, 2nd edition, 1975.

**REFERENCES:**

1. George M Siouris, 'Aerospace Avionics System; A Modern Synthesis', Academic Press Inc., 1993.
2. Albert Helfrick, 'Practical Aircraft Electronic Systems', Prentice Hall Education, Career & Technology, 1995.
3. Albert D. Helfrick, 'Modern Aviation Electronics', Second Edition, Prentice Hall Career & Technology, 1994.
4. Paul. D. Groves. 'Principles of GNSS, Inertial, and Multisensor Integrated Navigation Systems', Artech House, 2013.
5. Maxwell Noton, "Spacecraft navigation and guidance", Springer (London, New York), 1998

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	2	2	2	-	-	-	-	-	3	3	2	2
2	3	3	3	2	2	2	-	-	-	-	-	2	3	2	2
3	3	3	3	2	2	2	-	-	-	-	-	2	3	2	3
4	3	3	3	2	2	2	-	-	-	-	-	2	2	2	2
5	3	3	3	3	2	2	-	-	-	-	-	2	2	2	2
CO	3	3	3	2	2	2	-	-	-	-	-	2	2	2	2

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

**COURSE OBJECTIVES:**

The student should be made to:

- Understand the basics of satellite orbits
- Understand the satellite segment and earth segment
- understand Link Power budget calculation
- Understand the various satellite access and coding technology
- Understand the applications of satellite

**UNIT I SATELLITE ORBITS 9**

Kepler's Laws, Newton's law, orbital parameters, orbital perturbations, station keeping, geo stationary and non Geo-stationary orbits – Look Angle Determination- Limits of visibility – eclipse-Sub satellite point –Sun transit outage-Launching Procedures - launch vehicles and propulsion.

**UNIT II SPACE SEGMENT 9**

Spacecraft Technology- Structure, Primary power, Attitude and Orbit control, Thermal control and Propulsion, communication Payload and supporting subsystems, Telemetry, Tracking and command-Transponders Antenna Subsystem.

**UNIT III SATELLITE LINK DESIGN 9**

Basic link analysis, Uplink and Downlink Design equation, Free space loss-Atmospheric effects, Ionospheric scintillation, Rain induced attenuation and interference, system noise temperature, Link Design with and without frequency reuse.

**UNIT IV SATELLITE ACCESS AND CODING Techniques 9**

Modulation and Multiplexing: Voice, Data, Video, Analog – digital transmission system, Digital video Broadcast, multiple access: FDMA, TDMA, CDMA, PAMA and DAMA Assignment Methods, compression – encryption, Coding Schemes.

**UNIT V SATELLITE APPLICATIONS 9**

INTELSAT Series, INSAT, VSAT, Mobile satellite services: GSM, GPS, LEO, MEO, Satellite Navigational System. GPS-Position Location Principles, Differential GPS, Direct Broadcast satellites (DBS/DTH).

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the student will be able to:

- CO1:**Identify the satellite orbits
- CO2:**Analyze the satellite subsystems
- CO3:**Evaluate the satellite link power budget
- CO4:**Identify access technology for satellite
- CO5:**Design various satellite applications

**TEXT BOOKS:**

1. Dennis Roddy, "Satellite Communication", 4th Edition, Mc Graw Hill International, 2017.
2. Timothy Pratt, Charles, W.Bostain,Jeremy E.Allnutt,"SatelliteCommunication",3rd Edition, Wiley Publications,2021.

**REFERENCES:**

1. Tri T. Ha, "Digital Satellite Communications", 2<sup>nd</sup> edition, Mc Graw Hill education, 2017.



2. Wilbur L.Pritchard, Hendri G. Suyderhoud, Robert A. Nelson, "Satellite Communications Systems Engineering", 2<sup>nd</sup> edition , Prentice Hall/Pearson , 2013.
3. M.Richharia, "Satellite Communication Systems-Design Principles", Macmillan, 1999.
4. Brian Ackroyd, "World Satellite Communication and earth station Design", BSP professional Books, 1990.
5. Bruce R. Elbert, "The Satellite Communication Applications", Hand Book, Artech House Bostan London, 2003.

#### CO's-PO's & PSO's MAPPING

C O	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO2	PS O3
1	3	3	3	3	2	3	1	1	-	1	-	1	3	3	3
2	3	2	2	3	2	3	-	-	-	-	-	1	3	3	3
3	3	3	3	2	1	3	-	-	-	-	-	1	3	3	3
4	3	3	2	3	2	3	-	-	-	-	-	1	3	3	3
5	3	2	3	2	2	1	-	-	-	-	-	1	3	3	3
C O	3	3	3	3	2	3	1	1	-	1	-	1	3	3	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CEC348**

**REMOTE SENSING**

**L T P C**

**3 0 0 3**

#### **UNIT I REMOTE SENSING AND ELECTROMAGNETIC RADIATION**

**9**

Definition – components of RS – History of Remote Sensing – Merits and demerits of Data Collation between conventional and remote sensing methods - Electromagnetic Spectrum – Radiation principles - Wave theory, Planck's law, Wien's Displacement Law, Stefan's Boltzmann law, Kirchoff's law – Radiation sources: active & passive – Radiation Quantities.

#### **UNIT II EMR INTERACTION WITH ATMOSPHERE AND EARTH MATERIAL**

**9**

Standard atmospheric profile – main atmospheric regions and its characteristics – interaction of radiation with atmosphere – Scattering, absorption and refraction – Atmospheric windows – Energy balance equation – Specular and diffuse reflectors – Spectral reflectance & emittance– Spectroradiometer – Spectral Signature concepts – Typical spectral reflectance curves for vegetation, soil and water – solid surface scattering in microwave region.

#### **UNIT III ORBITS AND PLATFORMS**

**9**

Motions of planets and satellites – Newton 's law of gravitation – Gravitational field and potential - Escape velocity - Kepler 's law of planetary motion - Orbit elements and types – Orbital perturbations and maneuvers – Types of remote sensing platforms - Ground based, Air borne platforms and Space borne platforms – Classification of satellites – Sun synchronous and Geosynchronous satellites – Legrange Orbit

#### **UNIT IV SENSING TECHNIQUES**

**9**

Classification of remote sensors – Resolution concept: spatial, spectral, radiometric and temporal resolutions - Scanners - Along and across track scanners – Optical-infrared sensors – Thermal sensors – microwave sensors – Calibration of sensors – High Resolution Sensors - LIDAR, UAV – Orbital and sensor characteristics of live Indian earth observation satellites.

Photographic and digital products – Types, levels and open-source satellite data products – selection and procurement of data – Visual interpretation: basic elements and interpretation keys - Digital interpretation – Concepts of Image rectification, Image enhancement and Image classification.

**TOTAL:45 PERIODS**

### TEXTBOOKS:

1. Thomas M. Lillesand, Ralph W. Kiefer and Jonathan W. Chipman, Remote Sensing and Image interpretation, John Wiley and Sons, Inc., New York, 2015.
2. George Joseph and C Jeganathan, Fundamentals of Remote Sensing, Third Edition Universities Press (India) Private limited, Hyderabad, 2018.

### REFERENCES:

1. Stanley A Morain; Amelia M Budge; Michael S Renslow. Manual of Remote Sensing. Vol. I, American Society for Photogrammetry and Remote Sensing, Virginia, USA,2019, 4th edition
2. Verbyla, David, Satellite Remote Sensing of Natural Resources. CRC Press,2022 first edition.
3. Paul Curran P. J. Principles of Remote Sensing Longman, RLBS, 1996.
4. Introduction to Physics and Techniques of Remote Sensing, Charles Elachi and Jacob Van Zyl, 2021 Edition3, Wiley Publication.
5. BasudebBhatta, Remote Sensing and GIS, Oxford University Press, 2020 third edition.

### COURSE OUTCOMES

**CO1:** To understand the principles of electromagnetic radiation.

**CO2:** To learn the atmospheric radiation interactions.

**CO3:** To study the laws of planetary motion.

**CO4:** To classify the different types of resolution.

**CO5:** To know the concepts of digital interpretation.

### CO's-PO's & PSO's MAPPING

CO	P O1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO3
1	3	2	2	3	1	3	2	-	-	-	-	1	3	3	3
2	3	2	2	3	1	3	2	-	-	-	-	1	3	3	3
3	1	2	1	3	2	3	2	-	-	-	-	1	3	3	3
4	1	2	3	1	3	3	2	-	-	-	-	1	3	3	3
5	2	2	2	-	3	3	2	-	-	-	-	1	3	3	3
CO	2	2	2	2	2	3	2	-	-	-	-	1	3	3	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CEC351**

**ROCKETRY AND SPACE MECHANICS**

**L T P C**

**3 0 0 3**

### COURSE OBJECTIVES:

- This course presents the fundamental aspects of rocket motion along with detailed estimation of rocket trajectories.
- This course also imparts knowledge on optimization of multistage rockets.
- This course provides the basics of space mechanics required for an aeronautical student

- This course helps students to provide with the basics of orbit transfer of satellites.
- This course will help students to gain knowledge on various control methods of rockets.

**UNIT I ORBITAL MECHANICS 9**

Description of solar system – Kepler’s Laws of planetary motion – Newton’s Law of Universal gravitation – Two body and Three-body problems – Jacobi’s Integral, Librations points – Estimation of orbital and escape velocities.

**UNIT II SATELLITE DYNAMICS 9**

Geosynchronous and geostationary satellites- factors determining life time of satellites – satellite perturbations – orbit transfer and examples –Hohmann orbits – calculation of orbit parameters– Determination of satellite rectangular coordinates from orbital elements.

**UNIT III ROCKET MOTION 9**

Principle of operation of rocket motor – thrust equation – one dimensional and two dimensional rocket motions in free space and homogeneous gravitational fields – Description of vertical, inclined and gravity turn trajectories – determinations of range and altitude – simple approximations to burnout velocity.

**UNIT IV ROCKET AERODYNAMICS 9**

Description of various loads experienced by a rocket passing through atmosphere – drag estimation – wave drag, skin friction drag, form drag and base pressure drag – Boat-tailing in missiles – performance at various altitudes – rocket stability – rocket dispersion – launching problems.

**UNIT V STAGING AND CONTROL OF ROCKET VEHICLES 9**

Need for multi staging of rocket vehicles – multistage vehicle optimization – stage separation dynamics and separation techniques- aerodynamic and jet control methods of rocket vehicles – SITVC.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, students will be able

**CO1:** To knowledge on the fundamental laws of orbital mechanics with particular emphasis on interplanetary trajectories.

**CO2:** To calculate orbital parameters and perform conceptual trajectory designs for geocentric or interplanetary missions.

**CO3:** To familiarize themselves with trajectory calculations for planar motion of rockets.

**CO4:** To determine forces and moments acting on airframe of a missile.

**CO5:** To acquire knowledge on the need for staging and stage separation dynamics of rocket vehicles.

**TEXT BOOKS**

1. Cornelisse,JW, “Rocket Propulsion and Space Dynamics”, J.W. Freeman & Co., Ltd., London, 1982.
2. Parker,ER, “Materials for Missiles and Spacecraft”, McGraw-Hill Book Co., Inc., 1982.

**REFERENCES**

1. Suresh. B N & Sivan. K, “Integrated Design for Space Transportation System”, Springer India, 2015.
2. Sutton,GP, “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 8<sup>th</sup> Edition, 2010.
3. Van de Kamp, “Elements of Astromechanics”, Pitman Publishing Co., Ltd., London, 1980.

### CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	2	2	2	-	-	-	-	-	3	3	2	2
2	3	3	3	2	2	2	-	-	-	-	-	2	3	2	2
3	3	3	3	2	2	2	-	-	-	-	-	2	3	2	3
4	3	3	3	2	2	2	-	-	-	-	-	2	2	2	2
5	3	3	3	3	2	2	-	-	-	-	-	2	2	2	2
CO	3	3	3	2	2	2	-	-	-	-	-	2	2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

CEC345

OPTICAL COMMUNICATION & NETWORKS

L T P C

3 0 0 3

#### COURSE OBJECTIVES:

- To Study About The Various Optical Fiber Modes, Configuration Of Optical Fibers
- To Study Transmission Characteristics Of Optical Fibers.
- To Learn About The Various Optical Sources, Detectors And Transmission Techniques.
- To Explore Various Idea About Optical Fiber Measurements And Various Coupling Techniques.
- To Enrich The Knowledge About Optical Communication Systems And Networks.

#### UNIT-I

#### INTRODUCTION TO OPTICAL FIBER COMMUNICATION

9

Introduction - The General Systems - Advantages of Optical Fiber Communication- **Ray Theory Transmission** : Total Internal Reflection, Acceptance Angle, Numerical Aperture, Skew Rays - **Electromagnetic Mode Theory for Optical Propagation**: Modes in a Planar Guide, Phase and group velocity - **Cylindrical Fiber**: Step index fibers, Graded index fibers - **Single mode fibers**: Cutoff wavelength.

#### UNIT-II

#### TRANSMISSION CHARACTERISTICS OF OPTICAL FIBERS

9

Attenuation - **Material absorption losses in silica glass fibers**: Intrinsic absorption, Extrinsic absorption - **Linear scattering losses**: Rayleigh Scattering, Mie Scattering -**Nonlinear scattering losses**: Stimulated Brillouin Scattering, Stimulated Raman Scattering – Fiber Bend Loss – Dispersion- **Chromatic dispersion**: Material dispersion, Waveguide dispersion- **Intermodal dispersion** : Multimode step index fiber, Multimode graded index fiber.

#### UNIT-III

#### OPTICAL SOURCES AND OPTICAL DETECTORS

9

**The laser** : Introduction - **Basic concepts**: Absorption and emission of radiation, Population inversion , Optical feedback and laser oscillation, Threshold condition for laser oscillation- **Optical emission from semiconductors**: The PN junction, Spontaneous emission, Carrier recombination, Stimulated emission and lasing, Hetero junctions- **LED**: Introduction- Power and Efficiency - **LED structures**: Planar LED, Dome LED, Surface emitter LED, Edge emitter LED- LED Characteristics. **Optical Detectors**:Introduction ,Optical Detection Principles, Quantum Efficiency, Resposivity, P-N Photodiode ,P-I-N Photo Diode and Avalanche Photodiode.

#### UNIT-IV

#### OPTICAL FIBER MEASUREMENTS

9

Introduction- Total Fiber Attenuation Measurement, Fiber Dispersion Measurements In Time Domain and Frequency Domain, Fiber Cut off Wavelength Measurements, Numerical Aperture Measurements. Fiber Diameter Measurements,.Reflectance And Optical Return Loss, Field Measurements

Introduction- **Optical Network Concepts**: Optical Networking Terminology, Optical Network Node And Switching Elements, Wavelength Division Multiplexed Networks, Public Telecommunications Network Overview- **Optical Network Transmission Modes, Layers And Protocols**: Synchronous Networks, Asynchronous Transfer Mode, Open System Interconnection Reference Model, Optical Transport Network, Internet Protocol- **Wavelength Routing Networks**: Routing And Wavelength Assignment- **Optical Switching Networks**: Optical Circuit Switched Networks, Optical Packet Switched Networks, Multiprotocol Label Switching, Optical Burst Switching Networks- **Optical Network Deployment** : Long Haul Networks, Metropolitan area networks, Access networks, Local Area Networks- **Optical Ethernet**: Network protection, restoration and survivability.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

**At the end of the course, the student will be able to understand the**

- CO1:**Realize Basic Elements In Optical Fibers, Different Modes And Configurations.
- CO2:**Analyze The Transmission Characteristics Associated With Dispersion And Polarization Techniques.
- CO3:**Design Optical Sources And Detectors With Their Use In Optical Communication System.
- CO4:**Construct Fiber Optic Receiver Systems, Measurements And Techniques.
- CO5:**Design Optical Communication Systems And Its Networks.

**TEXT BOOKS:**

1. John M.Senior, "Optical Fiber Communication", Pearson Education, Fouth Edition.2010.

**REFERENCES:**

1. Gred Keiser,"Optical Fiber Communication", McGraw Hill Education (India) Private Limited. Fifth Edition, Reprint 2013.
2. Govind P. Agrawal, "Fiber-Optic Communication Systems", Third Edition, John Wiley & Sons, 2004.
3. J.Gower, "Optical Communication System", Prentice Hall Of India, 2001
4. Rajiv Ramaswami, "Optical Networks " , Second Edition, Elsevier , 2004.
5. P Chakrabarti, "Optical Fiber Communication", McGraw Hill Education (India)Private Limited, 2016

**CO's-PO's & PSO's MAPPING**

C O	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
1	3	3	2	3	3	1	-	-	-	-	-	1	2	1	2
2	3	3	2	1	3	2	-	-	-	-	-	2	2	2	2
3	3	3	3	3	2	1	-	-	-	-	-	1	2	2	2
4	3	3	2	2	2	1	-	-	-	-	-	1	2	1	2
5	3	3	3	3	2	1	-	-	-	-	-	1	2	2	2
C O	3	3	2	3	3	1	-	-	-	-	-	1	2	1	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES**

- To study the various network layer and transport layer protocols for wireless networks
- To study the architecture and interference mitigation techniques in 3G standards
- To learn about 4G technologies and LTE-A in mobile cellular network.
- To learn about the layer level functionalities in interconnecting networks.
- To study the emerging techniques in 5G network.

**UNIT I WIRELESS PROTOCOLS 9**

Mobile network layer- Fundamentals of Mobile IP, data forwarding procedures in mobile IP, IPv4, IPv6, IP mobility management, IP addressing - DHCP, Mobile transport layer-Traditional TCP, congestion control, slow start, fast recovery/fast retransmission, classical TCP improvements- Indirect TCP, snooping TCP, Mobile TCP.

**UNIT II 3G EVOLUTION 9**

IMT-2000 - W-CDMA, CDMA 2000 - radio & network components, network structure, packet-data transport process flow, Channel Allocation, core network, interference-mitigation techniques, UMTS-services, air interface, network architecture of 3GPP, UTRAN – architecture, High Speed Packet Data-HSDPA, HSUPA.

**UNIT III 4G EVOLUTION 9**

Introduction to LTE-A – Requirements and Challenges, network architectures – EPC, E- UTRAN architecture - mobility management, resource management, services, channel -logical and transport channel mapping, downlink/uplink data transfer, MAC control element, PDU packet formats, scheduling services, random access procedure.

**UNIT IV LAYER-LEVEL FUNCTIONS 9**

Characteristics of wireless channels - downlink physical layer, uplink physical layer, MAC scheme - frame structure, resource structure, mapping, synchronization, reference signals and channel estimation, SC-FDMA, interference cancellation – CoMP, Carrier aggregation, Services - multimedia broadcast/multicast, location-based services.

**UNIT V 5G EVOLUTION 9**

5G Roadmap - Pillars of 5G - 5G Architecture, The 5G internet - IoT and context awareness - Networking reconfiguration and virtualization support - Mobility QoS control - emerging approach for resource over provisioning, Small cells for 5G mobile networks- capacity limits and achievable gains with densification - Mobile data demand, Demand Vs Capacity, Small cell challenges, conclusion and future directions.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

**Upon completion of the course, the student will be able to**

**CO1:** Design and implement the various protocols in wireless networks.

**CO2:** Analyze the architecture of 3G network standards.

**CO3:** Analyze the difference of LTE-A network design from 4G standard.

**CO4:** Design the interconnecting network functionalities by layer level functions.

**CO5:** Explore the current generation (5G) network architecture.

**TEXTBOOKS**

1. Kaveh Pahlavan, “Principles of wireless networks”, Prentice-Hall of India, 2008

## REFERENCES

1. Vijay K.Garg, "Wireless Network Evolution - 2G & 3G". Prentice Hall, 2008.
2. Clint Smith,P.E, Dannel Collins, "3G Wireless Networks" Tata McGraw- Hill, 2nd Edition, 2011.
3. Sassan Ahmadi, "LTE-Advanced – A practical systems approach to understanding the 3GPP LTE Releases 10 and 11 radio access technologies", Elsevier, 2014.
4. Jonathan Rodriguez, "Fundamentals of 5G Mobile networks", John Wiley, 2015.

### CO's-PO's & PSO's MAPPING

CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO 3
1	3	2	2	3	3	1	-	-	-	-	2	3	3	1	1
2	3	3	2	1	3	2	-	-	-	-	-	-	3	2	2
3	3	3	3	3	2	1	-	-	-	-	-	3	3	2	2
4	2	3	3	3	2	2	-	-	-	-	-	3	2	1	2
5	2	-	3	3	2	2	-	-	-	-	-	3	2	2	1
CO	2.6	2.75	2.6	2.6	2.4	1.6	-	-	-	-	2	3	2.6	1.6	1.6

1 - low, 2 - medium, 3 - high, '-' - no correlation

CEC331

4G / 5G COMMUNICATION NETWORKS

L T P C  
2 0 2 3

### COURSE OBJECTIVES

- To learn the evolution of wireless networks.
- To get acquainted with the fundamentals of 5G networks.
- To study the processes associated with 5G architecture.
- To study spectrum sharing and spectrum trading.
- To learn the security features in 5G networks.

#### UNIT I EVOLUTION OF WIRELESS NETWORKS

6

Networks evolution: 2G,3G,4G, evolution of radio access networks, need for 5G. 4G versus 5G, Next Generation core(NG-core), visualized Evolved Packet core(vEPC).

#### UNIT II 5G CONCEPTS AND CHALLENGES

6

Fundamentals of 5G technologies, overview of 5G core network architecture,5G new radio and cloud technologies, Radio Access Technologies (RATs), EPC for 5G.

#### UNIT III NETWORK ARCHITECTURE AND THE PROCESSES

6

5G architecture and core, network slicing, multi access edge computing(MEC)visualization of 5G components, end-to-end system architecture, service continuity, relation to EPC, and edge computing. 5G protocols: 5G NAS,NGAP, GTP-U, IPSec and GRE.

#### UNIT IV DYNAMIC SPECTRUM MANAGEMENT AND MM-WAVES

6

Mobility management, Command and control, spectrum sharing and spectrum trading, cognitive radio based on 5G, millimeter waves.

#### UNIT V SECURITY IN 5G NETWORKS

6

Security features in 5G networks, network domain security, user domain security, flow based QoS framework,mitigating the threats in 5G.

30 PERIODS

**PRACTICAL EXERCISES:  
SIMULATION USING MATLAB**

**30 PERIODS**

1. 5G-Compliant waveform generation and testing
2. Modeling of 5G Synchronization signal blocks and bursts
3. Channel modeling in 5G networks
4. Multiband OFDM demodulation
5. Perfect Channel estimation
6. Development of 5g New Radio Polar Coding

**COURSE OUTCOMES**

**CO1:**To understand the evolution of wireless networks.

**CO2:**To learn the concepts of 5G networks.

**CO3:**To comprehend the 5G architecture and protocols.

**CO4:**To understand the dynamic spectrum management.

**CO5:**To learn the security aspects in 5G networks.

**TOTAL 60 PERIODS**

**TEXT BOOKS**

1. 5G Core networks: Powering Digitalization , Stephen Rommer, Academic Press,2019
2. An Introduction to 5G Wireless Networks : Technology, Concepts and Use cases, Saro Velrajan,First Edition, 2020.

**REFERENCES**

1. 5G Simplified: ABCs of Advanced Mobile Communications Jyrki. T.J.Penttinen,Copyrighted Material.
2. 5G system Design: An end to end Perspective , Wan Lee Anthony, Springer Publications,2019.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	3	2	-	-	-	-	-	-	-	1	1	3
2	3	3	3	2	2	-	-	-	-	-	-	-	1	1	2
3	3	3	2	2	2	-	-	-	-	-	-	-	2	2	2
4	3	3	3	3	2	-	-	-	-	-	-	-	3	2	2
5	3	2	3	3	2	-	-	-	-	-	-	-	2	2	2
CO	3	2.8	2.6	2.6	2	-	-	-	-	-	-	-	1.8	1.6	2.2

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

**CEC354**

**SOFTWARE DEFINED NETWORKS**

**L T P C**

**2 0 2 3**

**COURSE OBJECTIVES:**

- To understand the need for SDN and its data plane operations
- To understand the functions of control plane
- To comprehend the migration of networking functions to SDN environment
- To explore various techniques of network function virtualization
- To comprehend the concepts behind network virtualization

**UNIT I**

**SDN: BACKGROUND AND DATA PLANE**

**6**

Evolving Network Requirements – The SDN Approach – SDN and NFV-Related Standards – SDN Data Plane – OpenFlow Logical Network Device – OpenFlow Protocol.





### CO's-PO's & PSO's MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
1	3	3	3	3	3	2	-	-	-	-	-	3	3	3	2
2	3	3	3	2	2	2	-	-	-	-	-	3	3	2	2
3	3	3	3	3	1	2	-	-	-	-	-	3	2	3	2
4	2	3	3	2	2	1	-	-	-	-	-	2	2	1	2
5	3	3	2	2	2	1	-	-	-	-	-	2	2	2	2
CO	3	3	3	2	2	2	-	-	-	-	-	2	2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CEC371**

**MASSIVE MIMO NETWORKS**

**L T P C**

**2 0 2 3**

#### **COURSE OBJECTIVES:**

- To gain knowledge about massive MIMO networks.
- To understand the massive MIMO propagation channels.
- To learn about channel estimation in single cell and multicell massive MIMO systems.
- To comprehend the concepts of massive MIMO deployment in the context of single cell and multicell deployment.

#### **UNIT I MASSIVE MIMO NETWORKS**

**6**

Definition of Massive MIMO, Correlated Rayleigh Fading, System Model for Uplink and Downlink, Basic Impact of Spatial Channel Correlation, Channel Hardening and Favourable Propagation, Local Scattering Spatial Correlation Model

#### **UNIT II THE MASSIVE MIMO PROPAGATION CHANNEL**

**6**

Favorable Propagation and Deterministic Channels-Capacity Upper Bound-Distance from Favorable Propagation-Favorable Propagation and Linear Processing-Singular Values and Favorable Propagation, Favorable Propagation and Random Channels-Independent Rayleigh Fading-Uniformly Random Line-of-Sight (UR-LoS)-Independent Rayleigh Fading versus UR-LoS - Finite-Dimensional Channels

#### **UNIT III SINGLE-CELL SYSTEMS**

**6**

Uplink Pilots and Channel Estimation - Orthogonal Pilots- De-Spreading of the Received Pilot Signal-MMSE Channel Estimation, Uplink Data Transmission - Zero-Forcing -Maximum-Ratio, Downlink Data Transmission-Linear Precoding-Zero-Forcing-Maximum-Ratio, Discussion- Interpretation of the Effective SINR Expressions-Implications for Power Control-Scaling Laws and Upper Bounds on the SINR - Near-Optimality of Linear Processing when  $M \gg K$  - Net Spectral Efficiency - Limiting Factors: Number of Antennas and Mobility

#### **UNIT IV MULTI-CELL SYSTEMS**

**6**

Uplink Pilots and Channel Estimation, Uplink Data Transmission - Zero-Forcing -Maximum-Ratio, Downlink Data Transmission -Zero-Forcing - Maximum-Ratio, Discussion -Asymptotic Limits with Infinite Numbers of Base Station Antennas - The Effects of Pilot Contamination - Non-Synchronous Pilot Interference

#### **UNIT V CASE STUDIES**

**6**

Single-Cell Deployment Example: Fixed Broadband Access in Rural Area, Multi-Cell Deployment: Preliminaries and Algorithms, Multi-Cell Deployment Examples: Mobile Access - Dense Urban

Scenario - Suburban Scenario - Minimum Per-Terminal Throughput Performance -Additional Observations - Comparison of Power Control Policies

**30 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

Implementation of (Using Matlab)

1. Massive MIMO hybrid beamforming
2. Single cell massive MIMO downlink communications
3. Multicell massive MIMO downlink communications.
4. Precoding in massive MIMO single cell and multicell downlink communications
5. Channel estimation in massive MIMO system

**COURSE OUTCOMES:**

- CO1:** Understand and explain massive MIMO networks.
- CO2:** Analyze massive MIMO propagation channels and their capacity bounds
- CO3:** Examine channel estimation techniques for single cell system.
- CO4:** Analyze channel estimation techniques for multi cell system.
- CO5:** Explain the concepts underlining the deployment of single and multicell massive MIMO systems.

**TOTAL:60 PERIODS**

**TEXT BOOKS**

1. Thomas L. Marzetta, Erik G. Larsson, Hong Yang, Hien Quoc Ngo, “Fundamentals of Massive MIMO”, Cambridge University Press 2016. (UNITS II-V)
2. Emil Björnson, Jakob Hoydis and Luca Sanguinetti (2017), “Massive MIMO Networks: Spectral, Energy, and Hardware Efficiency”, Foundations and Trends, Now, 2017. (UNIT I)

**REFERENCES**

1. Long Zhao, Hui Zhao, Kan Zheng, “Wei Xiang Massive MIMO in 5G Networks: Selected Applications”, Springer 2018.
2. Leibo Liu, Guiqiang Peng, Shaojun Wei, “Massive MIMO Detection Algorithm and VLSI Architecture”, Springer 2019.
3. Shahid Mumtaz, Jonathan Rodriguez, Linglong Dai, “mmWave Massive MIMO A Paradigm for 5G”, Elsevier, 2017

**CO’s-PO’s & PSO’s MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1	1	2	2	-	-	-	-	-	2	3	1	2
2	3	3	2	2	2	2	-	-	-	-	-	1	2	2	1
3	3	2	2	2	2	2	-	-	-	-	-	1	3	3	2
4	3	3	2	2	2	2	-	-	-	-	-	1	3	1	3
5	3	2	2	2	2	2	-	-	-	-	-	2	3	3	2
CO	3	2.4	1.8	1.8	2	2	-	-	-	-	-	1.4	3	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CEC333      ADVANCED WIRELESS COMMUNICATION TECHNIQUES**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES**

- To understand the evolving paradigm of cooperative communication
- To understand concepts related to green wireless communication
- To enable the student to understand the different power saving strategies and energy efficient signal, system and network design.
- To expose the student to the energy saving techniques adopted in existing wireless components

- To provide understanding on protocols and networks related to green future wireless communication technologies.

**UNIT I COOPERATIVE COMMUNICATIONS AND GREEN CONCEPTS 9**

Network architectures and research issues in cooperative cellular wireless networks ; Cooperative communications in OFDM and MIMO cellular relay networks: issues and approaches; Fundamental trade-offs on the design of green radio networks, Green modulation and coding schemes.

**UNIT II COOPERATIVE TECHNIQUES 9**

Cooperative techniques for energy efficiency, Cooperative base station techniques for cellular wireless networks; Turbo base stations; Antenna architectures for cooperation; Cooperative communications in 3GPP LTE-Advanced, Partial information relaying and Coordinated multi-point transmission in LTE-Advanced.

**UNIT III RELAY-BASED COOPERATIVE CELLULAR NETWORKS 9**

Distributed space-time block codes ; Collaborative relaying in downlink cellular systems ; Radio resource optimization; Adaptive resource allocation ; Cross-layer scheduling design for cooperative wireless two-way relay networks ; Network coding in relay-based networks.

**UNIT IV GREEN RADIO NETWORKS 9**

Base Station Power-Management Techniques- Opportunistic spectrum and load management, Energy-saving techniques in cellular wireless base stations , Power-management for base stations in smart grid environment, Cooperative multi cell processing techniques for energy-efficient cellular wireless communications.

**UNIT V ACCESS TECHNIQUES FOR GREEN RADIO NETWORKS 9**

Cross-layer design of adaptive packet scheduling for green radio networks; Energy-efficient relaying for cooperative cellular wireless networks ; Energy performance in TDD-CDMA multihop cellular networks ; Resource allocation for green communication in relay-based cellular networks ; Green Radio Test-Beds and Standardization Activities.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1:** The student would be able to appreciate the necessity and the design aspects of cooperative communication

**CO2:** The student would be able to appreciate the necessity and the design aspects of green wireless communication.

**CO3:** The student would be able to evolve new techniques in wireless communication

**CO4:** The students would be able to demonstrate the feasibility of using mathematical models using simulation tools.

**CO5:** The student would be able to demonstrate the impact of the green engineering solutions in a global, economic, environmental and societal context.

**TEXT BOOKS**

1. Ekram Hossain, Dong In Kim, Vijay K. Bhargava , “Cooperative Cellular Wireless Networks”, Cambridge University Press, 2011.
2. Ekram Hossain, Vijay K. Bhargava(Editor), Gerhard P. Fettweis (Editor), “Green Radio Communication Networks”, Cambridge University Press, 2012.

**REFERENCES**

1. F. Richard Yu, Yu, Zhang and Victor C. M. Leung “Green Communications and Networking”, CRC press, 2012.

2. Ramjee Prasad and Shingo Ohmori, Dina Simunic, "Towards Green ICT", River Publishers, 2010.
3. Jinsong Wu, Sundeep Rangan and Honggang Zhang, "Green Communications: Theoretical Fundamentals, Algorithms and Applications", CRC Press, 2012.

**CO's-PO's & PSO's MAPPING**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	2	1	1	-	-	-	-	-	2	3	3	3
2	3	3	3	2	2	1	-	-	-	-	-	2	3	2	3
3	3	2	2	1	2	1	-	-	-	-	-	2	2	1	1
4	3	3	3	3	2	1	-	-	-	-	-	2	3	1	2
5	3	3	3	2	1	2	-	-	-	-	-	2	2	3	1
<b>CO</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>	<b>2</b>	<b>1.6</b>	<b>1.2</b>	-	-	-	-	-	<b>2</b>	<b>3</b>	<b>2</b>	<b>2</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation



**TEXT BOOKS:**

1. Harold Koontz and Heinz Weihrich "Essentials of management" Tata McGraw Hill, 1998.
2. Stephen P. Robbins and Mary Coulter, "Management", Prentice Hall (India) Pvt. Ltd., 10<sup>th</sup> Edition, 2009.

**REFERENCES:**

1. Robert Kreitner and Mamata Mohapatra, "Management", Biztantra, 2008.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, "Fundamentals of Management" Pearson Education, 7th Edition, 2011.
3. Tripathy PC and Reddy PN, "Principles of Management", Tata McGraw Hill, 1999.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1	3		-	-	-	1	-	-	-	-	-	-	2	1	1	
2	-	1	1	-	-	-	-	-	-	-	-	-	2	1	-	
3	1		-	2	-	-	1	-	2	-	1	1	-	-	2	
4	-	1	1	1	2	-	-	1	2	-	-	-	1	1	1	
5	1		-	-	1	1	-	-	-	3	-	1	1	-	1	
<b>AVg.</b>	1.66	1	1	1.5	1.5	1	1	1	1	2	3	1	1	1.5	1	1.25

1 - low, 2 - medium, 3 - high, '-' - no correlation

**GE3752****TOTAL QUALITY MANAGEMENT****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- Teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
- Explain the TQM Principles for application.
- Define the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
- Describe Taguchi's Quality Loss Function, Performance Measures and apply Techniques like QFD, TPM, COQ and BPR.
- Illustrate and apply QMS and EMS in any organization.

**UNIT I****INTRODUCTION****9**

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality - Definition of TQM - Basic concepts of TQM - Gurus of TQM (Brief introduction) - TQM Framework - Barriers to TQM - Benefits of TQM.

**UNIT II****TQM PRINCIPLES****9**

Leadership - Deming Philosophy, Quality Council, Quality statements and Strategic planning - Customer Satisfaction - Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal - Continuous process improvement - Juran Trilogy, PDCA cycle, 5S and Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating and Relationship development.

**UNIT III TQM TOOLS & TECHNIQUES I 9**

The seven traditional tools of quality - New management tools - Six-sigma Process Capability- Bench marking - Reasons to benchmark, Benchmarking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, Learning from the data, Using the findings, Pitfalls and Criticisms of Benchmarking - FMEA - Intent , Documentation, Stages: Design FMEA and Process FMEA.

**UNIT IV TQM TOOLS & TECHNIQUES II 9**

Quality circles – Quality Function Deployment (QFD) - Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures- Cost of Quality - BPR.

**UNIT V QUALITY MANAGEMENT SYSTEM 9**

Introduction-Benefits of ISO Registration-ISO 9000 Series of Standards-Sector-Specific Standards - AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements-Implementation-Documentation- Internal Audits-Registration-ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001-Benefits of EMS.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- CO1:** Ability to apply TQM concepts in a selected enterprise.
- CO2:** Ability to apply TQM principles in a selected enterprise.
- CO3:** Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
- CO4:** Ability to understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.
- CO5:** Ability to apply QMS and EMS in any organization.

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		3										3	2		3
2						3						3		2	
3					3				3					2	3
4		2			3	2	3	2				3	3	2	
5			3			3	3	2							
<b>AVg.</b>		2.5	3		3	2.6	3	2	3			3	2.5	2	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

**TEXT BOOK:**

1. Dale H. Besterfield, Carol B. Michna, Glen H. Besterfield, Mary B. Sacre, Hemant Urdhware she and Rashmi Urdhware she, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.

**REFERENCES:**

1. Joel E. Ross, "Total Quality Management – Text and Cases", Routledge., 2017.
2. Kiran D.R, "Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.
3. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.
4. Suganthi, L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006 .



**COURSE OBJECTIVES:**

- Understanding the concept of Engineering Economics.
- Implement various micro economics concept in real life.
- Gaining knowledge in the field of macro economics to enable the students to have better understanding of various components of macro economics.
- Understanding the different procedures of pricing.
- Learn the various cost related concepts in micro economics.

**UNIT I DEMAND & SUPPLY ANALYSIS 9**

Managerial Economics - Relationship with other disciplines - Firms: Types, objectives and goals - Managerial decisions - Decision analysis. Demand - Types of demand - Determinants of demand - Demand function – Demand elasticity - Demand forecasting - Supply - Determinants of supply - Supply function - Supply elasticity.

**UNIT II PRODUCTION AND COST ANALYSIS 9**

Production function - Returns to scale - Production optimization - Least cost input - Isoquants - Managerial uses of production function. Cost Concepts - Cost function - Determinants of cost - Short run and Long run cost curves - Cost Output Decision - Estimation of Cost.

**UNIT III PRICING 9**

Determinants of Price - Pricing under different objectives and different market structures - Price discrimination - Pricing methods in practice.

**UNIT IV FINANCIAL ACCOUNTING (ELEMENTARY TREATMENT) 9**

Balance sheet and related concepts - Profit & Loss Statement and related concepts - Financial Ratio Analysis - Cash flow analysis - Funds flow analysis - Comparative financial statements - Analysis & Interpretation of financial statements.

**UNIT V CAPITAL BUDGETING (ELEMENTARY TREATMENT) 9**

Investments - Risks and return evaluation of investment decision - Average rate of return - Payback Period - Net Present Value - Internal rate of return.

**TOTAL: 45 PERIODS****COURSE OUTCOMES: Students able to**

**CO1:** Upon successful completion of this course, students will acquire the skills to apply the basics of economics and cost analysis to engineering and take economically sound decisions

**CO2:** Evaluate the economic theories, cost concepts and pricing policies

**CO3:** Understand the market structures and integration concepts

**CO4:** Understand the measures of national income, the functions of banks and concepts of globalization

**CO5:** Apply the concepts of financial management for project appraisal

**TEXT BOOKS:**

1. Panneer Selvam, R, "Engineering Economics", Prentice Hall of India Ltd, New Delhi, 2001.
2. Managerial Economics: Analysis, Problems and Cases - P. L. Mehta, Edition, 13. Publisher, Sultan Chand, 2007.

**REFERENCES:**

1. Chan S.Park, "Contemporary Engineering Economics", Prentice Hall of India, 2011.
2. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg. Press, Texas, 2010.
3. Degarmo, E.P., Sullivan, W.G and Canada, J.R, "Engineering Economy", Macmillan, New York, 2011.
4. Zahid A khan: Engineering Economy, "Engineering Economy", Dorling Kindersley, 2012
5. Dr. S. N. Maheswari and Dr. S.K. Maheshwari: Financial Accounting, Vikas, 2009

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	-	3	-	-	-	-	-	-	-	2	-	-	1	3	-
2	-	3	-	-	-	-	-	-	-	-	-	-	-	2	2
3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
4	2	3	3	-	2	-	-	-	-	-	-	-	2	3	-
5	3	3	3	-	2	-	-	-	-	-	-	-	2	-	2
<b>AVg.</b>	2.5	2.4	3	-	2	-	-	-	-	2	-	-	1.8	2.6	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**GE3754****HUMAN RESOURCE MANAGEMENT**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVE:**

- To provide knowledge about management issues related to staffing,
- To provide knowledge about management issues related to training,
- To provide knowledge about management issues related to performance
- To provide knowledge about management issues related to compensation
- To provide knowledge about management issues related to human factors consideration and compliance with human resource requirements.

**UNIT I INTRODUCTION TO HUMAN RESOURCE MANAGEMENT 9**

The importance of human resources – Objective of Human Resource Management - Human resource policies - Role of human resource manager.

**UNIT II HUMAN RESOURCE PLANNING 9**

Importance of Human Resource Planning – Internal and External sources of Human Resources - Recruitment - Selection – Socialization.

**UNIT III TRAINING AND EXECUTIVE DEVELOPMENT 9**

Types of training and Executive development methods – purpose – benefits.

**UNIT IV EMPLOYEE COMPENSATION 9**

Compensation plan – Reward – Motivation – Career Development - Mentor – Protege relationships.

**UNIT V PERFORMANCE EVALUATION AND CONTROL 9**

Performance evaluation – Feedback - The control process – Importance – Methods – grievances – Causes – Redressal methods.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:****CO1:** Students would have gained knowledge on the various aspects of HRM**CO2:** Students will gain knowledge needed for success as a human resources professional.**CO3:** Students will develop the skills needed for a successful HR manager.**CO4:** Students would be prepared to implement the concepts learned in the workplace.**CO5:** Students would be aware of the emerging concepts in the field of HRM**TEXT BOOKS:**

1. Decenzo and Robbins, "Human Resource Management", 8th Edition, Wiley, 2007.

2. John Bernardin. H., "Human Resource Management – An Experimental Approach", 5th Edition, Tata McGraw Hill, 2013, New Delhi.

**REFERENCES:**

1. Luis R., Gomez-Mejia, DavidB. Balkin and Robert L. Cardy, "Managing Human Resources", 7<sup>th</sup> Edition, PHI, 2012.
2. Dessler, "Human Resource Management", Pearson Education Limited, 2007.

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	1	2	2	2	1	1	2	1	1	1	1	1	1
2	3	3	2	3	2	2	2	2	3	1	2	1	1	2	1
3	3	3	3	3	3	3	2	2	3	1	2	1	1	2	1
4	3	3	2	3	3	2	2	2	2	1	1	1	1	1	1
5	3	3	1	2	2	2	2	2	2	1	1	1	1	1	1
<b>AVg.</b>	2.8	2.8	1.8	2.6	2.6	2.2	1.8	1.8	2.4	1	1.4	1	1	1.4	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

**GE3755****KNOWLEDGE MANAGEMENT****L T P C**  
**3 0 0 3****COURSE OBJECTIVES:**

The student should be made to:

- Learn the Evolution of Knowledge management.
- Be familiar with tools.
- Be exposed to Applications.
- Be familiar with some case studies.

**UNIT I INTRODUCTION****9**

Introduction: An Introduction to Knowledge Management - The foundations of knowledge management- including cultural issues- technology applications organizational concepts and processes- management aspects- and decision support systems. The Evolution of Knowledge management: From Information Management to Knowledge Management - Key Challenges Facing the Evolution of Knowledge Management - Ethics for Knowledge Management.

**UNIT II CREATING THE CULTURE OF LEARNING AND KNOWLEDGE SHARING****9**

Organization and Knowledge Management - Building the Learning Organization. Knowledge Markets: Cooperation among Distributed Technical Specialists – Tacit Knowledge and Quality Assurance.

**UNIT III KNOWLEDGE MANAGEMENT-THE TOOLS 9**

Telecommunications and Networks in Knowledge Management - Internet Search Engines and Knowledge Management - Information Technology in Support of Knowledge Management - Knowledge Management and Vocabulary Control - Information Mapping in Information Retrieval - Information Coding in the Internet Environment - Repackaging Information.

**UNIT IV KNOWLEDGE MANAGEMENT APPLICATION 9**

Components of a Knowledge Strategy - Case Studies (From Library to Knowledge Center, Knowledge Management in the Health Sciences, Knowledge Management in Developing Countries).

**UNIT V FUTURE TRENDS AND CASE STUDIES 9**

Advanced topics and case studies in knowledge management - Development of a knowledge management map/plan that is integrated with an organization's strategic and business plan - A case study on Corporate Memories for supporting various aspects in the process life -cycles of an organization.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, the student should be able to:

**CO1:** Understand the process of acquiring knowledge from experts

**CO2:** Understand the learning organization.

**CO3:** Use the knowledge management tools.

**CO4:** Develop knowledge management Applications.

**CO5:** Design and develop enterprise applications.

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1					1											
2					2								1			
3					2									2		
4				1	1				1					1		
5				1	1				1					1		
<b>AVg.</b>				1	1.4				1				1	1.33		

1 - low, 2 - medium, 3 - high, '-' - no correlation

**TEXT BOOK:**

1. Srikantiah, T.K., Koenig, M., "Knowledge Management for the Information Professional" Information Today, Inc., 2000.

**REFERENCE:**

1. Nonaka, I., Takeuchi, H., "The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation", Oxford University Press, 1995.

**COURSE OBJECTIVES**

- To study the basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.
- To study the planning; organizing and staffing functions of management in professional organization.
- To study the leading; controlling and decision making functions of management in professional organization.
- To learn the organizational theory in professional organization.
- To learn the principles of productivity and modern concepts in management in professional organization.

**UNIT – I INTRODUCTION TO MANAGEMENT 9**

Management: Introduction; Definition and Functions – Approaches to the study of Management – Mintzberg's Ten Managerial Roles – Principles of Taylor; Fayol; Weber; Parker – Forms of Organization: Sole Proprietorship; Partnership; Company (Private and Public); Cooperative – Public Sector Vs Private Sector Organization – Business Environment: Economic; Social; Political; Legal – Trade Union: Definition; Functions; Merits & Demerits.

**UNIT – II FUNCTIONS OF MANAGEMENT - I 9**

Planning: Characteristics; Nature; Importance; Steps; Limitation; Planning Premises; Strategic Planning; Vision & Mission statement in Planning– Organizing: Organizing Theory; Principles; Types; Departmentalization; Centralization and Decentralization; Authority & Responsibility – Staffing: Systems Approach; Recruiting and Selection Process; Human Resource Development (HRD) Concept and Design.

**UNIT – III FUNCTIONS OF MANAGEMENT - II 9**

Directing (Leading): Leadership Traits; Style; Morale; Managerial Grids (Blake-Mouton, Reddin) – Communication: Purpose; Model; Barriers – Controlling: Process; Types; Levels; Guidelines; Audit (External, Internal, Merits); Preventive Control – Decision Making: Elements; Characteristics; Nature; Process; Classifications.

**UNIT – IV ORGANIZATION THEORY 9**

Organizational Conflict: Positive Aspects; Individual; Role; Interpersonal; Intra Group; Inter Group; Conflict Management – Maslow's hierarchy of needs theory; Herzberg's motivation-hygiene theory; McClelland's three needs motivation theory; Vroom's valence-expectancy theory – Change Management: Concept of Change; Lewin's Process of Change Model; Sources of Resistance; Overcoming Resistance; Guidelines to managing Conflict.

**UNIT – V PRODUCTIVITY AND MODERN TOPICS 9**

Productivity: Concept; Measurements; Affecting Factors; Methods to Improve – Modern Topics (concept, feature/characteristics, procedure, merits and demerits): Business Process Reengineering (BPR); Benchmarking; SWOT/SWOC Analysis; Total Productive Maintenance; Enterprise Resource Planning (ERP); Management of Information Systems (MIS).

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course the students would be able to

- CO1 Explain basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.
- CO2 Discuss the planning; organizing and staffing functions of management in professional organization.
- CO3 Apply the leading; controlling and decision making functions of management in professional organization.
- CO4 Discuss the organizational theory in professional organization.
- CO5 Apply principles of productivity and modern concepts in management in professional organization.

**TEXTBOOKS:**

1. M. Govindarajan and S. Natarajan, "Principles of Management", Prentice Hall of India, New Delhi, 2009.
2. Koontz. H. and Wehrich. H., "Essentials of Management: An International Perspective", 8<sup>th</sup> Edition, Tata McGrawhill, New Delhi, 2010.

**REFERENCES:**

1. Joseph J, Massie, "Essentials of Management", 4<sup>th</sup> Edition, Pearson Education, 1987.
2. Saxena, P. K., "Principles of Management: A Modern Approach", Global India Publications, 2009.
3. S.Chandran, "Organizational Behaviours", Vikas Publishing House Pvt. Ltd., 1994.
4. Richard L. Daft, "Organization Theory and Design", South Western College Publishing, 11<sup>th</sup> Edition, 2012.
5. S. TrevisCerto, "Modern Management Concepts and Skills", Pearson Education, 2018.

**CO's-PO's & PSO's MAPPING**

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
2	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
3	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
4	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
5	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

## MANDATORY COURSES I

<b>MX3081</b>	<b>INTRODUCTION TO WOMEN AND GENDER STUDIES</b>	<b>L T P C</b> <b>3 0 0 0</b>
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### **COURSE OUTLINE**

#### **UNIT I            CONCEPTS**

Sex vs. Gender, masculinity, femininity, socialization, patriarchy, public/ private, essentialism, binaryism, power, hegemony, hierarchy, stereotype, gender roles, gender relation, deconstruction, resistance, sexual division of labour.

#### **UNIT II            FEMINIST THEORY**

Liberal, Marxist, Socialist, Radical, Psychoanalytic, postmodernist, ecofeminist.

#### **UNIT III            WOMEN'S MOVEMENTS: GLOBAL, NATIONAL AND LOCAL**

Rise of Feminism in Europe and America.  
Women's Movement in India.

#### **UNIT IV            GENDER AND LANGUAGE**

Linguistic Forms and Gender.  
Gender and narratives.

#### **UNIT V            GENDER AND REPRESENTATION**

Advertising and popular visual media.

Gender and Representation in Alternative Media.  
Gender and social media.

**TOTAL : 45 PERIODS**

<b>MX3082</b>	<b>ELEMENTS OF LITERATURE</b>	<b>L T P C</b> <b>3 0 0 0</b>
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### **OBJECTIVE:**

- To make the students aware about the finer sensibilities of human existence through an art form. The students will learn to appreciate different forms of literature as suitable modes of expressing human experience.

### **1. COURSE CONTENTS**

Introduction to Elements of Literature

#### **1. Relevance of literature**

- a) Enhances Reading, thinking, discussing and writing skills.
- b) Develops finer sensibility for better human relationship.
- c) Increases understanding of the problem of humanity without bias.

d) Providing space to reconcile and get a cathartic effect.

## **2. Elements of fiction**

- a) Fiction, fact and literary truth.
- b) Fictional modes and patterns.
- c) Plot character and perspective.

## **3. Elements of poetry**

- a) Emotions and imaginations.
- b) Figurative language.
- c) (Simile, metaphor, conceit, symbol, pun and irony).
- d) Personification and animation.
- e) Rhetoric and trend.

## **4. Elements of drama**

- a) Drama as representational art.
- b) Content mode and elements.
- c) Theatrical performance.
- d) Drama as narration, mediation and persuasion.
- e) Features of tragedy, comedy and satire.

## **3. READINGS:**

1. An Introduction to the Study of English Literature, W.H. Hudson, Atlantic, 2007.
2. An Introduction to Literary Studies, Mario Klarer, Routledge, 2013.
3. The Experience of Poetry, Graham Mode, Open college of Arts with Open Unv Press, 1991.
4. The Elements of Fiction: A Survey, Ulf Wolf (ed), Wolfstuff, 2114.
5. The Elements of Drama, J.L.Styan, Literary Licensing, 2011.

### **3.1 Textbook:**

3.2 \*Reference Books:: To be decided by the teacher and student, on the basis of individual student so as to enable him or her to write the term paper.



#### 4. OTHER SESSION:

4.1\*Tutorials:

4.2\*Laboratory:

4.3\*Project: The students will write a term paper to show their understanding of a particular piece of literature

#### 5.\*ASSESSMENT:

5.1HA:

5.2Quizzes-HA:

5.3Periodical Examination: one

5.4Project/Lab: one (under the guidance of the teachers the students will take a volume of poetry, fiction or drama and write a term paper to show their understanding of it in a given context; sociological, psychological, historical, autobiographical etc.

5.5Final Exam:

**TOTAL : 45 PERIODS**

#### OUTCOME OF THE COURSE:

- Students will be able to understand the relevance of literature in human life and appreciate its aspects in developing finer sensibilities.

**MX3083**

**FILM APPRECIATION**

**L T P C  
3 0 0 0**

In this course on film appreciation, the students will be introduced broadly to the development of film as an art and entertainment form. It will also discuss the language of cinema as it evolved over a century. The students will be taught as to how to read a film and appreciate the various nuances of a film as a text. The students will be guided to study film joyfully.

#### **Theme - A: The Component of Films**

A-1: The material and equipment

A-2: The story, screenplay and script

A-3: The actors, crew members, and the director

A-4: The process of film making... structure of a film

#### **Theme - B: Evolution of Film Language**

B-1: Film language, form, movement etc.

B-2: Early cinema... **silent film** (Particularly French)

B-3: The emergence of feature films: **Birth of a Nation**

B-4: Talkies



measures, Roles and responsibilities of- community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Early Warning System – Advisories from Appropriate Agencies.- Relevance of indigenous Knowledge, appropriate technology and Local resources.

### **UNIT III DISASTER MANAGEMENT**

**9**

Components of Disaster Management – Preparedness of rescue and relief, mitigation, rehabilitation and reconstruction- Disaster Risk Management and post disaster management – Compensation and Insurance- Disaster Management Act (2005) and Policy - Other related policies, plans, programmes and legislation - Institutional Processes and Framework at State and Central Level- (NDMA –SDMA-DDMA-NRDF- Civic Volunteers)

### **UNIT IV TOOLS AND TECHNOLOGY FOR DISASTER MANAGEMENT**

**9**

Early warning systems -Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment. - Elements of Climate Resilient Development –Standard operation Procedure for disaster response – Financial planning for disaster Management

### **UNIT V DISASTER MANAGEMENT: CASE STUDIES**

**9**

Discussion on selected case studies to analyse the potential impacts and actions in the context of disasters-Landslide Hazard Zonation: Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.- Field work-Mock drill -

**TOTAL : 45 PERIODS**

#### **TEXT BOOKS:**

- 1 Taimpo (2016), Disaster Management and Preparedness, CRC Publications
- 2 Singh R (2017), Disaster Management Guidelines for earthquakes, Landslides, Avalanches and tsunami, Horizon Press Publications
- 3 Singhal J.P. “Disaster Management”, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
- 4 Tushar Bhattacharya, “Disaster Science and Management”, McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10:** 1259007367, **ISBN-13:** 978-1259007361]

#### **REFERENCES**

1. Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005.
2. Government of India, National Disaster Management Policy, 2009.
3. Shaw R (2016), Community based Disaster risk reduction, Oxford University Press

#### **COURSE OUTCOME:**

**CO1:** To impart knowledge on the concepts of Disaster, Vulnerability and Disaster Risk reduction (DRR)

**CO2:** To enhance understanding on Hazards, Vulnerability and Disaster Risk Assessment prevention and risk reduction

**CO3:** To develop disaster response skills by adopting relevant tools and technology

**CO4:** Enhance awareness of institutional processes for Disaster response in the country and

**CO5:** Develop rudimentary ability to respond to their surroundings with potential

Disaster response in areas where they live, with due sensitivity

### CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	3	-	-	2	2	-	-	2	-	2	-	1
2	3	3	3	3	-	-	2	1	-	-	2	-	2	-	1
3	3	3	3	3	-	-	2	2	-	-	-	-	2	-	1
4	3	3	2	3	-	-	2	1	-	-	2	-	2	-	1
5	3	3	2	3	-	-	2	2	-	-	2	-	3	-	1
<b>AVG</b>	3	3	3	3	-	-	2	2	-	-	2	-	2	-	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

### MANDATORY COURSES II

<b>MX3085</b>	<b>WELL-BEING WITH TRADITIONAL PRACTICES-YOGA, AYURVEDA AND SIDDHA</b>	<b>L T P C</b>
		<b>3 0 0 0</b>

#### **COURSE OBJECTIVES:**

- To enjoy life happily with fun filled new style activities that help to maintain health also
- To adapt a few lifestyle changes that will prevent many health disorders
- To be cool and handbill every emotion very smoothly in every walk of life
- To learn to eat cost effective but healthy foods that are rich in essential nutrients
- To develop immunity naturally that will improve resistance against many health disorders

#### **UNIT I HEALTH AND ITS IMPORTANCE**

**2+4**

**Health: Definition - Importance of maintaining health** - More importance on prevention than treatment

Ten types of health one has to maintain - Physical health - Mental health - Social health - Financial health - Emotional health - Spiritual health - Intellectual health - Relationship health - Environmental health - Occupational/Professional health.

**Present health status** - The life expectancy-present status - mortality rate - dreadful diseases - Non-communicable diseases (NCDs) the leading cause of death - 60% - heart disease – cancer – diabetes - chronic pulmonary diseases - risk factors – tobacco – alcohol - unhealthy diet - lack of physical activities.

**Types of diseases and disorders** - Lifestyle disorders – Obesity – Diabetes - Cardiovascular diseases – Cancer – Strokes – COPD - Arthritis - Mental health issues.

**Causes of the above diseases / disorders - Importance of prevention of illness** - Takes care of health - Improves quality of life - Reduces absenteeism - Increase satisfaction - Saves time

**Simple lifestyle modifications to maintain health** - Healthy Eating habits (Balanced diet according to age) Physical Activities (Stretching exercise, aerobics, resisting exercise) - Maintaining BMI-Importance and actions to be taken

## UNIT II            DIET

4+6

**Role of diet in maintaining health** - energy one needs to keep active throughout the day - nutrients one needs for growth and repair - helps one to stay strong and healthy - helps to prevent diet-related illness, such as some cancers - keeps active and - helps one to maintain a healthy weight - helps to reduce risk of developing lifestyle disorders like diabetes – arthritis – hypertension – PCOD – infertility – ADHD – sleeplessness -helps to reduce the risk of heart diseases - keeps the teeth and bones strong.

**Balanced Diet and its 7 Components** - Carbohydrates – Proteins – Fats – Vitamins – Minerals - Fibre and Water.

**Food additives and their merits & demerits** - Effects of food additives - Types of food additives - Food additives and processed foods - Food additives and their reactions

### **Definition of BMI and maintaining it with diet**

Importance - Consequences of not maintaining BMI - different steps to maintain optimal BM

### **Common cooking mistakes**

Different cooking methods, merits and demerits of each method

## UNIT III            ROLE OF AYURVEDA & SIDDHA SYSTEMS IN MAINTAINING HEALTH            4+4

**AYUSH systems and their role in maintaining health** - preventive aspect of AYUSH - AYUSH as a soft therapy.

**Secrets of traditional healthy living** - Traditional Diet and Nutrition - Regimen of Personal and Social Hygiene - Daily routine (Dinacharya) - Seasonal regimens (Ritucharya) - basic sanitation and healthy living environment - Sadvritta (good conduct) - for conducive social life.

**Principles of Siddha & Ayurveda systems** - Macrocosm and Microcosm theory - Panchekarana Theory / (Five Element Theory) 96 fundamental Principles - Uyir Thathukkal (Tri-Dosha Theory) - Udal Thathukkal

### **Prevention of illness with our traditional system of medicine**

Primary Prevention - To decrease the number of new cases of a disorder or illness - Health promotion/education, and - Specific protective measures - Secondary Prevention - To lower the rate of established cases of a disorder or illness in the population (prevalence) - Tertiary Prevention - To decrease the amount of disability associated with an existing disorder.

## UNIT IV            MENTAL WELLNESS

3+4

**Emotional health** - Definition and types - Three key elements: the subjective experience - the physiological response - the behavioral response - Importance of maintaining emotional health - Role of emotions in daily life -Short term and long term effects of emotional disturbances - Leading a healthy life with emotions - Practices for emotional health - Recognize how thoughts influence emotions - Cultivate positive thoughts - Practice self-compassion - Expressing a full range of emotions.

**Stress management** - Stress definition - Stress in daily life - How stress affects one's life - Identifying the cause of stress - Symptoms of stress - Managing stress (habits, tools, training, professional help) - Complications of stress mismanagement.

**Sleep** - Sleep and its importance for mental wellness - Sleep and digestion.

**Immunity** - Types and importance - Ways to develop immunity

## UNIT V YOGA

2+12

**Definition and importance of yoga** - Types of yoga - How to Choose the Right Kind for individuals according to their age - The Eight Limbs of Yoga - Simple yogasanas for cure and prevention of health disorders - What yoga can bring to our life.

**TOTAL : 45 PERIODS**

### TEXT BOOKS:

1. Nutrition and Dietetics - Ashley Martin, Published by White Word Publications, New York, NY 10001, USA
2. Yoga for Beginners\_ 35 Simple Yoga Poses to Calm Your Mind and Strengthen Your Body, by Cory Martin, Copyright © 2015 by Althea Press, Berkeley, California

### REFERENCES:

1. WHAT WE KNOW ABOUT EMOTIONAL INTELLIGENCE How It Affects Learning, Work, Relationships, and Our Mental Health, by Moshe Zeidner, Gerald Matthews, and Richard D. Roberts
2. A Bradford Book, The MIT Press, Cambridge, Massachusetts, London, England The Mindful Self-Compassion Workbook, Kristin Neff, Ph.D Christopher Germer, Ph.D, Published by The Guilford Press A Division of Guilford Publications, Inc.370 Seventh Avenue, Suite 1200, New York, NY 10001
1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4799645/>
2. **Simple lifestyle modifications to maintain health**  
<https://www.niddk.nih.gov/health-information/diet-nutrition/changing-habits-better-health#:~:text=Make%20your%20new%20healthy%20habit,t%20have%20time%20to%20cook.>
3. **Read more:** <https://www.legit.ng/1163909-classes-food-examples-functions.html>
4. <https://www.yaclass.in/p/science-state-board/class-9/nutrition-and-health-5926>
5. **Benefits of healthy eating** <https://www.cdc.gov/nutrition/resources-publications/benefits-of-healthy-eating.html>
6. **Food additives** <https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/food-additives>
7. **BMI** <https://www.hsph.harvard.edu/nutritionsource/healthy-weight/>  
<https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle--who-recommendations>
8. **Yoga** <https://www.healthifyme.com/blog/types-of-yoga/>  
<https://yogamedicine.com/guide-types-yoga-styles/>  
**Ayurveda** : <https://vikaspedia.in/health/ayush/ayurveda-1/concept-of-healthy-living-in-ayurveda>
9. **Siddha** : [http://www.tkdl.res.in/tkdl/langdefault/Siddha/Sid\\_Siddha\\_Concepts.asp](http://www.tkdl.res.in/tkdl/langdefault/Siddha/Sid_Siddha_Concepts.asp)
10. **CAM** : <https://www.hindawi.com/journals/ecam/2013/376327/>
11. **Preventive** herbs : <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3847409/>

### COURSE OUTCOMES:

After completing the course, the students will be able to:

**CO1:** Learn the importance of different components of health

**CO2:** Gain confidence to lead a healthy life

**CO3:** Learn new techniques to prevent lifestyle health disorders

**CO4:** Understand the importance of diet and workouts in maintaining health

**UNIT-I CONCEPTS AND PERSPECTIVES**

Meaning of History

Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history  
Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation  
verses evidence, concept of historical inevitability, Historical Positivism.

Science and Technology-Meaning, Scope and Importance, Interaction of science, technology &  
society, Sources of history on science and technology in India.

**UNIT-II HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA**

Introduction to the works of D.D. Kosambi, Dharmapal, Debiprasad Chattopadhyay, Rehman, S. Irfan  
Habib, Deepak Kumar, Dhruv Raina, and others.

**UNIT-III SCIENCE AND TECHNOLOGY IN ANCIENT INDIA**

Technology in pre-historic period

Beginning of agriculture and its impact on technology

Science and Technology during Vedic and Later Vedic times

Science and technology from 1<sup>st</sup> century AD to C-1200.

**UNIT-IV SCIENCE AND TECHNOLOGY IN MEDIEVAL INDIA**

Legacy of technology in Medieval India, Interactions with Arabs

Development in medical knowledge, interaction between Unani and Ayurveda and alchemy

Astronomy and Mathematics: interaction with Arabic Sciences

Science and Technology on the eve of British conquest

**UNIT-V SCIENCE AND TECHNOLOGY IN COLONIAL INDIA**

Science and the Empire

Indian response to Western Science

Growth of techno-scientific institutions

**UNIT-VI SCIENCE AND TECHNOLOGY IN A POST-INDEPENDENT INDIA**

Science, Technology and Development discourse

Shaping of the Science and Technology Policy

Developments in the field of Science and Technology

Science and technology in globalizing India

Social implications of new technologies like the Information Technology and Biotechnology

**TOTAL : 45 PERIODS**

Pre-Requisite: None. (Desirable: Universal Human Values 1, Universal Human Values 2)

**COURSE OBJECTIVES:**

- This course will begin with a short overview of human needs and desires and how different political-economic systems try to fulfill them. In the process, we will end with a critique of different systems and their implementations in the past, with possible future directions.

## **COURSE TOPICS:**

Considerations for humane society, holistic thought, human being's desires, harmony in self, harmony in relationships, society, and nature, societal systems. **(9 lectures, 1 hour each)**

(Refs: A Nagaraj, M K Gandhi, JC Kumarappa)

Capitalism – Free markets, demand-supply, perfect competition, laissez-faire, monopolies, imperialism. Liberal democracy. **(5 lectures)**

(Refs: Adam smith, J S Mill)

Fascism and totalitarianism. World war I and II. Cold war. **(2 lectures)**

Communism – Mode of production, theory of labour, surplus value, class struggle, dialectical materialism, historical materialism, Russian and Chinese models.

(Refs: Marx, Lenin, Mao, M N Roy) **(5 lectures)**

Welfare state. Relation with human desires. Empowered human beings, satisfaction. **(3 lectures)**

Gandhian thought. Swaraj, Decentralized economy & polity, Community. Control over one's lives. Relationship with nature. **(6 lectures)**

(Refs: M K Gandhi, Schumacher, Kumarappa)

Essential elements of Indian civilization. **(3 lectures)**

(Refs: Pt Sundarlal, R C Mazumdar, Dharampal)

Technology as driver of society, Role of education in shaping of society. Future directions. **(4 lectures)** (Refs: Nandkishore Acharya, David Dixon, Levis Mumford)

**Conclusion (2 lectures)**

**Total lectures: 39**

**Preferred Textbooks:** See Reference Books

**Reference Books:** Authors mentioned along with topics above. Detailed reading list will be provided.

## **GRADING:**

Mid sems	30
End sem	20
Home Assign	10
Term paper	40

**TOTAL : 45 PERIODS**



**COURSE OUTCOME:**

- The students will get an understanding of how societies are shaped by philosophy, political and economic system, how they relate to fulfilling human goals & desires with some case studies of how different attempts have been made in the past and how they have fared.

**MX3088****STATE, NATION BUILDING AND POLITICS IN INDIA****L T P C****3 0 0 0****COURSE OBJECTIVE:**

The objective of the course is to provide an understanding of the state, how it works through its main organs, primacy of politics and political process, the concept of sovereignty and its changing contours in a globalized world. In the light of this, an attempt will be made to acquaint the students with the main development and legacies of national movement and constitutional development in India, reasons for adopting a Parliamentary-federal system, the broad philosophy of the Constitution of India and the changing nature of Indian Political System. Challenges/ problems and issues concerning national integration and nation-building will also be discussed in the contemporary context with the aim of developing a future vision for a better India.

**TOPICS:**

Understanding the need and role of State and politics.

Development of Nation-State, sovereignty, sovereignty in a globalized world.

Organs of State – Executive, Legislature, Judiciary. Separation of powers, forms of government-unitary-federal, Presidential-Parliamentary,  
The idea of India.

1857 and the national awakening.

1885 Indian National Congress and development of national movement – its legacies. Constitution making and the Constitution of India.

Goals, objective and philosophy.

Why a federal system?

National integration and nation-building.

Challenges of nation-building – State against democracy (Kothari)

New social movements.

The changing nature of Indian Political System, the future scenario.

What can we do?

**OUTCOME OF THE COURSE:**

It is expected that this course will make students aware of the theoretical aspect of the state, its organs, its operationalization aspect, the background and philosophy behind the founding of the present political system, broad streams and challenges of national integration and nation-building in India. It will equip the students with the real understanding of our political system/ process in correct perspective and make them sit up and think for devising ways for better participation in the system with a view to making the governance and delivery system better for the common man who is often left unheard and unattended in our democratic setup besides generating a lot of dissatisfaction and difficulties for the system.

### **SUGGESTED READING:**

- i. Sunil Khilnani, The Idea of India. Penguin India Ltd., New Delhi.
- ii. Madhav Khosla, The Indian Constitution, Oxford University Press. New Delhi, 2012.
- iii. Brij Kishore Sharma, Introduction to the Indian Constitution, PHI, New Delhi, latest edition.
- iv. Sumantra Bose, Transforming India: Challenges to the World's Largest Democracy, Picador India, 2013.
- v. Atul Kohli, Democracy and Discontent: India's Growing Crisis of Governability, Cambridge University Press, Cambridge, U. K., 1991.
- vi. M. P. Singh and Rekha Saxena, Indian Politics: Contemporary Issues and Concerns, PHI, New Delhi, 2008, latest edition.
- vii. Rajni Kothari, Rethinking Democracy, Orient Longman, New Delhi, 2005.

**TOTAL : 45 PERIODS**

**MX3089**

**INDUSTRIAL SAFETY**

**L T P C**  
**3 0 0 0**

### **COURSE OBJECTIVES**

- To Understand the Introduction and basic Terminologies safety.
- To enable the students to learn about the Important Statutory Regulations and standards.
- To enable students to Conduct and participate the various Safety activities in the Industry.
- To have knowledge about Workplace Exposures and Hazards.
- To assess the various Hazards and consequences through various Risk Assessment Techniques.

### **UNIT I SAFETY TERMINOLOGIES**

Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators- lag Indicators-Flammability- Toxicity Time-weighted Average (TWA) - Threshold LimitValue (TLV) - Short Term Exposure Limit (STEL)- Immediately dangerous to life or health (IDLH)- acute and chronic Effects- Routes of Chemical Entry-Personnel Protective Equipment- Health and Safety Policy-Material Safety Data Sheet MSDS

### **UNIT II STANDARDS AND REGULATIONS**

Indian Factories Act-1948- Health- Safety- Hazardous materials and Welfare- ISO 45001:2018 occupational health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998- Hazard Identification and Risk Analysis- code of practice IS 15656:2006

### **UNIT III SAFETY ACTIVITIES**

Toolbox Talk- Role of safety Committee- Responsibilities of Safety Officers and Safety Representatives- Safety Training and Safety Incentives- Mock Drills- On-site Emergency Action Plan- Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment

### **UNIT IV WORKPLACE HEALTH AND SAFETY**

Noise hazard- Particulate matter- musculoskeletal disorder improper sitting poster and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety-Toxic gas Release

## **UNIT V HAZARD IDENTIFICATION TECHNIQUES**

Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment- Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment

**TOTAL : 45 PERIODS**

### **COURSE OUTCOMES:**

Course outcomes on completion of this course the student will be able:

**CO1:**Understand the basic concept of safety.

**CO2:**Obtain knowledge of Statutory Regulations and standards.

**CO3:**Know about the safety Activities of the Working Place.

**CO4:**Analyze on the impact of Occupational Exposures and their Remedies

**CO5:**Obtain knowledge of Risk Assessment Techniques.

### **TEXTBOOKS**

1. R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems KHANNA PUBLISHER
2. L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education

### **REFERENCES**

1. Frank Lees (2012) 'Lees' Loss Prevention in Process Industries.Butterworth-Heinemann publications, UK, 4th Edition.
2. John Ridley & John Channing (2008)Safety at Work: Routledge, 7th Edition.
3. Dan Petersen (2003) Techniques of Safety Management: A System Approach.
4. Alan Waring.(1996).Safety management system: Chapman &Hall,England
5. Society of Safety Engineers, USA

### **ONLINE RESOURCES**

ISO 45001:2018 occupational health and safety (OH&S) International Organization for Standardization <https://www.iso.org/standard/63787.html>

Indian Standard code of practice on occupational safety and health audit <https://law.resource.org/pub/in/bis/S02/is.14489.1998.pdf>

Indian Standard code of practice on Hazard Identification and Risk Analysis IS 15656:2006 <https://law.resource.org/pub/in/bis/S02/is.15656.2006.pdf>

**CO's-PO's & PSO's MAPPING**

Course Outcomes	Statement	Program Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the basic concept of safety.	3	3	3	1	1	3	2	2	3	3	1	3	3	3	3
CO2	Obtain knowledge of Statutory Regulations and standards.	2	3	2	2	1	3	2	3	3	2	1	3	3	3	3
CO3	Know about the safety Activities of the Working Place.	2	2	2	2	1	2	2	2	3	2	1	2	3	3	3
CO4	Analyze on the impact of Occupational Exposures and their Remedies	3	3	3	2	2	3	2	2	3	2	1	3	3	3	3
CO5	Obtain knowledge of Risk Assessment Techniques.	3	2	3	2	2	3	2	2	3	2	2	3	3	3	3
<b>Industrial safety</b>		3	3	3	2	1	3	2	2	3	2	1	3	3	3	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

## OPEN ELECTIVE I

OAS351

SPACE SCIENCE

L T P C  
3 0 0 3

### **COURSE OBJECTIVES:**

- To outline the space environment and their effects.
- To extend the origin of universe and development.
- To classify the galaxies and their evolution.
- To interpret the variable stars in the galaxies.
- To explain theory of formation of our solar system.

### **UNIT I INTRODUCTION 9**

Introduction to space science and applications – historical development – Space Environment-Vacuum and its Effects, Plasma & Radiation Environments and their Effects, Debris Environment and its Effects - Newton's Law of gravitation – Fundamental Physical Principles.

### **UNIT II ORIGIN OF UNIVERSE 9**

Early history of the universe – Big-Bang and Hubble expansion model of the universe – cosmic microwave background radiation – dark matter and dark energy.

### **UNIT III GALAXIES 7**

Galaxies, their evolution and origin – active galaxies and quasars – Galactic rotation – Stellar populations – galactic magnetic field and cosmic rays.

### **UNIT IV STARS 10**

Stellar spectra and structure – stellar evolution – Nucleo-synthesis and formation of elements – Classification of stars – Harvard classification system – Hertzsprung-Russel diagram – Luminosity of star – variable stars – composite stars (white dwarfs, Neutron stars, black hole, star clusters, supernova and binary stars) – Chandrasekhar limit.

### **UNIT V SOLAR SYSTEM 10**

Nebular theory of formation of our Solar System – Solar wind and nuclear reaction as the source of energy – Sun and Planets: Brief description about shape size – period of rotation about axis and period of revolution – distance of planets from sun – Bode's law – Kepler's Laws of planetary motion – Newton's deductions from Kepler's Laws – correction of Kepler's third law – determination of mass of earth – determination of mass of planets with respect to earth – Brief description of Asteroids – Satellites and Comets.

**TOTAL: 45 PERIODS**

### **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1:** Obtain a broad, basic knowledge of the space sciences.

**CO2:** Explain the scientific concepts such as evolution by means of natural selection, age of the Earth and solar system and the Big-Bang.

**CO3:** Describe the main features and formation theories of the various types of observed galaxies, in particular the Milky Way.

**CO4:** Explain stellar evolution, including red giants, supernovas, neutron stars, pulsars, white dwarfs and black holes, using evidence and presently accepted theories;

**CO5:** Describe the presently accepted formation theories of the solar system based upon observational and physical constraints;

**TEXT BOOKS:**

1. Hess W., "Introduction to Space Science", Gordon & Breach Science Pub; Revised Ed., 1968.
2. Krishnaswami K. S., "Astrophysics: A modern Perspective", New Age International, 2006.

**REFERENCES:**

1. Arnab Rai Choudhuri, "Astrophysics for Physicists", Cambridge University Press, New York, 2010.
2. Krishnaswami K. S., "Understanding cosmic Panorama", New Age International, 2008.

**OIE351****INTRODUCTION TO INDUSTRIAL ENGINEERING****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

The objective of this course is to provide foundation in Industrial Engineering in order to enable the students to make significant contributions for improvements in diverse organizations.

- Explain the concepts productivity and productivity measurement approaches.
- Explain the basic principles in facilities planning and plant location.
- Apply work study and ergonomic principles to design workplaces for the improvement of human performance
- Impart knowledge to design and implement Statistical Process control in any industry.
- Recognize the concept of Production and Operations Management in creating and enhancing a firm's competitive advantages

**UNIT I INTRODUCTION****9**

Concepts of Industrial Engineering – History and development of Industrial Engineering – Roles of Industrial Engineer – Applications of Industrial Engineering – Production Management Vs Industrial Engineering – Production System – Input Output Model – Productivity – Factors affecting Productivity – Increasing Productivity of resources – Kinds of Productivity measures.

**UNIT II PLANT LOCATION AND LAYOUT****9**

Factors affecting Plant location – COURSE OBJECTIVES of Plant Layout – Principles of Plant Layout – Types of Plant Layout – Methods of Plant and Facility Layout – Storage Space requirements – Plant Layout procedure – Line Balancing methods.

**UNIT III WORK SYSTEM DESIGN & ERGONOMICS****9**

Need – COURSE OBJECTIVES – Method Study procedure – Principles of Motion Economy – Work

Measurement procedures – Time Study – Work sampling- Ergonomics and its areas of application in the work system - Physical work load and energy expenditure, Anthropometry – measures – design procedure, Work postures-sitting, standing.

**UNIT IV STATISTICAL QUALITY CONTROL****9**

Definition and Concepts – Fundamentals – Control Charts for variables – Control Charts for attributes – Acceptance Sampling- O.C curve – Single sampling plan- Double sampling plan.

**UNIT V PRODUCTION PLANNING AND CONTROL****9**

Forecasting – Qualitative and Quantitative forecasting techniques – Types of production – Process planning – Economic Batch Quantity– Loading – Scheduling and control of production – Dispatching–Progress control.

**COURSE OUTCOMES:**

At the end of the course, Students will be able to

**CO1:** Ability To define the concepts of productivity and productivity measurement approaches.

**CO2:** Ability to evaluate appropriate location models for various facility types and design various facility layouts

**CO3:** Ability To conduct a method study and time study to improve the efficiency of the system.

**CO4:** Ability to Control the quality of processes using control charts in manufacturing/service industries.

**CO5:** Ability to define the Planning strategies and Material Requirement Plan.

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1	2											1		1		
2	2	2	3	2												
3	2	2	2	1	1			2				1	2			
4	2	2	3	1	1											
5	1	2	2									1			3	
<b>AVg.</b>	2.2	2	2.5	1.3	1			2				1	1	2	1	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

**TEXT BOOK:**

1. O.P.Khanna, 2010, Industrial Engineering and Management, Dhanpat Rai Publications.

**REFERENCES:**

1. Ravi Shankar, 2009, Industrial Engineering and Management, Galgotia Publications & Private Limited.
2. Martand Telsang, 2006, Industrial Engineering and Production Management, S. Chand and Company

**OBT351**

**FOOD, NUTRITION AND HEALTH**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- Build knowledge and an overview on general aspects of nutrition and health.
- Distinguish the nutritive value of various food items, BMI calculation differentiating super junk, and functional foods in the market.
- To Solve the real-world problems based on nutrition and health

**UNIT-I FOOD AND MICROBIOLOGY OF HEALTH:**

**9**

Food resources (plant, animal, microbes); Overview of current production systems; constraints and necessity of novel strategies. Functional and "Super" Foods - role in optimal nutrition. Sugar, protein and fat substitutes. Food and behaviour- physiological disturbances in alcoholism, drug abuse and smoking. Food Related Laws: Inspection – Microbial Indicators of product quality – Indicators of food safety – 229 Microbiological safety of foods - control strategies – Hazard Analysis Critical Point System (HACCP concept)- Microbiological criteria.





**COURSE OBJECTIVE:**

- To impart the knowledge and skills to identify, assess and mitigate the environmental and social impacts of developmental projects

**UNIT I INTRODUCTION****9**

Impacts of Development on Environment – Rio Principles of Sustainable Development- Environmental Impact Assessment (EIA) – Objectives – Historical development – EIA Types – EIA in project cycle –EIA Notification and Legal Framework–Stakeholders and their Role in EIA– Selection & Registration Criteria for EIA Consultants

**UNIT II ENVIRONMENTAL ASSESSMENT****9**

Screening and Scoping in EIA – Drafting of Terms of Reference, Baseline monitoring, Prediction and Assessment of Impact on land, water, air, noise and energy, flora and fauna - Matrices – Networks – Checklist Methods - Mathematical models for Impact prediction – Analysis of alternatives

**UNIT III ENVIRONMENTAL MANAGEMENT PLAN****9**

Plan for mitigation of adverse impact on water, air and land, water, energy, flora and fauna – Environmental Monitoring Plan – EIA Report Preparation – Review of EIA Reports – Public Hearing-Environmental Clearance Post Project Monitoring

**UNIT IV SOCIO ECONOMIC ASSESSMENT****9**

Baseline monitoring of Socio economic environment – Identification of Project Affected Personal – Rehabilitation and Resettlement Plan- Economic valuation of Environmental impacts – Cost benefit Analysis-

**UNIT V CASE STUDIES****9**

EIA case studies pertaining to Infrastructure Projects – Real Estate Development - Roads and Bridges – Mass Rapid Transport Systems - Ports and Harbor – Airports - Dams and Irrigation projects - Power plants – CETPs- Waste Processing and Disposal facilities – Mining Projects.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

The students completing the course will have ability to

**CO1:**carry out scoping and screening of developmental projects for environmental and social assessments

**CO2:**explain different methodologies for environmental impact prediction and assessment

**CO3:**plan environmental impact assessments and environmental management plans

**CO4:**evaluate environmental impact assessment reports

**TEXTBOOKS:**

- Canter, R.L, "Environmental impact Assessment ", 2nd Edition, McGraw Hill Inc, New Delhi,1995.
- Lohani, B., J.W. Evans, H. Ludwig, R.R. Everitt, Richard A. Carpenter, and S.L. Tu, "Environmental Impact Assessment for Developing Countries in Asia", Volume 1 – Overview, Asian Development Bank,1997.
- Peter Morris, Riki Therivel "Methods of Environmental Impact Assessment", Routledge Publishers,2009.

## REFERENCES:

1. Becker H. A., Frank Vanclay, "The International handbook of social impact assessment" conceptual and methodological advances, Edward Elgar Publishing, 2003.
2. Barry Sadler and Mary McCabe, "Environmental Impact Assessment Training Resource Manual", United Nations Environment Programme, 2002.
3. Judith Petts, "Handbook of Environmental Impact Assessment Vol. I and II", Blackwell Science New York, 1998.
4. Ministry of Environment and Forests EIA Notification and Sectoral Guides, Government of India, New Delhi, 2010.

**OEE351**

**RENEWABLE ENERGY SYSTEM**

**L T P C**

**3 0 0 3**

## COURSE OBJECTIVES:

- To Provide knowledge about various renewable energy technologies
- To enable students to understand and design a PV system.
- To provide knowledge about wind energy system.
- To Provide knowledge about various possible hybrid energy systems
- To gain knowledge about application of various renewable energy technologies

### UNIT I INTRODUCTION

**9**

Primary energy sources, renewable vs. non-renewable primary energy sources, renewable energy resources in India, Current usage of renewable energy sources in India, future potential of renewable energy in power production and development of renewable energy technologies.

### UNIT II SOLAR ENERGY

**9**

Solar Radiation and its measurements, Solar Thermal Energy Conversion from plate Solar Collectors, Concentrating Collectors and its Types, Efficiency and performance of collectors,. Direct Solar Electricity Conversion from Photovoltaic, types of solar cells and its application of battery charger, domestic lighting, street lighting, and water pumping, power generation schemes. Recent Advances in PV Applications: Building Integrated PV, Grid Connected PV Systems,

### UNIT III WIND ENERGY

**9**

Wind energy principles, wind site and its resource assessment, wind assessment, Factors influencing wind, wind turbine components, wind energy conversion systems (WECS), Classification of WECS devices, wind electric generating and control systems, characteristics and applications.

### UNIT IV BIO-ENERGY

**9**

Energy from biomass, Principle of biomass conversion technologies/process and their classification, Bio gas generation, types of biogas plants, selection of site for biogas plant, classification of biogas plants, Advantage and disadvantages of biogas generation, thermal gasification of biomass, biomass gasifies, Application of biomass and biogas plants and their economics.

### UNIT V OTHER TYPES OF ENERGY

**9**

Energy conversion from Hydrogen and Fuel cells, Geo thermal energy Resources, types of wells, methods of harnessing the energy, potential in India. OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants and their economics.

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES:

At the end of the course students will be able to:

**CO1:** Attained knowledge about various renewable energy technologies

**CO2:** Ability to understand and design a PV system.

**CO3:** Understand the concept of various wind energy system.

**CO4:** Gained knowledge about various possible hybrid energy systems

**CO5:** Attained knowledge about various application of renewable energy technologies

## REFERENCES

1. Twidell & Wier, 'Renewable Energy Resources' CRC Press( Taylor & Francis).
2. Tiwari and Ghosal/ Narosa, 'Renewable energy resources'.
3. D.P.Kothari, K.C.Singhal, 'Renewable energy sources and emerging technologies', P.H.I.
4. D.S.Chauhan, S.K. Srivastava, 'Non – Conventional Energy Resources', New Age Publishers, 2006.
5. B.H.Khan, 'Non – Conventional Energy Resources', Tata Mc Graw Hill, 2006.

## CO's-PO's & PSO's MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	2	3	3	3
CO2	3	2	-	-	-	-	-	-	-	-	-	2	3	3	3
CO3	3	2	-	-	-	-	-	-	-	-	-	2	3	3	3
CO4	3	2	-	-	-	-	-	-	-	-	-	2	3	3	3
CO5	3	2	-	-	-	-	-	-	-	-	-	2	3	3	3
Avg.	3	2	-	-	-	-	-	-	-	-	-	2	3	3	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

## OEI351 INTRODUCTION TO INDUSTRIAL INSTRUMENTATION AND CONTROL L T P C 3 0 0 3

### COURSE OBJECTIVES:

- To introduce common unit operations carried out in process industries.
- To impart knowledge about the important unit operations taking place in process industries.
- To prepare them to take up a case study on selected process industries like petrochemical industry, power plant industry and paper & pulp industry to make the students understand the different measurement and control techniques for important processes.
- Facilitate the students to apply knowledge to select appropriate measurement technique and control strategy for a given process.

### UNIT - I COMMON UNIT OPERATIONS IN PROCESS INDUSTRIES - I 9

Unit Operation, Measurement and Control:-Transport of solid, liquid and gases - Evaporators – Crystallizers-Dryers.

### UNIT -II COMMON UNIT OPERATIONS IN PROCESS INDUSTRIES -II 9

Unit Operation, Measurement and Control: - Distillation – Refrigeration processes – Chemical reactors.

**UNIT - III PROCESS MEASUREMENT AND CONTROL IN PETROCHEMICAL INDUSTRY 9**

Process flow diagram of Petro Chemical Industry - Gas oil separation in production platform – wet gas processing – Fractionation Column – Catalytic Cracking unit – Catalytic reforming unit

**UNIT - IV PROCESS MEASUREMENT AND CONTROL IN THERMAL POWER PLANT INDUSTRY 9**

Process flow diagram of Coal fired thermal Power Plant– Coal pulverizer - Deaerator – Boiler drum - Superheater – Turbines.

**UNIT - V PROCESS MEASUREMENT AND CONTROL IN PAPER & PULP INDUSTRY 9**

Process flow diagram of paper and pulp industry – Batch digester – Continuous sulphated digester – Control problems on the paper machine.

**TOTAL: 45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 5**

- Study the characteristics of various processing units involved in chemical plant.
- Develop the process model by using predefined unit operations (e.g. mixing, distillation, heating) from the library of any process simulator.
- Analyse the functioning of each processing units with help of virtual unit operations packages.
- Perform a physical property analysis using simulation packages
- Implement distillation column analysis using simulation software.
- Create process flow models and diagrams

**COURSE OUTCOMES:**

**Students able to**

- CO1** understand common unit operations in process industries. L2
- CO2** Identify the dynamics of important unit operations in petro chemical industry. L2
- CO3** develop understanding of important processes taking place selected case studies namely petrochemical industry, power plant industry and paper & pulp industry. L5
- CO4** Select appropriate measurement techniques for selective processes. L5
- CO5** Develop controller structure based on the process knowledge. L5
- CO6** Analyze the operation and challenges in integrated industrial processes. L4

**TEXT BOOKS:**

1. Balchen ,J.G., and Mumme, K.J., “ Process Control structures and applications”, Van Nostrand Reinhold Co., New York, 1988
2. Warren L. McCabe, Julian C. Smith and Peter Harriot, “Unit Operations of Chemical Engineering”, McGraw-Hill International Edition, New York, Sixth Edition, 2001.

**REFERENCES:**

1. Liptak B.G., “Instrument and Automation Engineers' Handbook: Process Measurement and Analysis”, Fifth Edition, CRC Press, 2016.
2. James R.couper, Roy Penny, W., James R.Fair and Stanley M.Walas, “Chemical Process Equipment: Selection and Design”, Gulf Professional Publishing, 2010.
3. Austin G.T and Shreeves, A.G.T., “Chemical Process Industries”, McGraw–Hill International student, Singapore, 1985.

- Luyben W.C., "Process Modeling, Simulation and Control for Chemical Engineers", McGraw-Hill International edition, USA, 1989.
- K. Krishnaswamy, Process Control, new age publishers , 2009.

**List of Open Source Software/ Learning website:**

- <https://www.aspentech.com/en>
- <http://avtechscientific.com/>
- <https://www.chemstations.com/CHEMCAD/>
- <https://www.prosim.net/en/product/prosimplus-steady-state-simulation-and-optimization-of-processes/>
- <https://www.cocosimulator.org/>
- <https://dwsim.fossee.in/>

**CO's-PO's & PSO's MAPPING**

PO,PS O CO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O 1	PS O 2	PS O 3
CO1	3	3	1					1		1					
CO2	3	3	1					1		1	2				2
CO3	3	3	1					1		1					
CO4	3	3	1	3	3			1		1			3	3	
CO5	3	3	3			3		1		1			3	3	3
CO6	3	3	2	3	2	1	2	1		2	1	1			2
Avg	3	3	1.5	3	2.5	2	2	1		1.16	1.5	1	3	3	2.3 3

1- low, 2-medium, 3-high, '-'- no correlation

OMA351

GRAPH THEORY

L T P C  
3 0 0 3

**COURSE OBJECTIVES**

- To understand the graph models and basic concepts of graphs.
- To study the characterization and properties of trees and graph connectivity.
- To provide an exposure to the Eulerian and Hamiltonian graphs.
- To introduce Graph colouring and explain its significance.
- To provide an understanding of Optimization Graph Algorithms.

**UNIT I INTRODUCTION TO GRAPHS**

9

Graphs and Graph Models – Connected graphs – Common classes of graphs – Multi graphs and Digraphs – Degree of a vertex – Degree Sequence – Graphs and Matrices – Isomorphism of graphs.

**UNIT I TREES AND CONNECTIVITY**

9

Bridges – Trees – Characterization and properties of trees – Cut vertices – Connectivity.

**UNIT III TRAVERSABILITY****9**

Eulerian graphs – Characterization of Eulerian graphs – Hamiltonian graphs – Necessary condition for Hamiltonian graphs – Sufficient condition for Hamiltonian graphs.

**UNIT IV PLANARITY AND COLOURING****9**

Planar Graphs – The Euler Identity – Non planar Graphs – Vertex Colouring – Lower and Upper bounds of chromatic number.

**UNIT V OPTIMIZATION GRAPH ALGORITHMS****9**

Dijkstra's shortest path algorithm – Kruskal's and Prim's minimum spanning tree algorithms – Transport Network – The Max-Flow Min-Cut Theorem – The Labeling Procedure – Maximum flow problem.

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

At the end of this course, the student will be able to

**CO1:**Apply graph models for solving real world problem.

**CO2:**Understand the importance the natural applications of trees and graph connectivity.

**CO3:**Understand the characterization study of Eulerian graphs and Hamiltonian graphs.

**CO4:**Apply the graph colouring concepts in partitioning problems.

**CO5:**Apply the standard optimization graph algorithms in solving application problems.

**TEXT BOOKS**

1. Gary Chartrand and Ping Zhang, "Introduction to Graph Theory", Tata McGraw – Hill companies Inc., New York, 2006.
2. Ralph P. Grimaldi, "Discrete and Combinatorial Mathematics, An applied introduction" Fifth edition, Pearson Education, Inc, Singapore, 2004.

**REFERENCES**

1. Balakrishnan R. and Ranganathan K., "A Text Book of Graph Theory", Springer – Verlag, New York, 2012.
2. Douglas B. West, "Introduction to Graph Theory", Pearson, Second Edition, New York, 2018.

**CO's-PO's & PSO's MAPPING**

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3												
CO2		2	2		2										
CO3		2	2	2						2					
CO4	2	2	2												
CO5		3	2		2					3					
CO6															

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CCS355****NEURAL NETWORKS AND DEEP LEARNING****L T P C****2 0 2 3****COURSE OBJECTIVES:**

- To understand the basics in deep neural networks
- To understand the basics of associative memory and unsupervised learning networks

- To apply CNN architectures of deep neural networks
- To analyze the key computations underlying deep learning, then use them to build and train deep neural networks for various tasks.
- To apply autoencoders and generative models for suitable applications.

#### **UNIT I INTRODUCTION 6**

Neural Networks-Application Scope of Neural Networks-Artificial Neural Network: An Introduction-Evolution of Neural Networks-Basic Models of Artificial Neural Network- Important Terminologies of ANNs-Supervised Learning Network.

#### **UNIT II ASSOCIATIVE MEMORY AND UNSUPERVISED LEARNING NETWORKS 6**

Training Algorithms for Pattern Association-Autoassociative Memory Network-Heteroassociative Memory Network-Bidirectional Associative Memory (BAM)-Hopfield Networks-Iterative Autoassociative Memory Networks-Temporal Associative Memory Network-Fixed Weight Competitive Nets-Kohonen Self-Organizing Feature Maps-Learning Vector Quantization-Counter propagation Networks-Adaptive Resonance Theory Network.

#### **UNIT III THIRD-GENERATION NEURAL NETWORKS 6**

Spiking Neural Networks-Convolutional Neural Networks-Deep Learning Neural Networks-Extreme Learning Machine Model-Convolutional Neural Networks: The Convolution Operation – Motivation – Pooling – Variants of the basic Convolution Function – Structured Outputs – Data Types – Efficient Convolution Algorithms – Neuroscientific Basis – Applications: Computer Vision, Image Generation, Image Compression.

#### **UNIT IV DEEP FEEDFORWARD NETWORKS 6**

History of Deep Learning- A Probabilistic Theory of Deep Learning- Gradient Learning – Chain Rule and Backpropagation - Regularization: Dataset Augmentation – Noise Robustness -Early Stopping, Bagging and Dropout - batch normalization- VC Dimension and Neural Nets.

#### **UNIT V RECURRENT NEURAL NETWORKS 6**

Recurrent Neural Networks: Introduction – Recursive Neural Networks – Bidirectional RNNs – Deep Recurrent Networks – Applications: Image Generation, Image Compression, Natural Language Processing. Complete Auto encoder, Regularized Autoencoder, Stochastic Encoders and Decoders, Contractive Encoders.

**30 PERIODS**

#### **LAB EXPERIMENTS:**

1. Implement simple vector addition in TensorFlow.
2. Implement a regression model in Keras.
3. Implement a perceptron in TensorFlow/Keras Environment.
4. Implement a Feed-Forward Network in TensorFlow/Keras.
5. Implement an Image Classifier using CNN in TensorFlow/Keras.
6. Improve the Deep learning model by fine tuning hyper parameters.
7. Implement a Transfer Learning concept in Image Classification.
8. Using a pre trained model on Keras for Transfer Learning
9. Perform Sentiment Analysis using RNN
10. Implement an LSTM based Autoencoder in TensorFlow/Keras.
11. Image generation using GAN

**Additional Experiments:**

12. Train a Deep learning model to classify a given image using pre trained model
13. Recommendation system from sales data using Deep Learning
14. Implement Object Detection using CNN
15. Implement any simple Reinforcement Algorithm for an NLP problem

**30 PERIODS**  
**TOTAL:60 PERIODS**

**COURSE OUTCOMES:**

**At the end of this course, the students will be able to:**

**CO1:** Apply Convolution Neural Network for image processing.

**CO2:** Understand the basics of associative memory and unsupervised learning networks.

**CO3:** Apply CNN and its variants for suitable applications.

**CO4:** Analyze the key computations underlying deep learning and use them to build and train deep neural networks for various tasks.

**CO5:** Apply autoencoders and generative models for suitable applications.

**TEXT BOOKS:**

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016.
2. Francois Chollet, "Deep Learning with Python", Second Edition, Manning Publications, 2021.

**REFERENCES:**

1. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn and TensorFlow", Oreilly, 2018.
2. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017.
3. Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", Springer International Publishing, 1st Edition, 2018.
4. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
5. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
6. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017.
7. S Rajasekaran, G A Vijayalakshmi Pai, "Neural Networks, FuzzyLogic and Genetic Algorithm, Synthesis and Applications", PHI Learning, 2017.
8. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017
9. James A Freeman, David M S Kapura, "Neural Networks Algorithms, Applications, and Programming Techniques", Addison Wesley, 2003.

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	2	3	1	-	-	2	1	-	-	2	2	1
2	3	1	2	1	-	-	-	-	-	1	2	2	-	1	-
3	3	3	3	3	3	1	-	-	2	1	-	-	2	2	1
4	3	3	3	3	3	-	-	-	2	-	2	3	2	2	2
5	1	1	3	2	3	-	-	-	2	-	-	-	1	1	-
<b>AVg.</b>	2.6	2	2.8	2.2	2.4	0.4	0	0	1.6	0.6	0.8	1	1.4	1.6	0.8

1 - low, 2 - medium, 3 - high, '-' - no correlation



**COURSE OBJECTIVES:**

- The primary objective of this module is to examine and explore the role and importance of digital marketing in today's rapidly changing business environment.
- It also focuses on how digital marketing can be utilized by organizations and how its effectiveness can be measured.

**UNIT I INTRODUCTION TO ONLINE MARKET 6**

Online Market space- Digital Marketing Strategy- Components - Opportunities for building Brand Website - Planning and Creation - Content Marketing.

**UNIT II SEARCH ENGINE OPTIMISATION 6**

Search Engine optimisation - Keyword Strategy- SEO Strategy - SEO success factors -On-Page Techniques - Off-Page Techniques. Search Engine Marketing- How Search Engine works- SEM components- PPC advertising -Display Advertisement

**UNIT III E- MAIL MARKETING 6**

E- Mail Marketing - Types of E- Mail Marketing - Email Automation - Lead Generation - Integrating Email with Social Media and Mobile- Measuring and maximizing email campaign effectiveness. Mobile Marketing- Mobile Inventory/channels- Location based; Context based; Coupons and offers, Mobile Apps, Mobile Commerce, SMS Campaigns-Profiling and targeting

**UNIT IV SOCIAL MEDIA MARKETING 6**

Social Media Marketing - Social Media Channels- Leveraging Social media for brand conversations and buzz. Successful /benchmark Social media campaigns. Engagement Marketing- Building Customer relationships - Creating Loyalty drivers - Influencer Marketing.

**UNIT V DIGITAL TRANSFORMATION 6**

Digital Transformation & Channel Attribution- Analytics- Ad-words, Email, Mobile, Social Media, Web Analytics - Changing your strategy based on analysis- Recent trends in Digital marketing.

**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS**

1. Subscribe to a weekly/quarterly newsletter and analyze how its content and structure aid with the branding of the company and how it aids its potential customer segments.
2. Perform keyword search for a skincare hospital website based on search volume and competition using Google keyword planner tool.
3. Demonstrate how to use the Google WebMasters Indexing API
4. Discuss an interesting case study regarding how an insurance company manages leads.
5. Discuss negative and positive impacts and ethical implications of using social media for political advertising.
6. Discuss how Predictive analytics is impacting marketing automation

**COURSE OUTCOMES:**

**CO1:** To examine and explore the role and importance of digital marketing in today's rapidly changing business environment..

**CO2:** To focuses on how digital marketing can be utilized by organizations and how its effectiveness can be measured.

**CO3:** To know the key elements of a digital marketing strategy.

**CO4:** To study how the effectiveness of a digital marketing campaign can be measured

**CO5:** To demonstrate advanced practical skills in common digital marketing tools such as SEO, SEM, Social media and Blogs.

**TOTAL:60 PERIODS**

**TEXT BOOKS**

1. Fundamentals of Digital Marketing by Puneet Singh Bhatia;Publisher: Pearson Education;
2. First edition ( July 2017);ISBN-10: 933258737X;ISBN-13: 978-9332587373.
3. Digital Marketing by Vandana Ahuja ;Publisher: Oxford University Press ( April 2015). ISBN-10: 0199455449
4. Marketing 4.0: Moving from Traditional to Digital by Philip Kotler;Publisher: Wiley; 1st edition ( April 2017); ISBN10: 9788126566938;ISBN 13: 9788126566938;ASIN: 8126566930.
5. Ryan, D. (2014 ). Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation, Kogan Page Limited..
6. Barker, Barker, Bormann and Neher(2017), Social Media Marketing: A Strategic Approach, 2E South-Western ,Cengage Learning.
7. Pulizzi,J Beginner's Guide to Digital Marketing , Mcgraw Hill Education

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	1	3	-	-	-	1	2	3	3	3	3	3
2	2	2	2	1	3	-	-	-	1	2	3	3	3	3	3
3	1	1	1	2	2	-	-	-	1	2	1	1	3	2	1
4	3	2	2	3	1	-	-	-	1	3	2	3	2	3	2
5	2	3	1	3	3	-	-	-	2	3	1	2	1	2	1
<b>AVg.</b>	2.2	2.2	1.6	2	2.4	-	-	-	1.2	2.4	2	2.4	2.4	2.6	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OPEN ELECTIVE II**

**OIE352**

**RESOURCE MANAGEMENT TECHNIQUES**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- Learn to formulate linear programming problems and solve LPP using simple algorithm
- Learn to solve networking problems
- Learn to formulate and solve integer programming problems
- Learn to solve Non Linear programming problems
- Learn to understand and solve project management problems

**UNIT I LINEAR PROGRAMMING**

**9**

Principal components of decision problem – Modeling phases – LP formulation and graphic solution – Resource allocation problems – simplex method – sensitivity analysis.

**UNIT II DUALITY AND NETWORKS**

**9**

Definition of dual problems – primal – Dual relationships – Dual simplex method –post optimality analysis – Transportation and assignment model – Shortest route problem.

**UNIT III INTEGER PROGRAMMING 9**

Cutting plan algorithm – Branch and bound methods, Multistage (Dynamic) programming.

**UNIT IV CLASSICAL OPTIMISATION THEROY: 9**

Unconstrained external problems, Newton – Ralphson method – Equality constraints –Jacobean methods – Lagrangian method – Kuhn – Tucker conditions – Simple problems.

**UNIT V OBJECT SCHEDULOING: 9**

Network diagram representation – Critical path method – Time charts and resource leveling – PERT.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of the course, the students should be able to:

**CO1** : Understand to formulate linear programming problems and solve LPP using simple algorithm

**CO2** : Understand to solve networking problems

**CO3** : Understand to formulate and solve integer programming problems

**CO4** : Understand to solve Non Linear programming problems

**CO5** : Understand to understand and solve project management problems

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		3	3	2									3	2	3
2		3	3	2									3	2	3
3		3	3	2									3	2	3
4		3	3	2									3	2	3
5		3	3	2									3	2	3
AVg.		3	3	2									3	2	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

**TEXT BOOK:**

1. H.A. Taha, "Operation Research", Prentice Hall of India, 2002.

**RFERENCES:**

1. Paneer selvam, 'Operations Research' Prentice Hall of India, 2002.
2. Anderson 'Quantitative Methods for Business', 8<sup>th</sup> Edition, Thomson Learning, 2002.
3. Winston 'Operations Research for Business', Thomson Learning, 2003.
4. Vohra, 'Quantitative Techniques in Management', Tata Mc Graw Hill, 2002.
5. Anand sarma, 'Operation Research' Himalaya Publishing House, 2003.

**OMG351**

**FINTECH REGULATION**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

1. To learn about Laws and Regulation
2. To acquire the knowledge of Regulations of Fintech firm and their role in Market

**UNIT I INTRODUCTION 9**

The Role of the Regulators, Equal Treatment and Competition, Need for a regulatory assessment of Fintech, India Regulations, The Risks to Consider, Regtech and SupTech, The rise of TechFins, Regulatory sandboxes, compliance and whistleblowing.

**UNIT II INNOVATION AND REGULATION 9**

The technology, market and the law, Regulation and Innovation in Banking and Finance, Regulations of Fintech Firms and their role in Market-Based Chains, Current Regulatory Approach, Fintech Innovations in Banking, Asset Management, Insurance, Pensions and Healthcare Schemes, Patentability of FinTech inventions.

**UNIT II CROWDFUNDING AND DIGITAL ASSETS 9**

Types of crowdfunding, The Jobs Act, Regulation crowdfunding, Regulation A+, Regulation D crowdfunding, Intrastate offerings, Digital Assets – Three uses of Digital Assets, A world of Altcoins, Stablecoins, Digital Asset Forks, Initial Coin Offerings, Regulatory Framework for Digital and Crypto Assets, Central Bank Digital Currencies.

**UNIT IV MARKETPLACE LENDING AND MOBILE PAYMENTS 9**

Online Lending Business Models, Payday Loans, Consumer Protection Laws, Debt Collection, Equal Credit Opportunity Act, Contract Formation and the E-Sign Act, Military Lending Act, Securities Laws Considerations, Mobile Devices, Payment Cards and the Law, Truth in Lending Act and Regulation Z, Card Act, Electronic Fund Transfer Act and Regulation E, Fair Credit Reporting Act, Federal Bank Secrecy Act, State Money Transmitter Laws.

**UNIT V ANTI-MONEY LAUNDERING AND CYBERSECURITY 9**

Reporting requirements under the Bank Secrecy Act, Patriot Act, Panalties for violating the BSA, Virtual currencies and the Bank Secrecy Act, Cybersecurity Frameworks, Cybersecurity Act of 2015, Contractual and Self Regulatory obligations.

**TOTAL:45 PERIODS**

**REFERENCES**

1. JelenaMadir, FinTech – Law and Regulation, Edward Elgar Publishing Limited, 2019
2. Valerio Lemma, Fintech Regulation : Exploring New Challenges of the Capital Markets Union, Palgrave Macmillan, 2020
3. Chris Brummer, Fintech Law in a Nutshell, West Academic Publishing, 2020
4. Bernardo Nicoletti, The Future of Fintech, Integrating Finance and Technology in Financial Services, Springer Nature, 2017
5. Kevin C. Taylor, FinTech Law : A Guide to Technology Law in the Financial Services Industry, BNA Books, 2014
6. Lee Reiners, FinTech Law and Policy, 2018

**OFD351 HOLISTIC NUTRITION L T P C  
3 0 0 3**

**UNIT I NUTRITION AND HEALTH 9**

Introduction to the principles of nutrition; Basics of nutrition including; micronutrients (vitamins and minerals), the energy-yielding nutrients (Carbohydrates, Lipids and Proteins), metabolism, digestion, absorption and energy balance. Lipids: their functions, classification, dietary requirements, digestion & absorption, metabolism and links to the major fatal diseases, heart disease and cancer.

**UNIT II AYURVEDA – MIND/BODY HEALING 9**

Philosophy of Holistic Nutrition with spiritual and psychological approaches towards attaining optimal health; Principles and practical applications of Ayurveda, the oldest healing system in the world. Three forces – Vata, Pitta and Kapha, that combine in each being into a distinct constitution. Practical dietary and lifestyle recommendations for different constitutions will also be explored in real case studies.

**UNIT III NUTRITION AND ENVIRONMENT 9**

Based on an underlying philosophy that environments maintain and promote health and that individuals have a right to self-determination and self-knowledge, Nutrition principles which promote health and prevent disease. Safety of our food supply, naturally occurring and environmental toxins in foods, microbes and food poisoning.

**UNIT IV COMPARATIVE DIETS 9**

Evaluating principles of food dynamics, nutrient proportions, holistic individuality, the law of opposites, food combining, and more. Therapeutic benefits and limitations of several alternative diet approaches, including: modern diets (intermittent fasting, macrobiotics), food combining (colour-therapy/rainbow diet), high protein diets (Ketogenic, Paleo), Vegetarian approaches (plant-based/vegetarian/vegan variations, fruitarian, raw food), as well as cleansing and detoxification diets (caffeine, alcohol, and nicotine detoxes, juice fasts).

**UNIT V PREVENTIVE HEALTH CARE 9**

Proper nutrition protection against, reverse and/or retard many ailments including: osteoporosis, diabetes, atherosclerosis and high blood pressure, arthritis, cancer, anemia, kidney disease and colon cancer. Current research developments on phytochemicals, antioxidants and nutraceuticals will be explored.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

- CO1** Discuss the role of essential nutrients in physical, mental and emotional wellness
- CO2** Discuss the role of deficiencies in essential nutrients in the disease process
- CO3** Explain how the standard American diet relates to the disease process
- CO4** Identify five contemporary eating “styles” and lists the pros and cons of each
- CO5** Discuss the concept of whole foods nutrition and its relationship to wellness

**TEXTBOOKS**

1. Desai, B. B., Handbook of Nutrition and Diet. Marcel Dekker, New York. 2000
2. Macrae, R., Rolonson Roles and Sadlu, M.J. 1994. Encyclopedia of Food Science & Technology & Nutrition. Vol. XI. Academic Press

**REFERENCES**

1. Modern Nutrition in Health & Disease by Young & Shils.
2. Food, Nutrition and Diet Therapy – by Krause and Mahan 1996, Publisher- W.B. Saunders, ISBN: 0721658350
3. Nutritive Value of Indian Foods.- by C. Gopalan, B. V. Rama Sastri, S. C. Balasubramanian Published by National Institute of Nutrition, Indian Council of Medical Research, 1989



**CO3:**The students will be able to apply IT principles and concepts for management of field operations.

**CO4:**The students will get an understanding about weather models, their inputs and applications.

**CO5:**The students will get an understanding of how IT can be used for e-governance in agriculture.

### CO's-PO's & PSO's MAPPING

PO/PSO		Course Outcome					Overall correlation of CO s to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	2	3	2	3	2	2
PO2	Problem Analysis	3	3	3	3	3	3
PO3	Design/ Development of Solutions	3	3	3	3	3	3
PO4	Investigations	2	3	2	1	2	2
PO5	Modern Tool Usage	3	3	3	3	3	3
PO6	Individual and Team work	1	1	2	2	3	2
PO7	Communication	3	3	3	3	3	3
PO8	The Engineer and Society	3	3	2	3	3	3
PO9	Ethics	1	1	2	1	2	1
PO10	Environment and Sustainability	3	3	3	3	3	3
PO11	Project Management and Finance	3	3	3	3	3	3
PO12	Life Long Learning	3	3	3	3	3	3
PSO1	To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	1	1	2	2	3	2
PSO2	To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.	1	1	2	2	3	2
PSO3	To inculcate entrepreneurial skills through strong Industry-Institution linkage.	1	1	2	2	3	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES:**

- To introduce the control system components and transfer function model with their graphical representation
- To understand the analysis of system in time domain along with steady state error.
- To introduce frequency response analysis of systems.
- To accord basic knowledge in design of compensators.
- To introduce the state space models.

**UNIT – I MATHEMATICAL MODELLING 9**

Introduction – transfer function – simple electrical, mechanical, ,pneumatic , hydraulic and thermal systems–analogies

**UNIT -II FEEDBACK CONTROL SYSTEMS 9**

Control system components - Block diagram representation of control systems, Reduction of block diagrams, Signal flow graphs, Output to input ratios

**UNIT - III TIME DOMAIN ANALYSIS 9**

Response of systems to different inputs viz., Step impulse, pulse, parabolic and sinusoidal inputs, Time response of first and second order systems, steady state errors and error constants of unity feedback circuit.

**UNIT - IV STABILITY ANALYSIS 9**

Necessaryandsufficientconditions,Routh-Hurwitzcriteriaofstability,RootlocusandBodetechniques,Conceptandconstruction,frequencyresponse.

**UNIT - V STATE SPACE TECHNIQUE 9**

State vectors–state space models-Digital Controllers–design aspects.

**TOTAL: 45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 5**

1. Explore various controllers presently used in industries.
2. Develop control structures for industrial processes.
3. Implement the controllers for various transfer functions of industrial systems.
4. Using software tools for practical exposures to the controllers used in industries by undergoing training.
5. Realisation of various stability criterion techniques for economical operation of process.

**COURSE OUTCOMES:**

- CO1** To represent and develop systems in different forms using the knowledge gained (L5).
- CO2** To analyses the system in time and frequency domain (L4).
- CO3** Ability to Derive Transfer function Model of Electrical and Mechanical Systems. (L2)
- CO4** Ability to Obtain the transfer Function by the Reduction of Block diagram & Signal flow graph (L3)
- CO5** To analyses the stability of physical systems(L4).
- CO6** To acquire and analyse knowledge in State variable model for MIMO systems(L1)



**TEXT BOOKS:**

1. Nagarath, I.J. and Gopal, M., "Control Systems Engineering", New Age International Publishers, 2017.
2. Benjamin C. Kuo, "Automatic Control Systems", Wiley, 2014

**REFERENCES:**

1. Katsuhiko Ogata, "Modern Control Engineering", Pearson, 2015.
2. Richard C. Dorf and Bishop, R.H., "Modern Control Systems", Pearson Education, 2009.
3. John J.D., Azzo Constantine, H. and Houpis Stuart, N Sheldon, "Linear Control System Analysis and Design with MATLAB", CRC Taylor & Francis Reprint 2009.
4. Ramesh C. Panda and T. Thyagarajan, "An Introduction to Process Modelling Identification and Control of Engineers", Narosa Publishing House, 2017.
5. M. Gopal, "Control System: Principle and design", McGraw Hill Education, 2012.
6. NPTEL Video Lecture Notes on "Control Engineering" by Prof. S. D. Agashe, IIT Bombay.

**List of Open Source Software/ Learning website:**

1. <https://nptel.ac.in/courses/112107240>
2. [https://onlinecourses.nptel.ac.in/noc20\\_me25/preview](https://onlinecourses.nptel.ac.in/noc20_me25/preview)
3. [https://onlinecourses.nptel.ac.in/noc20\\_ee90/preview](https://onlinecourses.nptel.ac.in/noc20_ee90/preview)
4. <https://www.classcentral.com/course/swayam-automatic-control-9850>

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1 L5	3	3	3	3	-	-	-	1	-	1	-	1			
2 L4	3	3	3	2	-	-	-	1	-	1	-	1			
3 L2	2	1	2	1	-	-	-	1	-	1	-	1			
4 L5	3	3	3	3	-	-	-	1	-	1	-	1			
5 L4	3	3	3	2	-	-	-	1	-	1	-	1			
6 L4	3	3	3	2	-	-	-	1	-	1	-	1			
AVg.	2.8	2.6	3	2.1	-	-	-	1	-	1	-	1			

1-low, 2-medium, 3-high, "-"- no correlation

**Note:** The average value of this course to be used for program articulation matrix.

OPY351

PHARMACEUTICAL NANOTECHNOLOGY

L T P C

3 0 0 3

**COURSE OBJECTIVES:**

- The goal of this course is to provide an insight into the fundamentals of nanotechnology in biomedical and Pharmaceutical research. It will also guide the students to understand how nanomaterials can be used for a diversity of analytical and medicinal rationales.

**UNIT I NANOSTRUCTURES**

9

Preparation, properties and characterization - Self-assembling nanostructure - vesicular and micellar polymerization-nanofilms - Metal Nanoparticles- lipid nanoparticles- nanoemulsion - Molecular nanomaterials: dendrimers, etc.,

- UNIT II NANOTECHNOLOGY IN BIOMEDICAL INDUSTRY 9**  
 Reconstructive Intervention and Surgery- Nanomaterials in bone substitutes and dentistry – Implants and Prosthesis -in vivo imaging- genetic defects and other disease states — Nanorobotics in Surgery –Nanocarriers: sustained, controlled, targeted drug delivery systems.
- UNIT III NANOTECHNOLOGY IN CANCER THERAPY 9**  
 Cancer Cell Targeting and Detection- Polymeric Nanoparticles for cancer treatment – mechanism of drug delivery to tumors -advantages and limitations - Multifunctional Agents - Cancer Imaging – Magnetic Resonance Imaging- Cancer Immunotherapy.
- UNIT IV NANOTECHNOLOGY IN COSMETICS 9**  
 Polymers in cosmetics: Film Formers – Thickeners – Hair Colouring – Conditioning Polymers: conditioning, Cleansing – Silicons – Emulsions – Stimuli Responsive Polymeric Systems - Formulation of Nano Gels, Shampoos, Hair-conditioners -Micellar self-assembly Sun-screen dispersions for UV protection – Color cosmetics.
- UNIT V NANOTOXICITY 9**  
 NanoToxicology- introduction, dose relationship- Hazard Classification-Risk assessment and management - factors affecting nano toxicity- Dermal Effects of Nanomaterials, Pulmonary, Neuro and Cardiovascular effects of Nanoparticles - Gene–Cellular and molecular Interactions of Nanomaterials.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

The student will be able to

- CO1:**Identify the process for the preparation and characterization of the different nanostructured materials.
- CO2:**Apply the nanotechnology in biomedical discipline with related to drug delivery and disease diagnosis
- CO3:**Develop the process, experiments and apply in identifying in a societal and global context.
- CO4:**Design and develop the process with suitable equipment for the preparation of nanomaterials in developing cosmetic products.
- CO5:**Understand the ethical principles to confirm the safety of the nano products with respect to risk assessment and its management.
- CO6:**Have the knowledge about nanotechnology products and its different applications in a societal and global context.

**TEXT BOOKS:**

1. Springer Handbook of Nanotechnology- Ed. by B. Bhushan, Springer-Verlag 2004
2. Nanobiotechnology: Concepts, Applications and Perspectives,. CM.Niemeyer C A. Mirkin, (Eds) , Wiley, 2004
3. Nanotechnology: Health and Environmental Risks, Jo Anne Shatkin, Second Edition, CRC Press, 2013
4. Sarah E. Morgan, Kathleen O. Havelka, Robert Y. Lochhead “Cosmetic Nanotechnology: Polymers and Colloids in Cosmetics”, American Chemical Society, 2006.

**REFERENCES:**

1. Nanotechnology in Biology and Medicine: Methods, Devices and Applications, Tuan VoDinh, CRC Press, 2007
2. The Chemistry of Nanomaterials: Synthesis, Properties and Applications, C.N.R. Rao, A. Muller, A. K. Cheetham (Eds), Wiley-VCH Verlag 2004
3. Nanotechnology: Environmental Health and safety, Risks, Regulation and Management, Matthew Hull and Diana Bowman, Elsevier, 2010.

## CO's-PO's & PSO's MAPPING

Course Outcome Statements	Programme Outcomes (PO)															
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
<b>CO1</b>	3	3							1	2		2	3			2
<b>CO2</b>	3	3			2	2	3							3		
<b>CO3</b>		3	3	3	2	2			1				3		3	
<b>CO4</b>			3	3		2			1						3	
<b>CO5</b>						3		3	2			2	3			3
<b>CO6</b>	3		3			2						2	3		3	2
<b>Overall CO</b>	3	3							1	2		2	3			2

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

(1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.)

**OAE351**

**AVIATION MANAGEMENT**

**L T P C  
3 0 0 3**

### COURSE OBJECTIVES:

- To acquire solid background of managerial skills in aviation management
- To develop personality to face business difficulties.
- To control multicultural conditions.
- To identify the relevant analytical and logical skills to deal with problems in the airline industry.
- To learn the concepts of performing well in teams, professionalism, and the knowledge acquired in the field of airport planning, airport security, passengers forecasting, aerodromes work etc

### UNIT I INTRODUCTION

**9**

History of aviation – organisation, global, social & ethical environment – history of Aviation in India – major players in the airline industry - swot analysis of the different Airline companies in India – market potential of airline industry in India – new airport Development plans – current challenges in the airline industry - competition in the Airline industry – domestic and international from an Indian perspective

### UNIT II AIRPORT INFRASTRUCTURE AND MANAGEMENT

**8**

Airport planning – terminal planning design and operation – airport operations – Airport functions – organisation structure in an airline - airport authority of India - Comparison of global and Indian airport management – role of AAI -airline privatisation - full Privatisation - gradual privatisation – partial privatization

### UNIT III AIR TRANSPORT SERVICES

**12**

Various airport services - international air transport services – Indian scenario – an Overview of airports in Delhi, Mumbai, Hyderabad and Bangalore – the role of private Operators – airport development fees, rates, tariffs

**UNIT IV      INSTITUTIONAL FRAMEWORK      8**  
Role of DGCA - slot allocation – methodology followed by AFC and DGCA -management of Bilaterals – economic regulations

**UNIT V      CONTROLLING      8**  
Role of air traffic control - airspace and navigational aids – control process – case Studies in airline industry – Mumbai Delhi airport privatisation – Navi Mumbai airport Tendering process – 6 cases in the airline industry

**TOTAL : 45 PERIODS**

**TEXT BOOKS**

1. Graham.A. Managing Airports: An International Perspective - Butterworth - Heinemann, Oxford 2001.
2. Wells.A. Airport Planning and Management, 4th Edition McGraw- Hill, London 2000.

**REFERENCES**

1. Doganis. R. The Airport Business Routledge, London 1992
2. Alexender T. Wells, Seth Young, Principles of Airport Management, McGraw Hill 2003
3. P S Senguttavan Fundamentals of Air Transport Management , Excel Books 2007
4. Richard de Neuffille, Airport Systems: Planning, Design and Management, McGraw-Hill London 2007.
- 5.. Manual of Aerodrome licensing of AAI airports – AAI website – freely downloadable – issue may 2010

**COURSE OUTCOMES:**

**CO1:**To interpret business difficulties.

**CO2:**To Dissect multicultural conditions.

**CO3:**To identify and apply the relevant analytical and logical skills to deal with problems in the airline industry.

**CO4:**To Develop well in teams, professionalism etc.

**CO5:**To apply the knowledge acquired in the field of airport planning, airport security, passengers forecasting, aerodromes work etc.

**CCS342**

**DEVOPS**

**L T P C**  
**2 0 2 3**

**COURSE OBJECTIVES:**

- To introduce DevOps terminology, definition & concepts
- To understand the different Version control tools like Git, Mercurial
- To understand the concepts of Continuous Integration/ Continuous Testing/ Continuous Deployment)
- To understand Configuration management using Ansible
- Illustrate the benefits and drive the adoption of cloud-based Devops tools to solve real world problems

**UNIT I      INTRODUCTION TO DEVOPS      6**  
Devops Essentials - Introduction To AWS, GCP, Azure - Version control systems: Git and Github.

**UNIT II                    COMPILE AND BUILD USING MAVEN & GRADLE                    6**  
Introduction, Installation of Maven, POM files, Maven Build lifecycle, Build phases(compile build, test, package) Maven Profiles, Maven repositories(local, central, global),Maven plugins, Maven create and build Artifacts, Dependency management, Installation of Gradle, Understand build using Gradle

**UNIT III                    CONTINUOUS INTEGRATION USING JENKINS                    6**  
Install & Configure Jenkins, Jenkins Architecture Overview, Creating a Jenkins Job, Configuring a Jenkins job, Introduction to Plugins, Adding Plugins to Jenkins, Commonly used plugins (Git Plugin, Parameter Plugin, HTML Publisher, Copy Artifact and Extended choice parameters). Configuring Jenkins to work with java, Git and Maven, Creating a Jenkins Build and Jenkins workspace.

**UNIT IV                    CONFIGURATION MANAGEMENT USING ANSIBLE                    6**  
Ansible Introduction, Installation, Ansible master/slave configuration, YAML basics, Ansible modules, Ansible Inventory files, Ansible playbooks, Ansible Roles, adhoc commands in ansible

**UNIT V                    BUILDING DEVOPS PIPELINES USING AZURE                    6**  
Create Github Account, Create Repository, Create Azure Organization, Create a new pipeline, Build a sample code, Modify azure-pipelines.yaml file

**COURSE OUTCOMES:**

- CO1:** Understand different actions performed through Version control tools like Git.
- CO2:** Perform Continuous Integration and Continuous Testing and Continuous Deployment using Jenkins by building and automating test cases using Maven & Gradle.
- CO3:** Ability to Perform Automated Continuous Deployment
- CO4:** Ability to do configuration management using Ansible
- CO5:** Understand to leverage Cloud-based DevOps tools using Azure DevOps

**30 PERIODS**  
**30 PERIODS**

**PRACTICAL EXERCISES:**

1. Create Maven Build pipeline in Azure
2. Run regression tests using Maven Build pipeline in Azure
3. Install Jenkins in Cloud
4. Create CI pipeline using Jenkins
5. Create a CD pipeline in Jenkins and deploy in Cloud
6. Create an Ansible playbook for a simple web application infrastructure
7. Build a simple application using Gradle
8. Install Ansible and configure ansible roles and to write playbooks

**TEXT BOOKS**

1. Roberto Vormittag, “A Practical Guide to Git and GitHub for Windows Users: From Beginner to Expert in Easy Step-By-Step Exercises”, Second Edition, Kindle Edition, 2016.
2. Jason Cannon, “Linux for Beginners: An Introduction to the Linux Operating System and Command Line”, Kindle Edition, 2014

**REFERENCES**

1. Hands-On Azure Devops: Cidc Implementation For Mobile, Hybrid, And Web Applications Using Azure Devops And Microsoft Azure: CICD Implementation for ... DevOps and Microsoft Azure (English Edition) Paperback – 1 January 2020

2. by Mitesh Soni
3. Jeff Geerling, "Ansible for DevOps: Server and configuration management for humans", First Edition, 2015.
4. David Johnson, "Ansible for DevOps: Everything You Need to Know to Use Ansible for DevOps", Second Edition, 2016.
5. Mariot Tsitoara, "Ansible 6. Beginning Git and GitHub: A Comprehensive Guide to Version Control, Project Management, and Teamwork for the New Developer", Second Edition, 2019.
6. <https://www.jenkins.io/user-handbook.pdf>
7. <https://maven.apache.org/guides/getting-started/>

### CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	3	-	-	-	-	-	-	-	2	2	2
2	3	3	3	2	3	-	-	-	-	-	-	-	2	2	2
3	3	3	3	2	3	-	-	-	-	-	-	-	2	2	2
4	3	3	3	2	3	-	-	-	-	-	-	-	2	2	2
5	3	3	3	2	3	-	-	-	-	-	-	-	2	2	2
AVg.	3	3	3	2	3	-	-	-	-	-	-	-	2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

CCS361

ROBOTIC PROCESS AUTOMATION

L T P C  
2 0 2 3

#### COURSE OBJECTIVES:

- To understand the basic concepts of Robotic Process Automation.
- To expose to the key RPA design and development strategies and methodologies.
- To learn the fundamental RPA logic and structure.
- To explore the Exception Handling, Debugging and Logging operations in RPA.
- To learn to deploy and Maintain the software bot.

#### UNIT I INTRODUCTION TO ROBOTIC PROCESS AUTOMATION

6

Emergence of Robotic Process Automation (RPA), Evolution of RPA, Differentiating RPA from Automation - Benefits of RPA - Application areas of RPA, Components of RPA, RPA Platforms. Robotic Process Automation Tools - Templates, User Interface, Domains in Activities, Workflow Files.

#### UNIT II AUTOMATION PROCESS ACTIVITIES

6

Sequence, Flowchart & Control Flow: Sequencing the Workflow, Activities, Flowchart, Control Flow for Decision making. Data Manipulation: Variables, Collection, Arguments, Data Table, Clipboard management, File operations Controls: Finding the control, waiting for a control, Act on a control, UiExplorer, Handling Events

#### UNIT III APP INTEGRATION, RECORDING AND SCRAPING

6

App Integration, Recording, Scraping, Selector, Workflow Activities. Recording mouse and keyboard actions to perform operation, Scraping data from website and writing to CSV. Process Mining.

**UNIT IV EXCEPTION HANDLING AND CODE MANAGEMENT****6**

Exception handling, Common exceptions, Logging- Debugging techniques, Collecting crash dumps, Error reporting. Code management and maintenance: Project organization, Nesting workflows, Reusability, Templates, Commenting techniques, State Machine.

**UNIT V DEPLOYMENT AND MAINTENANCE****6**

Publishing using publish utility, Orchestration Server, Control bots, Orchestration Server to deploy bots, License management, Publishing and managing updates. RPA Vendors - Open Source RPA, Future of RPA

**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS****Setup and Configure a RPA tool and understand the user interface of the tool:**

1. Create a Sequence to obtain user inputs display them using a message box;
2. Create a Flowchart to navigate to a desired page based on a condition;
3. Create a State Machine workflow to compare user input with a random number.
4. Build a process in the RPA platform using UI Automation Activities.
5. Create an automation process using key System Activities, Variables and Arguments
6. Also implement Automation using System Trigger
7. Automate login to (web)Email account
8. Recording mouse and keyboard actions.
9. Scraping data from website and writing to CSV
10. Implement Error Handling in RPA platform
11. Web Scraping
12. Email Query Processing

**TOTAL:60 PERIODS****TEXT BOOKS:**

1. Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath by Alok Mani Tripathi, Packt Publishing, 2018.
2. Tom Taulli , “The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems”, Apress publications, 2020.

**REFERENCES:**

1. Frank Casale (Author), Rebecca Dilla (Author), Heidi Jaynes (Author), Lauren Livingston (Author), Introduction to Robotic Process Automation: a Primer, Institute of Robotic Process Automation, Amazon Asia-Pacific Holdings Private Limited, 2018
2. Richard Murdoch, Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant, Amazon Asia-Pacific Holdings Private Limited, 2018
3. A Gerardus Blokdyk, “Robotic Process Automation Rpa A Complete Guide “, 2020

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	3	-	-	-	1	3	3	2	2	2	1
2	1	1	2	3	3	-	-	-	1	2	3	1	3	2	1
3	2	3	2	3	3	-	-	-	2	3	1	1	3	3	3
4	1	2	1	2	2	-	-	-	1	2	1	3	3	3	2
5	3	3	3	3	3	-	-	-	3	1	1	1	3	2	1
AVg.	2	2.2	2	2.4	2.8	-	-	-	1.6	2.2	1.8	1.6	2.8	2.4	1.6

1 - low, 2 - medium, 3 - high, '-' - no correlation

### OPEN ELCTIVE III

OHS351

ENGLISH FOR COMPETITIVE EXAMINATIONS

L T P C

3 0 0 3

#### **Course Description:**

Students aspiring to take up competitive exams of which the English language is a vital component will find this course useful. Designed for students in the higher semesters, the course will help students to familiarise themselves with those aspects of English that are tested in these examinations.

#### **COURSE OBJECTIVES:**

- To train the students in the language components essential to face competitive examinations both at the national (UPSC, Banking, Railway, Defence) and the international level (GRE, TOEFL, IELTS).
- To enhance an awareness of the specific patterns in language testing and the respective skills to tackle verbal reasoning and verbal ability tests.
- To inculcate effective practices in language-learning in order to improve accuracy in usage of grammar and coherence in writing.
- To improve students' confidence to express their ideas and opinions in formal contexts
- To create awareness of accuracy and precision in communication

#### **UNIT I**

9

Orientation on different formats of competitive exams - Vocabulary – Verbal ability – Verbal reasoning - Exploring the world of words – Essential words – Meaning and their usage – Synonyms-antonyms – Word substitution – Word analogy – Idioms and phrases – Commonly confused words – Spellings – Word expansion – New words in use.

#### **UNIT II**

9

Grammar – Sentence improvement –Sentence completion – Rearranging phrases into sentences – Error identification –Tenses – Prepositions – Adjectives – Adverbs – Subject-verb agreement – Voice – Reported speech – Articles – Clauses – Speech patterns.

#### **UNIT III**

9

Reading - Specific information and detail – Identifying main and supporting ideas – Speed reading techniques – Improving global reading skills – Linking ideas – Summarising – Understanding argument – Identifying opinion/attitude and making inferences - Critical reading.

#### **UNIT IV**

9

Writing – Pre-writing techniques – Mindmap - Describing pictures and facts - Paragraph structure – organising points – Rhetoric writing – Improving an answer – Drafting, writing and developing an argument – Focus on cohesion – Using cohesive devices –Analytic writing – Structure and types of essay – Mind maps – Structure of drafts, letters, memos, emails – Statements of Purpose – Structure, Content and Style.

#### **UNIT V**

9

Listening and Speaking – Contextual listening – Listening to instructions – Listening for specific information – Identifying detail, main ideas – Following signpost words – Stress, rhythm and intonation - Speaking to respond and elicit ideas – Guided speaking – Opening phrases – Interactive communication – Dysfluency -Sentence stress – Speaking on a topic – Giving opinions



– Giving an oral presentation – Telling a story or a personal anecdote – Talking about oneself - Utterance – Speech acts- Brainstorming ideas – Group discussion.

**TOTAL: 45 PERIODS**

**LEARNING OUTCOMES:**

At the end of the course, learners will be able

**CO1:**expand their vocabulary and gain practical techniques to read and comprehend a wide range of texts with the emphasis required

**CO2:**identify errors with precision and write with clarity and coherence

**CO3:**understand the importance of task fulfilment and the usage of task-appropriate vocabulary

**CO4:**communicate effectively in group discussions, presentations and interviews

**CO5:**write topic based essays with precision and accuracy

**CO's-PO's & PSO's MAPPING**

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	3	3	1	3	3	3	3	1	3	1	3	-	-	-
2	2	3	3	2	3	3	3	3	1	3	3	3	-	-	-
3	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
4	2	2	2	2	2	2	2	2	3	3	3	3	-	-	-
5	2	2	2	2	2	2	2	2	2	3	2	3	-	-	-
<b>AVg.</b>	<b>2</b>	<b>2.6</b>	<b>2.6</b>	<b>2</b>	<b>2.6</b>	<b>2.6</b>	<b>2.6</b>	<b>2.6</b>	<b>2</b>	<b>3</b>	<b>2.4</b>	<b>3</b>	-	-	-

1-low, 2-medium, 3-high, '-'- no correlation

**Note:** The average value of this course to be used for program articulation matrix.

**Teaching Methods:**

Instructional methods will involve discussions, taking mock tests on various question papers – Objective, multiple-choice and descriptive. Peer evaluation, self-check on improvement and peer feedback - Practice sessions on speaking assessments, interview and discussion – Using multimedia.

**Evaluative Pattern:**

Internal Tests – 50%

End Semester Exam - 50%

**TEXTBOOKS:**

1. R.P.Bhatnagar - *General English for Competitive Examinations*. Macmillan India Limited, 2009.

**REFERENCEBOOKS:**

1. Educational Testing Service - *The Official Guide to the GRE Revised General Test*, Tata McGraw Hill, 2010.
2. *The Official Guide to the TOEFL Test*, Tata McGraw Hill, 2010.
3. R Rajagopalan- *General English for Competitive Examinations*, McGraw Hill Education (India) Private Limited, 2008.

**Websites**

<http://www.examenglish.com/>, <http://www.ets.org/>, <http://www.bankxams.com/>  
<http://civilservicesmentor.com/>, <http://www.educationobserver.com>  
<http://www.cambridgeenglish.org/in/>

**COURSE OBJECTIVES**

- to understand the importance of sustainable development
- to acquire a reasonable knowledge on the legal frameworks pertaining to pollution control and environmental management
- to comprehend the role of NGOs in attaining sustainable development

**Unit I ENVIRONMENTAL CONCERNS 9**

Introduction to sustainable development goals, Global responsibility of environmental concern, Importance of environmental preservation, Environmental threats, Pollution and its types, Effects of Pollution, Pollution control, Treatment of wastes

**UNIT II ROLE OF NGOS 9**

Role of NGO's in national development, NGO's and participatory management, Challenges and limitations of NGO's, Community Development programmes, Role of NGO's in Community Development programmes, Participation of NGO's in environment management, Corporate Social responsibility, NGO's and corporate social responsibility

**UNIT III SUSTAINABLE DEVELOPMENT 9**

Issues and Challenges of Sustainable Development, Bioenergy, Sustainable Livelihoods and Rural Poor in Sustainable Development, Protecting ecosystem services for sustainable development, Non-renewable sources of energy and its effect, Renewable sources of energy for sustainability, Nuclear resources and Legal Regulation of Hazardous Substances, Sustainable Development: Programme and Policies, Sustainability assessment and Indicators

**UNIT IV NGO'S FOR SUSTAINABILITY 9**

Civil Society Initiatives in Environment Management, Civil Society Initiatives for Sustainable Development, Global Initiatives in Protecting Global Environment, World Summit on Sustainable Development (Johannesburg Summit 2002), Ecological economics, Environmental sustainability, Social inclusion, Health for all, education for all, Food security and Water security, NGOs and Sustainable Development strategies

**UNIT V LEGAL FRAMEWORKS 9**

Need for a Legal framework and its enforcement, Legal measures to control pollution, Environmental Legislations in India, Mechanism to implement Environmental Laws in India, Legal Protection of Forests Act 1927, Legal Protection of Wild Life, Role of NGO's in implementing environmental laws, Challenges in the implementation of environmental legislation

**TOTAL 45 : PERIODS****COURSE OUTCOMES**

Upon completion of this course, the student will :

- CO1** Have a thorough grounding on the issues and challenges being faced in attaining sustainable development
- CO2** have a knowledge on the role of NGOs towards sustainable developemnt
- CO3** present strategies for NGOs in attaining sustainable development
- CO4** recognize the importance of providing energy, food security and health equity to all members of the society without damaging the environment
- CO5** understand the environmental legislations

## REFERENCE BOOKS

1. Kulsange, S and Kamble, R. (2019). Environmental NGO's: Sustainability Stewardship, Lap Lambert Academic Publishing, India, ISBN-13: 978-6200442444.
2. Dodds, F. (2007). NGO diplomacy: The influence of nongovernmental organizations in international environmental negotiations. Mit Press, Cambridge, ISBN-13: 978-0262524766.
3. Ghosh, S. (Ed.). (2019). Indian environmental law: Key concepts and principles. Orient BlackSwan, India, ISBN-13: 978-9352875795.
4. Alan Fowler and Chiku Malunga (2010) NGO Management: The Earthscan Companion, Routledge, ISBN-13 : 978-1849711197.

**OMG353**

**DEMOCRACY AND GOOD GOVERNANCE**

**L T P C**  
**3 0 0 3**

### **UNIT-I**

**(9)**

Structure and Process of Governance: Indian Model of Democracy, Parliament, Party Politics and Electoral Behaviour, Federalism, the Supreme Court and Judicial Activism, Units of Local Governance

### **UNIT-II**

**(9)**

Regulatory Institutions – SEBI, TRAI, Competition Commission of India,

### **UNIT-III**

**(9)**

Lobbying Institutions: Chambers of Commerce and Industries, Trade Unions, Farmers Associations, etc.

### **UNIT- IV**

**(9)**

Contemporary Political Economy of Development in India: Policy Debates over Models of Development in India, Recent trends of Liberalisation of Indian Economy in different sectors, E-governance

### **UNIT-V**

**(9)**

Dynamics of Civil Society: New Social Movements, Role of NGO's, Understanding the political significance of Media and Popular Culture.

**TOTAL 45 : PERIODS**

## **REFERENCES:**

1. Atul Kohli (ed.): The Success of India's Democracy, Cambridge University Press, 2001.
2. Corbridge, Stuart and John Harris: Reinventing India: Liberalisation, Hindu Nationalism and Popular Democracy, Oxford University Press, 2000.
3. J.Dreze and A.Sen, India: Economic Development and Social Opportunity, Clarendon, 1995.
4. Saima Saeed: Screening the Public Sphere: Media and Democracy in India, 2013
5. Himat Singh: Green Revolution Reconsidered: The Rural World of Punjab, OUP, 2001.
6. Jagdish Bhagwati: India in Transition: Freeing The Economy, 1993.
7. Smitu Kothari: Social Movements and the Redefinition of Democracy, Boulder, Westview, 1993.

**COURSE OBJECTIVES**

- To know the Indian and global energy scenario
- To learn the various solar energy technologies and its applications.
- To educate the various wind energy technologies.
- To explore the various bio-energy technologies.
- To study the ocean and geothermal technologies.

**UNIT – I ENERGY SCENARIO 9**

Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status-Potential of various renewable energy sources-Global energy status-Per capita energy consumption - Future energy plans

**UNIT – II SOLAR ENERGY 9**

Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications.

**UNIT – III WIND ENERGY 9**

Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.

**UNIT – IV BIO-ENERGY 9**

Bio resources – Biomass direct combustion – thermochemical conversion - biochemical conversion-mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration – Carbonisation – Pyrolysis - Biogas plants – Digesters –Biodiesel production – Ethanol production - Applications.

**UNIT – V OCEAN AND GEOTHERMAL ENERGY 9**

Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

At the end of the course the students would be able to

**CO1:**Discuss the Indian and global energy scenario.

**CO2:**Describe the various solar energy technologies and its applications.

**CO3:**Explain the various wind energy technologies.

**CO4:**Explore the various bio-energy technologies.

**CO5:**Discuss the ocean and geothermal technologies.

**TEXT BOOKS:**

1. Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, cGraw Hill; First edition (10 December 2020), ISBN-10 : 9390385636

- Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 8120344707

#### REFERENCES:

- Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012.
- Rai.G.D., "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2014.
- Sukhatme.S.P., "Solar Energy: Principles of Thermal Collection and Storage", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
- Tiwari G.N., "Solar Energy – Fundamentals Design, Modelling and applications", Alpha Science Intl Ltd, 2015.
- Twidell, J.W. & Weir A., "Renewable Energy Resources", EFNSpon Ltd., UK, 2015.

#### CO's-PO's & PSO's MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	1	1	2	3	2	2	1	1	3	2	1	2
2	3	2	2	1	1	1	3	1	1	1	2	3	2	1	2
3	3	2	3	1	2	1	3	1	1	1	1	3	1	1	2
4	2	2	2	1	2	1	3	1	1	1	2	3	2	2	2
5	2	1	2	1	2	1	3	1	1	1	1	3	2	1	2

Low (1) ; Medium (2) ; High (3)

OME354

APPLIED DESIGN THINKING

L T P C

3 0 0 3

#### COURSE OBJECTIVES:

The course aims to

- Introduce tools & techniques of design thinking for innovative product development
- Illustrate customer-centric product innovation using on simple use cases
- Demonstrate development of Minimum usable Prototypes
- Outline principles of solution concepts & their evaluation
- Describe system thinking principles as applied to complex systems

#### UNIT I DESIGN THINKING PRINCIPLES

9

Exploring Human-centered Design - Understanding the Innovation process, discovering areas of opportunity, Interviewing & empathy-building techniques, Mitigate validation risk with FIR [Forge Innovation rubric] - Case studies

#### UNIT II ENDUSER-CENTRIC INNOVATION

9

Importance of customer-centric innovation - Problem Validation and Customer Discovery - Understanding problem significance and problem incidence - Customer Validation. Target user, User persona & user stories. Activity: Customer development process - Customer interviews and field visit

#### UNIT III APPLIED DESIGN THINKING TOOLS

9

Concept of Minimum Usable Prototype [MUP] - MUP challenge brief - Designing & Crafting the value proposition - Designing and Testing Value Proposition; Design a compelling value proposition; Process, tools and techniques of Value Proposition Design



**UNIT I INTRODUCTION & GEOMETRIC FORM****9 Hours**

Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

**UNIT II MATERIAL CHARACTERISTICS AND PROCESS IDENTIFICATION****9 Hours**

.Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification.

**UNIT III DATA PROCESSING****9 Hours**

Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility.

**UNIT IV 3D SCANNING AND MODELLING****9 Hours**

Introduction, working principle and operations of 3D scanners: Laser, White Light, Blue Light - Applications- Software for scanning and modelling: Types- Applications- Preparation techniques for Scanning objects- Scanning and Measuring strategies - Calibration of 3D Scanner- Step by step procedure: 3D scanning - Geometric modelling – 3D inspection- Case studies.

**UNIT V INDUSTRIAL APPLICATIONS****9 Hours**

Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry. Case studies and Solving Industrial projects in Reverse Engineering. Legality: Patent – Copyrights –Trade Secret – Third-Party Materials.

**TOTAL : 45 PERIODS****COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

CO1:Apply the fundamental concepts and principles of reverse engineering in product design and development.

CO2:Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.

CO3:Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.

CO4:Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.

CO5:Analyze the various legal aspect

CO6:Applications of reverse engineering in product design and development.

**TEXT BOOKS:**

1. Robert W. Messler, Reverse Engineering: Mechanisms, Structures, Systems & Materials, 1st Edition, McGraw-Hill Education, 2014
2. Wego Wang, Reverse Engineering Technology of Reinvention, CRC Press, 2011

**REFERENCES:**

1. Scott J. Lawrence , Principles of Reverse Engineering, Kindle Edition, 2022
2. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Prentice Hall, 2001
3. Kathryn, A. Ingle, "Reverse Engineering", McGraw-Hill, 1994.
4. Linda Wills, "Reverse Engineering", Kluwer Academic Publishers, 1996

5. Vinesh Raj and Kiran Fernandes, "Reverse Engineering: An Industrial Perspective", Springer-Verlag London Limited 2008.

**OPR351**

**SUSTAINABLE MANUFACTURING**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To be acquainted with sustainability in manufacturing and its evaluation.
- To provide knowledge in environment and social sustainability.
- To provide the student with the knowledge of strategy to achieve sustainability.
- To familiarize with trends in sustainable operations.
- To create awareness in current sustainable practices in manufacturing industry.

**UNIT – I ECONOMIC SUSTAINABILITY 9**

Industrial Revolution-Economic sustainability: globalization and international issues Sustainability status - Emerging issues- Innovative products- Reconfiguration manufacturing enterprises - Competitive manufacturing strategies - Performance evaluation- Management for sustainability - Assessments of economic sustainability

**UNIT – II SOCIAL AND ENVIRONMENTAL SUSTAINABILITY 9**

Social sustainability – Introduction-Work management -Human rights - Societal commitment - Customers -Business practices -Modelling and assessing social sustainability. Environmental issues pertaining to the manufacturing sector: Pollution - Use of resources -Pressure to reduce costs - Environmental management: Processes that minimize negative environmental impacts - environmental legislation and energy costs - need to reduce the carbon footprint of manufacturing Operations-Modelling and assessing environmental sustainability

**UNIT – III SUSTAINABILITY PRACTICES 9**

Sustainability awareness - Measuring Industry Awareness-Drivers and barriers -Availability of sustainability indicators -Analysis of sustainability practicing -Modeling and assessment of sustainable practicing -Sustainability awareness -Sustainability drivers and barriers - Availability of sustainability indicators- Designing questionnaires- Optimizing Sustainability Indexes-Elements – Cost and time model.

**UNIT – IV MANUFACTURING STRATEGY FOR SUSTAINABILITY 9**

Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.

**UNIT – V TRENDS IN SUSTAINABLE OPERATIONS 9**

Principles of sustainable operations - Life cycle assessment manufacturing and service activities - influence of product design on operations - Process analysis – Capacity management - Quality management -Inventory management - Just-In-Time systems - Resource efficient design - Consumerism and sustainable well-being.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:  
CO1: Discuss the importance of economic sustainability.



- CO2: Describe the importance of sustainable practices.  
 CO3: Identify drivers and barriers for the given conditions.  
 CO4: Formulate strategy in sustainable manufacturing.  
 CO5: Plan for sustainable operation of industry with environmental, cost consciousness.

**TEXT BOOKS:**

1. Ibrahim Garbie, "Sustainability in Manufacturing Enterprises Concepts, Analyses and Assessments for Industry 4.0", Springer International Publishing., United States, 2016, ISBN-13: 978-3319293042.
2. Davim J.P., "Sustainable Manufacturing", John Wiley & Sons., United States, 2010, ISBN: 978-1-848-21212-1.

**REFERENCES:**

1. Jovane F, Emper, W.E. and Williams, D.J., "The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing", Springer, 2009, United States, ISBN 978-3-540-77011-4.
2. Kutz M., "Environmentally Conscious Mechanical Design", John Wiley & Sons., United States, 2007, ISBN: 978-0-471-72636-4.
3. Seliger G., "Sustainable Manufacturing: Shaping Global Value Creation", Springer, United States, 2012, ISBN 978-3-642-27289-9.

<b>CO's-PO's &amp; PSO's MAPPING</b>															
COs/Pos &PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	-	2	-	-	-	2	2	-	1	1	2	2	2	1
CO2	3	-	-	-	-	-	2	-	-	1	1	2	1	2	2
CO3	3	-	-	-	-	-	2	3	-	1	1	2	1	2	2
CO4	3	-	3	-	-	-	2	-	-	1	1	2	2	2	1
CO5	3	-	3	-	-	-	2	2	-	1	1	2	2	2	1
CO/PO & PSO Average	3	-	3	-	-	-	2	2	-	1	1	2	2	2	1
<b>1 - low, 2 - medium, 3 - high, '-' - no correlation</b>															

**AU3791**

**ELECTRIC AND HYBRID VEHICLES**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- The objective of this course is to prepare the students to know about the general aspects of Electric and Hybrid Vehicles (EHV), including architectures, modelling, sizing, and sub system design and hybrid vehicle control.

**UNIT I DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES**

**9**

Need for Electric vehicle- Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. - Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refuelling Systems.

**UNIT II ENERGY SOURCES 9**

Battery Parameters- - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion- Sodium based- Metal Air. Battery Modelling - Equivalent circuits, Battery charging- Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System.

**UNIT III MOTORS AND DRIVES 9**

Types of Motors- DC motors- AC motors, PMSM motors, BLDC motors, Switched reluctance motors working principle, construction and characteristics.

**UNIT IV POWER CONVERTERS AND CONTROLLERS 9**

Solid state Switching elements and characteristics – BJT, MOSFET, IGBT, SCR and TRIAC - Power Converters – rectifiers, inverters and converters - Motor Drives - DC, AC motor, PMSM motors, BLDC motors, Switched reluctance motors – four quadrant operations –operating modes

**UNIT V HYBRID AND ELECTRIC VEHICLES 9**

Main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of this course, the student will be able to

- CO1:Understand the operation and architecture of electric and hybrid vehicles
- CO2:Identify various energy source options like battery and fuel cell
- CO3:Select suitable electric motor for applications in hybrid and electric vehicles.
- CO4:Explain the role of power electronics in hybrid and electric vehicles
- CO5:Analyze the energy and design requirement for hybrid and electric vehicles.

**TEXT BOOKS:**

1. Iqbal Husain, “ Electric and Hybrid Vehicles-Design Fundamentals”, CRC Press,2003
2. Mehrdad Ehsani, “ Modern Electric, Hybrid Electric and Fuel Cell Vehicles”, CRCPress,2005.

**REFERENCES:**

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained “ John Wiley & Sons,2003
2. Lino Guzzella, “ Vehicle Propulsion System” Springer Publications,2005
3. Ron HodKinson, “Light Weight Electric/ Hybrid Vehicle Design”, Butterworth Heinemann Publication,2005.

**CO’s-PO’s & PSO’s MAPPING**

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	2	1	-	3	2					2		1	3
2	1	1	2	1		3	2					2		1	3
3	1	1	2	1		3	2					2		1	3
4	1	1	2	1		3	2					2		1	3
5	1	1	2	1		3	2					2		1	3
Avg.	1	1	2	1		3	2					2		1	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES:**

- Use the standard atmosphere tables and equations.
- Find lift and drag coefficient data from NACA plots.
- Apply the concept of static stability to flight vehicles.
- Describe the concepts of stress, strain, Young's modulus, Poisson's ratio, yield strength.
- Demonstrate a basic knowledge of dynamics relevant to orbital mechanics.

**UNIT I STANDARD ATMOSPHERE****6**

History of aviation – standard atmosphere - pressure, temperature and density altitude.

**UNIT II AERODYNAMICS****10**

Aerodynamic forces – Lift generation Viscosity and its implications - Shear stress in a velocity profile - Lagrangian and Eulerian flow field - Concept of a streamline – Aircraft terminology and geometry - Aircraft types - Lift and drag coefficients using NACA data.

**UNIT III PERFORMANCE AND PROPULSION****9**

Viscous and pressure drag - flow separation - aerodynamic drag - thrust calculations -thrust/power available and thrust/power required.

**UNIT IV AIRCRAFT STABILITY AND STRUCTURAL THEORY****10**

Degrees of freedom of aircraft motions - stable, unstable and neutral stability - concept of static stability - Hooke's Law- brittle and ductile materials - moment of inertia - section modulus.

**UNIT V SPACE APPLICATIONS****10**

History of space research - spacecraft trajectories and basic orbital manoeuvres - six orbital elements - Kepler's laws of orbits - Newtons law of gravitation.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

- Illustrate the history of aviation & developments over the years
- Ability to identify the types & classifications of components and control systems
- Explain the basic concepts of flight & Physical properties of Atmosphere
- Identify the types of fuselage and constructions.
- Distinguish the types of Engines and explain the principles of Rocket

**TEXT BOOKS:**

1. John D. Anderson, Introduction to Flight, 8 th Ed., McGraw-Hill Education, New York,2015.
2. E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021.
3. Stephen. A. Brandt, "Introduction to Aeronautics: A design perspective " American Institute of Aeronautics & Astronautics,1997.

**REFERENCE:**

1. Kermode, A.C., "Mechanics of Flight", Himalayan Book, 1997.

**COURSE OBJECTIVES:**

- To introduce fundamental concepts of industrial management
- To understand the approaches to the study of Management
- To learn about Decision Making, Organizing and leadership
- To analyze the Managerial Role and functions
- To know about the Supply Chain Management'

**UNIT I INTRODUCTION****9**

Technology Management - Definition - Functions - Evolution of Modern Management - Scientific Management Development of Management Thought. Approaches to the study of Management, Forms of Organization -Individual Ownership - Partnership - Joint Stock Companies - Co-operative Enterprises - Public Sector Undertakings, Corporate Frame Work- Share Holders - Board of Directors - Committees - Chief Executive Line and Functional Managers,-Financial-Legal-Trade Union

**UNIT II FUNCTIONS OF MANAGEMENT****9**

Planning - Nature and Purpose - Objectives - Strategies – Policies and Planning Premises - Decision Making - Organizing - Nature and Process - Premises - Departmentalization - Line and staff - Decentralization -Organizational culture, Staffing - selection and training .Placement - Performance appraisal - Career Strategy – Organizational Development. Leading - Managing human factor - Leadership .Communication, Controlling - Process of Controlling - Controlling techniques, productivity and operations management - Preventive control, Industrial Safety.

**UNIT III ORGANIZATIONAL BEHAVIOUR****9**

Definition - Organization - Managerial Role and functions -Organizational approaches, Individual behaviour - causes - Environmental Effect - Behaviour and Performance, Perception - Organizational Implications. Personality - Contributing factors - Dimension – Need Theories - Process Theories - Job Satisfaction, Learning and Behaviour-Learning Curves, Work Design and approaches.

**UNIT IV GROUPDYNAMICS****9**

Group Behaviour - Groups - Contributing factors - Group Norms, Communication - Process - Barriers to communication - Effective communication, leadership - formal and informal characteristics – Managerial Grid - Leadership styles - Group Decision Making - Leadership Role in Group Decision, Group Conflicts - Types -Causes - Conflict Resolution -Inter group relations and conflict, Organization centralization and decentralization - Formal and informal - Organizational Structures Organizational Change and Development -Change Process – Resistance to Change - Culture and Ethics.

**UNIT V MODERN CONCEPTS****9**

Management by Objectives (MBO) - Management by Exception (MBE),Strategic Management - Planning for Future direction - SWOT Analysis -Evolving development strategies, information technology in management Decisions support system-Management Games Business Process Re-engineering(BPR) –Enterprises Resource Planning (ERP) - Supply Chain Management (SCM) - Activity Based Management (AM) - Global Perspective - Principles and Steps Advantages and disadvantage

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1:** Understand the basic concepts of industrial management

**CO2:** Identify the group conflicts and its causes.

**CO3:** Perform swot analysis

**CO4 :** Analyze the learning curves

**CO5 :** Understand the placement and performance appraisal

**REFERENCES:**

Maynard H.B, "Industrial Engineering Hand book", McGraw-Hill, sixth 2008

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1											2	1	
2		3	2	3											2
3	2	3	2	3									1	2	3
4	2	2	3	3										3	3
5	2	2											2		
<b>AVg.</b>	2	2.2	2.3	3									1.8	2	2.6

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OIE354**

**QUALITY ENGINEERING**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- Developing a clear knowledge in the basics of various quality concepts.
- Facilitating the students in understanding the application of control charts and its techniques.
- Developing the special control procedures for service and processor oriented industries.
- Analyzing and understanding the process capability study.
- Developing the acceptance sampling procedures for incoming raw material.

**UNIT I INTRODUCTION**

**9**

Quality Dimensions–Quality definitions–Inspection–Quality control–Quality Assurance–Quality planning–Quality costs–Economics of quality– Quality loss function

**UNIT II CONTROL CHARTS**

**9**

Chance and assignable causes of process variation, statistical basis of the control chart, control charts for variables- X, R and S charts, attribute control charts - p, np, c and u- Construction and application.

**UNIT III SPECIAL CONTROL PROCEDURES**

**9**

Warning and modified control limits, control chart for individual measurements, multi-vari chart, Xchart with a linear trend, chart for moving averages and ranges, cumulative-sum and exponentially weighted moving average control charts.

**UNIT IV STATISTICAL PROCESS CONTROL**

**9**

Process stability, process capability analysis using a Histogram or probability plots and control chart. Gauge capability studies, setting specification limits.

**UNIT V ACCEPTANCE SAMPLING****9**

The acceptance sampling fundamental, OC curve, sampling plans for attributes, simple, double, multiple and sequential, sampling plans for variables, MIL-STD-105D and MIL-STD-414E & IS 2500 standards.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

Students will be able to:

**CO1:** Control the quality of processes using control charts for variables in manufacturing industries.

**CO2:** Control the occurrence of defective product and the defects in manufacturing companies.

**CO3:** Control the occurrence of defects in services.

**CO4:** Analyzing and understanding the process capability study.

**CO5:** Developing the acceptance sampling procedures for incoming raw material.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	3		3			1	2			2	1		
2		3	3		3	3			3			3		2	
3	3	3	3		3				3			3	1		
4	3		2		3						1		1		
5		2			3				3			3			1
<b>AVg.</b>	2.6	2.7	2.7		3	3		1	2.7		1	2.7	1	2	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OSF351****FIRE SAFETY ENGINEERING****L T P C****3 0 0 3****COURSE OBJECTIVES**

- To enable the students to acquire knowledge of Fire and Safety Studies
- To learn about the effect of fire on materials used for construction, the method of test for non-combustibility & fire resistance
- To learn about fire area, fire stopped areas and different types of fire-resistant doors
- To learn about the method of fire protection of structural members and their repair due to fire damage.
- To develop safety professionals for both technical and management through systematic and quality-based study programmes

**UNIT I INHERENT SAFETY CONCEPTS****9**

Compartment fire-factors controlling fire severity, ventilation controlled and fuel controlled fires; Spread of fire in rooms, within building and between buildings. Effect of temperature on the properties of structural materials- concrete, steel, masonry and wood; Behavior of non-structural materials on fire- plastics, glass, textile fibres and other house hold materials.

**UNIT II PLANT LOCATIONS****9**

Compartment temperature-time response at pre-flashover and post flashover periods; Equivalence of fire severity of compartment fire and furnace fire; Fire resistance test on structural elements- standard heating condition, Indian standard test method, performance criteria.

**UNIT III      WORKING CONDITIONS      9**

Fire separation between building- principle of calculation of safe distance. Design principles of fire resistant walls and ceilings; Fire resistant screens- solid screens and water curtains; Local barriers; Fire stopped areas-in roof, in fire areas and in connecting structures; Fire doors- Low combustible, Non-combustible and Spark-proof doors; method of suspension of fire doors; Air-tight sealing of doors;

**UNIT IV      FIRE SEVERITY AND REPAIR TECHNIQUES      9**

Fabricated fire proof boards-calcium silicate, Gypsum, Vermiculite, and Perlite boards; Fire protection of structural elements - Wooden, Steel and RCC.. Reparability of fire damaged structures- Assessment of damage to concrete, steel, masonry and timber structures, Repair techniques- repair methods to reinforced concrete Columns, beams and slabs, Repair to steel structural members, Repair to masonry structures.

**UNIT V      WORKING AT HEIGHTS      9**

Safe Access - Requirement for Safe Work Platforms- Stairways - Gangways and Ramps-Fall Prevention & Fall Protection - Safety Belts - Safety nets - Fall Arrestors- Working on Fragile Roofs - Work Permit Systems-Accident Case Studies.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES**

On completion of the course the student will be able to

**CO1:**Understand the effect of fire on materials used for construction

**CO2:**Understand the method of test for non-combustibility and fire resistance; and will be able to select different structural elements and their dimensions for a particular fire resistance rating of a building.

**CO3:**To understand the design concept of fire walls, fire screens, local barriers and fire doors and able to select them appropriately to prevent fire spread.

**CO4:**To decide the method of fire protection to RCC, steel, and wooden structural elements and their repair methods if damaged due to fire.

**CO5:**Describe the safety techniques and improve the analytical and intelligence to take the right decision at right time.

**TEXT BOOKS**

- Roytman, M. Y,"Principles of fire safety standards for building construction". Amerind Publishing Co. Pvt. Ltd., New Delhi,1975
- John A. Purkiss,"Fire safety engineering design of structures" (2nd edn.), Butterworth Heinemann, Oxford, UK,2009.

**REFERENCES:**

2. Smith, E.E. and Harmathy, T.Z. (Editors),"Design of buildings for fire safety". ASTM Special Publication 685, American Society for Testing and Materials, Boston, U.S.A,1979.
3. Butcher, E. G. and Parnell, A. C, "Designing of fire safety". JohnWiley and Sons Ltd., New York, U.S.A.1983.
4. Jain, V.K,"Fire safety in buildings" (2nd edn.). New Age International(P) Ltd., New Delhi,2010.
4. Hazop&Hazan,"Identifying and Assessing Process Industry Hazards", Fourth Edition ,1999
5. Frank R. Spellman, Nancy E. Whiting,"The Handbook of Safety Engineering: Principles and Applications", 2009

## CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1	2	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-
2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
3	1	-	2	-	-	-	3	-	-	1	-	-	-	-	-	-
4	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
5	2	-	1	-	-	1	1	1	-	1	-	1	-	-	-	-
AVg.	1.3	-	1.75	-	-	1	1.3	1		1	-	1	-	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

OML351

INTRODUCTION TO NON-DESTRUCTIVE TESTING

L T P C

3 0 0 3

### COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Understanding the basic importance of NDT in quality assurance.
- Imbibing the basic principles of various NDT techniques, its applications, limitations, codes and standards.
- Equipping themselves to locate a flaw in various materials, products.
- Applying apply the testing methods for inspecting materials in accordance with industry specifications and standards.
- Acquiring the knowledge on the selection of the suitable NDT technique for a given application

### UNIT I INTRODUCTION TO NDT & VISUAL TESTING

9

Concepts of Non-destructive testing-relative merits and limitations-NDT Versus mechanical testing, Fundamentals of Visual Testing – vision, lighting, material attributes, environmental factors, visual perception, direct and indirect methods – mirrors, magnifiers, boroscopes and fibrosopes – light sources and special lighting.

### UNIT II LIQUID PENETRANT & MAGNETIC PARTICLE TESTING

9

Liquid Penetrant Inspection: principle, applications, advantages and limitations, dyes, developers and cleaners, Methods & Interpretation.

Magnetic Particle Inspection: Principles, applications, magnetization methods, magnetic particles, Testing Procedure, demagnetization, advantages and limitations, – Interpretation and evaluation of test indications.

### UNIT III EDDY CURRENT TESTING & THERMOGRAPHY

9

Eddy Current Testing: Generation of eddy currents– properties– eddy current sensing elements, probes, Instrumentation, Types of arrangement, applications, advantages, limitations – Factors affecting sensing elements and coil impedance, calibration, Interpretation/Evaluation.

Thermography- Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal – Concept, example, advantages & limitations. Electromagnetic spectrum, infrared thermography- approaches, IR detectors, Instrumentation and methods, applications.

### UNIT IV ULTRASONIC TESTING & AET

9

Ultrasonic Testing: Types of ultrasonic waves, characteristics, attenuation, couplants, probes, EMAT. Inspection methods-pulse echo, transmission and phased array techniques, types of



scanning and displays, angle beam inspection of welds, time of flight diffraction (TOFD) technique, Thickness determination by ultrasonic method, Study of A, B and C scan presentations, calibration. Acoustic Emission Technique – Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages & Limitations, Interpretation of Results, Applications.

**UNIT V RADIOGRAPHY TESTING**

**9**

Sources-X-rays and Gamma rays and their characteristics-absorption, scattering. Filters and screens, Imaging modalities-film radiography and digital radiography (Computed, Direct, Real Time, CT scan). Problems in shadow formation, exposure factors, inverse square law, exposure charts, Penetrameters, safety in radiography.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the students will be able to

**CO1:**Realize the importance of NDT in various engineering fields.

**CO2:**Have a basic knowledge of surface NDE techniques which enables to carry out various inspection in accordance with the established procedures.

**CO3:**Calibrate the instrument and inspect for in-service damage in the components by means of Eddy current testing as well as Thermography testing.

**CO4:**Differentiate various techniques of UT and AET and select appropriate NDT methods for better evaluation.

**CO5:**Interpret the results of Radiography testing and also have the ability to analyse the influence of various parameters on the testing.

**TEXT BOOKS:**

- Baldev Raj, T. Jayakumar and M. Thavasimuthu, Practical Non Destructive Testing, Alpha Science International Limited, 3rd edition, 2002.
- J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition, 2011.
- Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010.

**REFERENCES:**

- ASM Metals Handbook, V-17, "Nondestructive Evaluation and Quality Control", American Society of Metals, USA, 2001.
- Barry Hull and Vernon John,"Nondestructive Testing", Macmillan, 1989.
- Chuck Hellier, "Handbook of Nondestructive Evaluation", Mc Graw Hill, 2012.
- Louis Cartz, "Nondestructive Testing", ASM International, USA, 1995.

**CO's-PO's & PSO's MAPPING**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
C01	2	2	2	3			2	2				2	1	2	
C02	3	1	2	2			2	2				2	2	2	1
C03	3	2	1	2			2	2				2	2	2	
CO4	3	1	2	2			2	2				2	2	2	2
CO5	3	2	2	2			2	2				2	2	2	1
Avg	2.8	1.6	1.8	2.2			2	2				2	1.8	2	1.3

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

1. Selecting sensors to develop mechatronics systems.
2. Explaining the architecture and timing diagram of microprocessor, and also interpret and develop programs.
3. Designing appropriate interfacing circuits to connect I/O devices with microprocessor.
4. Applying PLC as a controller in mechatronics system.
5. Designing and develop the apt mechatronics system for an application.

**UNIT – I INTRODUCTION AND SENSORS 9**

Introduction to Mechatronics – Systems – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and Dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance Sensors – Strain Gauges – Eddy Current Sensor – Hall Effect Sensor –Temperature Sensors – Light Sensors.

**UNIT – II 8085 MICROPROCESSOR 9**

Introduction – Pin Configuration - Architecture of 8085 – Addressing Modes – Instruction set, Timing diagram of 8085.

**UNIT – III PROGRAMMABLE PERIPHERAL INTERFACE 9**

Introduction – Architecture of 8255, Keyboard Interfacing, LED display – Interfacing, ADC and DAC Interface, Temperature Control – Stepper Motor Control – Traffic Control Interface.

**UNIT – IV PROGRAMMABLE LOGIC CONTROLLER 9**

Introduction – Architecture – Input / Output Processing – Programming with Timers, Counters and Internal relays – Data Handling – Selection of PLC.

**UNIT – V ACTUATORS AND MECHATRONICS SYSTEM DESIGN 9**

Types of Stepper and Servo motors – Construction – Working Principle – Characteristics, Stages of Mechatronics Design Process – Comparison of Traditional and Mechatronics Design Concepts with Examples – Case studies of Mechatronics Systems – Pick and Place Robot – Engine Management system – Automatic Car Park Barrier.

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

**CO1:** Select sensors to develop mechatronics systems.

**CO2:** Explain the architecture and timing diagram of microprocessor, and also interpret and develop programs.

**CO3:** Design appropriate interfacing circuits to connect I/O devices with microprocessor.

**CO 4:** Apply PLC as a controller in mechatronics system.

**CO 5:** Design and develop the apt mechatronics system for an application.

<b>CO's-PO's &amp; PSO's MAPPING</b>															
<b>COs/POs &amp; PSOs</b>	<b>POs</b>												<b>PSOs</b>		
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>1</b>	<b>2</b>	<b>3</b>
CO1	3	2	1	3		2						2	3	2	3
CO2	3	2	1	3		2						2	3	2	3
CO3	3	2	1	3		2						2	3	2	3
CO4	3	2	1	3		2						2	3	2	3
CO5	3	2	1	3		2						2	3	2	3
CO/PO & PSO Average	3	2	1	3		2						2	3	2	3
<b>1 - low, 2 - medium, 3 - high, '-' - no correlation</b>															

### TEXT BOOKS

1. Bolton W., "Mechatronics", Pearson Education, 6th Edition, 2015.
2. Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Penram International Publishing Private Limited, 6th Edition, 2013.

### REFERENCES

1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., "Mechatronics", Chapman and Hall, 1993.
2. Davis G. Alciatore and Michael B. Hstand, "Introduction to Mechatronics and Measurement systems", McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, "Mechatronics Principles, Concepts and Applications", McGraw Hill Education, 2015.
5. Smali. A and Mrad. F, "Mechatronics Integrated Technologies for Intelligent Machines", Oxford University Press, 2007.

**ORA351**

**FOUNDATION OF ROBOTICS**

**L T P C**  
**3 0 0 3**

### COURSE OBJECTIVES:

- To study the kinematics, drive systems and programming of robots.
- To study the basics of robot laws and transmission systems.
- To familiarize students with the concepts and techniques of robot manipulator, its kinematics.
- To familiarize students with the various Programming and Machine Vision application in robots.
- To build confidence among students to evaluate, choose and incorporate robots in engineering systems.

### UNIT – I FUNDAMENTALS OF ROBOT

**9**

Robot – Definition – Robot Anatomy – Co-ordinate systems, Work Envelope, types and classification – specifications – Pitch, yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and their functions – Need for Robots – Different Applications.

**UNIT – II ROBOT KINEMATICS 9**

Forward kinematics, inverse kinematics and the difference: forward kinematics and inverse Kinematics of Manipulators with two, three degrees of freedom (in 2 dimensional), four degrees of freedom (in 3 dimensional) – derivations and problems. Homogeneous transformation matrices, translation and rotation matrices.

**UNIT – III ROBOT DRIVE SYSTEMS AND END EFFECTORS 9**

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of All These Drives. End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic grippers, vacuum grippers, internal grippers and external grippers, selection and design considerations of a gripper

**UNIT – IV SENSORS IN ROBOTICS 9**

Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors, safety considerations in robotic cell, proximity sensors, fail safe hazard sensor systems, and compliance mechanism. Machine vision system - camera, frame grabber, sensing and digitizing image data – signal conversion, image storage, lighting techniques, image processing and analysis – data reduction, segmentation, feature extraction, object recognition, other algorithms, applications – Inspection, identification, visual serving and navigation.

**UNIT – V PROGRAMMING AND APPLICATIONS OF ROBOT 9**

Teach pendant programming, lead through programming, robot programming languages – VAL programming – Motion Commands, Sensors commands, End-Effector Commands, and simple programs - Role of robots in inspection, assembly, material handling, underwater, space and medical fields.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES**

At the end of the course, students will be able to:

CO1: Interpret the features of robots and technology involved in the control.

CO2: Apply the basic engineering knowledge and laws for the design of robotics.

CO3: Explain the basic concepts like various configurations, classification and parts of end effectors compare various end effectors and grippers and tools and sensors used in robots.

CO4: Explain the concept of kinematics, degeneracy, dexterity and trajectory planning.

CO5: Demonstrate the image processing and image analysis techniques by machine vision system.

<b>CO's-PO's &amp; PSO's MAPPING</b>															
<b>COs/POs &amp; PSOs</b>	<b>POs</b>												<b>PSOs</b>		
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>1</b>	<b>2</b>	<b>3</b>
CO1	3	2	1	1								1			3
CO2	3	2	1	1								1			3
CO3	3	2	1	1								1			3
CO4	3	2	1	1								1			3
CO5	3	2	1	1								1			3
CO/PO & PSO Average															
<b>1 - low, 2 - medium, 3 - high, '-' - no correlation</b>															

**TEXT BOOKS:**

1. Ganesh.S.Hedge, "A textbook of Industrial Robotics", Lakshmi Publications, 2006.
2. Mikell.P.Groover , "Industrial Robotics – Technology, Programming and applications" McGraw Hill 2<sup>ND</sup> edition 2012.

**REFERENCES:**

1. Fu K.S. Gonalz R.C. and ice C.S.G."Robotics Control, Sensing, Vision and Intelligence", McGraw Hill book co. 2007.
2. YoramKoren, "Robotics for Engineers", McGraw Hill Book, Co., 2002.
3. Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill 2005.
4. John. J.Craig, "Introduction to Robotics: Mechanics and Control" 2nd Edition, 2002.
5. Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer India reprint, 2010.

**OAE352****FUNDAMENTALS OF AERONAUTICAL ENGINEERING****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- To acquire the knowledge on the Historical evaluation of Airplanes
- To learn the different component systems and functions
- To know the concepts of basic properties and principles behind the flight
- To learn the basics of different structures & construction
- To learn the various types of power plants used in aircrafts

**UNIT I HISTORY OF FLIGHT****8**

Balloon flight-ornithopter-Early Airplanes by Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

**UNIT II AIRCRAFT CONFIGURATIONS AND ITS CONTROLS****10**

Different types of flight vehicles, classifications-Components of an airplane and their functions- Conventional control, powered control- Basic instruments for flying-Typical systems for control actuation.

**UNIT III BASICS OF AERODYNAMICS****9**

Physical Properties and structures of the Atmosphere, Temperature, pressure and altitude relationships, Newton's Law of Motions applied to Aeronautics-Evolution of lift, drag and moment. Aerofoils, Mach number, Maneuvers.

**UNIT IV BASICS OF AIRCRAFT STRUCTURES****9**

General types of construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Metallic and non-metallic materials. Use of Aluminium alloy, titanium, stainless steel and composite materials. Stresses and strains-Hooke's law- stress-strain diagrams- elastic constants-Factor of Safety.

**UNIT V BASICS OF PROPULSION****9**

Basic ideas about piston, turboprop and jet engines – use of propeller and jets for thrust production- Comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space.

**TOTAL : 45 PERIODS**

## **COURSE OUTCOMES:**

CO1: Illustrate the history of aircraft & developments over the years

CO2: Ability to identify the types & classifications of components and control systems

CO3: Explain the basic concepts of flight & Physical properties of Atmosphere

CO4: Identify the types of fuselage and constructions.

CO5: Distinguish the types of Engines and explain the principles of Rocket

## **TEXT BOOKS**

1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition , 2015

2. . E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021

3. Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.

## **REFERENCE**

1. SADHU SINGH, "INTERNAL COMBUSTION ENGINES AND GAS TURBINE"-, SS Kataria & sons, 2015

2. KERMODE , "FLIGHT WITHOUT FORMULAE", -, Pitman; 4th Revised edition 1989

**OGI351**

**REMOTE SENSING CONCEPTS**

**L T P C**

**3 0 0 3**

## **COURSE OBJECTIVES:**

- To introduce the concepts of remote sensing processes and its components.
- To expose the various remote sensing platforms and sensors and to introduce the elements of data interpretation

## **UNIT I                      REMOTE SENSING AND ELECTROMAGNETIC RADIATION                      9**

Definition – components of RS – History of Remote Sensing – Merits and demerits of data collation between conventional and remote sensing methods - Electromagnetic Spectrum – Radiation principles - Wave theory, Planck's law, Wien's Displacement Law, Stefan's Boltzmann law, Kirchoff's law – Radiation sources: active & passive - Radiation Quantities

## **UNIT II                      EMR INTERACTION WITH ATMOSPHERE AND EARTH MATERIAL                      9**

Standard atmospheric profile – main atmospheric regions and its characteristics – interaction of radiation with atmosphere – Scattering, absorption and refraction – Atmospheric windows - Energy balance equation – Specular and diffuse reflectors – Spectral reflectance & emittance – Spectroradiometer – Spectral Signature concepts – Typical spectral reflectance curves for vegetation, soil and water – solid surface scattering in microwave region.

## **UNIT III                      ORBITS AND PLATFORMS                      9**

Motions of planets and satellites – Newton's law of gravitation - Gravitational field and potential - Escape velocity - Kepler's law of planetary motion - Orbit elements and types – Orbital perturbations and maneuvers – Types of remote sensing platforms - Ground based, Airborne platforms and Space borne platforms – Classification of satellites – Sun synchronous and Geosynchronous satellites – Lagrange Orbit.

## **UNIT IV                      SENSING TECHNIQUES                      9**

Classification of remote sensors – Resolution concept : spatial, spectral, radiometric and temporal resolutions - Scanners - Along and across track scanners – Optical-infrared sensors – Thermal

sensors – microwave sensors – Calibration of sensors - High Resolution Sensors - LIDAR , UAV – Orbital and sensor characteristics of live Indian earth observation satellites

**UNIT V DATA PRODUCTS AND INTERPRETATION 9**

Photographic and digital products – Types, levels and open source satellite data products – selection and procurement of data– Visual interpretation: basic elements and interpretation keys - Digital interpretation – Concepts of Image rectification, Image enhancement and Image classification

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the student is expected to

- CO 1** Understand the concepts and laws related to remote sensing
- CO 2** Understand the interaction of electromagnetic radiation with atmosphere and earth material
- CO 3** Acquire knowledge about satellite orbits and different types of satellites
- CO 4** Understand the different types of remote sensors
- CO 5** Gain knowledge about the concepts of interpretation of satellite imagery

**TEXTBOOKS:**

1. Thomas M.Lillesand, Ralph W. Kiefer and Jonathan W. Chipman, Remote Sensing and Image interpretation, John Wiley and Sons, Inc, New York,2015.
2. George Joseph and C Jeganathan, Fundamentals of Remote Sensing,Third Edition Universities Press (India) Private limited, Hyderabad, 2018

**REFERENCES:**

1. Janza, F.Z., Blue H.M. and Johnson,J.E. Manual of Remote Sensing. Vol.1, American Society of Photogrametry, Virginia, USA, 2002.
2. Verbyla, David, Satellite Remote Sensing of Natural Resources. CRC Press, 1995
3. Paul Curran P.J. Principles of Remote Sensing. Longman, RLBS, 1988.
4. Introduction to Physics and Techniques of Remote Sensing , Charles Elachi and Jacob Van Zyl, 2006 Edition II, Wiley Publication.
5. Basudeb Bhatta, Remote Sensing and GIS, Oxford University Press, 2011

**CO's-PO's & PSO's MAPPING**

PO	Graduate Attribute	Course Outcome					Average
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering Knowledge	3	3	3	3	3	3
PO2	Problem Analysis				3	3	3
PO3	Design/Development of Solutions				3	3	3
PO4	Conduct Investigations of Complex Problems				3	3	3
PO5	Modern Tool Usage				3	3	3
PO6	The Engineer and Society						
PO 7	Environment and Sustainability						
PO 8	Ethics						
PO 9	Individual and Team Work						
PO 10	Communication						
PO 11	Project Management and Finance						
PO 12	Life-long Learning	3		3	3	3	3
PSO 1	Knowledge of Geoinformatics discipline	3	3	3	3	3	3
PSO 2	Critical analysis of Geoinformatics	3	3	3	3	3	3

	Engineering problems and innovations						
PSO 3	Conceptualization and evaluation of Design solutions	3	3	3	3	3	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OAI351**

**URBAN AGRICULTURE**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce the students the principles of agricultural crop production and the production practices of crops in modern ways.
- To delineate the role of agricultural engineers in relation to various crop production practices.

**UNIT I INTRODUCTION**

**9**

Benefits of urban agriculture- economic benefits, environmental benefits, social and cultural benefits, educational, skill-building and job training benefits, health, nutrition and food accessibility benefits.

**UNIT II VERTICAL FARMING**

**9**

**Vertical farming- types**, green facade, living/green wall-modular green wall , vegetated mat wall- Structures and components for green wall system: plant selection, growing media, irrigation and plant nutrition: Design, light, benefits of vertical gardening. Roof garden and its types. Kitchen garden, hanging baskets: The house plants/ indoor plants

**UNIT III SOIL LESS CULTIVATION**

**9**

Hydroponics, aeroponics, aquaponics: merits and limitations, costs and Challenges, backyard gardens- tactical gardens- street landscaping- forest gardening, greenhouses, urban beekeeping

**UNIT IV MODERN CONCEPTS**

**9**

Growth of plants in vertical pipes in terraces and inside buildings, micro irrigation concepts suitable for roof top gardening, rain hose system, Green house, polyhouse and shade net system of crop production on roof tops

**UNIT V WASTE MANAGEMENT**

**9**

Concept, scope and maintenance of waste management- recycle of organic waste, garden wastes- solid waste management-scope, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, waste utilization.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

**CO1:**Demonstrate the principles behind crop production and various parameters that influences the crop growth on roof tops

**CO2:**Explain different methods of crop production on roof tops

**CO3:**Explain nutrient and pest management for crop production on roof tops

**CO4:**Illustrate crop water requirement and irrigation water management on roof tops

**CO5:**Explain the concept of waste management on roof tops

**TEXT BOOKS:**

1. Martellozzo F and J S Landry. 2020. Urban Agriculture. Scitus Academics Llc.

2. Rob Roggema. 2016. Sustainable Urban Agriculture and Food Planning. Routledge Taylor and Francis Group.



3. Akrong M O. 2012. Urban Agriculture. LAP Lambert Academic Publishing.

**REFERENCES:**

1. Agha Rokh A. 2008. Evaluation of ornamental flowers and fishes breeding in Bushehr urban wastewater using a pilot-scale aquaponic system. *Water and Wastewater*, 19 (65): 47–53.
2. Agrawal M, Singh B, Rajput M, Marshall F and Bell J. N. B. 2003. Effect of air pollution on peri-urban agriculture: A case study. *Environmental Pollution*, 126 (3): 323–329. <https://www.sciencedirect.com/science/article/pii/S0269749103002458#aep-section-id24>.
3. Jac Smit and Joe Nasr. 1992. Urban agriculture for sustainable cities: using wastes and idle land and water bodies as resources. *Environment and Urbanization*, 4 (2):141-152.

**CO’s-PO’s & PSO’s MAPPING**

PO/PSO		CO1	CO2	CO3	CO4	CO5	Overall correlation of COs with POs
PO1	Engineering Knowledge	1	2	1	1	2	1
PO2	Problem Analysis	1	1	1	1	1	2
PO3	Design/ Development of Solutions	1	2	1	1	3	2
PO4	Conduct Investigations of Complex Problems	1	1	2	2	1	1
PO5	Modern Tool Usage	1	2	1	1	1	2
PO6	The Engineer and Society	1	2	1	2	1	1
PO7	Environment and sustainability	1	2	1	1	2	1
PO8	Ethics	2	1	1	1	2	1
PO9	Individual and team work:	1	1	2	1	1	1
PO10	Communication	1	2	1	1	2	1
PO11	Project management and finance	1	1	1	1	1	2
PO12	Life-long learning:	1	2	1	1	3	2
PSO1	To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	1	2	1	1	2	1
PSO2	To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.	2	1	2	1	1	1
PSO3	To inculcate entrepreneurial skills through strong Industry-Institution linkage.	1	2	1	2	1	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OEN351**

**DRINKING WATER SUPPLY AND TREATMENT**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVE:**

- To equip the students with the principles and design of water treatment units and distribution system.

<b>UNIT I</b>	<b>SOURCES OF WATER</b>	<b>9</b>
Public water supply system – Planning, Objectives, Design period, Population forecasting; Water demand – Sources of water and their characteristics, Surface and Groundwater – Impounding Reservoir – Development and selection of source – Source Water quality – Characterization – Significance – Drinking Water quality standards.		
<b>UNIT II</b>	<b>CONVEYANCE FROM THE SOURCE</b>	<b>9</b>
Water supply – intake structures – Functions; Pipes and conduits for water – Pipe materials – Hydraulics of flow in pipes – Transmission main design – Laying, jointing and testing of pipes – appurtenances – Types and capacity of pumps – Selection of pumps and pipe materials.		
<b>UNIT III</b>	<b>WATER TREATMENT</b>	<b>9</b>
Objectives – Unit operations and processes – Principles, functions, and design of water treatment plant units, aerators of flash mixers, Coagulation and flocculation – sand filters - Disinfection – Construction, Operation and Maintenance aspects.		
<b>UNIT IV</b>	<b>ADVANCED WATER TREATMENT</b>	<b>9</b>
Water softening – Desalination- R.O. Plant – demineralization – Adsorption - Ion exchange– Membrane Systems - Iron and Manganese removal - Defluoridation - Construction and Operation and Maintenance aspects		
<b>UNIT V</b>	<b>WATER DISTRIBUTION AND SUPPLY</b>	<b>9</b>
Requirements of water distribution – Components – Selection of pipe material – Service reservoirs - Functions – Network design – Economics - Computer applications – Appurtenances – Leak detection - Principles of design of water supply in buildings – House service connection – Fixtures and fittings, systems of plumbing and types of plumbing.		

**TOTAL: 45 PERIODS**

### **COURSE OUTCOMES**

- CO1: an understanding of water quality criteria and standards, and their relation to public health
- CO2: the ability to design the water conveyance system
- CO3: the knowledge in various unit operations and processes in water treatment
- CO4: an ability to understand the various systems for advanced water treatment
- CO5: an insight into the structure of drinking water distribution system

### **TEXTBOOKS :**

1. Garg. S.K., "Water Supply Engineering", Khanna Publishers, Delhi, September 2008.
2. Punmia B.C, Arun K.Jain, Ashok K.Jain, " Water supply Engineering" Lakshmi publication private limited, New Delhi, 2016.
3. Rangwala "Water Supply and Sanitary Engineering", February 2022
4. Birdie.G.S., "Water Supply and Sanitary Engineering", Dhanpat Rai and sons, 2018.

### **REFERENCES :**

1. Fair. G.M., Geyer.J.C., "Water Supply and Wastewater Disposal", John Wiley and Sons, 1954.
2. Babbit.H.E, and Donald.J.J, "Water Supply Engineering" , McGraw Hill book Co, 1984.
3. Steel. E.W.et al., "Water Supply Engineering" , Mc Graw Hill International book Co, 1984.
4. Duggal. K.N., "Elememts of public Health Engineering", S.Chand and Company Ltd, New Delhi, 1998.

## CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		3						3		3			3		
2		3		2		2				3			3		
3				2		2				3			3		
4			3	2				3	2	3			3		
5			3	2			1		2	3		1			
Avg.		3	3	2		2	1	3	2	3		1	3		

1.low, 2-medium, 3-high, '-''- no correlation

**Note: The average value of this course to be used for program articulation matrix.**

**OEE352**

**ELECTRIC VEHICLE TECHNOLOGY**

**L T P C**  
**3 0 0 3**

### COURSE OBJECTIVES

- To provide knowledge about electric machines and special machine
- To understand the basics of power converters
- To know the concepts of controlling DC and AC drive systems
- To understand the architecture and power train components.
- To impart knowledge on vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs)

#### UNIT I ROTATING POWER CONVERTERS

**9**

Magnetic circuits- DC machine and AC machine –Working principle of Generator and Motor-DC and AC - Voltage and torque equations – Characteristics and applications. Working principle of special machines like: Brushless DC motor, Switched reluctance motor and PMSM.

#### UNIT II STATIC POWER CONVERTERS

**9**

Working and Characteristics of Power Diodes, MOSFET and IGBT. Working of uncontrolled rectifiers, controlled rectifiers (Single phase and Three phase), DC choppers, single and three phase inverters, Multilevel inverters and Matrix Converters.

#### UNIT III CONTROL OF DC AND AC MOTOR DRIVES

**9**

Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and braking) of induction motor drives, Transformation theory, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives

#### UNIT IV HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENTS

**9**

History of evolution of Electric Vehicles - Comparison of Electric Vehicles with Internal Combustion Engines - Architecture of Electric Vehicles (EV) and Hybrid Electric Vehicles (HEV) – Plug-in Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes.

## UNIT V MECHANICS OF HYBRID ELECTRIC VEHICLES AND CONTROL OF VEHICLES 9

Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of HEV's - motor torque and power rating and battery capacity. HEV supervisory control - Selection of modes - power split mode - parallel mode - engine brake mode - regeneration mode - series parallel mode

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:

CO1: Able to understand the principles of conventional and special electrical machines.

CO2: Acquired the concepts of power devices and power converters

CO3: Able to understand the control for DC and AC drive systems.

CO4: Learned the electric vehicle architecture and power train components.

CO5: Acquired the knowledge of mechanics of electric vehicles and control of electric vehicles.

### CO's-PO's & PSO's MAPPING

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2			3								3	3	3
CO2	3	2	2			3			3				3	3	3
CO3	3			3		2	2						3	3	3
CO4	3	2	2		3								3	3	3
CO5	3		2								2		3	3	3
Avg	3	2	2	3	3	1	2		3		2		3	3	3

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

### REFERENCES:

- 1 Stephen D. Umans, "Fitzgerald & Kingsley's Electric Machinery", Tata McGraw Hill, 7<sup>th</sup> Edition, 2020.
- 2 Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011
- 3 Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek "Analysis of Electric Machinery and Drive Systems", 3<sup>rd</sup> Edition, Wiley-IEEE Press, 2013.
- 4 Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Pearson, fourth Edition, 10<sup>th</sup> Impression 2021.
- 5 Iqbal Husain, 'Electric and Hybrid Electric Vehicles', CRC Press, 2021.
- 6 Wei Liu, 'Hybrid Electric Vehicle System Modeling and Control', Second Edition, WILEY, 2017
- 7 James Larminie and John Lowry, 'Electric Vehicle Technology Explained', Second Edition, Wiley, 2012

**OEI353**

**INTRODUCTION TO PLC PROGRAMMING**

**L T P C**

**3 0 0 3**

### COURSE OBJECTIVES:

- Understand basic PLC terminologies digital principles, PLC architecture and operation.
- Familiarize different programming language of PLC.
- Develop PLC logic for simple applications using ladder logic.
- Understand the hardware and software behind PLC and SCADA.
- Exposures about communication architecture of PLC/SCADA.

**UNIT I INTRODUCTION TO PLC 9**

Introduction to PLC: Microprocessor, I/O Ports, Isolation, Filters, Drivers, Microcontrollers/DSP, PLC/DDC- PLC Construction: What is a PLC, PLC Memories, PLC I/O, , PLC Special I/O, PLC Types.

**UNIT II PLC INSTRUCTIONS 9**

PLC Basic Instructions: PLC Ladder Language- Function block Programming- Ladder/Function Block functions- PLC Basic Instructions, Basic Examples (Start Stop Rung, Entry/Reset Rung)- Configuration of Sensors, Switches, Solid State Relays-Interlock examples- Timers, Counters, Examples.

**UNIT III PLC PROGRAMMING 9**

Different types of PLC program, Basic Ladder logic, logic functions, PLC module addressing, registers basics, basic relay instructions, Latching Relays, arithmetic functions, comparison functions, data handling, data move functions, timer-counter instructions, input-output instructions, sequencer instructions

**UNIT IV COMMUNICATION OF PLC AND SCADA 9**

Communication Protocol – Modbus, HART, Profibus- Communication facilities SCADA: - Hardware and software, Remote terminal units, Master Station and Communication architectures

**UNIT V CASE STUDIES 9**

Stepper Motor Control- Elevator Control-CNC Machine Control- conveyor control-Interlocking Problems

**TOTAL:45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 5**

1. Market survey of the recent PLCs and comparison of their features.
2. Summarize the PLC standards
3. Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)
4. Market survey of Communication Network Used for PLC/SCADA.

**COURSE OUTCOMES:**

- CO1** Know the basic requirement of a PLC input/output devices and architecture. (L1)  
**CO2** Ability to apply Basics Instruction Sets used for ladder Logic and Function Block Programming.(L2)  
**CO3** Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.(L3)  
**CO4** Able to develop a PLC logic for a specific application on real world problem. (L5)  
**CO5** Ability to Understand the Concepts of Communication used for PLC/SCADA.(L1)

**TEXT BOOKS:**

1. Frank Petruzzola, Programmable Logic Controllers, Tata Mc-Graw Hill Edition
2. John W. Webb, Ronald A. Reis, Programmable Logic Controllers Principles and Applications, PHI publication

**REFERENCES:**

1. MadhuchandMitra and SamerjitSengupta, Programmable Logic Controllers Industrial Automation an Introduction, Penram International Publishing Pvt. Ltd.

- J. R. Hackworth and F. D. Hackworth, Programmable Logic Controllers Principles and Applications, Pearson publication

**List of Open Source Software/ Learning website:**

- <https://nptel.ac.in/courses/108105063>
- <https://www.electrical4u.com/industrial-automation/>
- <https://www.etf.ues.rs.ba/~slubura/Procesni%20racunari/Programmable%20Logic%20Controllers%20Programming%20Methods.pdf>
- <https://www.electrical4u.com/industrial-automation/>

**CO's-PO's & PSO's MAPPING**

PO, PSO CO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
<b>CO1</b>	3	2	1					1		1					
<b>CO2</b>	3	3	2					1		1	2				2
<b>CO3</b>	3	3	3	3	1			1		1					
<b>CO4</b>	3	3		3	3			1		1			3	3	
<b>CO5</b>	3	3	3	2	1			1		1			3	3	3
<b>Avg</b>	3	2.9	2.25	2.6	1.6			1		1			3	3	2.9

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OCH351**

**NANO TECHNOLOGY**

**L T P C  
3 0 0 3**

**UNIT I INTRODUCTION**

**8**

General definition and size effects—important nano structured materials and nano particles- importance of nano materials- Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials- surface area - band gap energy and applications. Photochemistry and Electrochemistry of nanomaterials –Ionic properties of nanomaterials- Nano catalysis.

**UNIT II SYNTHESIS OF NANOMATERIALS**

**8**

Bottom up and Top-down approach for obtaining nano materials - Precipitation methods – sol gel technique – high energy ball milling, CVD and PVD methods, gas phase condensation, magnetron sputtering and laser deposition methods – laser ablation, sputtering.

**UNIT III NANO COMPOSITES**

**10**

Definition- importance of nanocomposites- nano composite materials-classification of composites- metal/metal oxides, metal-polymer- thermoplastic based, thermoset based and elastomer based- influence of size, shape and role of interface in composites applications.

**UNIT IV NANO STRUCTURES AND CHARACTERIZATION TECHNIQUES**

**10**

Classifications of nanomaterials - Zero dimensional, one-dimensional and two-dimensional nanostructures- Kinetics in nanostructured materials- multilayer thin films and superlattice-clusters of metals, semiconductors and nanocomposites. Spectroscopic techniques, Diffraction methods, thermal analysis method, BET analysis method.

**UNIT V APPLICATIONS OF NANO MATERIALS****9**

Overview of nanomaterials properties and their applications, nano painting, nano coating, nanomaterials for renewable energy, Molecular Electronics and Nanoelectronics – Nanobots-Biological Applications. Emerging technologies for environmental applications- Practice of nanoparticles for environmental remediation and water treatment.

**TOTAL : 45 PERIODS****COURSE OUTCOMES:**

CO1 - understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications.

CO2 – able to acquire knowledge about the different types of nano material synthesis

CO3 – describes about the shape, size,structure of composite nano materials and their interference

CO4 – understand the different characterization techniques for nanomaterials

CO5 - develop a deeper knowledge in the application of nanomaterials in different fields.

**TEXT BOOKS**

1. Mick Wilson, Kamali Kannangara,Geoff Smith, Michelle Simmom, Burkhard Raguse, “ Nano Technology: Basic Science & Engineering Technology”, 2005, Overseas Press

2. G. Cao, “Nanostructures & Nanomaterials: Synthesis, Properties &Applications” Imperial College Press, 2004

3.William A Goddard “Handbook of Nanoscience, Engineering and Technology”, 3<sup>rd</sup> Edition, CRC Taylor and Francis group 2012.

**REFERENCES**

1. R.H.J.Hannink & A.J.Hill, Nanostructure Control, Wood Head Publishing Ltd.,Cambridge, 2006.
2. C.N.R.Rao, A.Muller, A.K.Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications Vol. I & II, 2nd edition, 2005, Wiley VCH Verlag Gbtl & Co
3. Ivor Brodie and Julius J.Muray,'The physics of Micro/Nano – Fabrication',Springer International Edition,2010

**CO's-PO's & PSO's MAPPING**

Course Outcomes	Statement	Program Outcome														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications	2	3	2	3	3	-	-	-	1	1	-	3	1	1	3
CO2	acquire knowledge about the different types of nano material synthesis	2	3	1	3	3	-	-	-	1	1	-	3	2	1	3
CO3	describes about the shape, size,structure of composite nano materials and their	2	2	2	3	3	1	1	-	1	1	-	3	2	1	3

	interference															
<b>CO4</b>	understand the different characterization techniques for nanomaterials	2	2	1	3	3	1	1	1	1	-	1	3	1	1	3
<b>CO5</b>	develop a deeper knowledge in the application of nanomaterials in different fields	2	2	1	3	3	1	1	1	1	-	1	3	2	1	3
	Overall CO	3	2	2	1	3	3	1	1	1	1	1	1	3	2	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OCH352**

**FUNCTIONAL MATERIALS**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVE:**

- The course emphasis on the molecular safe assembly and materials for polymer electronics

**UNIT I INTRODUCTION**

**9**

Historical Perspectives, Lessons from the Nature, Engineering the Functions, Tuning the functions, Multiscale Modeling and Computation, Classification of Functional Materials, Functional Diversity of Materials, Hybrid Materials, Technological Relevance, Societal Impact.

**UNIT II MOLECULAR SELF ASSEMBLY**

**9**

Molecular Organization, Self-Assembly in Biology, Energetics of Self-Organization, A Few Case Studies, Synthetic Protocols and Challenges, Solvent-assisted Self-Assembly, Directed Assembly-Langmuir-Blodgett and Langmuir-Schaefer techniques, Technological Applications of SAMs.

**UNIT III BIO-INSPIRED MATERIALS**

**9**

Bio-inspired materials, Classification, Biomimicry, Spider Silk, Lotus Leaf, Gecko feet, Synovial fluid, 'Bionics'-Bio-inspired Information Technologies, Artificial Sensory Organs, Biomineralization-En route to Nanotechnology.

**UNIT IV SMART OR INTELLIGENT MATERIALS**

**9**

Criteria for Smartness, Significance of Smart Materials, Representative Examples like Smart Gels and Polymers, Electro/Magneto Rheological Fluids, Smart Electroceramics, Technical Limitations and Challenges, Functional Nanocomposites, Polymer-carbon nanotube composites.

**UNIT V MATERIALS FOR POLYMER ELECTRONICS**

**9**

Polymers for Electronics, Organic Light Emitting Diodes, Working Principle of OLEDs, Illustrated Examples, Organic Field-Effect Transistors Operating Principle, Design Considerations, Polymer FETs vs Inorganic FETs, Liquid Crystal Displays, Engineering Aspects of Flat Panel Displays, Intelligent Polymers for Data Storage, Polymer-based Data Storage-Principle, Magnetic Vs. Polymer-based Data Storage.

**TOTAL: 45 PERIODS**



**COURSE OUTCOME:**

- Students will be able to differentiate among various functional properties and select appropriate material for certain functional applications, analyze the nature and potential of functional material.

**TEXT BOOK:**

1. Vijayamohan K. Pillai and MeeraParthasarathy, "Functional Materials: A chemist's perspective", Universities Press Hyderabad (2012).

**REFERENCE:**

1. Stephen Manne "Biomimetic Materials Chemistry" Wiley-VCH Newyork, 1966.

**OFD352****TRADITIONAL INDIAN FOODS****L T P C****3 0 0 3****COURSE OBJECTIVE:**

- To help students acquire a sound knowledge on diversities of foods, food habits and patterns in India with focus on traditional foods.

**UNIT I HISTORICAL AND CULTURAL PERSPECTIVES****9**

Food production and accessibility - subsistence foraging, horticulture, agriculture and pastoralization, origin of agriculture, earliest crops grown. Food as source of physical sustenance, food as religious and cultural symbols; importance of food in understanding human culture - variability, diversity, from basic ingredients to food preparation; impact of customs and traditions on food habits, heterogeneity within cultures (social groups) and specific social contexts - festive occasions, specific religious festivals, mourning etc. Kosher, Halal foods; foods for religious and other fasts.

**UNIT II TRADITIONAL METHODS OF FOOD PROCESSING****9**

Traditional methods of milling grains – rice, wheat and corn – equipments and processes as compared to modern methods. Equipments and processes for edible oil extraction, paneer, butter and ghee manufacture – comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation – sundrying, osmotic drying, brining, pickling and smoking.

**UNIT III TRADITIONAL FOOD PATTERNS****9**

Typical breakfast, meal and snack foods of different regions of India. Regional foods that have gone Pan Indian / Global. Popular regional foods; Traditional fermented foods, pickles and preserves, beverages, snacks, desserts and sweets, street foods; IPR issues in traditional foods

**UNIT IV COMMERCIAL PRODUCTION OF TRADITIONAL FOODS****9**

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods – types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods – ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters.

**UNIT V HEALTH ASPECTS OF TRADITIONAL FOODS 9**

Comparison of traditional foods with typical fast foods / junk foods – cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1** To understand the historical and traditional perspective of foods and food habits

**CO2** To understand the wide diversity and common features of traditional Indian foods and meal patterns.

**TEXT BOOKS:**

1. Sen, Colleen Taylor “Food Culture in India” Greenwood Press, 2005.

2. Davidar, Ruth N. “Indian Food Science: A Health and Nutrition Guide to Traditional Recipes: East West Books, 2001.

**OFD353 INTRODUCTION TO FOOD PROCESSING L T P C  
3 0 0 3**

**COURSE OBJECTIVE:**

• The course aims to introduce the students to the area of Food Processing. This is necessary for effective understanding of a detailed study of food processing and technology subjects. This course will enable students to appreciate the importance of food processing with respect to the producer, manufacturer and consumer.

**UNIT I PROCESSING OF FOOD AND ITS IMPORTANCE 9**

Source of food - plant, animal and microbial origin; different foods and groups of foods as raw materials for processing – cereals, pulses, grains, vegetables and fruits, milk and animal foods, sea weeds, algae, oil seeds & fats, sugars, tea, coffee, cocoa, spices and condiments, additives; need and significance of processing these foods.

**UNIT II METHODS OF FOOD HANDLING AND STORAGE 9**

Nature of harvested crop, plant and animal; storage of raw materials and products using low temperature, refrigerated gas storage of foods, gas packed refrigerated foods, sub atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; freezing of raw and processed foods.

**UNIT III LARGE-SCALE FOOD PROCESSING 12**

Milling of grains and pulses; edible oil extraction; Pasteurisation of milk and yoghurt; canning and bottling of foods; drying – Traditional and modern methods of drying, Dehydration of fruits, vegetables, milk, animal products etc; preservation by use of acid, sugar and salt; Pickling and curing with microorganisms, use of salt, and microbial fermentation; frying, baking, extrusion cooking, snack foods.

**UNIT IV FOOD WASTES IN VARIOUS PROCESSES 6**

Waste disposal-solid and liquid waste; rodent and insect control; use of pesticides; ETP; selecting and installing necessary equipment.

**UNIT V FOOD HYGIENE****9**

Food related hazards – Biological hazards – physical hazards – microbiological considerations in foods. Food adulteration – definition, common food adulterants, contamination with toxic metals, pesticides and insecticides; Safety in food procurement, storage handling and preparation; Relationship of microbes to sanitation, Public health hazards due to contaminated water and food; Personnel hygiene; Training & Education for safe methods of handling and processing food; sterilization and disinfection of manufacturing plant; use of sanitizers, detergents, heat, chemicals, Cleaning of equipment and premises.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

On completion of the course the students are expected to

**CO1** Be aware of the different methods applied to processing foods.

**CO2** Be able to understand the significance of food processing and the role of food and beverage industries in the supply of foods.

**TEXT BOOKS/REFERENCES:**

1. Karnal, Marcus and D.B. Lund "Physical Principles of Food Preservation". Rutledge, 2003.
2. VanGarde, S.J. and Woodburn. M "Food Preservation and Safety Principles and Practice". Surbhi Publications, 2001.
3. Sivasankar, B. "Food Processing & Preservation", Prentice Hall of India, 2002.
4. Khetarpaul, Neelam, "Food Processing and Preservation", Daya Publications, 2005.

**OPY352****IPR FOR PHARMA INDUSTRY****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- To provide the basic fundamental knowledge of different forms of Intellectual Property Rights in national and international level.
- To provide the significance of the Intellectual Property Rights about the patents, copyrights, industrial design, plant and geographical indications.
- This paper is to study significance of the amended patent act on pharma industry.

**UNIT I INTRODUCTION- INTELLECTUAL PROPERTY RIGHTS****9**

Introduction, Types of Intellectual Property Rights -patents, plant varieties protection, geographical indicators, copyright, trademark, trade secrets.

**UNIT II PATENTS****9**

Patents-Objective, Introduction, Requirement for patenting- Novelty, Inventive step (Non-obviousness) and industrial application (utility), Non-patentable inventions, rights of patent owner, assignment of patent rights, patent specification (provisional and complete), parts of complete specification, claims, procedure for obtaining patents, compulsory license.

**UNIT III PLANT VARIETY-TRADITIONAL KNOWLEDGE –GEOGRAPHICAL INDICATIONS****9**

Plant variety- Justification, criteria for protection of plant variety and protection in India. Traditional knowledge- Concept of traditional knowledge, protection of traditional knowledge under Intellectual Property frame works in national level and Traditional knowledge digital library (TKDL). Geographical Indications – Justification for protection, National and International position.

**UNIT IV ENFORCEMENT AND PRACTICAL ASPECTS OF IPR 9**

Introduction – civil remedies – injunction, damage, account of profit – criminal remedies – patent, trademark. Practical aspects – Introduction, benefits of licensing, licensing of basic types of IPR, licensing clauses of IPR. Case studies of patent infringement, compulsory licensing, simple patent license agreements.

**UNIT V INTERNATIONAL BACKGROUND OF INTELLECTUAL PROPERTY 9**

International Background of Intellectual Property- Paris Convention, Berne convention, World Trade Organization (WTO), World Intellectual Property Organization (WIPO), Trade Related Aspects of Intellectual Property Rights (TRIPS) and Patent Co-operation Treaty (PCT).

**TOTAL:45 PERIODS****TEXT BOOKS:**

1. N. Nagpal, M. Arora, M.R.D. Usman, S. Rahar, "Intellectual Property Rights" Edu creation Publishing, New Delhi, 2017.
2. The Patents Act, 1970 (Bare Act with Short Notes) (New Delhi: Universal Law Publishing Company Pvt. Ltd. 2012.
3. B.S. Rao, P.V. Appaji, "Intellectual Property Rights in Pharmaceutical Industry: Theory and Practice", 2015.

**REFERENCES:**

1. Patents for Chemicals, Pharmaceuticals, & Biotechnology-Fundamentals of Global Law, Practice and Strategy. Philip W. Grubb, Oxford University Press, 2004.
2. Basic Principles of patent law – Basics principles and acquisition of IPR. Ramakrishna T. CIPRA, NLSIU, Bangalore, 2005
3. S. Lakshmana Prabu, TNK. Suriyaprakash, "Intellectual Property Rights", 1st ed., In Tech open access, Croatia, 2017.

**COURSE OUTCOME**

The student will be able to

**CO1** Understand and differentiate the categories of intellectual property rights.

**CO2** Describe about patents and procedure for obtaining patents.

**CO3** Distinguish plant variety, traditional knowledge and geographical indications under IPR.

**CO4** Provide the information about the different enforcements and practical aspects involved in protection of IPR.

**CO5** Provide different organizations role and responsibilities in the protection of IPR in the international level.

**CO6** Understand the interrelationships between different Intellectual Property Rights on International Society

<b>CO's-PO's &amp; PSO's MAPPING</b>												
<b>IPR FOR PHARMA INDUSTRY</b>												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>C1</b>	3	3		2					2	2		
<b>C2</b>		3	3				2	2				
<b>C3</b>	3	3					2	2				1
<b>C4</b>					2		3	3		2	2	
<b>C5</b>		3					3			2		1
<b>C6</b>	3	2				2	2					2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVE:**

- To enable the students to understand the basics and different types of finishes required for textile materials and machines used for finishing.

**UNIT I RESIN FINISHING****9**

Importance of finishing and its classification. Resin finishing: Mechanism of creasing, Types of Resins .Anti crease, wash and wear, durable press resin finishing. Study about eco friendly method of anti crease finishing.

**UNIT II FLAME PROOF & WATERPROOF****9**

Concept of Flame proof & flame retardancy. Flame retardant finishes for cotton, Concept of waterproof and water repellent Finishes, Durable & Semi durable and Temporary finishes, Concept of Antimicrobial finish.

**UNIT III SOIL RELEASE AND ANTISTATIC FINISHES****9**

Soil Release Finishing: Mechanism of soil retention & soil release. Anti pilling Finishing: chemical and mechanical methods to produce anti pilling. Concept of UV Protection finishes- Concept of antistatic finishes.

**UNIT IV MECHANICAL FINISHES****9**

Mechanical finishing of textile materials - calendaring, compacting, Sanforising, Peach finishing. Object of Heat setting. Various methods of heat setting and mechanism of heat setting.

**UNIT V STIFFENING AND SOFTENING****9**

Concept of stiffening and softening of textile materials. Mechanism in the weight reduction of PET .Concept of Micro encapsulation techniques in finishing process, Nano finish, Plasma Treatment and Bio finishing.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

Upon completion of the course, the students will be able to Understand the

CO: 1 Basics of Resin Finishing Process.

CO:2 Concept of Flame proof & flame retardancy, waterproof and water repellent, Antimicrobial finishes.

CO: 3 Concept of Soil Release, Anti Pilling, UV Protection and Antistatic finishes.

CO: 4 Concept of Mechanical finishing.

CO: 5 Basics of Micro encapsulation techniques, Nano finish, Plasma Treatment.

**TEXT BOOKS:**

- V.A.Shennai, "Technology of Finishing", Vol X, Sevak Publications, Mumbai
- Perkins, W.S., "Textile colouration and finishing", Carolina Academic Press., U.K, ISBN: 0890898855.2004.

**REFERENCES:**

- Microencapsulation in finishing, Review of progress of Colouration, SDC, 2001 62
- Chakraborty, J.N, Fundamentals and Practices in colouration of Textiles, Woodhead Publishing India, 2009, ISBN-13:978-81-908001-4-3
- W. D. Schindler and P. J. Hauser "Chemical finishing of textiles", Woodhead Publishing Cambridge England,2004.

**COURSE OBJECTIVES:**

- To enable the students to learn about basics of industrial engineering and different tools of industrial engineering and its application in apparel industry

**UNIT I INTRODUCTION**

9

Scope of industrial engineering in apparel Industry, role of industrial engineers.

**Productivity:** Definition - Productivity, Productivity measures .Reduction of work content due to the product and process, Reduction of ineffective time due to the management, due to the worker. Causes for low productivity in apparel industry and measures for improvement.

**UNIT II WORK STUDY**

9

Definition, Purpose, Basic procedure and techniques of work-study.

**Work environment** – Lighting, Ventilation, Climatic condition on productivity. Temperature control, humidity control, noise control measures. Safety and ergonomics on work station and work environment

**Material Handling** – Objectives, Classification and characteristics of material handling equipments, Specialized material handling equipments.

**UNIT III METHOD STUDY**

9

Definition, Objectives, Procedure, Process charts and symbols. Various charts – Charts indicating process sequence: Outline process chart, flow process chart (man type, material type and equipment type); Charts using time scale – multiple activity chart. Diagrams indicating movement – flow diagram, string diagram, cycle graph, chrono cycle graph, travel chart

**MOTION STUDY:** Principle of motion economy, Two handed process chart, micro motion analysis – therbligs, SIMO chart.

**UNIT IV WORK MEASUREMENT**

9

Definition, purpose, procedure, equipments, techniques. Time study - Definition, basics of time study- equipments. Time study forms, Stop watch procedure. Predetermined motion time standards (PMTS). Time Study rating, calculation of standard time, Performance rating – relaxation and other allowances. Calculation of SAM for different garments, GSD.

**UNIT V WORK STUDY APPLICATION**

9

Application of work study techniques in cutting, stitching and packing in garment industry. Workaids in sewing, Pitch diagram, Line balancing, Capacity planning, scientific method of training.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

Upon the completion of the course the student shall be able to understand

CO1: Fundamental concepts of industrial Engineering and productivity

CO2: Method study

CO3: Motion analysis

CO4: Work measurement and SAM

CO5: Ergonomics and its application to garment industry

**TEXTBOOKS:**

- George Kanwaty, "Introduction to Work Study ", ILO, Geneva, 1996, ISBN: 9221071081  
|ISBN-13: 9789221071082

2. Enrick N. L., "Time study manual for Textile industry", Wiley Eastern (P) Ltd., 1989, ISBN: 0898740444 | ISBN-13: 9780898740448
3. Khanna O. P., and Sarup A., "Industrial Engineering and Management", Dhanpat Rai Publications, New Delhi, 2010, ISBN: 818992835X / ISBN: 978-8189928353

## REFERENCES

1. Norberd Lloyd Enrick., "Industrial Engineering Manual for Textile Industry", Wiley Eastern (P) Ltd., New Delhi, 1988, ISBN: 0882756311 | ISBN-13: 9780882756318
2. Chuter A. J., "Introduction to Clothing Production Management", Wiley-Black well Science, U.S. A., 1995, ISBN: 0632039396 | ISBN-13: 9780632039395
3. GordanaColovic., "Ergonomics in the garment industry", Wood publishing India Pvt. Ltd., India, 2014, ISBN: 0857098225 | ISBN-13: 9780857098221
4. Rajesh Bheda, "Managing Productivity in Apparel Industry "CBS Publishers & Distributors, 2008

## CO's-PO's & PSO's MAPPING

Course Outcomes	Statement	Program Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Fundamental concepts of industrial Engineering and productivity	2	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO2	Method study	1	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO3	Motion analysis	1	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO4	Work measurement and SAM	1	2	3	3	2	1	1	2	2	1	3	2	1	1	-
CO5	Ergonomics and its application to garment industry	1	2	3	3	2	1	2	2	2	1	3	2	1	1	-
<b>Overall CO</b>		1.2	2	3	3	2	1	1.2	2	2	1	2.4	2	1	1	-

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OTT353**

**BASICS OF TEXTILE MANUFACTURE**

**L T P C  
3 0 0 3**

### COURSE OBJECTIVES:

To enable the students to learn about the basics of fibre forming, yarn production, fabric formation, coloration of fabrics and garment manufacturing

<b>UNIT I</b>	<b>NATURAL FIBRES</b>	<b>9</b>
Introduction: Definition of staple fibre, filament; Classification of natural and man-made fibres, essential and desirable properties of fibres. Production and cultivation of Natural Fibers: Cultivation of cotton, production of silk (sericulture), wool and jute – physical and chemical structure of these fibres..		
<b>UNIT II</b>	<b>REGENERATED AND SYNTHETIC FIBRES</b>	<b>9</b>
Production sequence of regenerated and modified cellulosic fibres: viscose rayon, Acetate Rayon, high wet modulus and high tenacity fibres; synthetic fibres – chemical structure, fibre forming polymers, production principles.		
<b>UNIT III</b>	<b>BASICS OF SPINNING</b>	<b>9</b>
Spinning – principle of yarn formation, sequence of machines for yarn production with short staple fibres and blends, principles of opening and cleaning machines; yarn numbering - calculations		
<b>UNIT IV</b>	<b>BASICS OF WEAVING</b>	<b>9</b>
Woven fabric – warp, weft, weaving, path of warp; looms – classification, handloom and its parts, powerloom, automatic looms, shuttleless looms, special type of looms; preparatory machines for weaving process and their objectives; basic weaving mechanism - primary, secondary and auxiliary mechanisms,		
<b>UNIT V</b>	<b>BASICS OF KNITTING AND NONWOVEN</b>	<b>9</b>
Knitting – classification, principle, types of fabrics; nonwoven process –classification, principle, types of fabrics.		

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

On completion of this course, the students shall have the basic knowledge on

**CO1:** Classification of fibres and production of natural fibres

**CO2:** Regenerated and synthetic fibres

**CO3:** Yarn spinning

**CO4:** Weaving

**CO5:** Knitting and nonwoven

**TEXTBOOKS**

1. Mishra S. P. , “A Text Book of Fibre Science and Technology”, New Age Publishers, 2000,
2. ISBN: 8122412505
3. Marks R., and Robinson. T.C., “Principles of Weaving”, The Textile Institute, Manchester, 1989, ISBN: 0 900739 258.
4. Spencer D.J., “Knitting Technology”, III Ed., Textile Institute, Manchester, 2001, ISBN: 185573 333 1.

**REFERENCES:**

1. Hornberer M., Eberle H., Kilgus R., Ring W. and Hermeling H., “Clothing Technology: From Fibre to Fabric”, Europa LehrmittelVerlag, 2008, ISBN: 3808562250 / ISBN: 978-3808562253.
2. Wynne A., “Motivate Series-Textiles”, Maxmillan Publications, London, 1997.
3. Carr H. and Latham B., “The Technology of Clothing Manufacture” Backwell Science, U.K., 1994, ISBN: 0632037482 / ISBN:13: 9780632037483.Klein W., “The Rieter Manual of Spinning, Vol.1”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-1-4 / ISBN 13 978-3-9523173-1-0.



4. Klein W., "The Rieter Manual of Spinning, Vol.2", Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-2-2 / ISBN 13 978-3-9523173-2-7.
  5. Klein W., "The Rieter Manual of Spinning, Vol.1-3", Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-3-0 / ISBN 13 978-3-9523173-3-4.
  6. Talukdar. M.K., Sriramulu. P.K., and Ajaonkar. D.B., "Weaving: Machines, Mechanisms, Management", Mahajan Publishers, Ahmedabad, 1998, ISBN: 81-85401-16-0.
  7. Morton W. E., and Hearle J. W. S., "Physical Properties of Textile Fibres", The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95
  8. Gohl E. P. G., "Textile Science", CBS Publishers and distributors, 1987, ISBN 0582685958
- CO's-PO's & PSO's MAPPING**

Course Outcomes	Statement	Program Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	Classification of fibres and production of natural fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO2.	Regenerated and synthetic fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO3.	Yarn spinning	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO4.	Weaving	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO5.	Knitting and nonwoven	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>Overall CO</b>		-	-	-	-	-	-	-	2	1	-	1	1	-	1	-

1 -

low, 2 - medium, 3 - high, '-' - no correlation

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OPE351**

**INTRODUCTION TO PETROLEUM REFINING AND PETROCHEMICALS**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVE:**

The course is aimed to

Gain knowledge about petroleum refining process and production of petrochemical products.

**UNIT I ORIGIN, FORMATION AND REFINING OF CRUDE OIL**

**9**

Origin, Formation and Evaluation of Crude Oil. Testing of Petroleum Products. Refining of Petroleum - Atmospheric and Vacuum Distillation.

**UNIT II CRACKING 9**  
Cracking, Thermal Cracking, Vis-breaking, Catalytic Cracking (FCC), Hydro Cracking, Coking and Air Blowing of Bitumen

**UNIT III REFORMING AND HYDROTREATING 9**  
Catalytic Reforming of Petroleum Feed Stocks. Lube oil processing- Solvent Treatment Processes, Dewaxing, Clay Treatment and Hydrofining. Treatment Techniques: Removal of Sulphur Compounds in all Petroleum Fractions to improve performance.

**UNIT IV INTRODUCTION TO PETROCHEMICALS 9**  
Petrochemicals - Cracking of Naphtha and Feed stock gas for the production of Ethylene, Propylene, Isobutylene and Butadiene. Production of Acetylene from Methane, and Extraction of Aromatics.

**UNIT V PRODUCTION OF PETROCHEMICALS 9**  
Production of Petrochemicals like Dimethyl Terephthalate(DMT), Ethylene Glycol, Synthetic glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate (MMA), Vinyl Acetate Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol, Acetone, Methanol, Formaldehyde, Acetaldehyde, Pentaerythritol and production of Carbon Black.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On the completion of the course students are expected to

**CO1:** Understand the classification, composition and testing methods of crude petroleum and its products. Learn the mechanism of refining process.

**CO2:** Understand the insights of primary treatment processes to produce the precursors.

**CO3:** Study the secondary treatment processes cracking, vis-breaking and coking to produce more petroleum products.

**CO4:** Appreciate the need of treatment techniques for the removal of sulphur and other impurities from petroleum products.

**CO5:** Understand the societal impact of petrochemicals and learn their manufacturing processes.

**CO6:** Learn the importance of optimization of process parameters for the high yield of petroleum products.

**TEXT BOOKS**

1. Nelson, W. L., "Petroleum Refinery Engineering", 4th Edition., McGraw Hill, New York, 1985.
2. Wiseman. P., "Petrochemicals", UMIST Series in Science and Technology, John Wiley & Sons, 1986.

**REFERENCES**

1. Bhaskara Rao, B. K., "Modern Petroleum Refining Processes", 2nd Edition, Oxford and IBH Publishing Company, New Delhi, 1990.
2. Bhaskara Rao, B. K. "A Text on Petrochemicals", 1st Edition, Khanna Publishers

**CPE334 ENERGY CONSERVATION AND MANAGEMENT L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

At the end of the course, the student is expected to

- understand and analyse the energy data of industries
- carryout energy accounting and balancing

- conduct energy audit and suggest methodologies for energy savings and
- utilise the available resources in optimal ways

## **UNIT I INTRODUCTION 9**

Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

## **UNIT II ELECTRICAL SYSTEMS 9**

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

## **UNIT III THERMAL SYSTEMS 9**

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution & U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

## **UNIT IV ENERGY CONSERVATION IN MAJOR UTILITIES 9**

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets

## **UNIT V ECONOMICS 9**

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept

**TOTAL: 45 PERIODS**

### **COURSE OUTCOMES:**

Upon completion of this course, the students can able to analyze the energy data of industries.

CO1: Remember the knowledge for Basic combustion and furnace design and selection of thermal and mechanical energy equipment.

CO2: Study the Importance of Stoichiometry relations, Theoretical air required for complete combustion.

CO3: Skills on combustion thermodynamics and kinetics.

CO4: Apply calculation and design tube still heaters.

CO5: Studied different heat treatment furnace.

CO6: Practical and theoretical knowledge burner design.

### **TEXT BOOKS:**

1. Energy Manager Training Manual (4 Volumes) available at [www.energymanagertraining.com](http://www.energymanagertraining.com). a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.

### **REFERENCES:**

1. Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988.
2. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford, 1981.
3. Dryden. I.G.C., "The Efficient Use of Energy" Butterworths, London, 1982
4. Turner. W.C., "Energy Management Hand book", Wiley, New York, 1982.
5. Murphy. W.R. and G. Mc KAY, "Energy Management", Butterworths, London 1987

**COURSE OBJECTIVES**

- Understand the fundamentals of plastics processing, such as the relationships between material structural properties and required processing parameters, and so on
- To gain practical knowledge on the polymer selection and its processing
- Understanding the major plastic material processing techniques (Extrusion, Injection molding, Compression and Transfer molding, Blow molding, Thermoforming and casting)
- To understand suitable additives for plastics compounding
- To Propose troubleshooting mechanisms for defects found in plastics products manufactured by various processing techniques

**UNIT I INTRODUCTION TO PLASTICS PROCESSING****9**

Introduction to plastic processing – Principles of plastic processing: processing of plastics vs. metals and ceramics. Factors influencing the efficiency of plastics processing: molecular weight, viscosity and rheology. Difference in approach for thermoplastic and thermoset processing. Additives for plastics compounding and processing: antioxidants, light stabilizers, UV stabilizers, lubricants, impact modifiers, flame retardants, antistatic agents, stabilizers and plasticizers. Compounding: plastic compounding techniques, plasticization, pelletization.

**UNIT II EXTRUSION****9**

Extrusion – Principles of extrusion. Features of extruder: barrel, screw, types of screws, drive mechanism, specifications, heating & cooling systems, types of extruders. Flow mechanism: process variables, die entry effects and exit instabilities. Die swell, Defects: melt fracture, shark skin, bambooning. Factors determining efficiency of an extruder. Extrusion of films: blown and cast films. Tube/pipe extrusion. Extrusion coating: wire & cable. Twin screw extruder and its applications. Applications of extrusion and new developments.

**UNIT III INJECTION MOLDING****9**

Injection molding – Principles and processing outline, machinery, accessories and functions, specifications, process variables, mould cycle. Types of clamping: hydraulic and toggle mechanisms. Start-up and shut down procedures-Cylinder nozzles- Press capacity projected area -Shot weight Basic theoretical concepts and their relationship to processing - Interaction of moulding process aspect effects in quoted variables. Basic mould types. Reciprocating vs. plunger type injection moulding. Thermoplastic vs. thermosetting injection moulding. Injection moulding vs. other plastic processing techniques. State-of-the art injection moulding techniques - Introduction to trouble shooting

**UNIT IV COMPRESSION AND TRANSFER MOLDING****9**

Compression moulding – Basic principles of compression and transfer moulding-Meaning of terms-Bulk factor and flow properties, moulding materials, process variables and process cycle, Inter relation between flow properties-Curing time-Mould temperature and Pressure requirements. Preforms and preheating- Techniques of preheating. Machines used-Types of compression mould-positive, semi-positive and flash. Common moulding faults and their correction- Finishing of mouldings. Transfer moulding: working principle, equipment, Press capacity-Integral moulds and auxiliary ram moulds, moulding cycle, moulding tolerances, pot transfer, plunger transfer and screw transfer moulding techniques, advantages over compression moulding

**UNIT V BLOW MOLDING, THERMOFORMING AND CASTING****9**

Blow moulding: principles and terminologies. Injection blow moulding. Extrusion blow moulding. Design guidelines for optimum product performance and appearance. Thermoforming: principle, vacuum forming, pressure forming mechanical forming. Casting: working principle, types and applications.

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

**CO1:**Ability to find out the correlation between various processing techniques with product properties.

**CO2:**Understand the major plastics processing techniques used in moulding (injection, blow, compression, and transfer), extrusion, thermoforming, and casting.

**CO3:**Acquire knowledge on additives for plastic compounding and methods employed for the same

**CO4:**Familiarize with the machinery and ancillary equipment associated with various plastic processing techniques.

**CO5:**Select an appropriate processing technique for the production of a plastic product

**REFERENCES**

1. S. S. Schwart, S. H. Goodman, Plastics Materials and Processes, Van Nostrad Reinhold Company Inc. (1982).
2. F. Hensen (Ed.), Plastic Extrusion Technology, Hanser Gardner (1997).
3. W. S. Allen and P. N. Baker, Hand Book of Plastic Technology, Volume-1, Plastic Processing Operations [Injection, Compression, Transfer, Blow Molding], CBS Publishers and Distributors (2004).
4. M. Chanda, S. K. Roy, Plastic Technology handbook, 4th Edn., CRC Press (2007).
5. I. I. Rubin, Injection Molding Theory & Practice, Society of Plastic Engineers, Wiley (1973).
6. D.V. Rosato, M. G. Rosato, Injection Molding Hand Book, Springer (2012).
7. M. L. Berins (Ed.), SPI Plastic Engineering Hand Book of Society of Plastic Industry Inc., Springer (2012).
8. B. Strong, Plastics: Material & Processing, A, Pearson Prentice hall (2005).
9. D.V Rosato, Blow Molding Hand Book, Carl HanserVerlag GmbH & Co (2003).

**CBM348 FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- To understand the global trends and development methodologies of various types of products and services
- To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
- To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification
- To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
- To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

**UNIT I BASICS OF PRODUCT DEVELOPMENT 9**

Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies - Product Life Cycle – Product Development Planning and Management.

**UNIT II REQUIREMENTS AND SYSTEM DESIGN 9**

Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - System Design & Modeling - Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.

**UNIT III DESIGN AND TESTING 9**

Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines - Concept Screening & Evaluation - Detailed Design - Component Design and Verification – Mechanical, Electronics and Software Subsystems - High Level Design/Low Level Design of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping - Introduction to Rapid Prototyping and Rapid Manufacturing - System Integration, Testing, Certification and Documentation

**UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT 9**

Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - Sustenance -Maintenance and Repair – Enhancements - Product EoL - Obsolescence Management – Configuration Management - EoL Disposal

**UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY 9**

The Industry - Engineering Services Industry - Product Development in Industry versus Academia –The IPD Essentials - Introduction to Vertical Specific Product Development processes - Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to:

**CO1:**Define, formulate, and analyze a problem

**CO2:**Solve specific problems independently or as part of a team

**CO3:**Gain knowledge of the Innovation & Product Development process in the Business Context

**CO4:**Work independently as well as in teams

**CO5:**Manage a project from start to finish

**TEXT BOOKS:**

1. Book specially prepared by NASSCOM as per the MoU.
2. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011.
3. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.

## REFERENCES:

1. Hiriappa B, "Corporate Strategy – Managing the Business", Author House, 2013.
2. Peter F Drucker, "People and Performance", Butterworth – Heinemann [Elsevier], Oxford, 2004.
3. Vinod Kumar Garg and Venkita Krishnan N K, "Enterprise Resource Planning – Concepts", Second Edition, Prentice Hall, 2003.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013

## CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	1						1		1			
2	3	2	3	1						1		1			
3	3	2	3	1	1			1	1	1		1			
4	3	2	3	1	1			1	1	1		1			
5	3	2	3	1	1			1	1	1		1			
AVg.															

1 - low, 2 - medium, 3 - high, '-' - no correlation

CBM333

ASSISTIVE TECHNOLOGY

L T P C  
3 0 0 3

## COURSE OBJECTIVES:

The student should be made to:

- To know the hardware requirement various assistive devices
- To understand the prosthetic and orthotic devices
- To know the developments in assistive technology

### UNIT I CARDIAC ASSIST DEVICES

9

Cardiac functions and parameters, principle of External counter pulsation techniques, intra aortic balloon pump, Auxillary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves, cardiac pacemaker.

### UNIT II HEMODIALYSERS

9

Physiology of kidney, Artificial kidney, Dialysis action, hemodialyser unit, membrane dialysis, portable dialyser monitoring and functional parameters.

### UNIT III HEARING AIDS

9

Anatomy of ear, Common tests – audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids – principles, drawbacks in the conventional unit, DSP based hearing aids.

### UNIT IV PROSTHETIC AND ORTHODIC DEVICES

9

Hand and arm replacement – different types of models, externally powered limb prosthesis, feedback in orthotic system, functional electrical stimulation, sensory assist devices.

### UNIT V RECENT TRENDS

9

Transcutaneous electrical nerve stimulator, bio-feedback, assistive devices in drug delivery

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

- CO1: Interpret the various mechanical techniques that will help in assisting the heart functions.
- CO2: Describe the underlying principles of hemodialyzer machine.
- CO3: Indicate the methodologies to assess the hearing loss.
- CO4: Evaluate the types of assistive devices for mobilization.
- CO5: Explain about TENS and biofeedback system.

**TEXT BOOKS**

1. Joseph D. Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press,2006
2. Marion. A. Hersh, Michael A. Johnson,Assistive Technology for visually impaired and blind,Springer Science & Business Media, 1st edition, 12-May-2010
3. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, CRC Press, 1st edition,2010.

**REFERENCES**

1. Kenneth J. Turner Advances in Home Care Technologies: Results of the match Project, Springer, 1st edition, 2011.
2. Gerr M. Craddock Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003.
3. 3D Printing in Orthopaedic Surgery, Matthew Dipaola , Elsevier 2019 ISBN 978 -0-323-662116
4. Cardiac Assist Devices, Daniel Goldstein (Editor), Mehmet Oz (Editor), Wiley-Blackwell April 2000 ISBN: 978-0-879-93449-1

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1	3	1	1	1	1											
2	3	1	1	1	1											
3	3	1	1	1	1											
4	3	1	1	1	1											
5	3	1	1	1	1											
<b>AVg.</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>											

1 - low, 2 - medium, 3 - high, '-' - no correlation

OMA352

OPERATIONS RESEARCH

L T P C  
3 0 0 3

**COURSE OBJECTIVES:**

This course will help the students to

- determine the optimum solution for Linear programming problems.
- study the Transportation and assignment models and various techniques to solve them.
- acquire the knowledge of optimality, formulation and computation of integer programming problems.
- acquire the knowledge of optimality, formulation and computation of dynamic programming problems.
- determine the optimum solution for non-linear programming problems.



<b>UNIT I</b>	<b>LINEAR PROGRAMMING</b>	<b>9</b>
Formulation of linear programming models – Graphical solution – Simplex method - Big M Method – Two phase simplex method - Duality - Dual simplex method.		
<b>UNIT II</b>	<b>TRANSPORTATION AND ASSIGNMENT PROBLEMS</b>	<b>9</b>
Matrix form of Transportation problems – Loops in T.P – Initial basic feasible solution – Transportation algorithm – Assignment problem – Unbalanced assignment problems .		
<b>UNIT III</b>	<b>INTEGER PROGRAMMING</b>	<b>9</b>
Introduction – All and mixed I.P.P – Gomory’s method – Cutting plane algorithm – Branch and bound algorithm – Zero – one programming.		
<b>UNIT IV</b>	<b>DYNAMIC PROGRAMMING PROBLEMS</b>	<b>9</b>
Recursive nature of computation – Forward and backward recursion – Resource Allocation model – Cargo – loading model – Work – force size model - Investment model – Solution of L.P.P by dynamic programming .		
<b>UNIT V</b>	<b>NON - LINEAR PROGRAMMING PROBLEMS</b>	<b>9</b>
Lagrange multipliers – Equality constraints – Inequality constraints – Kuhn – Tucker Conditions – Quadratic programming.		

**TOTAL:45 PERIODS**

**COURSE OUTCOMES :**

At the end of the course, students will be able to

- CO1:** Could develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems.
- CO2:** analyze the concept of developing, formulating, modeling and solving transportation and assignment problems.
- CO3:** solve the integer programming problems using various methods.
- CO4:** conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming.
- CO5:** determine the optimum solution for non linear programming problems.

**TEXT BOOKS:**

1. Kanti Swarup, P.K.Gupta and Man Mohan, " Operations Research " , Sultan Chand & Sons, New Delhi, Fifth Edition , 1990.
2. Taha. H.A, " Operations Research – An Introduction , Pearson Education, Ninth Edition , New Delhi, 2012.

**REFERENCES :**

1. J.K.Sharma , " Operations Research - Theory and Applications " Mac Millan India Ltd , Second Edition , New Delhi , 2003.
2. Richard Bronson & Govindasami Naadimuthu , " Operations Research " ( Schaum’s Outlines – TMH Edition) Tata McGraw Hill, Second Edition, New Delhi, 2004.
3. Pradeep Prabhakar Pai , " Operations Research and Practice", Oxford University Press, New Delhi , 2012.
4. J.P.Singh and N.P.Singh , " Operations Research , Ane Books Pvt.Ltd, New Delhi , 2014.
5. F.S.Hillier and G.J. Lieberman, " Introduction to Operations Research " , Tata McGraw Hill, Eighth Edition , New Delhi, 2005.

### CO's-PO's & PSO's MAPPING

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO2	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
CO3	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO4	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO5	3	3	2	2	0	0	0	0	2	0	0	2	-	-	-
Avg	3	3	1	0.8	0	0	0	0	2	0	0	2	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

OMA353

ALGEBRA AND NUMBER THEORY

L T P C

3 0 0 3

#### COURSE OBJECTIVES:

- To introduce the basic notions of groups, rings, fields which will then be used to solve related problems.
- To examine the key questions in the Theory of Numbers.
- To give an integrated approach to number theory and abstract algebra, and provide a firm basis for further reading and study in the subject.

#### UNIT I GROUPS AND RINGS

9

Groups: Definition - Properties - Homomorphism - Isomorphism - Cyclic groups - Cosets - Lagrange's theorem.

Rings: Definition - Sub rings - Integral domain - Field - Integer modulo  $n$  - Ring homomorphism.

#### UNIT II FINITE FIELDS AND POLYNOMIALS

9

Rings - Polynomial rings - Irreducible polynomials over finite fields - Factorization of polynomials over finite fields.

#### UNIT III DIVISIBILITY THEORY AND CANONICAL DECOMPOSITIONS

9

Division algorithm- Base- $b$  representations – Number patterns – Prime and composite numbers – GCD – Euclidean algorithm – Fundamental theorem of arithmetic – LCM.

#### UNIT IV DIOPHANTINE EQUATIONS AND CONGRUENCES

9

Linear Diophantine equations – Congruence's – Linear Congruence's - Applications : Divisibility tests - Modular exponentiation - Chinese remainder theorem –  $2 \times 2$  linear systems.

#### UNIT V CLASSICAL THEOREMS AND MULTIPLICATIVE FUNCTIONS

9

Wilson's theorem – Fermat's Little theorem – Euler's theorem – Euler's Phi functions – Tau and Sigma functions.

**TOTAL: 45 PERIODS**

#### COURSE OUTCOMES :

**CO1:** Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.

**CO2:** Demonstrate accurate and efficient use of advanced algebraic techniques.

**CO3:** The students should be able to demonstrate their mastery by solving non-trivial problems related to the concepts, and by proving simple theorems about the, statements proven by the text

**TEXT BOOKS :**

1. Grimaldi, R.P and Ramana, B.V., "Discrete and Combinatorial Mathematics", Pearson Education, 5<sup>th</sup> Edition, New Delhi, 2007.
2. Thomas Koshy, "Elementary Number Theory with Applications", Elsevier Publications , New Delhi , 2002.

**REFERENCES:**

1. San Ling and Chaoping Xing, "Coding Theory – A first Course", Cambridge Publications, Cambridge, 2004.
2. Niven.I, Zuckerman.H.S., and Montgomery, H.L., "An Introduction to Theory of Numbers" , John Wiley and Sons , Singapore, 2004.
3. Lidl.R., and Pitz. G, "Applied Abstract Algebra", Springer Verlag, New Delhi, 2<sup>nd</sup> Edition , 2006.

**CO's-PO's & PSO's MAPPING**

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	3	1	2	-	-	-	2	1	-	1	2	2	-	-	-
<b>CO2</b>	3	3	1	1	3	1	2	1	1	1	2	2	-	-	-
<b>CO3</b>	3	3	2	1	3	1	3	1	1	1	2	3	-	-	-
<b>CO4</b>	3	3	2	2	3	2	2	1	1	1	2	3	-	-	-
<b>CO5</b>	2	2	1	-	3	1	2	1	1	1	3	3	-	-	-
<b>Avg</b>	2.8	2.4	1.6	0.8	2.4	1	2.2	1	0.8	1	2.2	2.6	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OMA354****LINEAR ALGEBRA**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To test the consistency and solve system of linear equations.
- To find the basis and dimension of vector space.
- To obtain the matrix of linear transformation and its eigenvalues and eigenvectors.
- To find orthonormal basis of inner product space and find least square approximation.
- To find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.

**UNIT I MATRICES AND SYSTEM OF LINEAR EQUATIONS****9**

Matrices - Row echelon form - Rank - System of linear equations - Consistency - Gauss elimination method - Gauss Jordan method.

**UNIT II VECTOR SPACES****9**

Vector spaces over Real and Complex fields - Subspace – Linear space - Linear independence and dependence - Basis and dimension.

**UNIT III LINEAR TRANSFORMATION****9**

Linear transformation - Rank space and null space - Rank and nullity - Dimension theorem– Matrix representation of linear transformation - Eigenvalues and eigenvectors of linear transformation – Diagonalization.

**UNIT IV INNER PRODUCT SPACES****9**

Inner product and norms - Properties - Orthogonal, Orthonormal vectors - Gram Schmidt orthonormalization process - Least square approximation.

**UNIT V EIGEN VALUE PROBLEMS AND MATRIX DECOMPOSITION****9**

Eigen value Problems : Power method, Jacobi rotation method - Singular value decomposition – QR decomposition.

**TOTAL : 45 PERIODS****COURSE OUTCOMES:**

After the completion of the course the student will be able to

**CO1:**Test the consistency and solve system of linear equations.

**CO2:**Find the basis and dimension of vector space.

**CO3:**Obtain the matrix of linear transformation and its eigenvalues and eigenvectors.

**CO4:**Find orthonormal basis of inner product space and find least square approximation.

**CO5:**Find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.

**TEXT BOOKS**

1. Faires J.D. and Burden R., Numerical Methods, Brooks/Cole (Thomson Publications), New Delhi, 2002.
2. Friedberg A.H, Insel A.J. and Spence L, Linear Algebra, Pearson Education, 5<sup>th</sup> Edition, 2019.

**REFERENCES**

1. Bernard Kolman, David R. Hill, Introductory Linear Algebra, Pearson Educations, New Delhi, 8<sup>th</sup> Edition, 2009.
2. Gerald C.F. and Wheatley P.O, Applied Numerical Analysis, Pearson Educations, New Delhi, 7<sup>th</sup> Edition, 2007.
3. Kumaresan S, Linear Algebra - A geometric approach, Prentice Hall of India, New Delhi, Reprint, 2010.
4. Richard Branson, Matrix Operations, Schaum's outline series, 1989.
5. Strang G, Linear Algebra and its applications, Thomson (Brooks / Cole) New Delhi, 4<sup>th</sup> Edition, 2005.
6. Sundarapandian V, Numerical Linear Algebra, Prentice Hall of India, New Delhi, 2014.

**CO's-PO's & PSO's MAPPING**

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	3	3	3	3	2	2	2	1	1	1	1	3	-	-	-
<b>CO2</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO3</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO4</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO5</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>Avg</b>	3	3	3	3	2.8	2	2	1	1	1	1	3	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVE:**

- To impart knowledge about the basics of lean principles, tools and techniques, and implementation in the construction industry.

**UNIT I INTRODUCTION****9**

Introduction and overview of the construction project management - Review of Project Management & Productivity Measurement Systems - Productivity in Construction - Daily Progress Report-The state of the industry with respect to its management practices -construction project phases - The problems with current construction management techniques.

**UNIT II LEAN MANAGEMENT****9**

Introduction to lean management - Toyota's management principle-Evolution of lean in construction industry - Production theories in construction –Lean construction value - Value in construction - Target value design - Lean project delivery system- Forms of waste in construction industry - Waste Elimination.

**UNIT III CORE CONCEPTS IN LEAN****9**

Concepts in lean thinking – Principles of lean construction – Variability and its impact – Traditional construction and lean construction – Traditional project delivery - Lean construction and workflow reliability – Work structuring – Production control.

**UNIT IV LEAN TOOLS AND TECHNIQUES****9**

Value Stream Mapping – Work sampling – Last planner system – Flow and pull based production – Last Planner System – Look ahead schedule – constraint analysis – weekly planning meeting- Daily Huddles – Root cause analysis – Continuous improvement – Just in time.

**UNIT V LEAN IMPLEMENTATION IN CONSTRUCTION INDUSTRY****9**

Lean construction implementation- Enabling lean through information technology - Lean in design - Design Structure - BIM (Building Information Modelling) - IPD (Integrated Project Delivery) – Sustainability through lean construction approach.

**TOTAL : 45 PERIODS****COURSE OUTCOME:**

On completion of this course, the student is expected to be able to

- CO1** Explains the contemporary management techniques and the issues in present scenario.
- CO2** Apply the basics of lean management principles and their evolution from manufacturing industry to construction industry.
- CO3** Develops a better understanding of core concepts of lean construction tools and techniques and their importance in achieving better productivity.
- CO4** Apply lean techniques to achieve sustainability in construction projects.
- CO5** Apply lean construction techniques in design and modeling.

**REFERENCES:**

- Corfe, C. and Clip, B., Implementing lean in construction: Lean and the sustainability agenda, CIRIA, 2013.
- Shang Gao and Sui Pheng Low, Lean Construction Management: The Toyota Way, Springer, 2014.

- Dave, B., Koskela, L., Kiviniemi, A., Owen, R., and Tzortzopoulos, P., Implementing lean in construction: Lean construction and BIM, CIRIA, 2013.
- Ballard, G., Tommelein, I., Koskela, L. and Howell, G., Lean construction tools and techniques, 2002.
- Salem, O., Solomon, J., Genaidy, A. and Luegring, M., Site implementation and Assessment of Lean Construction Techniques, Lean Construction Journal, 2005.

**OBT352**

**BASICS OF MICROBIAL TECHNOLOGY**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVE:**

- Enable the Non-biological student's to understand about the basics of life science and their pro and cons for living organisms.

**UNIT I BASICS OF MICROBES AND ITS TYPES 9**

Introduction to microbes, existence of microbes, inventions of great scientist and history, types of microorganisms – Bacteria, Virus, Fungi.

**UNIT II MICROBIAL TECHNIQUES 9**

Sterilization – types – physical and chemical sterilization, Decontamination, Preservation methods, fermentation, Cultivation and growth of microbes, Diagnostic methods.

**UNIT III PATHOGENIC MICROBES 9**

Infectious Disease – Awareness, Causative agent, Prevention and control - Cholera, Dengu, Malaria, Diarrhea, Tuberculosis, Typhoid, Covid, HIV.

**UNIT IV BENEFICIAL MICROBES 9**

Applications of microbes – Clinical microbiology, agricultural microbiology, Food Microbiology, Environmental Microbiology, Animal Microbiology, Marine Microbiology.

**UNIT V PRODUCTS FROM MICROBES 9**

Fermented products – Fermented Beverages, Curd, Cheese, Mushroom, Agricultural products – Biopesticide, Biofertilizers, Vermi compost, Pharmaceutical products - Antibiotics, Vaccines

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

At the end of the course the students will be able to

**CO1:**Microbes and their types

**CO2:**Cultivation of microbes

**CO3:**Pathogens and control measures for safety

**CO4:**Microbes in different industry for economy.

**TEXT BOOKS**

- Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993.
- Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.
- Prescott L.M., Harley J.P., Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 1996.

**COURSE OBJECTIVES:**

- The objective is to offer basic concepts of biochemistry to students with diverse background in life sciences including but not limited to the structure and function of various biomolecules and their metabolism.

**UNIT I CARBOHYDRATES****9**

Introduction to carbohydrate, classification, properties of monosaccharide, structural aspects of monosaccharides. Introduction to disaccharide (lactose, maltose, sucrose) and polysaccharide (Heparin, starch, and glycogen) biological function of carbohydrate.

**UNIT II LIPID AND FATTY ACIDS****9**

Introduction to lipid, occurrence, properties, classification of lipid. Importance of phospholipids, sphingolipid and glycerolipid. Biological function of lipid. Fatty acid, Introduction, Nomenclature and classification of fatty acid Essential and non essential fatty acids.

**UNIT III AMINO ACIDS AND PROTEIN.****9**

Introduction to amino acid, structure, classification of protein based on polarity. Introduction to protein, classification of protein based on solubility, shape, composition and Function. Peptide bond– Structure of peptide bond. Denaturation – renaturation of protein, properties of protein. Introduction to lipoprotein, glycoprotein and nucleoprotein. Biological function of protein.

**UNIT IV NUCLEIC ACIDS****9**

Introduction to nucleic acid, Difference between nucleotide and nucleoside, composition of DNA & RNA; RNA Structure of Nitrogen bases in DNA and RNA along with the nomenclature- DNA double helix (Watson and crick) model, types of DNA, RNA.

**UNIT V VITAMINS AND HORMONES****9**

Different types of vitamins, their diverse biochemical functions and deficiency related diseases. Overview of hormones. Hormone mediated signaling. Mechanism of action of steroid hormones, epinephrine, glucagons and insulin. Role of vitamins and hormones in metabolism; Hormonal disorders; Therapeutic uses of vitamins and hormones.

**COURSE OUTCOMES:**

**CO1:** Students will learn about various kinds of biomolecules and their physiological role.

**CO2:** Students will gain knowledge about various metabolic disorders and will help them to know the importance of various biomolecules in terms of disease correlation.

**TOTAL: 45 PERIODS****TEXT BOOKS**

- Lehninger Principles of Biochemistry 6th Edition by David L. Nelson, Michael M. Cox W.H. Freeman and Company 2017
- Satyanarayana, U. and U. Chakerapani, "Biochemistry" 3rd Rev. Edition, Books & Allied (P) Ltd., 2006.
- Rastogi, S.C. "Biochemistry" 2nd Edition, Tata McGraw-Hill, 2003.
- Conn, E.E., et al., "Outlines of Biochemistry" 5th Edition, John Wiley & Sons, 1987.
- Outlines of Biochemistry, 5th Edition: By E E Conn, P K Stumpf, G Bruening and R Y Doi. pp 693. John Wiley and Sons, New York. 1987.

**REFERENCES**

- Berg, Jeremy M. et al. "Biochemistry", 6th Edition, W.H. Freeman & Co., 2006.

- Murray, R.K., et al "Harper's Illustrated Biochemistry", 31st Edition, McGraw-Hill, 2018.
- Voet, D. and Voet, J.G., "Biochemistry", 4th Edition, John Wiley & Sons Inc., 2010.

**OBT354                      FUNDAMENTALS OF CELL AND MOLECULAR BIOLOGY                      L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To provide knowledge on the fundamentals of cell biology.
- To understand the signalling mechanisms.
- Understand basic principles of molecular biology at intracellular level to regulate growth, division and development.

**UNIT-I                      INTRODUCTION TO CELL                      9**

Cell, cell wall and Extracellular Matrix (ECM), composition, cellular dimensions, Evolution, Organisation, differentiation of prokaryotic and Eukaryotic cells, Virus, bacteria, cyanobacteria, mycoplasma and prions.

**UNIT II                      CELL ORGANELLES                      9**

Molecular organisation, biogenesis and function Mitochondria, endoplasmic reticulum, golgi apparatus, plastids, chloroplast, leucoplast, centrosome, lysosome, ribosome, peroxisome, Nucleus and nucleolus. Endo membrane system, concept of compartmentalisation.

**UNIT III                      BIO-MEMBRANE TRANSPORT                      9**

Physiochemical properties of cell membranes. Molecular constitute of membranes, asymmetrical organisation of lipids and proteins. Solute transport across membrane's-fick's law, simple diffusion, passive-facilitated diffusion, active transport- primary and secondary, group translocation, transport ATPases, membrane transport in bacteria and animals. Transport mechanism- mobile carriers and pores mechanisms. Transport by vesicle formation, endocytosis, exocytosis, cell respiration.

**UNIT IV                      CELL CYCLE                      9**

Cell cycle- Cell division by mitosis and meiosis, Comparison of meiosis and mitosis, regulation of cell cycle, cell lysis, Cytokinesis, Cell signaling, Cell communication, Cell adhesion and Cell junction, cell cycle checkpoints.

**UNIT V                      CENTRAL DOGMA                      9**

Overview of Central dogma DNA replication: Meselson & Stahl experiment, bi-directional DNA replication, Okazaki fragments. Structure and function of mRNA, rRNA and tRNA. RNA synthesis: Initiation, elongation and termination of RNA synthesis Introduction to Genetic code- Steps in translation: Initiation, Elongation and termination of protein synthesis.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- CO1:** Understanding of cell at structural and functional level.  
**CO2:** Understand the central dogma of life and its significance.  
**CO3:** Comprehend the basic mechanisms of cell division.

**TEXTBOOKS:**

- Cooper, G.M. and R.E. Hansman "The Cell: A Molecular Approach", 8th Edition, Oxford University Press, 2018
- Friefelder, David. "Molecular Biology." Narosa Publications, 1999
- Weaver, Robert F. "Molecular Biology" 11th Edition, Tata McGraw-Hill, 2003.



## REFERENCES:

1. Lodish H, Berk A, Matsudaira P, Kaiser CA, Krieger M, Schot MP, Zipursky L, Darnell J. Molecular Cell Biology, 6th Edition, 2007.
2. Becker, W.M. et al., "The World of the Cell", 9th Edition, Pearson Education, 2003.
3. Campbell, N.A., J.B. Reece and E.J. Simon "Essential Biology", 11th Edition, Pearson International, 2007.
4. Alberts, Bruce et al., "Essential Cell Biology", 4th Edition, W.W. Norton, 2013.

## OPEN ELECTIVE IV

OHS352

PROJECT REPORT WRITING

L T P C  
3 0 0 3

### COURSE OBJECTIVE

The Course will enable Learners to,

- Understand the essentials of project writing.
- Perceive the difference between general writing and technical writing
- Assimilate the fundamental features of report writing.
- Understand the essential differences that exist between general and technical writing.
- Learn the structure of a technical and project report.

### UNIT I

9

Writing Skills – Essential Grammar and Vocabulary – Passive Voice, Reported Speech, Concord, Signpost words, Cohesive Devices – Paragraph writing - Technical Writing vs. General Writing.

### UNIT II

9

Project Report – Definition, Structure, Types of Reports, Purpose – Intended Audience – Plagiarism – Report Writing in STEM fields – Experiment – Statistical Analysis.

### UNIT III

9

Structure of the Project Report: (Part 1) Framing a Title – Content – Acknowledgement – Funding Details -Abstract – Introduction – Aim of the Study – Background - Writing the research question - Need of the Study/Project Significance, Relevance – Determining the feasibility – Theoretical Framework.

### UNIT IV

9

Structure of the Project Report: (Part 2) – Literature Review, Research Design, Methods of Data Collection - Tools and Procedures - Data Analysis - Interpretation - Findings –Limitations - Recommendations – Conclusion – Bibliography.

### UNIT V

9

Proof reading a report – Avoiding Typographical Errors – Bibliography in required Format – Font – Spacing – Checking Tables and Illustrations – Presenting a Report Orally – Techniques.

**TOTAL:45 PERIODS**

### COURSE OUTCOMES

By the end of the course, learners will be able to

**CO1:**Write effective project reports.

**CO2:**Use statistical tools with confidence.

**CO3:**Explain the purpose and intension of the proposed project coherently and with clarity.

**CO4:**Create writing texts to suit achieve the intended purpose.

**CO5:**Master the art of writing winning proposals and projects.

### CO's-PO's & PSO's MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	1	1	1	3	2	2	3	3	3	3	-	-	-
2	2	2	2	1	1	1	2	1	2	3	2	3	-	-	-
3	2	2	3	3	2	3	2	2	2	3	2	3	-	-	-
4	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
5	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
<b>AVg.</b>	2.4	2.2	2.4	2.2	2	2.6	2.4	2.2	2.6	3	2.6	3	-	-	-

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

**Note:** The average value of this course to be used for program articulation matrix.

### REFERENCES

1. Gerson and Gerson - Technical Communication: Process and Product, 7th Edition, Prentice Hall(2012)
2. Virendra K. Pamecha - Guide to Project Reports, Project Appraisals and Project Finance (2012)
3. Daniel Riordan - Technical Report Writing Today (1998)  
Darla-Jean Weatherford - Technical Writing for Engineering Professionals (2016) Penwell Publishers.

**OMA355**

**ADVANCED NUMERICAL METHODS**

**L T P C**  
**3 0 0 3**

### COURSE OBJECTIVE:

- To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in engineering and technology. This will also serve as a precursor for future research.

### UNIT I ALGEBRAIC EQUATIONS AND EIGENVALUE PROBLEM 9

System of nonlinear equations : Fixed point iteration method - Newton's method; System of linear equations: Thomas algorithm for tri diagonal system - SOR iteration methods ; Eigen value problems: Given's method - Householder's method.

### UNIT II INTERPOLATION 9

Central difference: Stirling and Bessel's interpolation formulae ; Piecewise spline interpolation: Piecewise linear, piecewise quadratic and cubic spline ; Least square approximation for continuous data (upto 3rd degree).

### UNIT III NUMERICAL METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS 9

Explicit Adams - Bashforth Techniques - Implicit Adams - Moulton Techniques, Predictor - Corrector Techniques - Finite difference methods for solving two - point linear boundary value problems - Orthogonal Collocation method.

**UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS 9**

Laplace and Poisson's equations in a rectangular region : Five point finite difference schemes - Leibmann's iterative methods - Dirichlet's and Neumann conditions – Laplace equation in polar coordinates : Finite difference schemes .

**UNIT V FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATIONS 9**

Parabolic equations : Explicit and implicit finite difference methods – Weighted average approximation - Dirichlet's and Neumann conditions – First order hyperbolic equations - Method of characteristics - Different explicit and implicit methods; Wave equation : Explicit scheme – Stability of above schemes.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

**CO1:** demonstrate the understandings of common numerical methods for nonlinear equations, system of linear equations and eigenvalue problems;

**CO2:** understand the interpolation theory;

**CO3:** understand the concepts of numerical methods for ordinary differential equations;

**CO4:** demonstrate the understandings of common numerical methods for elliptic equations;

**CO5:** understand the concepts of numerical methods for time dependent partial differential equations

**TEXT BOOKS :**

1. Grewal, B.S., "Numerical Methods in Engineering & Science ", Khanna Publications, Delhi, 2013.
2. Gupta, S.K., "Numerical Methods for Engineers", (Third Edition), New Age Publishers, 2015.
3. Jain, M.K., Iyengar, S.R.K. and Jain, R.K., "Computational Methods for Partial Differential Equations", New Age Publishers, 1994.

**REFERENCES:**

1. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
2. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", 9 th Edition, Cengage Learning, New Delhi, 2016.
3. Gupta S.K., "Numerical Methods for Engineers", 4th Edition, New Age Publishers, 2019.
4. Sastry, S.S., "Introductory Methods of Numerical Analysis", 5th Edition, PHI Learning, 2015.
5. Morton, K.W. and Mayers D.F., "Numerical solution of Partial Differential equations", Cambridge University press, Cambridge, 2002.

**CO's-PO's & PSO's MAPPING**

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	3	3	3	3	2	2	2	1	1	1	1	3	-	-	-
<b>CO2</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO3</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO4</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO5</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>Avg</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES:**

- To introduce the basic concepts of probability, one and two dimensional random variables with applications to engineering which can describe real life phenomenon.
- To understand the basic concepts of random processes which are widely used in communication networks.
- To acquaint with specialized random processes which are apt for modelling the real time scenario.
- To understand the concept of correlation and spectral densities.
- To understand the significance of linear systems with random inputs.

**UNIT I      RANDOM VARIABLES****9**

Discrete and continuous random variables – Moments – Moment generating functions – Joint Distribution- Covariance and Correlation – Transformation of a random variable.

**UNIT II      RANDOM PROCESSES****9**

Classification – Characterization – Cross correlation and Cross covariance functions - Stationary Random Processes – Markov process - Markov chain.

**UNIT III      SPECIAL RANDOM PROCESSES****9**

Bernoulli Process – Gaussian Process - Poisson process – Random telegraph process.

**UNIT IV      CORRELATION AND SPECTRAL DENSITIES****9**

Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties.

**UNIT V      LINEAR SYSTEMS WITH RANDOM INPUTS****9**

Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and cross correlation functions of input and output.

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

**CO1:** Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.

**CO2:** Apply the concept random processes in engineering disciplines.

**CO3:** Understand and apply the concept of correlation and spectral densities.

**CO4:** Get an exposure of various distribution functions and help in acquiring skills in handling situations involving more than one variable.

**CO5:** Analyze the response of random inputs to linear time invariant systems.

**TEXT BOOKS**

1. Ibe, O.C., " Fundamentals of Applied Probability and Random Processes ", 1<sup>st</sup> Indian Reprint, Elsevier, 2007.
2. Peebles, P.Z., "Probability, Random Variables and Random Signal Principles ", Tata McGraw Hill, 4<sup>th</sup> Edition, New Delhi, 2002.

## REFERENCES

1. Cooper. G.R., McGillem. C.D., "Probabilistic Methods of Signal and System Analysis", Oxford University Press, New Delhi, 3<sup>rd</sup> Indian Edition, 2012.
2. Hwei Hsu, "Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes ", Tata McGraw Hill Edition, New Delhi, 2004.
3. Miller. S.L. and Childers. D.G., "Probability and Random Processes with Applications to Signal Processing and Communications ", Academic Press, 2004.
4. Stark. H. and Woods. J.W., "Probability and Random Processes with Applications to Signal Processing ", Pearson Education, Asia, 3<sup>rd</sup> Edition, 2002.
5. Yates. R.D. and Goodman. D.J., "Probability and Stochastic Processes", Wiley India Pvt. Ltd., Bangalore, 2<sup>nd</sup> Edition, 2012.

## CO's-PO's & PSO's MAPPING

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
<b>CO2</b>	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
<b>CO3</b>	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
<b>CO4</b>	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
<b>CO5</b>	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
<b>Avg</b>	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OMA357**

**QUEUEING AND RELIABILITY MODELLING**

**L T P C**

**3 0 0 3**

### COURSE OBJECTIVES:

- To provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems in communication engineering.
- To understand the concept of queueing models and apply in engineering.
- To provide the required mathematical support in real life problems and develop probabilistic models which can be used in several areas of science and engineering.
- To study the system reliability and hazard function for series and parallel systems.
- To implement Markovian Techniques for availability and maintainability which opens up new avenues for research.

### UNIT I RANDOM PROCESSES

**9**

Classification – Stationary process – Markov process - Poisson process – Discrete parameter Markov chain – Chapman Kolmogorov equations – Limiting distributions.

### UNIT II MARKOVIAN QUEUEING MODELS

**9**

Markovian queues – Birth and death processes – Single and multiple server queueing models – Little's formula - Queues with finite waiting rooms.

### UNIT III ADVANCED QUEUEING MODELS

**9**

M/G/1 queue – Pollaczek Khinchin formula - M/D/1 and M/E<sub>K</sub>/1 as special cases – Series queues – Open Jackson networks.

**UNIT IV SYSTEM RELIABILITY****9**

Reliability and hazard functions- Exponential, Normal, Weibull and Gamma failure distribution – Time - dependent hazard models – Reliability of Series and Parallel Systems.

**UNIT V MAINTAINABILITY AND AVAILABILITY****9**

Maintainability and Availability functions – Frequency of failures – Two Unit parallel system with repair – k out of m systems.

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

**CO1:**Enable the students to apply the concept of random processes in engineering disciplines.

**CO2:**Students acquire skills in analyzing various queueing models.

**CO3:**Students can understand and characterize phenomenon which evolve with respect to time in a probabilistic manner.

**CO4:**Students can analyze reliability of the systems for various probability distributions.

**CO5:**Students can be able to formulate problems using the maintainability and availability analyses by using theoretical approach.

**TEXT BOOKS**

1. Shortle J.F, Gross D, Thompson J.M,Harris C.M., "Fundamentals of Queueing Theory", John Wiley and Sons, New York,2018.
2. Balagurusamy E., "Reliability Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi,2010.

**REFERENCES**

1. Medhi J, "Stochastic models of Queueing Theory", Academic Press, Elsevier, Amsterdam, 2003.
2. Taha, H.A., "Operations Research", 9<sup>th</sup> Edition, Pearson India Education Services, Delhi, 2016.
3. Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications", 2<sup>nd</sup> Edition, John Wiley and Sons, 2002.
4. Govil A.K., "Reliability Engineering", Tata-McGraw Hill Publishing Company Ltd., New Delhi,1983.

**CO's-PO's & PSO's MAPPING**

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO2</b>	3	3	2	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO3</b>	3	3	0	2	0	0	0	0	2	0	0	2	-	-	-
<b>CO4</b>	3	3	2	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO5</b>	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
<b>Avg</b>	3	3	1.4	0.8	0	0	0	0	2	0	0	2	-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

## OMG354 PRODUCTION AND OPERATIONS MANAGEMENT FOR ENTREPRENEURS

L	T	P	C
3	0	0	3

### COURSE OBJECTIVES:

- To know the basic concept and function of Production and Operation Management for entrepreneurship.
- To understand the Production process and planning.
- To understand the Production and Operations Management Control for business owners.

### UNIT I INTRODUCTION TO PRODUCTION AND OPERATIONS MANGEMENT 9

Functions of Production Management - Relationship between production and other functions – Production management and operations management, Characteristics of modern production and operation management, organisation of production function, recent trends in production /operations management - production as an organisational function, decision making in production Operations research

### UNIT II PRODUCTION & OPERATION SYSTEMS 9

Production Systems- principles – Models - CAD and CAM- Automation in Production - Functions and significance- Capacity and Facility Planning: Importance of capacity planning- Capacity measurement – Capacity Requirement Planning (CRP) process for manufacturing and service industry

### UNIT III PRODUCTION & OPERATIONS PLANNING 9

Facility Planning – Location of facilities – Location flexibility – Facility design process and techniques – Location break even analysis-Production Process Planning: Characteristic of production process systems – Steps for production process- Production Planning Control Functions – Planning phase- Action phase- Control phase - Aggregate production planning

### UNIT IV PRODUCTION & OPERATIONS MANAGEMENT PROCESS 9

Process selection with PLC phases- Process simulation tools- Work Study – Significance – Methods, evolution of normal/ standard time – Job design and rating - Value Analysis - Plant Layout: meaning – characters – Plant location techniques - Types- MRP and Layout Design - Optimisation and Theory of Constraints (TOC)– Critical Chain Project Management (CCPM)- REL (Relationship) Chart – Assembly line balancing- – Plant design optimisation -Forecasting methods.

### UNIT V CONTROLLING PRODUCTION & OPERATIONS MANAGEMENT 9

Material requirement planning (MRP)- Concept- Process and control - Inventory control systems and techniques – JIT and Lean manufacturing - Network techniques - Quality Management: Preventive Vs Breakdown maintenance for Quality – Techniques for measuring quality - Control Chart (X , R , p , np and C chart ) - Cost of Quality, Continuous improvement (Kaizen) - Quality awards - Supply Chain Management - Total Quality Management - 6 Sigma approach and Zero Defect Manufacturing.

**TOTAL 45 : PERIODS**

### COURSE OUTCOMES:

Upon completion of this course the learners will be able :

**CO 1** To understand the basics and functions of Production and Operation Management for business owners.

**CO 2** To learn about the Production & Operation Systems.

**CO 3** To acquaint on the Production & Operations Planning Techniques followed by entrepreneurs in Industries.

**CO 4** To know about the Production & Operations Management Processes in organisations.

**CO 5** To comprehend the techniques of controlling , Production and Operations in industries.

## REFERENCES

1. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson, 2007.
2. Amitabh Raturi, Production and Inventory Management, , 2008.
3. Adam Jr. Ebert, Production and Operations Management, PHI Publication, 1992.
4. Muhlemann, Okland and Lockyer, Production and Operation Management, Macmillan India,1992.
6. Chary S.N, Production and Operations Management, TMH Publications, 2010.
7. Terry Hill ,Operation Management. Pal Grave McMillan (Case Study).2005.

**OMG355**

**MULTIVARIATE DATA ANALYSIS**

**L T P C**  
**3 0 0 3**

### COURSE OBJECTIVE:

- To know various multivariate data analysis techniques for business research.

#### **UNIT I INTRODUCTION**

**9**

Uni-variate, Bi-variate and Multi-variate techniques – Classification of multivariate techniques – Guidelines for multivariate analysis and interpretation.

#### **UNIT II PREPARING FOR MULTIVARIATE ANALYSIS**

**9**

Conceptualization of research model with variables, collection of data --Approaches for dealing with missing data – Testing the assumptions of multivariate analysis.

#### **UNIT III MULTIPLE LINEAR REGRESSION ANALYSIS, FACTOR ANALYSIS**

**9**

Multiple Linear Regression Analysis – Inferences from the estimated regression function – Validation of the model. -Approaches to factor analysis – interpretation of results.

#### **UNIT IV LATENT VARIABLE TECHNIQUES**

**9**

Confirmatory Factor Analysis, Structural equation modelling, Mediation models, Moderation models, Longitudinal studies.

#### **UNIT V ADVANCED MULTIVARIATE TECHNIQUES**

**9**

Multiple Discriminant Analysis, Logistic Regression, Cluster Analysis, Conjoint Analysis, multidimensional scaling.

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES :

**CO1:**Demonstrate a sophisticated understanding of the concepts and methods; know the exact scopes and possible limitations of each method; and show capability of using multivariate techniques to provide constructive guidance in decision making.

**CO2:**Use advanced techniques to conduct thorough and insightful analysis, and interpret the results correctly with detailed and useful information.

**CO3:**Show substantial understanding of the real problems; conduct deep analysis using correct methods; and draw reasonable conclusions with sufficient explanation and elaboration.

**CO4:**Write an insightful and well-organized report for a real-world case study, including thoughtful and convincing details.



CO5: Make better business decisions by using advanced techniques in data analytics. '

## REFERENCES :

1. Joseph F Hair, Rolph E Anderson, Ronald L. Tatham & William C. Black, Multivariate Data Analysis, Pearson Education, New Delhi, 2005.
2. Barbara G. Tabachnick, Linda S. Fidell, Using Multivariate Statistics, 6th Edition, Pearson, 2012.
3. Richard A Johnson and Dean W. Wichern, Applied Multivariate Statistical Analysis, Prentice Hall, New Delhi, 2005.
4. David R Anderson, Dennis J Seveency, and Thomas A Williams, Statistics for Business and Economics, Thompson, Singapore, 2002

**OME352**

**ADDITIVE MANUFACTURING**

L	T	P	C
3	0	0	3

## COURSE OBJECTIVES:

- To introduce the development, capabilities, applications, of Additive Manufacturing (AM), and its business opportunities.
- To be acquainted with vat polymerization and material extrusion processes
- To be familiar with powder bed fusion and binder jetting processes.
- To gain knowledge on applications of direct energy deposition, and material jetting processes.
- To impart knowledge on sheet lamination and direct write technologies.

### UNIT I INTRODUCTION

9

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain - ASTM/ISO 52900 Classification - Benefits - AM Unique Capabilities - AM File formats: STL, AMF Applications: Building Printing, Bio Printing, Food Printing, Electronics Printing, Automobile, Aerospace, Healthcare. Business Opportunities in AM.

### UNIT II VAT POLYMERIZATION AND MATERIAL EXTRUSION

9

Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process - top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications.

Material Extrusion: Fused Deposition Modeling (FDM) - Process-Materials -Applications and Limitations.

### UNIT III POWDER BED FUSION AND BINDER JETTING

9

Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications.

Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits - Limitations - Applications.

### UNIT IV MATERIAL JETTING AND DIRECTED ENERGY DEPOSITION

9

Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications.

Directed Energy Deposition: Laser Engineered Net Shaping (LENS) - Process - Material Delivery - Materials -Benefits -Applications.

**UNIT V SHEET LAMINATION AND DIRECT WRITE TECHNOLOGY****9**

Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding - Materials - Application and Limitation.

Ink-Based Direct Writing (DW): Nozzle Dispensing Processes, Inkjet Printing Processes, Aerosol DW - Applications of DW.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

At the end of this course students shall be able to:

**CO1:** Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.

**CO2:** Acquire knowledge on process vat polymerization and material extrusion processes and its applications.

**CO3:** Elaborate the process and applications of powder bed fusion and binder jetting.

**CO4:** Evaluate the advantages, limitations, applications of material jetting and directed energy deposition processes.

**CO5:** Acquire knowledge on sheet lamination and direct write technology.

**TEXT BOOKS:**

1. Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani "Additive manufacturing technologies". 3<sup>rd</sup> edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0
2. Andreas Gebhardt and Jan-Steffen Hötter "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.

**REFERENCES:**

1. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing", Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
2. Milan Brandt, "Laser Additive Manufacturing: Materials, Design, Technologies, and Applications", Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.
3. Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.
4. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer., United States ,2006, ISBN: 978-1-4614-9842-1.
5. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press., United States, 2011, ISBN: 9780849334092.

**CME343****NEW PRODUCT DEVELOPMENT**

L	T	P	C
3	0	0	3

**COURSE OBJECTIVES**

- To introduce the fundamental concepts of the new product development
- To develop material specifications, analysis and process.
- To Learn the Feasibility Studies & reporting of new product development.
- To study the New product qualification and Market Survey on similar products of new product development
- To learn Reverse Engineering. Cloud points generation, converting cloud data to 3D model

<b>UNIT I</b>	<b>FUNDAMENTALS OF NPD</b>	<b>9</b>
Introduction – Reading of Drawing – Grid reading, Revisions, ECN (Engg. Change Note), Component material grade, Specifications, customer specific requirements – Basics of monitoring of NPD applying Gantt chart, Critical path analysis – Fundamentals of BOM (Bill of Materials), Engg. BOM & Manufacturing BOM. Basics of MIS software and their application in industries like SAP, MS Dynamics, Oracle ERP Cloud – QFD.		
<b>UNIT II</b>	<b>MATERIAL SPECIFICATIONS, ANALYSIS &amp; PROCESS</b>	<b>9</b>
Material specification standards – ISO, DIN, JIS, ASTM, EN, etc. – Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis, ), Fabrications, Welding process. Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis.		
<b>UNIT III</b>	<b>ESSENTIALS OF NPD</b>	<b>9</b>
RFQ (Request of Quotation) Processing – Feasibility Studies & reporting – CFT (Cross Function Team) discussion on new product and reporting – Concept design, Machine selection for tool making, Machining – Manufacturing Process selection, Machining Planning, cutting tool selection – Various Inspection methods – Manual measuring, CMM – GOM (Geometric Optical Measuring), Lay out marking and Cut section analysis. Tool Design and Detail drawings preparation, release of details to machine shop and CAM programming. Tool assembly and shop floor trials. Initial sample submission with PPAP documents.		
<b>UNIT IV</b>	<b>CRITERIONS OF NPD</b>	<b>9</b>
New product qualification for Dimensions, Mechanical & Physical Properties, Internal Soundness proving through X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing frequencies. Market Survey on similar products, Risk analysis, validating samples with simulation results, Lesson Learned & Horizontal deployment in NPD.		
<b>UNIT V</b>	<b>REPORTING &amp; FORWARD-THINKING OF NPD</b>	<b>9</b>
Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) – Purpose & documents, deployment in shop floor. Prototyping & RPT - Concepts, Application and its advantages, 3D Printing – resin models, Sand cores for foundries; Reverse Engineering. Cloud points generation, converting cloud data to 3D model – Advantages & Limitation of RE, CE (Concurrent Engineering) – Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost.)		
		<b>TOTAL :45 PERIODS</b>

**COURSE OUTCOMES:**

At the end of the course the students would be able to

- CO1:**Discuss fundamental concepts and customer specific requirements of the New Product development
- CO2:**Discuss the Material specification standards, analysis and fabrication, manufacturing process.
- CO3:**Develop Feasibility Studies & reporting of New Product development
- CO4:**Analyzing the New product qualification and Market Survey on similar products of new product development
- CO5:**Develop Reverse Engineering. Cloud points generation, converting cloud data to 3D model

**TEXT BOOKS:**

1. Product Development – Sten Jonsson
2. Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger

**REFERENCES:**

1. Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark
2. Change by Design
3. Toyota Product Development System – James Morgan & Jeffrey K. Liker
4. Winning at New Products – Robert Brands 3rd Edition
5. Product Design & Value Engineering – Dr. M.A. Bulsara & Dr. H.R. Thakkar

**CO's-PO's & PSO's MAPPING**

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	3	1				1	1			1	1	3	2
2	1	1	3	1				1	1			1	1	3	2
3	1	1	3	1				1	1			1	1	3	2
4	1	1	3	1				1	1			1	1	3	2
5	1	1	3	1				1	1			1	1	3	2

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

**OME355****INDUSTRIAL DESIGN & RAPID PROTOTYPING TECHNIQUES****L T P C****3 0 0 3****COURSE OBJECTIVES:**

The course aims to

- Outline Fundamental concepts in UI & UX
- Introduce the principles of Design and Building an mobile app
- Illustrate the use of CAD in product design
- Outline the choice and use of prototyping tools
- Understanding design of electronic circuits and fabrication of electronic devices

**UNIT I UI/UX****9**

Fundamental concepts in UI & UX - Tools - Fundamentals of design principles - Psychology and Human Factors for User Interface Design - Layout and composition for Web, Mobile and Devices - Typography - Information architecture - Color theory - Design process flow, wireframes, best practices in the industry -User engagement ethics - Design alternatives

**UNIT II APP DEVELOPMENT****9**

SDLC - Introduction to App Development - Types of Apps - web Development - understanding Stack - Frontend - backend - Working with Databases - Introduction to API - Introduction to Cloud services - Cloud environment Setup- Reading and writing data to cloud - Embedding ML models to Apps - Deploying application.

**UNIT III INDUSTRIAL DESIGN****9**

Introduction to Industrial Design - Points, lines, and planes - Sketching and concept generation - Sketch to CAD - Introduction to CAD tools - Types of 3D modeling - Basic 3D Modeling Tools - Part creation – Assembly - Product design and rendering basics - Dimensioning & Tolerancing

**UNIT IV MECHANICAL RAPID PROTOTYPING 9**

Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - Mechanical Prototyping; 3D Printing and classification - Laser Cutting and engraving - RD Works - Additive manufacturing

**UNIT V ELECTRONIC RAPID PROTOTYPING 9**

Basics of electronic circuit design - lumped circuits - Electronic Prototyping - Working with simulation tool - simple PCB design with EDA

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

**At the end of the course, learners will be able to:**

**CO1:**Create quick UI/UX prototypes for customer needs

**CO2:**Develop web application to test product traction / product feature

**CO3:**Develop 3D models for prototyping various product ideas

**CO4:**Built prototypes using Tools and Techniques in a quick iterative methodology

**TEXT BOOKS**

1. Peter Fiell, Charlotte Fiell, Industrial Design A-Z, TASCHEN America Llc(2003)
2. Samar Malik, Autodesk Fusion 360 - The Master Guide.
3. Steve Krug, Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability, Pearson,3rd edition(2014)

**REFERENCES**

1. <https://www.adobe.com/products/xd/learn/get-started.html>
2. <https://developer.android.com/guide>
3. <https://help.autodesk.com/view/fusion360/ENU/courses/>
4. [https://help.prusa3d.com/en/category/prusaslicer\\_204](https://help.prusa3d.com/en/category/prusaslicer_204)

**MF3010**

**MICRO AND PRECISION ENGINEERING**

**LT P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

At the end of this course the student should be able to

- Learn about the precision machine tools
- Learn about the macro and micro components.
- Understand handling and operating of the precision machine tools.
- Learn to work with miniature models of existing machine tools/robots and other instruments.
- Learn metrology for micro system

**UNIT I INTRODUCTION TO MICROSYSTEMS 9**

Design, and material selection, micro-actuators: hydraulic, pneumatic, electrostatic/ magnetic etc. for medical to general purpose applications. Micro-sensors based on Thermal, mechanical, electrical properties; micro-sensors for measurement of pressure, flow, temperature, inertia, force, acceleration, torque, vibration, and monitoring of manufacturing systems.

**UNIT II FABRICATION PROCESSES FOR MICRO-SYSTEMS: 9**

Additive, subtractive, forming process, microsystems-Micro-pumps, micro- turbines, micro engines, micro-robot, and miniature biomedical devices

**UNIT III INTRODUCTION TO PRECISION ENGINEERING 9**

Machine tools, holding and handling devices, positioning fixtures for fabrication/ assembly of microsystems. Precision drives: inch worm motors, ultrasonic motors, stick- slip mechanism and other piezo-based devices.

**UNIT IV PRECISION MACHINING PROCESSES 9**

Precision machining processes for macro components - Diamond turning, fixed and free abrasive processes, finishing processes.

**UNIT V METROLOGY FOR MICRO SYSTEMS 9**

Metrology for micro systems - Surface integrity and its characterization.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon the completion of this course the students will be able to

**CO1:**Select suitable precision machine tools and operate

**CO2:**Apply the macro and micro components for fabrication of micro systems.

**CO3:**Apply suitable machining process

**CO4:**Able to work with miniature models of existing machine tools/robots and other instruments.

**CO5:**Apply metrology for micro system

**TEXT BOOKS:**

1. Davim, J. Paulo, ed. Microfabrication and Precision Engineering: Research and Development. Woodhead Publishing, 2017
2. Gupta K, editor. Micro and Precision Manufacturing. Springer; 2017

**REFERENCES:**

1. Dornfeld, D., and Lee, D. E., Precision Manufacturing, 2008, Springer.
2. H. Nakazawa, Principles of Precision Engineering, 1994, Oxford University Press.
3. Whitehouse, D. J., Handbook of Surface Metrology, Institute of Physics Publishing, Philadelphia PA, 1994.
4. Murthy.R.L, —Precision Engineering in Manufacturingll, New Age International, New Delhi, 2005

**OMF354 COST MANAGEMENT OF ENGINEERING PROJECTS LT P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

**UNIT I INTRODUCTION TO COSTING CONCEPTS 9**

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.'

**UNIT II INTRODUCTION TO PROJECT MANAGEMENT 9**

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts

**UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9**

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing

**UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9**

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

**UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9**

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

**CO1:** Understand the costing concepts and their role in decision making.

**CO2:** Understand the project management concepts and their various aspects in selection.

**CO3:** Interpret costing concepts with project execution.

**CO4:** Gain knowledge of costing techniques in service sector and various budgetary control techniques.

**CO5:** Become familiar with quantitative techniques in cost management.

**TEXT BOOKS:**

1. John M. Nicholas, Herman Steyn Project Management for Engineering, Business and Technology, Taylor & Francis, 2 August 2020, ISBN: 9781000092561.
2. Albert Lester ,Project Management, Planning and Control, Elsevier/Butterworth-Heinemann, 2007, ISBN: 9780750669566, 075066956X.

**REFERENCES:**

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991.
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988.
3. Charles T. Horngren et al Cost Accounting a Managerial Emphasis, Prentice Hall of India, New Delhi, 2011.
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003.
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007.

**COURSE OBJECTIVES:**

- The objective of this course is to make the students to understand the working and characteristics of different types of batteries and their management .

**UNIT I            ADVANCED BATTERIES****9**

Li-ion Batteries-different formats, chemistry, safe operating area, efficiency, aging. Characteristics-SOC,DOD, SOH. Balancing-Passive Balancing Vs Active Balancing. Other Batteries-NCM and NCA Batteries. *NCR18650B* specifications.

**UNIT II            BATTERY PACK****9**

Battery Pack- design, sizing, calculations, flow chart, real and simulation Model.Peak power – definition, testing methods-relationships with Power, Temperature and ohmic Internal Resistance. Cloud based and Local Smart charging.

**UNIT III          BATTERY MODELLING****9**

Battery Modelling Methods-Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model, PNGV model. State space Models-Introduction. Battery Modelling software/simulation frameworks

**UNIT IV          BATTERY STATE ESTIMATION****9**

SOC Estimation- Definition, importance, single cell Vs series batteries SOC. Estimation Methods-Load voltage, Electromotive force, AC impedance, Ah counting, Neural networks, Neuro-fuzzy forecast method, Kalman filter. Estimation Algorithms.

**UNIT V          BMS ARCHITECTURE AND REAL TIME COMPONENTS****9**

Battery Management System- need, operation, classification. BMS ASIC-bq76PL536A-Q1 Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex Ray-CANedge1 package.ARBIN Battery Tester. BMS Development with Modeling software and Model-Based Design.

**TOTAL:45 PERIODS****COURSE OUTCOMES:**

At the end of this course, students will be able to

**CO1:**Acquire knowledge of different Li-ion Batteries performance.

**CO2:**Design a Battery Pack and make related calculations.

**CO3:**Demonstrate a BatteryModel or Simulation.

**CO4:**Estimate State-of-Charges in a Battery Pack.

**CO5:**Approach different BMS architectures during real world usage.

**TEXT BOOKS**

- Jiuchun Jiang and Caiping Zhang, "Fundamentals and applications of Lithium-Ion batteries in Electric Drive Vehicles", Wiley, 2015.
- Daide Andrea, "Battery Management Systems for Large Lithium-Ion Battery Packs" ARTECH House, 2010.

**REFERENCE BOOKS**

- Developing Battery Management Systems with Simulink and Model-Based Design-whitepaper
- Panasonic *NCR18650B- DataSheet*
- bq76PL536A-Q1- IC DataSheet
- CC2662R-Q1- IC DataSheet



**COURSE OBJECTIVES:**

- The objective of this course is to make the students to list common types of sensor and actuators used in automotive vehicles.

**UNIT I INTRODUCTION TO MEASUREMENTS AND SENSORS 9**

Sensors: Functions- Classifications- Main technical requirement and trends Units and standards- Calibration methods- Classification of errors- Error analysis- Limiting error- Probable error- Propagation of error- Odds and uncertainty- principle of transduction-Classification. Static characteristics- mathematical model of transducers- Zero, First and Second order transducers- Dynamic characteristics of first and second order transducers for standard test inputs.

**UNIT II VARIABLE RESISTANCE AND INDUTANCE SENSORS 9**

Principle of operation- Construction details- Characteristics and applications of resistive potentiometer- Strain gauges- Resistive thermometers- Thermistors- Piezoresistive sensors Inductive potentiometer- Variable reluctance transducers:- EI pick up and LVDT

**UNIT III VARIABLE AND OTHER SPECIAL SENSORS 9**

Variable air gap type, variable area type and variable permittivity type- capacitor microphone Piezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor- digital transducers-Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor.

**UNIT IV AUTOMOTIVE ACTUATORS 9**

Electromechanical actuators- Fluid-mechanical actuators- Electrical machines- Direct-current machines- Three-phase machines- Single-phase alternating-current Machines - Duty-type ratings for electrical machines. Working principles, construction and location of actuators viz. Solenoid, relay, stepper motor etc.

**UNIT V AUTOMATIC TEMPERATURE CONTROL ACTUATORS 9**

Different types of actuators used in automatic temperature control- Fixed and variable displacement temperature control- Semi Automatic- Controller design for Fixed and variable displacement type air conditioning system.

**TOTAL:45 PERIODS****COURSE OUTCOMES:**

At the end of the course, the student will be able to

**CO1:**List common types of sensor and actuators used in vehicles.

**CO2:**Design measuring equipment's for the measurement of pressure force, temperature and flow.

**CO3:**Generate new ideas in designing the sensors and actuators for automotive application

**CO4:**Understand the operation of thesensors, actuators and electronic control.

**CO5:**Design temperature control actuators for vehicles.

**TEXT BOOKS:**

1. Doebelin's Measurement Systems: 7th Edition (SIE),Ernest O. Doebelin DhaneshN.Manik McGraw Hill Publishers, 2019.
2. Robert Brandy, " Automotive Electronics and Computer System", Prentice Hall,2001
3. William Kimberley," Bosch Automotive Handbook", 6th Edition, Robert Bosch GmbH, 2004.
4. Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th Edition, 2007, ISBN No: 978-3-658-01783-5.

**REFERENCES:**

1. James D Halderman, "Automotive Electrical and Electronics" , Prentice Hall, USA, 2013
2. Tom Denton, "Automotive Electrical and Electronics Systems," Third Edition, 2004, SAE International.
3. Patranabis.D, "Sensors and Transducers", 2nd Edition, Prentice Hall India Ltd,2003
4. William Ribbens, "Understanding Automotive Electronics -An Engineering Perspective," 7th Edition, Elsevier Butterworth-Heinemann Publishers, 2012.

**OAS353**

**SPACE VEHICLES**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

- To interpret the missile space stations, space vs earth environment.
- To explain the life support systems, mission logistics and planning.
- To deploy the skills effectively in the understanding of space vehicle configuration design.
- To explain Engine system and support of space vehicle
- To interpret nose cone configuration of space vehicle

**UNIT I FUNDAMENTAL ASPECTS**

**9**

Energy and Efficiencies of power plants for space vehicles – Typical Performance Values – Mission design – Structural design aspects during launch - role of launch environment on launch vehicle integrity.

**UNIT II SELECTION OF ROCKET PROPULSION SYSTEMS**

**9**

Ascent flight mechanics – Launch vehicle selection process – Criteria for Selection for different missions – selection of subsystems – types of staging – Interfaces – selection and criteria for stages and their role in launch vehicle configuration design.

**UNIT III ENGINE SYSTEMS, CONTROLS, AND INTEGRATION**

**9**

Propellant Budget – Performance of Complete or Multiple Rocket Propulsion Systems – Engine Design – Engine Controls – Engine System Calibration – System Integration and Engine Optimization.

**UNIT IV THRUST VECTOR CONTROL**

**9**

TVC Mechanisms with a Single Nozzle – TVC with Multiple Thrust Chambers or Nozzles – Testing – Integration with Vehicle – SITVC method – other jet control methods - exhaust plume problems in space environment

**UNIT V NOSE CONE CONFIGURATION**

**9**

Aerodynamic aspects on the selection of nose shape of a launch vehicle - design factors in the finalization of nose configuration with respect to payload - nose cone thermal protection system - separation of fairings - payload injection mechanism

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1:** Explain exotic space propulsion concepts, such as nuclear, solar sail, and antimatter.

**CO2:** Apply knowledge in selecting the appropriate rocket propulsion systems.

**CO3:** interpret the air-breathing propulsion suitable for initial stages and fly-back boosters.

**CO4:** Analyze aerodynamics aspect, including boost-phase lift and drag, hypersonic, and re-entry.

**CO5:**Adapt from aircraft engineers moving into launch vehicle, spacecraft, and hypersonic vehicle design.

**OIM352**

**MANAGEMENT SCIENCE**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

Of this course are

- To introduce fundamental concepts of management and organization to students.
- To impart knowledge to students on various aspects of marketing, quality control and marketing strategies.
- To make students familiarize with the concepts of human resources management.
- To acquaint students with the concepts of project management and cost analysis.
- To make students familiarize with the concepts of planning process and business strategies.

**UNIT I INTRODUCTION TO MANAGEMENT AND ORGANISATION 9**

Concepts of Management and organization- nature, importance and Functions of Management, Systems Approach to Management - Taylor's Scientific Management Theory- Fayal's Principles of Management- Maslow's theory of Hierarchy of Human Needs- Douglas McGregor's Theory X and Theory Y- Hertzberg Two Factor Theory of Motivation- Leadership Styles, Social responsibilities of Management, Designing Organisational Structures: Basic concepts related to Organisation - Departmentation and Decentralisation.

**UNIT II OPERATIONS AND MARKETING MANAGEMENT 9**

Principles and Types of Plant Layout- Methods of Production (Job, batch and Mass Production), Work Study - Basic procedure involved in Method Study and Work Measurement - Business Process Reengineering (BPR)- Statistical Quality Control: control charts for Variables and Attributes (simple Problems) and Acceptance Sampling, Objectives of Inventory control, EOQ, ABC Analysis, Purchase Procedure, Stores Management and Store Records - JIT System, Supply Chain Management, Functions of Marketing, Marketing Mix, and Marketing Strategies based on Product Life Cycle.

**UNIT III HUMAN RESOURCES MANAGEMENT 9**

Concepts of HRM, HRD and Personnel Management and Industrial Relations (PMIR), HRM vs PMIR, Basic functions of HR Manager: Manpower planning, Recruitment, Selection, Training and Development, Wage and Salary Administration, Promotion, Transfer, Performance Appraisal, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating – Capability Maturity Model (CMM) Levels.

**UNIT IV PROJECT MANAGEMENT 9**

Network Analysis, Programme Evaluation and Review Technique (PERT), Critical Path Method (CPM), identifying critical path, Probability of Completing the project within given time, Project Cost Analysis, Project Crashing (simple problems).

**UNIT V STRATEGIC MANAGEMENT AND CONTEMPORARY STRATEGIC ISSUES 9**

Mission, Goals, Objectives, Policy, Strategy, Programmes, Elements of Corporate Planning Process, Environmental Scanning, Value Chain Analysis, SWOT Analysis, Steps in Strategy Formulation and Implementation, Generic Strategy alternatives. Benchmarking and Balanced Score Cards as Contemporary Business Strategies.

**TOTAL: 45 PERIODS**

**OURSEOUTCOMES:**

Upon completion of the course, Students will be able to

CO1:Plananorganizationalstructureforagivencontextintheorganisationtocarryoutproductionoperation sthroughWork-study.

CO2:Surveythemarkets,customersandcompetitionbetterandpricethegivenproductsappropriately

CO3:Ensurequalityforagivenproduct or service.

CO4:Plan, schedule and control projects through PERTandCPM.

CO5:Evaluate strategyforabusiness orserviceorganisation.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3			3	3	3		3	3	2			2	3	
2	3			2	3	3		2	3	2				2	
3	3			3	2	2		3	2	2					2
4	3			3	3	2		3	2	3					3
5	3			2	3	3		2	3	3			2	1	
<b>AVg.</b>	3			2.6	2.8	2.6		2.6	2.6	2.4			2	2	2.5

1 - low, 2 - medium, 3 - high, '-' - no correlation

**TEXTBOOKS:**

1. KanishkaBedi, Production and Operations Management,OxfordUniversityPress,2007.
2. Stoner,Freeman,Gilbert, Management,6<sup>th</sup> Ed, PearsonEducation,NewDelhi,2004.
3. ThomasN.Duening & John M.Ivancevich Management Principles and Guidelines, Biztantra,2007.
4. P.VijayKumar,N.Appa Rao and Ashnab, Chnalill, CengageLearning India,2012.

**REFERECES:**

1. KotlerPhilip and KellerKevinLane: Marketing Management, Pearson, 2012.
2. KoontzandWeihrich: Essentials of Management, McGrawHill, 2012.
3. Lawrence RJauch,R.Guptaand William F. Glueck: Business Policy and Strategic Management Science,McGrawHill,2012.
4. SamuelC.Certo:Modern Management,2012.

**OIM353**

**PRODUCTION PLANNING AND CONTROL**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the concept of production planning and control act work study,
- To apply the concept of product planning,
- To analyze the production scheduling,
- To apply the Inventory Control concepts.
- To prepare the manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

**UNIT I INTRODUCTION**

**9**

Objectives and benefits of planning and control-Functions of production control-Types of production- job- batch and continuous-Product development and design-Marketing aspect - Functional aspects- Operational aspect-Durability and dependability aspect aesthetic aspect. Profit

consideration- Standardization, Simplification & specialization- Break even analysis-Economics of a new design.

**UNITII WORK STUDY 9**

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

**UNITIII PRODUCT PLANNING AND PROCESS PLANNING 9**

Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning- Steps in process planning-Quantity determination in batch production-Machine capacity, balancing- Analysis of process capabilities in a multi product system.

**UNITIV PRODUCTION SCHEDULING 9**

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance – Flow production scheduling- Batch production scheduling-Product sequencing – Production Control systems- Periodic batch control-Material requirement planning kanban – Dispatching-Progress reporting and expediting- Manufacturing lead time-Techniques for aligning completion times and due dates.

**UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC 9**

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size- ABC analysis - Recorder procedure-Introduction to computer integrated production planning systems- elements of JUST IN TIME SYSTEMS-Fundamentals of MRP II and ERP.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course,

- CO1:The students can able to prepare production planning and control act work study,
- CO2:The students can able to prepare product planning,
- CO3:The students can able to prepare production scheduling,
- CO4:The students can able to prepare Inventory Control.
- CO5:They can plan manufacturing requirements manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

**TEXT BOOKS:**

1. James. B. Dilworth, "Operations management – Design, Planning and Control for manufacturing and services" Mcgraw Hill International edition 1992.
2. Martand Telsang, "Industrial Engineering and Production Management", First edition, S. Chand and Company, 2000.

**REFERENCES**

1. Chary. S.N., "Theory and Problems in Production & Operations Management", Tata McGraw Hill, 1995.
2. Elwood S.Buffa, and Rakesh K.Sarin, "Modern Production / Operations Management", 8th Edition John Wiley and Sons, 2000
3. Jain. K.C. & Aggarwal. L.N., "Production Planning Control and Industrial Management", Khanna Publishers, 1990

4. Kanishka Bedi, "Production and Operations management", 2nd Edition, Oxford university press, 2007.
5. Melynk, Denzler, " Operations management – A value driven approach" Irwin Mcgraw hill.
6. Norman Gaither, G. Frazier, "Operations Management" 9th Edition, Thomson learning IE, 2007
7. Samson Eilon, "Elements of Production Planning and Control", Universal Book Corpn.1984
8. Upendra Kachru, " Production and Operations Management – Text and cases" 1st Edition, Excel books 2007

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1	3	3			3		1						1		3	
2	3	2			3										2	
3		2			3										2	
4		2	2													
5	3	3	2												1	
<b>AVg.</b>	3	2.6	2		3		1						1		3	1.8

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OIE353**

**OPERATIONS MANAGEMENT**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVE:**

- Recognize and appreciate the concept of Production and Operations Management in creating and enhancing a firm's competitive advantages.
- Describe the concept and contribution of various constituents of Production and Operations Management (both manufacturing and service).
- Relate the interdependence of the operations function with the other key functional areas of a firm.
- Teach analytical skills and problem-solving tools to the analysis of the operations problems.
- Apply scheduling and Lean Concepts for improving System Performance.

**UNIT I INTRODUCTION TO OPERATIONS MANAGEMENT**

**9**

Operations Management – Nature, Importance, historical development, transformation processes, differences between services and goods, a system perspective, functions, challenges, current priorities, recent trends; Operations Strategy - Strategic fit , framework; Supply Chain Management

**UNIT II FORECASTING, CAPACITY AND FACILITY DESIGN**

**9**

Demand Forecasting - Need, Types, COURSE OBJECTIVES and Steps. Overview of Qualitative and Quantitative methods. Capacity Planning - Long range, Types, Developing capacity alternatives. Overview of sales and operations planning. Overview of MRP, MRP II and ERP. Facility Location – Theories, Steps in Selection, Location Models. Facility Layout – Principles, Types, Planning tools and techniques.

**UNIT III DESIGN OF PRODUCT, PROCESS AND WORK SYSTEMS**

**9**

Product Design – Influencing factors, Approaches, Legal, Ethical and Environmental issues. Process – Planning, Selection, Strategy, Major Decisions. Work Study – COURSE OBJECTIVES, Procedure. Method Study and Motion Study. Work Measurement and Productivity – Measuring Productivity and Methods to improve productivity.

**UNIT IV MATERIALS MANAGEMENT****9**

Materials Management – COURSE OBJECTIVES, Planning, Budgeting and Control. Purchasing – COURSE OBJECTIVES, Functions, Policies, Vendor rating and Value Analysis. Stores Management – Nature, Layout, Classification and Coding. Inventory – COURSE OBJECTIVES, Costs and control techniques. Overview of JIT.

**UNIT V SCHEDULING AND PROJECT MANAGEMENT****9**

Project Management – Scheduling Techniques, PERT, CPM; Scheduling - work centers – nature, importance; Priority rules and techniques, shopfloor control; Flow shop scheduling – Johnson’s Algorithm – Gantt charts; personnel scheduling in services.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

- CO1:** The students will appreciate the role of Production and Operations management in enabling and enhancing a firm’s competitive advantages in the dynamic business environment.
- CO2:** The students will obtain sufficient knowledge and skills to forecast demand for Production and Service Systems.
- CO3:** The students will be able to Formulate and Assess Aggregate Planning strategies and Material Requirement Plan.
- CO4:** The students will be able to develop analytical skills to calculate capacity requirements and developing capacity alternatives.
- CO5:** The students will be able to apply scheduling and Lean Concepts for improving System Performance.

**CO’s- PO’s & PSO’s MAPPING**

CO’s	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3											2			
2		3	3											3	3
3		2	3	3									2	3	
4		3	3	3									2	3	
5			3	2											
<b>AVg.</b>	3	2.6	3	2.6								2	2	3	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

**TEXT BOOKS**

1. Richard B. Chase, Ravi Shankar, F. Robert Jacobs, Nicholas J. Aquilano, Operations and Supply Management, Tata McGraw Hill, 12<sup>th</sup> Edition, 2010.
2. Norman Gaither and Gregory Frazier, Operations Management, South Western Cengage Learning, 2002.

**REFERENCES**

1. William J Stevenson, Operations Management, Tata McGraw Hill, 9<sup>th</sup> Edition, 2009.
2. Russel and Taylor, Operations Management, Wiley, Fifth Edition, 2006.
3. Kanishka Bedi, Production and Operations Management, Oxford University Press, 2004.
4. Chary S. N, Production and Operations Management, Tata McGraw Hill, Third Edition, 2008.
5. Aswathappa K and Shridhara Bhat K, Production and Operations Management, Himalaya Publishing House, Revised Second Edition, 2008.
6. Mahadevan B, Operations Management Theory and practice, Pearson Education, 2007.

7. Pannerselvam R, Production and Operations Management, Prentice Hall India, Second Edition, 2008.

**OSF352**

**INDUSTRIAL HYGIENE**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- Demonstrate an understanding of how occupational hygiene standards are set and used in work health and safety.
- Compare and contrast the roles of environmental and biological monitoring in work health and safety
- Outline strategies for identifying, assessing and controlling risks associated with airborne gases, vapours and particulates
- Discuss how personal protective equipment can be used to reduce risks associated with workplace exposures
- Provide high-level advice on managing and controlling noise and noise-related hazards

**UNIT I INTRODUCTION AND SCOPE 9**

Occupational Health and Environmental Safety Management - Principles practices. Comm on Occupational diseases: Occupational Health Management Services at the work place. Pre-employment, periodic medical examination of workers, medical surveillance for control of occupational diseases and health records.

**UNIT II MONITORING FOR SAFETY, HEALTH & ENVIRONMENT 9**

Occupational Health and Environment Safety Management System, ILO and EPA Standards Industrial Hygiene: Definition of Industrial Hygiene, Industrial Hygiene: Control Methods, Substitution, Changing the process, Local Exhaust Ventilation, Isolation, Wet method, Personal hygiene, housekeeping and maintenance, waste disposal, special control measures.

**UNIT III OCCUPATIONAL HEALTH AND ENVIRONMENTAL SAFETY EDUCATION 9**

Element of training cycle, Assessment of needs. Techniques of training, design and development of training programs. Training methods and strategies types of training. Evaluation and review of training programs. Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety, Exposure Limit .

**UNIT IV OCCUPATIONAL SAFETY, HEALTH AND ENVIRONMENT MANAGEMENT 9**

Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000, OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards, Performance measurements to determine effectiveness of PSM. Importance of Industrial safety, role of safety department,

**UNIT-V INDUSTRIAL HAZARDS 9**

i. Radiation: Types and effects of radiation on human body, Measurement and detection of radiation intensity. Effects of radiation on human body, Measurement – disposal of radioactive waste, Control of radiation ii. Noise and Vibration: Sources, and its control, Effects of noise on the auditory system and health, Measurement of noise , Different air pollutants in industries, Effect of different gases and particulate matter ,acid fumes ,smoke, fog on human health, Vibration: effects.

**TOTAL PERIODS: 45**



## COURSE OUTCOMES:

Students able to

CO1: Explain and apply human factors engineering concepts in both evaluation of existing systems and design of new systems

CO2: Specify designs that avoid occupation related injuries

CO3: Define and apply the principles of work design, motion economy, and work environment design.

CO4: Identify the basic human sensory, cognitive, and physical capabilities and limitations with respect to human-machine system performance.

CO5: Acknowledge the impact of workplace design and environment on productivity

## TEXT BOOKS:

1. R. K. Jain and Sunil S. Rao , Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006)

2. Slote. L, Handbook of Occupational Safety and Health, John Willey and Sons, New York .

## REFERENCES:

1. Jeanne MagerStellman, Encyclopedia of Occupational Health and Safety (ILO) Ms. Irma Jourdan publication

2. Frank P Lees - Loss of prevention in Process Industries, Vol. 1 and 2,

3. ButterworthHeinemann Ltd., London (1991). 2. Industrial Safety - National Safety Council of India

4. Frank P Lees – Loss of prevention in Process Industries , Vol. 1 and 2, Butterworth- Heinemann Ltd., London

5. R. K. Jain and Sunil S. Rao, Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006).

## CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2		2		2	-	-	-	-	-	2	-	-	-	-
2	-		2		-	-	1	-	-	-	1	-	-	-	-
3	-		-		2	-	-	-	-	-	2	-	-	-	-
4	-		-		-	-	-	-	2	-	3	-	-	-	-
5	-		-		-	-	-	1	-	-	-	-	-	-	-
AVg.	2	-	2	-	-	-	1	1	2	-	2		-	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

OSF353

CHEMICAL PROCESS SAFETY

L T P C

3 0 0 3

## COURSE OBJECTIVES

- Teach the principles of safety applicable to the design, and operation of chemical process plants.
- Ensure that potential hazards are identified and mitigation measures are in place to prevent unwanted release of energy.
- Learn about the hazardous chemicals into locations that could expose employees and others to serious harm.

- Focuses on preventing incidents and accidents during large scale manufacturing of chemicals and pharmaceuticals.
- Ensure that the general design of the plant is capable of complying with the dose limits in force and with the radioactive releases.

#### **UNIT I SAFETY IN THE STORAGE AND HANDLING OF CHEMICALS AND GASES 9**

Types of storage-general considerations for storage layouts- atmospheric venting, pressure and temperature relief - relief valve sizing calculations - storage and handling of hazardous chemicals and industrial gases, safe disposal methods, reaction with other chemicals, hazards during transportation - pipe line transport - safety in chemical laboratories.

#### **UNIT II CHEMICAL REACTION HAZARDS 9**

Hazardous inorganic and organic reactions and processes, Reactivity as a process hazard, Detonations, Deflagrations, and Runaways, Assessment and Testing strategies, Self - heating hazards of solids, Explosive potential of chemicals, Structural groups and instability of chemicals, Thermochemical screening,

#### **UNIT III SAFETY IN THE DESIGN OF CHEMICAL PROCESS PLANTS 9**

Design principles -Process design development -types of designs, feasibility survey, preliminary design, Flow diagrams, piping and instrumentation diagram, batch versus continuous operation, factors in equipment scale up and design, equipment specifications - reliability and safety in designing - inherent safety - engineered safety - safety during startup and shutdown - non destructive testing methods - pressure and leak testing - emergency safety devices - scrubbers and flares- new concepts in safety design and operation- Pressure vessel testing standards- Inspection techniques for boilers and reaction vessels.

#### **UNIT IV SAFETY IN THE OPERATION OF CHEMICAL PROCESS PLANTS 9**

Properties of chemicals - Material Safety Data Sheets - the various properties and formats used - methods available for property determination. Operational activities and hazards -standards operating procedures - safe operation of pumps, compressors, heaters, column, reactors, pressure vessels, storage vessels, piping systems - effects of pressure, temperature, Flow rate and humidity on operations - corrosion and control measures- condition monitoring - control valves - safety valves - pressure reducing valves, drains, bypass valves, inert gases. Chemical splashes, eye irrigation and automatic showers.

#### **UNIT V SAFETY AND ANALYSIS 9**

Safety vs reliability- quantification of basic events, system safety quantification, Human error analysis, Accident investigation and analysis, OSHAS 18001 and OSHMS.

**TOTAL: 45 PERIODS**

#### **COURSE OUTCOMES:**

##### **Students able to**

- CO1** Differentiate between inherent safety and engineered safety and recognize the importance of safety in the design of chemical process plants.
- CO2** Develop thorough knowledge about safety in the operation of chemical plants.
- CO3** Apply the principles of safety in the storage and handling of gases.
- CO4** Identify the conditions that lead to reaction hazards and adopt measures to prevent them.
- CO5** Develop thorough knowledge about

## TEXT BOOK

- 1 David A Crowl & Joseph F Louvar, "Chemical Process safety", Pearson publication, 3<sup>rd</sup> Edition, 2014
- 2 Maurice Jones .A, "Fire Protection Systems, 2<sup>nd</sup> edition, Jones & Bartlett Publishers, 2015

## REFERENCES:

1. Ralph King and Ron Hirst, "King's safety in the process industries", Arnold, London, 1998.
2. Industrial Environment and its Evolution and Control, NIOSH Publication, 1973.
3. National Safety Council, "Accident prevention manual for industrial operations". Chicago, 1982.
4. Lewis, Richard. J., Sr, "Sax's dangerous properties of materials". (Ninth edition). Van Nostrand Reinhold, New York, 1996.
5. Roy E Sanders, "Chemical Process Safety", 3<sup>rd</sup> Edition, Gulf professional publishing, 2006

## CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	-	-	-	1	-	-	1	-	-	-	2	-	-
2	-			2	-	-	-	-	1	-		-	-	2	-
3	-	3		1	-	-	-	2	-	-	1	-	-	-	-
4	-	2	-		-	1	-	-	1	-		-	-	-	2
5	-	2	3		-	-	-	1	-	-	1	-	-	-	-
AVg.	2	2.5	3	1.5	-	1	-	1.5	1	-	1		2	2	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

OML352

ELECTRICAL, ELECTRONIC AND MAGNETIC MATERIALS

L T P C

3 0 0 3

## COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Understanding the importance of various materials used in electrical, electronics and magnetic applications
- Acquiring knowledge on the properties of electrical, electronics and magnetic materials.
- Gaining knowledge on the selection of suitable materials for the given application
- Knowing the fundamental concepts in Semiconducting materials
- Getting equipped with the materials used in optical and optoelectronic applications.

## UNIT I DIELECTRIC MATERIALS

9

Dielectric as Electric Field Medium, leakage currents, dielectric loss, dielectric strength, breakdown voltage, breakdown in solid dielectrics, flashover, liquid dielectrics, electric conductivity in solid, liquid and gaseous dielectrics, Ferromagnetic materials, properties of ferromagnetic materials in static fields, spontaneous, polarization, curie point, anti-ferromagnetic materials, piezoelectric materials, pyroelectric materials.

## UNIT II MAGNETIC MATERIALS

9

Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials, magnetic Anisotropy, Magnetostriction, diamagnetism, magnetically soft and hard materials, special purpose materials, feebly magnetic materials, Ferrites, cast and cermet permanent magnets, ageing of magnets. Factors effecting permeability and Hysteresis

**UNIT III SEMICONDUCTOR MATERIALS 9**

Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale Integration techniques. Concept of superconductivity; theories and examples for high temperature superconductivity; discussion on specific superconducting materials; comments on fabrication and engineering applications.

**UNIT IV MATERIALS FOR ELECTRICAL APPLICATIONS 9**

Materials used for Resistors, rheostats, heaters, transmission line structures, stranded conductors, bimetal fuses, soft and hard solders, electric contact materials, electric carbon materials, thermocouple materials. Solid, Liquid and Gaseous insulating materials, Effect of moisture on insulation.

**UNIT V OPTICAL AND OPTOELECTRONIC MATERIALS 9**

Principles of photoconductivity - effect of impurities - principles of luminescence-laser principles - He-Ne, injection lasers, LED materials - binary, ternary photoelectronic materials - LCD materials - photo detectors - applications of optoelectronic materials - optical fibres and materials - electro optic modulators - Kerr effect - Pockels effect.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

After completion of this course, the students will be able to

**CO1:** Understand various types of dielectric materials, their properties in various conditions.

**CO2:** Evaluate magnetic materials and their behavior.

**CO3:** Evaluate semiconductor materials and technologies.

**CO4:** Select suitable materials for electrical engineering applications.

**CO5:** Identify right material for optical and optoelectronic applications

**TEXT BOOKS:**

1. Pradeep Fulay, "Electronic, Magnetic and Optical materials", CRC Press, Taylor and Francis, 2nd illustrated edition, 2017.
2. "R K Rajput", "A course in Electrical Engineering Materials", Laxmi Publications, 2009.

**REFERENCE BOOKS:**

1. T K Basak, "A course in Electrical Engineering Materials", New Age Science Publications, 2009
2. TTTI Madras, "Electrical Engineering Materials", McGraw Hill Education, 2004.
3. Adrianus J. Dekker, "Electrical Engineering Materials", PHI Publication, 2006.
4. S. P. Seth, P. V. Gupta "A course in Electrical Engineering Materials", Dhanpat Rai & Sons, 2011.
5. C. Kittel, "Introduction to Solid State Physics", 7th Edition, John Wiley & Sons, Singapore, (2006).

**CO's-PO's & PSO's MAPPING**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C01	3	2	2	3								2	2	2	1
C02	3	1	2	2								2	2	2	1
C03	3	2	1	2								2	2	2	1
CO4	3	2	1	2								2	2	2	2
CO5	3	2	2	2								2	2	2	1

Avg	3	1.8	1.6	2.2							2	2	2	1.2
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1 - low, 2 - medium, 3 - high, '-' - no correlation

**OML353**

**NANOMATERIALS AND APPLICATIONS**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the evolution of nanomaterials in the scientific era and make them to understand different types of nanomaterials for the future engineering applications
- Gaining knowledge on dimensionality effects on different properties of nanomaterials
- Getting acquainted with the different processing techniques employed for fabricating nanomaterials
- Having knowledge on the different characterisation techniques employed to characterise the nanomaterials
- Acquiring knowledge on different applications of nanomaterials in different disciplines of engineering.

**UNIT I NANOMATERIALS**

**9**

Introduction, Classification: 0D, 1D, 2D, 3D nanomaterials and nano-composites, their mechanical, electrical, optical, magnetic properties; Nanomaterials versus bulk materials.

**UNIT II THERMODYNAMICS & KINETICS OF NANOSTRUCTURED MATERIALS**

**9**

Size and interface/interphase effects, interfacial thermodynamics, phase diagrams, diffusivity, grain growth, and thermal stability of nanomaterials.

**UNIT III PROCESSING**

**9**

Bottom-up and top-down approaches for the synthesis of nanomaterials, mechanical alloying, chemical routes, severe plastic deformation, and electrical wire explosion technique.

**UNIT IV STRUCTURAL CHARACTERISTICS**

**9**

Principles of emerging nanoscale X-ray techniques such as small angle X-ray scattering and X-ray absorption fine structure (XAFS), electron and neutron diffraction techniques and their application to nanomaterials; SPM, Nanoindentation, Grain size, phase formation, texture, stress analysis

**UNIT V APPLICATIONS**

**9**

Applications of nanoparticles, quantum dots, nanotubes, nanowires, nanocoatings; applications in electronic, electrical and medical industries

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the students will be able to

**CO1:**Evaluate nanomaterials and understand the different types of nanomaterials

**CO2:**Recognise the effects of dimensionality of materials on the properties

**CO3:**Process different nanomaterials and use them in engineering applications

**CO4:**Use appropriate techniques for characterising nanomaterials

**CO5:**Identify and use different nanomaterials for applications in different engineering fields.

**TEXT BOOKS:**

1. Bhusan, Bharat (Ed), "Springer Handbook of Nanotechnology", 2nd edition, 2007.
2. Carl C. Koch (ed.), NANOSTRUCTURED MATERIALS, Processing, Properties and Potential Applications, NOYES PUBLICATIONS, Norwich, New York, U.S.A.

**REFERENCES:**

1. Poole C.P, and Owens F.J., Introduction to Nanotechnology, John Wiley 2003
2. Nalwa H.S., Encyclopedia of Nanoscience and Nanotechnology, American Scientific Publishers 2004
3. Zehetbauer M.J. and Zhu Y.T., Bulk Nanostructured Materials, Wiley 2008
4. Wang Z.L., Characterization of Nanophase Materials, Wiley 2000
5. Gutkin Y., Ovid'ko I.A. and Gutkin M., Plastic Deformation in Nanocrystalline Materials, Springer 2004

**CO's-PO's & PSO's MAPPING**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
C01	2	2	2	3								2	1	2	
C02	3	1	2	2								2	2	2	1
C03	3	2	1	2								2	2	2	
CO4	3	1		2								2	2	2	2
CO5	3	2	2	2								2	2	2	1
Avg	2.8	1.6	1.7	2.2								2	1.8	2	1.3

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OMR352****HYDRAULICS AND PNEUMATICS**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

- To knowledge on fluid power principles and working of hydraulic pumps
- To obtain the knowledge in hydraulic actuators and control components
- To understand the basics in hydraulic circuits and systems
- To obtain the knowledge in pneumatic and electro pneumatic systems
- To apply the concepts to solve the trouble shooting

**UNIT I FLUID POWER PRINCIPLES AND HYDRAULIC PUMPS****9**

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

**UNIT II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS****9**

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications –

Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.

**UNIT III HYDRAULIC CIRCUITS AND SYSTEMS 9**

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

**UNIT IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9**

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits

**UNIT V TROUBLE SHOOTING AND APPLICATIONS 9**

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

- CO 1: Analyze the methods in fluid power principles and working of hydraulic pumps
- CO 2: Recognize the concepts in hydraulic actuators and control components
- CO 3: Obtain the knowledge in basics of hydraulic circuits and systems
- CO 4: Know about the basics concept in pneumatic and electro pneumatic systems
- CO 5: Apply the concepts to solve the trouble shooting hydraulic and pneumatics

<b>CO's-PO's &amp; PSO's MAPPING</b>																
<b>COs/POs &amp; PSOs</b>	<b>POs</b>												<b>PSOs</b>			
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>1</b>	<b>2</b>	<b>3</b>	
CO1	3	2	1		2	2						1	2	2	1	
CO2	3	2	1		2	2						1	2	2	1	
CO3	3	2	1		2	2						1	2	2	1	
CO4	3	2	1		2	2						1	2	2	1	
CO5	3	2	1		2	2						1	2	2	1	
CO/PO & PSO Average	3	2	1		2	2						1	2	2	1	
<b>1 - low, 2 - medium, 3 - high, '-' - no correlation</b>																

**TEXT BOOKS**

1. Anthony Esposito, "Fluid Power with Applications", Prentice Hall, 2009.
2. James A. Sullivan, "Fluid Power Theory and Applications", Fourth Edition, Prentice Hall, 1997.

**REFERENCES**

1. Shanmugasundaram.K, "Hydraulic and Pneumatic Controls". Chand & Co, 2006.
2. Majumdar, S.R., "Oil Hydraulics Systems – Principles and Maintenance", Tata McG Raw Hill, 2001.
3. Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata McGRaw Hill, 2007.

4. Dudley, A. Pease and John J Pippenger, "Basic Fluid Power", Prentice Hall, 1987
5. Srinivasan. R, "Hydraulic and Pneumatic Controls", Vijay Nicole Imprints, 2008
6. Joshi.P, "Pneumatic Control", Wiley India, 2008.
7. Jagadeesha T, "Pneumatics Concepts, Design and Applications ", Universities Press, 2015.

**OMR353**

**SENSORS**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- To learn the various types of sensors, transducers, sensor output signal types, calibration techniques, formulation of system equation and its characteristics.
- To understand basic working principle, construction, Application and characteristics of displacement, speed and ranging sensors.
- To understand and analyze the working principle, construction, application and characteristics of force, magnetic and heading sensors.
- To learn and analyze the working principle, construction, application and characteristics of optical, pressure, temperature and other sensors.
- To familiarize students with different signal conditioning circuits design and data acquisition system.

**UNIT I            SENSOR CLASSIFICATION, CHARACTERISTICS AND SIGNAL TYPES            9**

Basics of Measurement – Classification of Errors – Error Analysis – Static and Dynamic Characteristics of Transducers – Performance Measures of Sensors – Classification of Sensors – Sensor Calibration Techniques – Sensor Outputs - Signal Types - Analog and Digital Signals, PWM and PPM.

**UNIT II            DISPLACEMENT, PROXIMITY AND RANGING SENSORS            9**

Displacement Sensors – Brush Encoders - Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – Range Sensors - Ultrasonic Ranging - Reflective Beacons - Laser Range Sensor (LIDAR) – GPS - RF Beacons.

**UNIT III            FORCE, MAGNETIC AND HEADING SENSORS            9**

Strain Gage – Types, Working, Advantage, Limitation, and Applications: Load Measurement – Force and Torque Measurement - Magnetic Sensors – Types, Principle, Advantage, Limitation, and Applications - Magneto Resistive – Hall Effect, Eddy Current Sensor - Heading Sensors – Compass, Gyroscope and Inclinometers.

**UNIT IV            OPTICAL, PRESSURE, TEMPERATURE AND OTHER SENSORS            9**

Photo Conductive Cell, Photo Voltaic, Photo Resistive, LDR – Fiber Optic Sensors – Pressure – Diaphragm – Bellows - Piezoelectric - Piezo-resistive - Acoustic, Temperature – IC, Thermistor, RTD, Thermocouple – Non Contact Sensor - Chemical Sensors - MEMS Sensors - Smart Sensors.

**UNIT V            SIGNAL CONDITIONING            9**

Need for Signal Conditioning – Resistive, Inductive and Capacitive Bridges for Measurement - DC and AC Signal Conditioning - Voltage, Current, Power and Instrumentation Amplifiers – Filter and Isolation Circuits – Fundamentals of Data Acquisition System

**TOTAL: 45 PERIODS**



## COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Understand various sensor effects, sensor characteristics, signal types, calibration methods and obtain transfer function and empirical relation of sensors. They can also analyze the sensor response.

CO2: Analyze and select suitable sensor for displacement, proximity and range measurement.

CO3: Analyze and select suitable sensor for force, magnetic field, speed, position and direction measurement.

CO4: Analyze and Select suitable sensor for light detection, pressure and temperature measurement and also familiar with other miniaturized smart sensors.

CO5: Select and design suitable signal conditioning circuit with proper compensation and linearizing element based on sensor output signal.

CO's-PO's & PSO's MAPPING															
COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2								1	2	3	2	1
CO2	3	3	2	1	1	1					1	2	3	2	1
CO3	3	3	2	1	1	1					1	2	3	2	1
CO4	3	3	2	1	1	1					1	2	3	2	1
CO5	3	3	2	1	1	1					1	2	3	2	1
CO/PO & PSO Average	3	3	2	0.8	0.8	0.8					0.8	2	3	2	1
1 - low, 2 - medium, 3 - high, '-' - no correlation															

## TEXT BOOKS

1. Bolton W., "Mechatronics", Pearson Education, 6th Edition, 2015.
2. Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Penram International Publishing Private Limited, 6th Edition, 2013.

## REFERENCES

1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., "Mechatronics", Chapman and Hall, 1993.
2. Davis G. Alciatore and Michael B. Hstand, "Introduction to Mechatronics and Measurement systems", McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, "Mechatronics Principles, Concepts and Applications", McGraw Hill Education, 2015.
5. Smaili. A and Mrad. F, "Mechatronics Integrated Technologies for Intelligent Machines", Oxford University Press, 2007.

**ORA352**

**CONCEPTS IN MOBILE ROBOTS**

**L T P C**  
**3 0 0 3**

## COURSE OBJECTIVES

- To introduce mobile robotic technology and its types in detail.
- To learn the kinematics of wheeled and legged robot.
- To familiarize the intelligence into the mobile robots using various sensors.
- To acquaint the localization strategies and mapping technique for mobile robot.
- To aware the collaborative mobile robotics in task planning, navigation and intelligence.

**UNIT I INTRODUCTION TO MOBILE ROBOTICS 9**

Introduction – Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Robots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles

**UNIT II KINEMATICS 9**

Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints – Degree of Mobility and Steerability – **Manoeuvrability** – Workspace – Degrees of Freedom – Path and Trajectory Considerations – Motion Controls - Holonomic Robots

**UNIT III PERCEPTION 9**

Sensor for Mobile Robots – Classification and Performance Characterization – Wheel/Motor Sensors – Heading Sensors - Ground-Based Beacons - Active Ranging - Motion/Speed Sensors – Camera - Visual Appearance based Feature Extraction.

**UNIT IV LOCALIZATION 9**

Localization Based Navigation Versus Programmed Solutions - Map Representation - Continuous Representations - Decomposition Strategies - Probabilistic Map-Based Localization - Landmark-Based Navigation - Globally Unique Localization - Positioning Beacon Systems - Route-Based Localization - Autonomous Map Building - Simultaneous Localization and Mapping (SLAM).

**UNIT V PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS 9**

Introduction - Competences for Navigation: Planning and Reacting - Path Planning - Obstacle Avoidance - Navigation Architectures - Control Localization - Techniques for Decomposition - Case Studies – Collaborative Robots – Swarm Robots.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

**CO1:** Evaluate the appropriate mobile robots for the desired application.

**CO2:** Create the kinematics for given wheeled and legged robot.

**CO3:** Analyse the sensors for the intelligence of mobile robotics.

**CO4:** Create the localization strategies and mapping technique for mobile robot.

**CO5:** Create the collaborative mobile robotics for planning, navigation and intelligence for desired applications.

**TEXTBOOK**

1. Roland Siegwart and IllahR.Nourbakish, "Introduction to Autonomous Mobile Robots" MIT Press, Cambridge, 2004.

**REFERENCES:**

1. Dragomir N. Nenchev, Atsushi Konno, TeppeiTsujiita, "Humanoid Robots: Modelling and Control", Butterworth-Heinemann, 2018
2. MohantaJagadish Chandra, "Introduction to Mobile Robots Navigation", LAP Lambert Academic Publishing, 2015.
3. Peter Corke, "Robotics, Vision and Control", Springer, 2017.
4. Ulrich Nehmzow, "Mobile Robotics: A Practical Introduction", Springer, 2003.
5. Xiao Qi Chen, Y.Q. Chen and J.G. Chase, "Mobile Robots - State of the Art in Land, Sea, Air, and Collaborative Missions", Intec Press, 2009.
6. Alonzo Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, 2013, ISBN: 978-1107031159.



2. E.A. Stokoe "Reeds Ship construction for marine engineers", Vol. 5,2010
3. E.A. Stokoe, "Reeds Naval architecture for the marine engineers",4<sup>th</sup> Edition,2009

### REFERENCES BOOKS:

1. DJ Eyers and GJ Bruse, "Ship Construction", 7<sup>th</sup> Edition, 2006.
2. KJ Rawson and EC Tupper, "Basic Ship theory I" Vol. 1,5<sup>th</sup> Edition,2001.

### CO's-PO's & PSO's MAPPING

C O	PO												PSO			
	PO 1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
1	1	1	1	1	1						1	1		1		1
2	1	1	1											1		1
3	1			1	1				1	1	1		1	1		1
4	1		1	1										1		1
5	1		1	1										1		1
Av g	5/5 =1	2/2 =1	4/4 =1	4/4 =1	2/2 =1				1/1 =1	1/1 =1	2/2 =1	1/1 =1	1/1 =1	5/5 =1		5/5 =1

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OMV351**

**MARINE MERCHANT VESSELS**

**LT P C**

**3 0 0 3**

### COURSE OBJECTIVES:

**At the end of the course, students are expected to acquire**

- Knowledge on basics of Hydrostatics
- Familiarization on types of merchant ships
- Knowledge on Shipbuilding Materials
- Knowledge on marine propeller and rudder
- Awareness on governing bodies in shipping industry

### UNIT I INTRODUCTION TO HYDROSTATICS

**9**

Archimedes Principle- Laws of floatation– Meta centre – stability of floating and submerged bodies- Density, relative density - Displacement –Pressure –centre of pressure.

### UNIT II TYPES OF SHIP

**10**

General cargo ship - Refrigerated cargo ships - Container ships - Roll-on Roll-off ships – Oil tankers- Bulk carriers - Liquefied Natural Gas carriers - Liquefied Petroleum Gas carriers - Chemical tankers - Passenger ships

### UNIT III SHIPBUILDING MATERIALS

**9**

Types of Steels used in Shipbuilding - High tensile steels, Corrosion resistant steels, Steel sandwich panels, Steel castings, Steel forgings - Other shipbuilding materials, Aluminium alloys, Aluminium alloy sandwich panels, Fire protection especially for Aluminium Alloys, Fiber Reinforced Composites

### UNIT IV MARINE PROPELLER AND RUDDER

**8**

Types of rudder, construction of Rudder-Types of Propeller, Propeller material-Cavitations and its effects on propeller

**UNIT V GOVERNING BODIES FOR SHIPPING INDUSTRY 9**

Role of **IMO** (International Maritime Organization), **SOLAS** (International Convention for the Safety of Life at Sea), **MARPOL** (International Convention for the Prevention of Pollution from Ships), **MLC** (Maritime Labour Convention), **STCW 2010** (International Convention on Standards of Training, Certification and Watch keeping for Seafarers), Classification societies Administration authorities

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**Upon completion of this course, students would**

**CO1:Acquire Knowledge on floatation of ships**

**CO2:Acquire Knowledge on features of various ships**

**CO3:Acquire Knowledge of Shipbuilding Materials**

**CO4:Acquire Knowledge to identify the different types of marine propeller and rudder**

**CO5:Understand the Roles and responsibilities of governing bodies**

**TEXT BOOKS:**

1. D.J.Eyres, "Ship Constructions", Seventh Edition, Butter Worth Heinemann Publishing, USA,2015
2. Dr.DA Taylor, "Merchant Ship Naval Architecture" I. Mar EST publications, 2006
3. EA Stokoe, E.A, "Naval Architecture for Marine Engineers", Vol.4, Reeds Publications,2000

**REFERENCES:**

1. Kemp & Young "Ship Construction Sketches & Notes", Butter Worth Heinemann Publishing,USA, 2011
2. MARPOL Consolidated Edition , Bhandakar Publications, 2018
3. SOLAS Consolidated Edition , Bhandakar Publications, 2016

**OMV352 ELEMENTS OF MARINE ENGINEERING**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

**At the end of the course, students are expected to**

- Understand the role of Marine machinery systems
- Be familiar with Marine propulsion machinery system
- Acquaint with Marine Auxiliary machinery system
- Have acquired basics of Marine Auxiliary boiler system
- Be aware of ship propellers and steering system

**UNIT I ELEMENTARY KNOWLEDGE ON MARINE MACHINERY SYSTEMS 9**

Marine Engineering Terminologies, Parts of Ship, Introduction to Machinery systems on board ships – Propulsion Machinery system, Electricity Generator system, Steering gear system, Air compressors & Air reservoirs, Fuel oil and Lubricating Oil Purifiers, Marine Boiler systems

**UNIT II MARINE PROPULSION MACHINERY SYSTEM 9**

Two stroke Large Marine slow speed Diesel Engine – General Construction, Basic knowledge of Air starting and reversing mechanism, Cylinder lubrication oil system, Main lubricating oil system and cooling water system

**UNIT III MARINE AUXILIARY MACHINERY SYSTEM 9**  
 Four stroke medium speed Diesel engine – General Construction, Inline, V-type arrangement of engine, Difference between slow speed and medium speed engines – advantages, limitations and applications

**UNIT IV MARINE BOILER SYSTEM 9**  
 Types of Boiler – Difference between Water tube boiler and Fire tube boiler, Need for boiler on board ships, Uses of steam, Advantages of using steam as working medium, Boiler mountings and accessories – importance of mountings, need for accessories

**UNIT V SHIP PROPELLERS AND STEERING MECHANISM 9**  
 Importance of Propellor and Steering gear, Types of propellers - Fixed pitch propellers, Controllable pitch propellers, Water jet propellers, Steering gear systems - 2-Ram and 4 Ram steering gear, Electric steering gear

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**At the end of the course, students should able to,**

- CO1:**Distinguish the role of various marine machinery systems
- CO2:**Relate the components of marine propulsion machinery system
- CO3:**Explain the importance of marine auxiliary machinery system
- CO4:**Acquire knowledge of marine boiler system
- CO5:**Understand the importance of ship propellers and steering system

**TEXT BOOKS:**

1. Taylor, “Introduction to Marine engineering”, Revised Second Edition, Butterworth Heinemann, London, 2011
2. J.K.Dhar, “Basic Marine Engineering”, Tenth Edition, G-Maritime Publications, Mumbai, 2011
3. K.Ramaraj, “ Text book on Marine Engineering”, Eswar Press, Chennai, 2018

**REFERENCES:**

1. Alan L.Rowen, “Introduction to Practical Marine Engineering, Volume 1&2, The Institute of Marine Engineers (India), Mumbai, 2006
2. A.S.Tambwekar, “Naval Architecture and Ship Construction”, The Institute of Marine Engineers (India), Mumbai, 2015

<b>CRA332</b>	<b>DRONE TECHNOLOGIES</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

- To understand the basics of drone concepts
- To learn and understand the fundamentals of design, fabrication and programming of drone
- To impart the knowledge of an flying and operation of drone
- To know about the various applications of drone
- To understand the safety risks and guidelines of fly safely

**UNIT I INTRODUCTION TO DRONE TECHNOLOGY 9**  
 Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and

employability

**UNIT II DRONE DESIGN, FABRICATION AND PROGRAMMING 9**

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

**UNIT III DRONE FLYING AND OPERATION 9**

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone controls Flight operations –management tool –Sensors-Onboard storage capacity -Removable storage devices- Linked mobile devices and applications

**UNIT IV DRONE COMMERCIAL APPLICATIONS 9**

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

**UNIT V FUTURE DRONES AND SAFETY 9**

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

CO1: Know about a various type of drone technology, drone fabrication and programming.

CO2: Execute the suitable operating procedures for functioning a drone

CO3: Select appropriate sensors and actuators for Drones

CO4: Develop a drone mechanism for specific applications

CO5: Createthe programs for various drones

<b>CO's-PO's &amp; PSO's MAPPING</b>															
<b>COs/Pos&amp;P SOs</b>	<b>POs</b>												<b>PSOs</b>		
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>1</b>	<b>2</b>	<b>3</b>
CO1	1	2	3	1	3	2						1	2	1	3
CO2	1	2	3	1	3	2						1	2	1	3
CO3	1	2	3	1	3	2						1	2	1	3
CO4	1	2	3	1	3	2						1	2	1	3
CO5	1	2	3	1	3	2						1	2	1	3
CO/PO & PSO Average	1	2	3	1	3	2						1	2	1	3
<b>1 - low, 2 - medium, 3 - high, '-' - no correlation</b>															

**TEXT BOOKS**

1. Daniel Tal and John Altschuld, "Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation", 2021 John Wiley & Sons, Inc.
2. Terry Kilby and Belinda Kilby, "Make:Getting Started with Drones ",Maker Media, Inc,

**REFERENCES**

1. John Baichtal, "Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs", Que Publishing, 2016
2. Završnik, "Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance", Springer, 2018.

**OGI352****GEOGRAPHICAL INFORMATION SYSTEM****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- To impart the knowledge on basic components, data preparation and implementation of Geographical Information System.

**UNIT I FUNDAMENTALS OF GIS****9**

Introduction to GIS - Basic spatial concepts - Coordinate Systems - GIS and Information Systems – Definitions – History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Proprietary and open source Software - Types of data – Spatial, Attribute data- types of attributes – scales/ levels of measurements.

**UNIT II SPATIAL DATA MODELS****9**

Database Structures – Relational, Object Oriented – Entities – ER diagram - data models - conceptual, logical and physical models - spatial data models – Raster Data Structures – Raster Data Compression - Vector Data Structures - Raster vs Vector Models- TIN and GRID data models.

**UNIT III DATA INPUT AND TOPOLOGY****9**

Scanner - Raster Data Input – Raster Data File Formats – Georeferencing – Vector Data Input – Digitizer – Datum Projection and reprojection -Coordinate Transformation – Topology - Adjacency, connectivity and containment – Topological Consistency – Non topological file formats - Attribute Data linking – Linking External Databases – GPS Data Integration

**UNIT IV DATA QUALITY AND STANDARDS****9**

Data quality - Basic aspects - completeness, logical consistency, positional accuracy, temporal accuracy, thematic accuracy and lineage – Metadata – GIS Standards –Interoperability - OGC - Spatial Data Infrastructure

**UNIT V DATA MANAGEMENT AND OUTPUT****9**

Import/Export – Data Management functions- Raster to Vector and Vector to Raster Conversion - Data Output - Map Compilation – Chart/Graphs – Multimedia – Enterprise Vs. Desktop GIS-distributed GIS.

**TOTAL:45 PERIODS****COURSE OUTCOMES:**

On completion of the course, the student is expected to

**CO1** Have basic idea about the fundamentals of GIS.

**CO2** Understand the types of data models.

**CO3** Get knowledge about data input and topology

**CO4** Gain knowledge on data quality and standards



**CO5** Understand data management functions and data output

**TEXTBOOKS:**

1. Kang - Tsung Chang, Introduction to Geographic Information Systems, McGraw Hill Publishing, 2nd Edition, 2011.
2. Ian Heywood, Sarah Cornelius, Steve Carver, Srinivasa Raju, "An Introduction Geographical Information Systems, Pearson Education, 2nd Edition,2007.

**REFERENCES:**

1. Lo. C. P., Albert K.W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice-Hall India Publishers, 2006

**CO's-PO's & PSO's MAPPING: GEOGRAPHICAL INFORMATION SYSTEM**

PO	Graduate Attribute	Course Outcome					Average
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering Knowledge	3	3	3	3	3	3
PO2	Problem Analysis				3	3	3
PO3	Design/Development of Solutions			3	3	3	3
PO4	Conduct Investigations of Complex Problems			3	3	3	3
PO5	Modern Tool Usage		3		3	3	3
PO6	The Engineer and Society						
PO 7	Environment and Sustainability						
PO 8	Ethics						
PO 9	Individual and Team Work						
PO 10	Communication						
PO 11	Project Management and Finance						
PO 12	Life-long Learning						
PSO 1	Knowledge of Geoinformatics discipline	3	3	3	3	3	3
PSO 2	Critical analysis of Geoinformatics Engineering problems and innovations	3	3	3	3	3	3
PSO 3	Conceptualization and evaluation of Design solutions	3	3	3	3	3	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OAI352**

**AGRICULTURE ENTREPRENEURSHIP DEVELOPMENT**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES**

- To introduce the importance of Agri-business management, its characteristics and principles
- To impart knowledge on the functional areas of Agri-business like Marketing management, Product pricing methods and Market potential assessment.

**UNIT I ENTREPRENEURIAL ENVIRONMENT IN INDIAN CONTEXT**

**9**

Entrepreneur Development(ED): Concept of entrepreneur and entrepreneurship assessing overall business environment in Indian economy- Entrepreneurial and managerial characteristics-

Entrepreneurship development programmers (EDP)-Generation incubation and commercialization of ideas and innovations- Motivation and entrepreneurship development- Globalization and the emerging business entrepreneurial environment.

**UNIT II            AGRIPRNEURSHIP IN GLOBAL ARENA: LEGAL PERSPECTIVE            9**

Importance of agribusiness in Indian economy - International trade-WTO agreements- Provisions related to agreements in agricultural and food commodities - Agreements on Agriculture (AOA)- Domestic supply, market access, export subsidies agreements on sanitary and phyto-sanitary (SPS) measures, Trade related intellectual property rights (TRIPS).

**UNIT III            ENTREPRENEURSHIP MANAGEMENT: FINANCIAL PERSPECTIVE            9**

Entrepreneurship - Essence of managerial Knowledge -Management functions- Planning-organizing-Directing-Motivation-ordering-leading-supervision- communication and control- Understanding Financial Aspects of Business - Importance of financial statements-liquidity ratios-leverage ratios, coverage ratios-turnover ratios-Profitability ratios. Agro-based industries-Project-Project cycle-Project appraisal and evaluation techniques-undiscounted measures-Payback period-proceeds per rupee of outlay, Discounted measures-Net Present Value (NPV)-Benefit-Cost Ratio(BCR)-Internal Rate of Return(IRR)-Net benefit investment ratio(N/K ratio)-sensitivity analysis.

**UNIT IV            ENTREPRENEURIAL OPPORTUNITIES: ECONOMIC GROWTH            9**  
**PERSPECTIVE**

Managing an enterprise: Importance of planning, budgeting, monitoring evaluation and follow-up managing competition. Role of ED in economic development of a country- Overview of Indian social, political system and their implications for decision making by individual entrepreneurs- Economic system and its implication for decision making by individual entrepreneurs.

**UNITV            ENTREPRENEURIAL PROMOTION MEASURES AND GOVERNMENT            9**  
**SUPPORT**

Social responsibility of business. Morals and ethics in enterprise management- SWOT analysis- Government schemes and incentives for promotions of entrepreneurship. Government policy on small and medium enterprises (SMEs)/SSIs/MSME sectors- Venture capital (VC), contract framing (CF) and Joint Venture (JV), public-private partnerships (PPP) - overview of agricultural engineering industry, characteristics of Indian farm machinery industry.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

- CO1:**Judge about agricultural finance, banking and cooperation
- CO2:**Evaluate basic concepts, principles and functions of financial management
- CO3:**Improve the skills on basic banking and insurance schemes available to customers
- CO4:**Analyze various financial data for efficient farm management
- CO5:**Identify the financial institutions

**TEXT BOOKS**

1. Joseph L. Massie, 1995, "Essentials of Management", prentice Hall of India Pvt limited, New Delhi
2. Khanka S, 1999, Entrepreneurial Development, S, Chand and Co, New Delhi
3. Mohanty S K, 2007, Fundamentals of Entrepreneurship, Prentice Hall India, New Delhi.

## REFERENCES

1. Harih S B, Conner U J and Schwab G D, 1981, Management of the Farm Business, Prentice Hall Inc, New Jersey
2. Omri Ralins, N.1980, Introduction to Agricultural: Prentice Hall Inc, New Jersey
3. Gittenger Price, 1989, Economic Analysis of Agricultural project, John Hopkins University, Press, London.
4. Thomas W Zimmer and Norman M Scarborough, 1996, Entrepreneurship, Prentice Hall, New Jersey.
5. Mar J Dollinger, 1999, Entrepreneurship strategies and resources, Prentice –Hall, Upper Saddal Rover, New Jersey.

## CO's-PO's & PSO's MAPPING

PO/PSO		CO1	CO2	CO3	CO4	CO5	Overall correlation of COs with POs
PO1	Engineering Knowledge	1	2	1	1	1	2
PO2	Problem Analysis	2	1	1	1	2	1
PO3	Design/ Development of Solutions	1	1	1	2	1	2
PO4	Conduct Investigations of Complex Problems	1	1	2	1	1	1
PO5	Modern Tool Usage	2	1	1	1	1	2
PO6	The Engineer and Society	1	2	1	2	1	1
PO7	Environment and sustainability	1	1	2	1	1	1
PO8	Ethics	1	2	1	1	1	1
PO9	Individual and team work:	1	1	1	2	1	1
PO10	Communication	1	1	1	1	2	1
PO11	Project management and finance	1	1	2	1	1	1
PO12	Life-long learning:	1	2	1	1	1	2
PSO1	To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	1	2	1	1	1	1
PSO2	To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.	1	1	2	1	1	1
PSO3	To inculcate entrepreneurial skills through strong Industry-Institution linkage.	1	2	1	1	2	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

OEN352

BIODIVERSITY CONSERVATION

L T P C

3 0 0 3

### COURSE OBJECTIVE:

- The identification of different aspects of biological diversity and conservation techniques.

<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>9</b>
Concept of Species, Variation; Introduction to Major Plant Groups; Evolutionary relationships between Plant Groups; Nomenclature and History of plant taxonomy; Systems of Classification and their Application; Study of Plant Groups; Study of Identification Characters; Study of important families of Angiosperms; Plant Diversity Application.		
<b>UNIT II</b>	<b>INTRODUCTION TO ANIMAL DIVERSITY AND TAXONOMY</b>	<b>9</b>
Principles and Rules of Taxonomy; ICZN Rules, Animal Study Techniques; Concepts of Taxon, Categories, Holotype, Paratype, Topotype etc; Classification of Animal kingdom, Invertebrates, Vertebrates, Evolutionary relationships between Animal Groups.		
<b>UNIT III</b>	<b>MICROBIAL DIVERSITY</b>	<b>9</b>
Microbes and Earth History, Magnitude, Occurrence and Distribution. Concept of Species, Criteria for Classification, Outline Classification of Microorganisms (Bacteria, Viruses and Protozoa); Criteria for Classification and Identification of Fungi; Chemical and Biochemical Methods of Microbial Diversity Analysis		
<b>UNIT IV</b>	<b>MEGA DIVERSITY</b>	<b>9</b>
Biodiversity Hot-spots, Floristic and Faunal Regions in India and World; IUCN Red List; Factors affecting Diversity, Impact of Exotic Species and Human Disturbance on Diversity, Dispersal, Diversity-Stability Relationship; Socio- economic Issues of Biodiversity; Sustainable Utilization of Bioresources; National Movements and International Convention/Treaties on Biodiversity.		
<b>UNIT V</b>	<b>CONSERVATIONS OF BIODIVERSITY</b>	<b>9</b>
In-Situ Conservation- National parks, Wildlife sanctuaries, Biosphere reserves; Ex-situ conservation- Gene bank, Cryopreservation, Tissue culture bank; Long term captive breeding, Botanical gardens, Animal Translocation, Zoological Gardens; Concept of Keystone Species, Endangered Species, Threatened Species, Rare Species, Extinct Species		
		<b>TOTAL: 45 PERIODS</b>

#### **TEXT BOOKS:**

1. A textbook of Botany: Angiosperms- Taxonomy, Anatomy, Economic Botany & Embryology. S. Chand, Limited, Pandey, B. P. January 2001
2. Principles of Systematic Zoology, Mcgraw-Hill College, Ashlock, P.D., Latest Edition.
3. Microbiology, MacGraw Hill Companies Inc, Prescottt, L.M., Harley, J.P., and Klein D.A. (2022).
4. Microbiology, Pearson Publisher, Gerard J. Tortora, Berdell R. Funke, Christine L.Case, 13<sup>th</sup> Edition 2019

#### **REFERENCES:**

1. Ecological Census Technique: A Handbook, Cambridge University Press, Sutherland, W.
2. Encyclopedia of Biodiversity, Academic Press, Simonson Asher Levin.

#### **COURSE OUTCOMES**

Upon successful completion of this course, students will:

CO1: An insight into the structure and function of diversity for ecosystem stability.

CO2: Understand the concept of animal diversity and taxonomy

CO3: Understand socio-economic issues pertaining to biodiversity

CO4: An understanding of biodiversity in community resource management.

CO5: Student can apply fundamental knowledge of biodiversity conservation to solve problems associated with infrastructure development.

## CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		2						2		2			2	2	
2		2		2	2	2							3	2	
3				2		2							3	2	3
4	3	2			2			2	2	2	2		3	2	3
5		2	3	2			1					1		2	
Avg.	3	2	3	2	2	2	1	2	2	2	2	1	3	2	3

1.low, 2-medium, 3-high, '-'- no correlation

**Note:** The average value of this course to be used for program articulation matrix.

OEE353

INTRODUCTION TO CONTROL SYSTEMS

L T P C  
3 0 0 3

### COURSE OBJECTIVES

- To impart knowledge on various representations of systems.
- To familiarize time response analysis of LTI systems and steady state error.
- To analyze the frequency responses and stability of the systems
- To analyze the stability of linear systems in frequency domain and time domain
- To develop linear models mainly state variable model and transfer function model

### UNIT I MATHEMATICAL MODELS OF PHYSICAL SYSTEMS

9

Definition & classification of system – terminology & structure of feedback control theory – Analogous systems - Physical system representation by Differential equations – Block diagram reduction–Signal flow graphs.

### UNIT II TIME RESPONSE ANALYSIS & ROOTLOCUS TECHNIQUE

9

Standard test signals – Steady state error & error constants – Time Response of I and II order system–Root locus–Rules for sketching root loci.

### UNIT III FREQUENCY RESPONSE ANALYSIS

9

Correlation between Time & Frequency response – Polar plots – Bode Plots – Determination of Transfer Function from Bode plot.

### UNIT IV STABILITY CONCEPTS & ANALYSIS

9

Concept of stability – Necessary condition – RH criterion – Relative stability – Nyquist stability criterion – Stability from Bode plot – Relative stability from Nyquist & Bode – Closed loop frequency response.

### UNIT V STATE VARIABLE ANALYSIS

9

Concept of state – State Variable & State Model – State models for linear & continuous time systems–Solution of state & output equation–controllability & observability.

**TOTAL : 45 PERIODS**

### COURSE OUTCOMES:

Ability to

**CO1:** Design the basic mathematical model of physical System.

**CO2:** Analyze the time response analysis and techniques.

**CO3:** Analyze the transfer function from different plots.

**CO4:** Apply the stability concept in various criterion.

**CO5:** Assess the state models for linear and continuous Systems.

**TEXTBOOKS**

1. Farid Golnarghi , Benjamin C. Kuo, Automatic Control Systems Paper back McGraw Hill Education, 2018.
2. Katsuhiko Ogata, 'Modern Control Engineering', Pearson, 5<sup>th</sup> Edition 2015.
3. J. Nagrath and M. Gopal, Control Systems Engineering (Multi Colour Edition), New Age International, 2018.

**REFERENCES**

1. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, Pearson Education, 2010.
2. Control System Dynamics" by Robert Clark, Cambridge University Press, 1996 USA.
3. John J. D’Azzo, Constantine H. Houpis and Stuart N. Sheldon, Linear Control System Analysis and Design, 5<sup>th</sup> Edition, CRC PRESS, 2003.
4. S. Palani, Control System Engineering, McGraw-Hill Education Private Limited, 2009.
5. Yaduvir Singh and S. Janardhanan, Modern Control, Cengage Learning, First Impression 2010.

**CO’s-PO’s & PSO’s MAPPING**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
<b>CO1</b>	3	3	3	2	2							2	3	3	3
<b>CO2</b>	3	3	2	3	1								3	3	3
<b>CO3</b>	3	3	3	2	2								3	3	3
<b>CO4</b>	3	3	3	2	2							2	3	3	3
<b>CO5</b>	3	3	3	1	1							1	3	3	3
<b>Avg</b>	3	3	3	2	1							1	3	3	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OEI354 INTRODUCTION TO INDUSTRIAL AUTOMATION SYSTEMS**

**LT P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- To educate on design of signal conditioning circuits for various applications.
- To Introduce signal transmission techniques and their design.
- Study of components used in data acquisition systems interface techniques
- To educate on the components used in distributed control systems
- To introduce the communication buses used in automation industries.

**UNIT I INTRODUCTION**

**9**

Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems : Modbus & Profibus

**UNIT II AUTOMATION COMPONENTS**

**9**

Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.

**UNIT III COMPUTER AIDED MEASUREMENT AND CONTROL SYSTEMS 9**

Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer aided process control software, Computer based data acquisition system, Internet of things (IoT) for plant automation.

**UNIT IV PROGRAMMABLE LOGIC CONTROLLERS 9**

Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.

**UNIT V DISTRIBUTED CONTROL SYSTEM 9**

Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.

**TOTAL:45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 5**

1. Market survey of the recent PLCs and comparison of their features.
2. Summarize the PLC standards
3. Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)
4. Market survey of Industrial Data Networks.

**COURSE OUTCOMES:**

**Students able to**

**CO1** Design a signal conditioning circuits for various application (L3).

**CO2** Acquire a detail knowledge on data acquisition system interface and DCS system (L2).

**CO3** Understand the basics and Importance of communication buses in applied automation Engineering (L2).

**CO4** Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.(L3)

**CO5** Able to develop a PLC logic for a specific application on real world problem. (L5)

**TEXT BOOKS:**

1. S.K.Singh, "Industrial Instrumentation", Tata Mcgraw Hill, 2nd edition companies,2003.
2. C D Johnson, "Process Control Instrumentation Technology", Prentice Hall India,8th Edition, 2006.
3. E.A.Parr, Newnes ,NewDelhi,"Industrial Control Handbook",3rd Edition, 2000.

**REFERENCES:**

1. John W. Webb and Ronald A. Reis, "Programmable Logic Controllers: Principles and Applications", 5th Edition, Prentice Hall Inc., New Jersey, 2003.
2. Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, McGraw- Hill, New York, 2016.
3. Krishna Kant, "Computer - Based Industrial Control", 2nd Edition, Prentice Hall, New Delhi, 2011.

4. Gary Dunning, Thomson Delmar, "Programmable Logic Controller", Cengage Learning, 3rd Edition, 2005.

**List of Open Source Software/ Learning website:**

1. <https://archive.nptel.ac.in/courses/108/105/108105062/>
2. <https://nptel.ac.in/courses/108105063>
3. <https://www.electrical4u.com/industrial-automation/>
4. <https://realpars.com/what-is-industrial-automation/>
5. <https://automationforum.co/what-is-industrial-automation-2/>

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	2	1	1	-	1	-	1	-	1	1	-	1
CO2	3	1	1	-	1	-	-	1	-	1	-	-	1	-	1
CO3	3	-	1	-	1	-	-	1	-	1	-	-	1	-	1
CO4	3	3	3	3	1			1		1			1		1
CO5	3	3	3	3	1	1		1		1			1		1
AVg.	3	2.25	2	2.6	1	1	-	1	-	1	-	-	1	-	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

OCH353

ENERGY TECHNOLOGY

L T P C

3 0 0 3

**UNIT I INTRODUCTION**

**8**

Units of energy, conversion factors, general classification of energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, Renewable and non-renewable energy sources and their availability. Prospects of Renewable energy sources

**UNIT II CONVENTIONAL ENERGY**

**8**

Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.

**UNIT III NON-CONVENTIONAL ENERGY**

**10**

Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.

**UNIT IV BIOMASS ENERGY**

**10**

Biomass energy resources, thermo-chemical and biochemical methods of biomass conversion, combustion, gasification, pyrolysis, biogas production, ethanol, fuel cells, alkaline fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, solid polymer electrolyte



fuel cell, magneto hydrodynamic power generation, energy storage routes like thermal energy storage, chemical, mechanical storage and electrical storage.

## UNIT V ENERGY CONSERVATION

9

Energy conservation in chemical process plants, energy audit, energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, steam economy in chemical plants, energy conservation.

**TOTAL : 45 PERIODS**

### COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1: Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.

CO2: Students will excel as professionals in the various fields of energy engineering

CO3: Compare different renewable energy technologies and choose the most appropriate based on local conditions.

CO4: Explain the technological basis for harnessing renewable energy sources.

CO5: Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level.

### TEXT BOOKS

1. Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005.
2. Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi, 1984.
3. Bansal, N.K., Kleeman, M. and Meliss, M., Renewable Energy Sources and Conversion Technology, Tata McGraw Hill, 1990.
4. Nagpal, G.R., Power Plant Engineering, Khanna Publishers, 2008.

### REFERENCES

1. Nejat Vezirog, Alternate Energy Sources, IT, McGraw Hill, New York.
2. El. Wakil, Power Plant Technology, Tata McGraw Hill, New York, 2002.
3. Sukhatme. S.P., Solar Energy - Thermal Collection and Storage, Tata McGraw hill, New Delhi, 1981.

### CO's-PO's & PSO's MAPPING

Course Outcomes	Program Outcomes															
	Statements	P O 1	P O 2	P O 3	P O 4	P O 5	P O 6	P O 7	P O 8	P O 9	P O 10	P O 11	P O 12	P O 13	PS O2	PS O3
<b>CO 1</b>	Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.	2	3	2	3	3	-	-	-	1	1	-	3	1	1	3
<b>CO 2</b>	Students will excel as professionals in the	2	3	1	3	3	-	-	-	1	1	-	3	2	1	3

	various fields of energy engineering															
<b>CO 3</b>	Compare different renewable energy technologies and choose the most appropriate based on local conditions.	2	2	2	3	3	1	1	-	1	1	-	3	2	1	3
<b>CO 4</b>	Explain the technological basis for harnessing renewable energy sources.	2	2	1	3	3	1	1	1	1	-	1	3	1	1	3
<b>CO 5</b>	Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level	2	2	1	3	3	1	1	1	1	-	1	3	2	1	3
<b>OVERALL CO</b>		<b>2</b>	<b>2</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>3</b>

1 - low, 2 - medium, 3 - high, '-' - no correlation

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OCH354**

**SURFACE SCIENCE**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVE:**

- To enable the students to analyze properties of a surfaces and correlate them to structure, chemistry, and physics and surface modification technique.

**UNIT I SURFACE STRUCTURE AND EXPERIMENTAL PROBES**

**9**

Relevance of surface science to Chemical and Electrochemical Engineering, Heterogeneous Catalysis and Nanoscience; Surface structure and reconstructions, adsorbate structure, Band and Vibrational structure, Importance of UHV techniques, Electronic probes and molecular beams, Scanning probes and diffraction, Qualitative introduction to electronic and vibrational spectroscopy

**UNIT II ADSORPTION, DYNAMICS, THERMODYNAMICS AND KINETICS AT SURFACES**

**9**

Interactions at the surface, Physisorption, Chemisorption, Diffusion, dynamics and reactions of atoms/molecules on surfaces, Generic reaction mechanism on surfaces, Adsorption isotherms, Kinetics of adsorption, Use of temperature desorption methods

**UNIT III LIQUID INTERFACES 9**  
Structure and Thermodynamics of liquid-solid interface, Self-assembled monolayers, Electrified interfaces, Charge transfer at the liquid-solid interfaces, Photoelectrochemical processes, Gratzel cells

**UNIT IV HETEROGENEOUS CATALYSIS 9**  
Characterization of heterogeneous catalytic processes, Microscopic kinetics to catalysis, Overview of important heterogeneous catalytic processes: Haber-Bosch, Fischer-Tropsch and Automotive catalysis, Role of promoters and poisons, Bimetallic surfaces, surface functionalization and clusters in catalysis, Role of Sabatier principle in catalyst design, Rate oscillations and spatiotemporal pattern formation

**UNIT V EPITAXIAL GROWTH AND NANO SURFACE-STRUCTURES 9**  
Origin of surface forces, Role of stress and strain in epitaxial growth, Energetic and growth modes, Nucleation theory, Nonequilibrium growth modes, MBE, CVD and ablation techniques, Catalytic growth of nanotubes, Etching of surfaces, Formation of nanopillars and nanorods and its application in photoelectrochemical processes, Polymer surfaces and biointerfaces.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

- Upon completion of this course, the students can understand, predict and design surface properties based on surface structure. Students would understand the physics and chemistry behind surface phenomena

**TEXT BOOK:**

1. K. W. Kolasinski, "Surface Science: Foundations of catalysis and nanoscience" II Edition, John Wiley & Sons, New York, 2008.

**REFERENCE:**

1. Gabor A. Somorjai and Yimin Li "Introduction to Surface Chemistry and catalysis", II Edition John Wiley & Sons, New York, 2010.

**OFD354 FUNDAMENTALS OF FOOD ENGINEERING L T P C  
3 0 0 3**

**COURSE OBJECTIVES**

The course aims to

- acquaint and equip the students with different techniques of measurement of engineering properties.
- make the students understand the nature of food constituents in the design of processing equipment

**UNIT I 9**  
Engineering properties of food materials: physical, thermal, aerodynamic, mechanical, optical and electromagnetic properties.

**UNIT II 9**  
Drying and dehydration: Basic drying theory, heat and mass transfer in drying, drying rate curves, calculation of drying times, dryer efficiencies; classification and selection of dryers; tray, vacuum,

osmotic, fluidized bed, pneumatic, rotary, tunnel, trough, bin, belt, microwave, IR, heat pump and freeze dryers; dryers for liquid: Drum or roller dryer, spray dryer and foammat dryers

### **UNIT III**

**9**

Size reduction: Benefits, classification, determination and designation of the fineness of ground material, sieve/screen analysis, principle and mechanisms of comminution of food, Rittinger's, Kick's and Bond's equations, work index, energy utilization; Size reduction equipment: Principal types, crushers (jaw crushers, gyratory, smooth roll), hammer mills and impactors, attrition mills, buhr mill, tumbling mills, ultra fine grinders, fluid jet pulverizer, colloid mill, cutting machines (slicing, dicing, shredding, pulping)

### **UNIT IV**

**9**

Mixing: theory of solids mixing, criteria of mixer effectiveness and mixing indices, rate of mixing, theory of liquid mixing, power requirement for liquids mixing; Mixing equipment: Mixers for low- or medium-viscosity liquids (paddle agitators, impeller agitators, powder-liquid contacting devices, other mixers), mixers for high viscosity liquids and pastes, mixers for dry powders and particulate solids.

### **UNIT V**

**9**

Mechanical Separations: Theory, centrifugation, liquid-liquid centrifugation, liquid-solid centrifugation, clarifiers, desludging and decanting machine, Filtration: Theory of filtration, rate of filtration, pressure drop during filtration, applications, constant-rate filtration and constant-pressure filtration, derivation of equation; Filtration equipment; plate and frame filter press, rotary filters, centrifugal filters and air filters, filter aids, Membrane separation: General considerations, materials for membrane construction, ultra-filtration, microfiltration, concentration, polarization, processing variables, membrane fouling, applications of ultra-filtration in food processing, reverse osmosis, mode of operation, and applications; Membrane separation methods, demineralization by electro-dialysis, gel filtration, ion exchange, per-evaporation and osmotic dehydration.

**TOTAL: 45 PERIODS**

### **COURSE OUTCOMES:**

At the end of the course the students will be able to

CO1 understand the importance of food polymers

CO2 understand the effect of various methods of processing on the structure and texture of food materials

CO3 understand the interaction of food constituents with respect to thermal, electrical properties to develop new technologies for processing and preservation.

### **TEXTBOOKS:**

1. R.L. Earle. 2004. Unit Operations in Food Processing. The New Zealand Institute of Food Science & Technology, Nz. Warren L. McCabe, Julian Smith, Peter Harriott. 2004.
2. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA. Christie John Geankoplis. 2003.
3. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed. Prentice-Hall, NY, USA.
4. George D. Saravacos and Athanasios E. Kostaropoulos. 2002. Handbook of Food Processing Equipment. Springer Science+Business Media, New York, USA.
5. J. F. Richardson, J. H. Harker and J. R. Backhurst. 2002. Coulson & Richardson's Chemical Engineering, Vol. 2, Particle Technology and Separation Processes, 5th Ed.

**COURSE OBJECTIVES:**

- To characterize different type of food hazards, physical, chemical and biological in the industry and food service establishments
- To help become skilled in systems for food safety surveillance
- To be aware of the regulatory and statutory bodies in India and the world
- To ensure processed food meets global standards

**UNIT I****10**

Introduction to food safety and security: Hygienic design of food plants and equipments, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labeling. Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials. Control of rats, rodents, mice, birds, insects and microbes. Cleaning and Disinfection, ISO 22000 – Importance and Implementation

**UNIT II****8**

Food quality: Various Quality attributes of food, Instrumental, chemical and microbial Quality control. Sensory evaluation of food and statistical analysis. Water quality and other utilities.

**UNIT III****9**

Critical Quality control point in different stages of production including raw materials and processing materials. Food Quality and Quality control including the HACCP system. Food inspection and Food Law, Risk assessment – microbial risk assessment, dose response and exposure response modelling, risk management, implementation of food surveillance system to monitor food safety, risk communication

**UNIT IV****9**

Indian and global regulations: FAO in India, Technical Cooperation programmes, Bio-security in Food and Agriculture, World Health Organization (WHO), World Animal Health Organization (OIE), International Plant Protection Convention (IPPC)

**UNIT V****9**

Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

CO1 Thorough Knowledge of food hazards, physical, chemical and biological in the industry and food service establishments

CO2 Awareness on regulatory and statutory bodies in India and the world

**REFERENCES:**

1. Handbook of food toxicology by S. S. Deshpande, 2002
2. The food safety information handbook by Cynthia A. Robert, 2009
3. Nutritional and safety aspects of food processing by Tannenbaum SR, Marcel Dekker Inc., New York 1979
4. Microbiological safety of Food by Hobbs BC, 1973

5. Food Safety Handbook by Ronald H. Schmidt, Gary E. Rodrick, A John Wiley & Sons Publication, 2003

**OPY353**

**NUTRACEUTICALS**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the basic concepts of Nutraceuticals and functional food, their chemical nature and methods of extraction.
- To understand the role of Nutraceuticals and functional food in health and disease.

**UNIT I INTRODUCTION AND SIGNIFICANCE**

**6**

Introduction to Nutraceuticals and functional foods; importance, history, definition, classification, list of functional foods and their benefits, Phytochemicals, zoochemicals and microbes in food, plants, animals and microbes.

**UNIT II PHYTOCHEMICALS AS NUTRACEUTICALS**

**11**

Phytoestrogens in plants; isoflavones; flavonols, polyphenols, tannins, saponins, lignans, lycopene, chitin, carotenoids. Manufacturing practice of selected nutraceuticals such as lycopene, isoflavonoids, glucosamine, phytosterols. Formulation of functional foods containing nutraceuticals - stability, analytical and labelling issues.

**UNIT III ASSESSMENT OF ANTIOXIDANT ACTIVITY**

**11**

In vitro and in vivo methods for the assessment of antioxidant activity, Comparison of different *in vitro* methods to evaluate the antioxidant, antioxidant mechanism, Prediction of the antioxidant activity of natural phenolics from electrotopological state indices, Optimising phytochemical release by process technology; Variation of Antioxidant Activity during technological treatments, new food grade peptidases from plant sources.

**UNIT IV ROLE IN HEALTH AND DISEASE**

**11**

The health benefit of - Soy protein, Spirulina, Tea, Olive oil, plant sterols, Broccoli, omega3 fatty acid and eicosanoids. Nutraceuticals and Functional foods in Gastrointestinal disorder, Cancer, CVD, Diabetic Mellitus, HIV and Dental disease; Importance and function of probiotic, prebiotic and synbiotic and their applications, Functional foods and immune competence; role and use in obesity and nervous system disorders.

**UNIT V SAFETY ISSUES**

**6**

Health Claims, Adverse effects and toxicity of nutraceuticals, regulations and safety issues International and national.

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**

1. Bisset, Normal Grainger and Max Wich H "Herbal Drugs and Phytopharmaceuticals", 2nd Edition, CRC, 2001.
2. Handbook of Nutraceuticals and Functional Foods: Robert Wildman, CRC, Publications. 2006
3. WEBB, PP, Dietary Supplements and Functional Foods Blackwell Publishing Ltd (United Kingdom), 2006
4. Ikan, Raphael "Natural Products: A Laboratory Guide", 2nd Edition, Academic Press / Elsevier, 2005.

**REFERENCES:**

1. Asian Functional Foods (Nutraceutical Science and Technology) by John Shi (Editor), Fereidoon Shahidi (Editor), Chi-Tang Ho (Editor), CRC Publications, Taylor & Francis, 2007
2. Functional Foods and Nutraceuticals in Cancer Prevention by Ronald Ross Watson (Author), Blackwell Publishing, 2007
3. Marketing Nutrition: Soy, Functional Foods, Biotechnology, and Obesity by Brian Wansink.
4. Functional foods: Concept to Product: Edited by G R Gibson and C M Williams, Wood head Publ., 2000
5. Hanson, James R. "Natural Products: The Secondary Metabolites", Royal Society of Chemistry, 2003.

**COURSE OUTCOME - NUTRACEUTICALS**

<b>CO 1</b>	acquire knowledge about the Nutraceuticals and functional foods, their classification and benefits.
<b>CO 2</b>	acquire knowledge of phytochemicals, zoochemicals and microbes in food, plants, animals and microbes
<b>CO 3</b>	attain the knowledge of the manufacturing practices of selected nutraceutical components and formulation considerations of functional foods.
<b>CO 4</b>	distinguish the various <i>In vitro</i> and <i>In vivo</i> assessment of Antioxidant activity of compounds from plant sources.
<b>CO 5</b>	gain information about the health benefits of various functional foods and nutraceuticals in the prevention and treatment of various lifestyle diseases.
<b>CO 6</b>	Attain the knowledge of the regulatory and safety issues of nutraceuticals at national and international level.

**CO's-PO's & PSO's MAPPING**

<b>NUTRACEUTICALS</b>												
<b>Course outcome</b>	<b>PO1</b>	<b>PO2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO 5</b>	<b>PO6</b>	<b>PO 7</b>	<b>PO8</b>	<b>PO 9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>
<b>CO 1</b>	3											1
<b>CO 2</b>	3											1
<b>CO 3</b>	3					2						
<b>CO 4</b>	3											
<b>CO 5</b>	3					2						1
<b>CO 6</b>	3							2				1

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OTT354****BASICS OF DYEING AND PRINTING****L T P C****3 0 0 3****COURSE OBJECTIVE:**

- To enable the students to learn about the basics of Pretreatment, dyeing, printing and machinery in textile processing.

**UNIT I INTRODUCTION****9**

Impurities present in different fibres, Inspection of grey goods and lot preparation. Shearing,

**UNIT II PRE TREATMENT 9**  
 Desizing-Objective of Desizing- types of Desizing- Objective of Scouring- Mechanism of Scouring– Degumming of Silk, Scouring of wool - Bio Scouring. Bleaching -Objective of Bleaching: Bleaching mechanism of Hydrogen Peroxide, Hypo chlorites. Objective of Mercerizing - Physical and Chemical changes of Mercerizing.

**UNIT III DYEING 9**  
 Dye - Affinity, Substantively, Reactivity, Exhaustion and Fixation. Classification of dyes. Direct dyes: General properties, principles and method of application on cellulosic materials. Reactive dyes – principles and method of application on cellulosic materials hot brand, cold brand.

**UNIT IV PRINTING 9**  
 Definition of printing – Difference between printing and dying- Classification thickeners – Requirements to be good thickener, printing paste Preparation - different styles of printing.

**UNIT V MACHINERIES 9**  
 Fabric Processing - winch, jigger and soft flow machines. Beam dyeing machines: Printing -flat bed screen - Rotary screen. Thermo transfer printing machinery. Garment dyeing machines.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to Understand the

- CO1:** Basics of grey fabric
- CO2:** Basics of pre treatment
- CO3:** Concept of Dyeing
- CO4:** Concept of Printing
- CO5:** Machinery in processing industry

**TEXT BOOKS:**

1. Trotman, E.R., Textile Scouring and Bleaching, Charless Griffins, Com. Ltd., London 1990.
2. Shenai V.A. "Technology of Textile Processing Vol. IV" 1998, Sevak Publications, Mumbai.

**REFERENCES:**

1. Trotman E. R., "Dyeing and Chemical Technology of Textile Fibres", Charles Griffin & Co. Ltd., U.K., 1984, ISBN : 0 85264 165 6.
2. Dr. N N Mahapatra., "Textile dyeing", Wood head publishing India, 2018
3. Mathews Kolanjikombil., "Dyeing of Textile substrates III –Fibres, Yarns and Knitted fabrics", Wood head publishing India , 2021
4. Bleaching & Mercerizing – BTRA Silver Jubilee Monograph series
5. Chakraborty, J.N, "Fundamentals and Practices in colouration of Textiles", Wood head Publishing India, 2009, ISBN-13:978-81-908001-4-3.

**CO's-PO's & PSO's MAPPING**

- 1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Course Outcomes	Program Outcome															
	Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3



<b>CO1</b>	Classification of fibres and production of natural fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>CO2</b>	Regenerated and synthetic fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>CO3</b>	Yarn spinning	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>CO4</b>	Weaving	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>CO5</b>	Knitting and nonwoven	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>Overall CO</b>		-	-	-	-	-	-	-	2	1	-	1	1	-	1	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

**FT3201**

**FIBRE SCIENCE**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- To enable the students to learn about the types of fibre and its properties

**UNIT I INTRODUCTION TO TEXTILE FIBRES**

**9**

Definition of various forms of textile fibres - staple fibre, filament, bicomponent fibres. Classification of Natural and Man-made fibres, essential and desirable properties of Fibres. Production and cultivation of Natural Fibers: Cotton, Silk, Wool -Physical and chemical structure of the above fibres.

**UNIT II REGENERATED FIBRES**

**9**

Production Sequence of Regenerated Cellulosic fibres: Viscose Rayon, Acetate rayon – High wet modulus fibres: Modal and Lyocel ,Tencel

**UNIT III SYNTHETIC FIBRES**

**9**

Production Sequence of Synthetic Fibers: polymer-Polyester, Nylon, Acrylic and polypropylene. Mineral fibres: fibre glass ,carbon .Introduction to spin finishes and texturization

**UNIT IV SPECIALITY FIBRES**

**9**

Properties and end uses of high tenacity and high modulus fibres, high temperature and flame retardant fibres, Chemical resistant fibres

**UNIT V FUNCTIONAL SPECIALITY FIBRES 9**  
**Properties and end uses :** Fibres for medical application – Biodegradable fibres based on PLA ,Super absorbent fibres elastomeric fibres, ultra-fine fibres, electrospun nano fibres, metallic fibres – Gold and Silver coated.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES**

Upon completion of this course, the student would be able to

**CO1:**Understand the process sequence of various fibres

**CO2:**Understand the properties of various fibres

**TEXT BOOKS:**

1. Morton W. E., and Hearle J. W. S., “Physical Properties of Textile Fibres”, The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95
2. Meredith R., and Hearle J. W. S., “Physical Methods of Investigation of Textiles”, Wiley Publication, New York, 1989, ISBN: B00JCV6ZJU | ISBN-13:
3. Mukhopadhyay S. K., “Advances in Fibre Science”, The Textile Institute,1992, ISBN: 1870812379

**REFERENCES:**

1. Meredith R., “Mechanical Properties of Textile Fibres”, North Holland, Amsterdam, 1986, ISBN: 1114790699, ISBN-13: 9781114790698
2. Hearle J. W. S., Lomas B., and Cooke W. D., “Atlas of Fibre Fracture and Damage to Textiles”, The Textile Institute, 2<sup>nd</sup> Edition, 1998, ISBN: 1855733196.
3. Raheel M. (ed.), “Modern Textile Characterization Methods”, Marcel Dekker, 1995, ISBN:0824794737
4. Mukhopadhyay. S. K., “The Structure and Properties of Typical Melt Spun Fibres”, Textile Progress, Vol. 18, No. 4, Textile Institute, 1989, ISBN: 1870812115
5. Hearle J.W.S., “Polymers and Their Properties: Fundamentals of Structures and Mechanics Vol 1”, Ellis Horwood, England, 1982, ISBN: 047027302X | ISBN-13: 9780470273029 36

**OTT355 GARMENT MANUFACTURING TECHNOLOGY L T P C**  
**3 0 0 3**

**COURSE OBJECTIVE:**

- To enable the students to understand the basics of pattern making, cutting and sewing.
- To expose the students to various problems & remedies during garment manufacturing

**UNIT I PATTERN MAKING, MARKER PLANNING, CUTTING 9**  
 Anthropometry, specification sheet, pattern making – principles, basic pattern set drafting, grading, marker planning, spreading & cutting

**UNIT II TYPES OF SEAMS, STITCHES AND FUNCTIONS OF NEEDLES 9**  
 Different types of seams and stitches; single needle lock stitch machine – mechanism and accessories; needle – functions, special needles, needlepoint

**UNIT III COMPONENTS AND TRIMS USED IN GARMENT 9**  
 Sewing thread-construction, material, thread size, packages, accessories – labels, linings, interlinings, wadding, lace, braid, elastic, hook and loop fastening, shoulder pads, eyelets and laces, zip fasteners, buttons

**UNIT IV GARMENT INSPECTION AND DIMENSIONAL CHANGES 9**

Raw material, in process and final inspection; needle cutting; sewability of fabrics; strength properties of apparel; dimensional changes in apparel due to laundering, dry-cleaning, steaming and pressing.

**UNIT V GARMENT PRESSING, PACKING AND CARE LABELING 9**

Garment pressing – categories and equipment, packing; care labelling of apparels

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to Understand

- CO1:** Pattern making, marker planning, cutting
- CO2:** Types of seams, stitches and functions of needles
- CO3:** Components and trims used in garment
- CO4:** Garment inspection and dimensional changes
- CO5:** Garment pressing, packing and carelabelling

**TEXT BOOKS:**

1. Carr H., and Latham B., “The Technology of Clothing Manufacture”, Blackwell Science Ltd., Oxford, 1994.
2. Gerry Cooklin, “Introduction to Clothing Manufacture” Blackwell Science Ltd., 1995. 64
3. Harrison.P.W Garment Dyeing, The Textile Institute Publication, Textile Progress, Vol .19 No.2,1988.

**REFERENCES:**

1. Winifred Aldrich., “Metric Pattern Cutting”, Blackwell Science Ltd., Oxford, 1994
2. Peggall H., “The Complete Dress Maker”, Marshall Caverdish, London, 1985
3. Jai Prakash and Gaur R.K., “Sewing Thread”, NITRA, 1994
4. Ruth Glock, Grace I. Kunz, “Apparel Manufacturing”, Dorling Kindersley Publishing Inc., New Jersey, 1995.
5. Pradip V.Mehta, “An Introduction to Quality Control for the Apparel Industry”, J.S.N. Internationals, 1992.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
<b>1</b>	1	1	1	-	2	-	1	1	-	2	3	1	2	3	1	3
<b>2</b>	2	2	1	1	1	-	1	1	-	2	2	1	2	2	1	2
<b>3</b>	1	1	1	1	1	1	1	1	-	1	2	1	1	3	1	3
<b>4</b>	2	1	1	1	2	2	2	1	1	2	3	1	2	3	1	3
<b>5</b>	2	2	1	1	1	1	2	1	-	2	2	1	2	2	1	2
<b>Avg</b>	1.6	1.2	1	0.8	1.4	0.8	1.4	1	0.2	1.8	2.4	1	1.8	2.6	1	2.6

1 - low, 2 - medium, 3 - high, '-' - no correlation

**COURSE OBJECTIVES:**

- To educate about the health hazards and the safety measures to be followed in the industrial environment.
- Describe industrial legislations (Factories Acts, Workmen's Compensation and other laws) enacted for the protection of employees health at work settings
- Describe methods of prevention and control of Occupational Health diseases, accidents / emergencies and other hazards

**UNIT I INTRODUCTION 9**

Need for developing Environment, Health and Safety systems in work places - Accident Case Studies - Status and relationship of Acts - Regulations and Codes of Practice - Role of trade union safety representatives. International initiatives - Ergonomics and work place.

**UNIT II OCCUPATIONAL HEALTH AND HYGIENE 9**

Definition of the term occupational health and hygiene - Categories of health hazards - Exposure pathways and human responses to hazardous and toxic substances - Advantages and limitations of environmental monitoring and occupational exposure limits - Hierarchy of control measures for occupational health risks - Role of personal protective equipment and the selection criteria - Effects on humans - control methods and reduction strategies for noise, radiation and excessive stress.

**UNIT III WORKPLACE SAFETY AND SAFETY SYSTEMS 9**

Features of Satisfactory and Safe design of work premises – good housekeeping - lighting and colour, Ventilation and Heat Control – Electrical Safety – Fire Safety – Safe Systems of work for manual handling operations – Machine guarding – Working at different levels – Process and System Safety.

**UNIT IV HAZARDS AND RISK MANAGEMENT 9**

Safety appraisal - analysis and control techniques – plant safety inspection – Accident investigation - Analysis and Reporting – Hazard and Risk Management Techniques – major accident hazard control – Onsite and Offsite emergency Plans.

**UNIT V ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT 9**

Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and methods of its effective implementation and review – Elements of Management Principles – Education and Training – Employee Participation.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

After completion of this course, the student is expected to be able to:

**CO1:** Describe, with example, the common work-related diseases and accidents in occupational setting

**CO2:** Name essential members of the Occupational Health team

**CO3:** What roles can a community health practitioners play in an Occupational setting to ensure the protection, promotion and maintenance of the health of the employee

**COURSE OBJECTIVES:**

- To impart to the student basic knowledge on fluid mechanics, mechanical operations, heat transfer operations and mass transfer operations.

**UNIT I FLUID MECHANICS CONCEPTS 9**

Fluid definition and classification of fluids, types of fluids, Rheological behaviour of fluids & Newton's Law of viscosity. Fluid statics-Pascal's law, Hydrostatic equilibrium, Barometric equation and pressure measurement(problems),Basic equations of fluid flow - Continuity equation, Euler's equation and Bernoulli equation; Types of flow - laminar and turbulent; Reynolds experiment; Flow through circular and non-circular conduits - Hagen Poiseuille equation (no derivation). Flow through stagnant fluids – theory of Settling and Sedimentation – Equipment (cyclones, thickeners) Conceptual numericals.

**UNIT II FLOW MEASUREMENTS & MECHANICAL OPERATIONS 9**

Different types of flow measuring devices (Orifice meter, Venturimeter, Rotameter) with derivations, flow measurements –. Pumps – types of pumps (Centrifugal & Reciprocating pumps), Energy calculations and characteristics of pumps. Size reduction–characteristics of comminute products, sieve analysis, Properties and handling of particulate solids – characterization of solid particles, average particle size, screen analysis- Conceptual numerical of differential and cumulative analysis. Size reduction, crushing laws, working principle of ball mill. Filtration & types, filtration equipments (plate and frame, rotary drum). Conceptual numericals.

**UNIT III CONDUCTIVE & CONVECTIVE HEAT TRANSFER 9**

Modes of heat transfer; Conduction – steady state heat conduction through unilayer and multilayer walls, cylinders; Insulation, critical thickness of insulation. Convection- Forced and Natural convection, principles of heat transfer co-efficient, log mean temperature difference, individual and overall heat transfer co-efficient, fouling factor; Condensation – film wise and drop wise (no derivation). Heat transfer equipments – double pipe heat exchanger, shell and tube heat exchanger (with working principle and construction with applications).

**UNIT IV BASICS OF MASS TRANSFER 9**

Diffusion-Fick's law of diffusion. Types of diffusion. Steady state molecular diffusion in fluids at rest and laminar flow (stagnant / unidirection and bi direction). Measurement of diffusivity, Mass transfer coefficients and their correlations. Conceptual numerical.

**UNIT V MASS TRANSFER OPERATIONS 9**

Basic concepts of Liquid-liquid extraction – equilibrium, stage type extractors (belt extraction and basket extraction).Distillation – Methods of distillation, distillation of binary mixtures using McCabe Thiele method.Drying- drying operations, batch and continuous drying. Conceptual numerical.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

At the end of the course the student will be able to:

**CO1:**State and describe the nature and properties of the fluids.

**CO2:**Study the different flow measuring instruments, the principles of various size reductions, conveying equipment's, sedimentation and mixing tanks.

**CO3:**Comprehend the laws governing the heat and mass transfer operations to solve the problems.

**CO4:**Design the heat transfer equipment suitable for specific requirement.

## TEXTBOOK(S)

1. Unit operations in Chemical Engineering Warren L. McCabe, Julian C. Smith & Peter Harriot McGraw-Hill Education (India) Edition 2014
2. Fluid Mechanics K L Kumar S Chand & Company Ltd 2008
3. Introduction to Chemical Engineering Badger W.I. and Banchemo, J.T., Tata McGraw Hill New York 1997

## REFERENCE BOOKS

1. Principles of Unit Operations Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B. Anderson John Wiley & Sons 2nd edition 2008
2. Unit Operations of Chemical Engineering, Vol I &II Chattopadhyaya Khanna Publishers, Delhi-6 1996
3. Heat Transfer J P Holman McGraw Hill International Ed

**OPT352**

**PLASTIC MATERIALS FOR ENGINEERS**

**L T P C  
3 0 0 3**

## COURSE OBJECTIVES

- Understand the advantages, disadvantages and general classification of plastic materials
- To know the manufacturing, sources, and applications of engineering thermoplastics
- Understand the basics as well as the advanced applications of various plastic materials in the industry
- To understand the preparation methods of thermosetting materials
- Select suitable specialty plastics for different end applications

### **UNIT I INTRODUCTION TO PLASTIC MATERIALS 9**

Introduction to Plastics – Brief history of plastics, advantages and disadvantages, thermoplastic and thermosetting behavior, amorphous polymers, crystalline polymers and cross-linked structures. General purpose thermoplastics/ Commodity plastics: manufacture, structure, properties and applications of polyethylene (PE), cross-linked PE, chlorinated PE, polypropylene, polyvinyl chloride-compounding, formulation, polypropylene (PP)

### **UNIT II ENGINEERING THERMOPLASTICS AND APPLICATIONS 9**

Engineering thermoplastics – Aliphatic polyamides: structure, properties, manufacture and applications of Nylon 6, Nylon 66. Polyesters: manufacture, structure, properties and uses of PET, PBT. Manufacture, structure, properties and uses of Polycarbonates, acetal resins, polyimides, PMMA, polyphenylene oxide, thermoplastic polyurethane (PU)

### **UNIT III THERMOSETTING PLASTICS 9**

Thermosetting Plastics – Manufacture, curing, moulding powder, laminates, properties and uses of phenol formaldehyde resins, urea formaldehyde, melamine formaldehyde, unsaturated polyester resin, epoxy resin, silicone resins, polyurethane resins.

### **UNIT IV MISCELLANEOUS PLASTICS FOR END APPLICATIONS 9**

Miscellaneous plastics- Manufacture, properties and uses of polystyrene, HIPS, ABS, SAN, poly(tetrafluoroethylene) (PTFE), TFE and copolymers, PVDF, PVA, poly (vinyl acetate), poly (vinyl carbazole), cellulose acetate, PEEK, High energy absorbing polymers, super absorbent polymers-their synthesis, properties and applications

## **UNIT V PLASTICS MATERIALS FOR BIOMEDICAL APPLICATIONS 9**

Sources, raw materials, methods of manufacturing, properties and applications of bio-based polymers- poly lactic acid (PLA), poly hydroxy alkanooates (PHA), PBAT, bioplastics- bio-PE, bio-PP, bio-PET, polymers for biomedical applications

**TOTAL: 45 PERIODS**

### **COURSE OUTCOMES**

**CO1:**To study the importance, advantages and classification of plastic materials

**CO2:**Summarize the raw materials, sources, production, properties and applications of various engineering thermoplastics

**CO3:**To understand the application of polyamides, polyesters and other engineering thermoplastics, thermosetting resins

**CO4:**Know the manufacture, properties and uses of thermosetting resins based on polyester, epoxy, silicone and PU

**CO5:**To understand the engineering applications of various polymers in miscellaneous areas and applications of different biopolymers

### **REFERENCES**

1. Marianne Gilbert (Ed.), Brydson's Plastics Materials, 8<sup>th</sup> Edn., Elsevier (2017).
2. J.A.Brydson, Plastics Materials, 7<sup>th</sup> Edn., Butterworth Heinemann (1999).
3. Manas Chanda, Salil K. Roy, Plastics Technology Handbook, 4<sup>th</sup> Edn., CRC press (2006).
4. A. Brent Strong, Plastics: Materials and Processing, 3<sup>rd</sup> Edn., Pearson Prentice Hall (2006).
5. Olagoke Olabisi, Kolapo Adewale (Eds.), Handbook of Thermoplastics 2<sup>nd</sup> Edn., CRC press(2016).
6. Charles A. Harper, Modern Plastics Handbook, McGraw-Hill, New York, 1999.
7. H. Dominighaus, Plastics for Engineers, Hanser Publishers, Munich, 1988.

## **OPT353 PROPERTIES AND TESTING OF PLASTICS**

**L T P C**  
**3 0 0 3**

### **COURSE OBJECTIVES**

- To understand the relevance of standards and specifications as well as the specimen preparation for polymer testing.
- To study the mechanical properties and testing of polymer materials and their structural property relationships.
- To understand the thermal properties of polymers and their testing methods.
- To gain knowledge on the electrical and optical properties of polymers and their testing methods.
- To study about the environmental effects and prevent polymer degradation.

## **UNIT I INTRODUCTION TO CHARACTERIZATION AND TESTING OF POLYMERS 9**

Introduction- Standard organizations: BIS, ASTM, ISO, BS, DIN etc. Standards and specifications. Importance of standards in the quality control of polymers and polymer products. Preparation of test pieces, conditioning and test atmospheres. Tests on elastomers: processability parameters of rubbers – plasticity, Mooney viscosity, scorch time, cure time, cure rate index, Processability tests carried out on thermoplastics and thermosets: MFI, cup flow index, gel time, bulk density, bulk factor.

**UNIT II MECHANICAL PROPERTIES 9**

Mechanical properties: Tensile, compression, flexural, shear, tear strength, hardness, impact strength, resilience, abrasion resistance, creep and stress relaxation, compression set, dynamic fatigue, ageing properties, Basic concepts of stress and strain, short term tests: Viscoelastic behavior (simple models: Kelvin model for creep and stress relaxation, Maxwell-Voigt model, strain recovery and dynamic response), Effect of structure and composition on mechanical properties, Behavior of reinforced polymers

**UNIT III THERMAL RHEOLOGICAL PROPERTIES 9**

Thermal properties: Transition temperatures, specific heat, thermal conductivity, co-efficient of thermal expansion, heat deflection temperature, Vicat softening point, shrinkage, brittleness temperature, thermal stability and flammability. Product testing: Plastic films, sheeting, pipes, laminates, foams, containers, cables and tubes.

**UNIT IV ELECTRICAL AND OPTICAL PROPERTIES 9**

Electrical properties: volume and surface resistivity, dielectric strength, dielectric constant and power factor, arc resistance, tracking resistance, dielectric behavior of polymers (dielectric co-efficient, dielectric polarization), dissipation factor and its importance. Optical properties: transparency, refractive index, haze, gloss, clarity, birefringence.

**UNIT V ENVIRONMENTAL AND CHEMICAL RESISTANCE 9**

Environmental stress crack resistance (ESCR), water absorption, weathering, aging, ozone resistance, permeability and adhesion. Tests for chemical resistance. Acids, alkalies, Flammability tests- oxygen index test.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

**CO1:**Understand the relevance of standards and specifications.

**CO2:**Summarize the various test methods for evaluating the mechanical properties of the polymers.

**CO3:**To know the thermal, electrical & optical properties of polymers.

**CO4:**Identify various techniques used for characterizing polymers.

**CO5:**Distinguish the processability tests used for thermoplastics, thermosets and elastomers.

**REFERENCES**

1. F.Majewska, H.Zowall, Handbook of analysis of synthetic polymers and plastics, Ellis Horwood Limited Publisher 1977.
2. J.F.Rabek, Experimental Methods in Polymer Chemistry, John Wiley and Sons 1980.
3. R.P.Brown, Plastic test methods, 2<sup>nd</sup> Edn., Harlond, Longman Scientific, 1981.
4. A. B. Mathur, I. S. Bharadwaj, Testing and Evaluation of Plastcis, Allied Publishers Pvt. Ltd., New Delhi, 2003.
5. Vishu Shah, Handbook of Plastic Testing Technology, 3<sup>rd</sup> Edn., John Wiley & Sons 2007.
6. S. K. Nayak, S. N. Yadav, S. Mohanty, Fundamentals of Plastic Testing, Springer, 2010.



**COURSE OBJECTIVES:****The student should be made to:**

- To know the hardware requirement of wearable systems
- To understand the communication and security aspects in the wearable devices
- To know the applications of wearable devices in the field of medicine

**UNIT I INTRODUCTION TO WEARABLE SYSTEMS AND SENSORS 9**

Wearable Systems- Introduction, Need for Wearable Systems, Drawbacks of Conventional Systems for Wearable Monitoring, Applications of Wearable Systems, Types of Wearable Systems, Components of wearable Systems. Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Impedance plethysmography, Wearable ground reaction force sensor.

**UNIT II SIGNAL PROCESSING AND ENERGY HARVESTING FOR WEARABLE DEVICES 9**

Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, sampling frequency for reduced energy consumption, Rejection of irrelevant information. Power Requirements- Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.

**UNIT III WIRELESS HEALTH SYSTEMS 9**

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication Techniques.

**UNIT IV SMART TEXTILE 9**

Introduction to smart textile- Passive smart textile, active smart textile. Fabrication Techniques- Conductive Fibres, Treated Conductive Fibres, Conductive Fabrics, Conductive Inks. Case study- smart fabric for monitoring biological parameters - ECG, respiration.

**UNIT V APPLICATIONS OF WEARABLE SYSTEMS 9**

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, neural recording, Gait analysis, Sports Medicine.

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

CO1: Describe the concepts of wearable system.

CO2: Explain the energy harvestings in wearable device.

CO3: Use the concepts of BAN in health care.

CO4: Illustrate the concept of smart textile

CO5: Compare the various wearable devices in healthcare system

**TOTAL:45 PERIODS****TEXT BOOKS**

1. Annalisa Bonfiglio and Danilo De Rossi, Wearable Monitoring Systems, Springer, 2011
2. Zhang and Yuan-Ting, Wearable Medical Sensors and Systems, Springer, 2013
3. Edward Sazonov and Micheal R Neuman, Wearable Sensors: Fundamentals, Implementation and Applications, Elsevier, 2014

- Mehmet R. Yuce and Jamil Y. Khan, *Wireless Body Area Networks Technology, Implementation applications*, Pan Stanford Publishing Pte.Ltd, Singapore, 2012

## REFERENCES

- Sandeep K.S, Gupta, Tridib Mukherjee and Krishna Kumar Venkatasubramanian, *Body Area Networks Safety, Security, and Sustainability*, Cambridge University Press, 2013.
- Guang-Zhong Yang, *Body Sensor Networks*, Springer, 2006.

## CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	2			1					1		1
2	3	2	1	1	2			1					1		1
3	3	2	1	1	2			1					1		1
4	3	2	1	1	2			1					1		1
5	3	2	1	1	2			1					1		1
AVg.	3	2	1	1	2			1					1		1

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CBM356**

**MEDICAL INFORMATICS**

**L T P C**  
**3 0 0 3**

### Preamble:

- To study the applications of information technology in health care management.
- This course provides knowledge on resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine.

### **UNIT I INTRODUCTION TO MEDICAL INFORMATICS 9**

Introduction - Structure of Medical Informatics –Internet and Medicine -Security issues , Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, Health Informatics – Medical Informatics, Bioinformatics

### **UNIT II COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING 9**

Automated clinical laboratories-Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System - Computer assisted medical imaging- nuclear medicine, ultrasound imaging, computed X-ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance.

### **UNIT III COMPUTERISED PATIENT RECORD 9**

Introduction - conventional patient record, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for patients.

### **UNIT IV COMPUTER ASSISTED MEDICAL DECISION-MAKING 9**

Neuro computers and Artificial Neural Networks application, Expert system-General model of CMD, Computer-assisted decision support system-production rule system cognitive model, semantic networks, decisions analysis in clinical medicine-computers in the care of critically ill patients, Computer aids for the handicapped.

**UNIT V RECENT TRENDS IN MEDICAL INFORMATICS 9**

Virtual reality applications in medicine, Virtual endoscopy, Computer assisted surgery, Surgical simulation, Telemedicine - Tele surgery, Computer assisted patient education and health- Medical education and healthcare information, computer assisted instruction in medicine.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

**Upon completion of the course, students will be able to:**

**CO1:** Explain the structure and functional capabilities of Hospital Information System.

**CO2:** Describe the need of computers in medical imaging and automated clinical laboratory.

**CO3:** Articulate the functioning of information storage and retrieval in computerized patient record system.

**CO4:** Apply the suitable decision support system for automated clinical diagnosis.

**CO5:** Discuss the application of virtual reality and telehealth technology in medical industry.

**TEXT BOOKS:**

1. Mohan Bansal, "Medical informatics", Tata McGraw Hill Publishing Ltd, 2003.
2. R.D.Lele, "Computers in medicine progress in medical informatics", Tata McGraw Hill, 2005

**REFERENCES:**

1. Kathryn J. Hannah, Marion J Ball, "Health Informatics", 3<sup>rd</sup> Edition, Springer, 2006.

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	2			1					1	1	1
2	3	2	1	1	2			1					1	1	1
3	3	2	1	1	2			1					1	1	1
4	3	2	1	1	2			1					1	1	1
5	3	2	1	1	2			1					1	1	1
AVg.	3	2	1	1	2			1					1	1	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

**OCE354 BASICS OF INTEGRATED WATER RESOURCES MANAGEMENT L T P C  
3 0 0 3**

**COURSE OBJECTIVES**

- To introduce the interdisciplinary approach of water management.
- To develop knowledge base and capacity building on IWRM.

**UNIT I OVERVIEW OF IWRM 9**

Facts about water - Definition – Key challenges - Paradigm shift - Water management Principles - Social equity - Ecological sustainability – Economic efficiency - SDGs - World Water Forums.

**UNIT II WATER USE SECTORS: IMPACTS AND SOLUTION 9**

Water users: People, Agriculture, ecosystem and others - Impacts of the water use sectors on water resources - Securing water for people, food production, ecosystems and other uses - IWRM relevance in water resources management.

**UNIT III WATER ECONOMICS 9**

Economic characteristics of water good and services – Economic instruments – Private sector involvement in water resources management - PPP experiences through case studies.

**UNIT IV RECENT TREANDS IN WATER MANAGEMENT 9**  
River basin management - Ecosystem Regeneration – 5 Rs - WASH - Sustainable livelihood - Water management in the context of climate change.

**UNIT V IMPLEMENTATION OF IWRM 9**  
Barriers to implementing IWRM - Policy and legal framework - Bureaucratic reforms and inclusive development - Institutional Transformation - Capacity building - Case studies on conceptual framework of IWRM.

**TOTAL: 45 PERIODS**

### **COURSE OUTCOMES**

On completion of the course, the student will be able to apply appropriate management techniques towards managing the water resources.

**CO1** Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.

**CO2** Discuss on the different water uses; how it is impacted and ways to tackle these impacts.

**CO3** Explain the economic aspects of water and choose the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.

**CO4** Illustrate the recent trends in water management.

**CO5** Understand the implementation hitches and the institutional frameworks.

### **TEXT BOOKS**

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2. Mollinga P. *et al.* “ Integrated Water Resources Management”, Water in South Asia Volume I, Sage Publications, 2006.

### **REFERENCES**

1. Technical Advisory Committee, Background Papers No: 1, 4 and 7, Stockholm, Sweden. 2002.
2. IWRM Guidelines at River Basin Level (UNESCO, 2008).
3. Tutorial on Basic Principles of Integrated Water Resources Management ,CAP-NET. [http://www.pacificwater.org/userfiles/file/IWRM/Toolboxes/introduction%20to%20iwrn/Tutorial\\_text.pdf](http://www.pacificwater.org/userfiles/file/IWRM/Toolboxes/introduction%20to%20iwrn/Tutorial_text.pdf)
4. Pramod R. Bhave, 2011, Water Resources Systems, Narosa Publishers.
5. The 17 Goals, United Nations, <https://sdgs.un.org/goals>.

**UNIT I            BIOLOGICAL TREATMENT PROCESS****9**

Fundamentals of biological process - Anaerobic process – Pretreatment methods in anaerobic process – Aerobic process, Anoxic process, Aerobic and anaerobic digestion of organic wastes - Factors affecting process efficiency - Solid state fermentation – Submerged fermentation – Batch and continuous fermentation

**UNIT II            WASTE BIOMASS AND ITS VALUE ADDITION****9**

Types of waste biomass – Solid waste management - Nature of biomass feedstock – Biobased economy/process – Value addition of waste biomass – Biotransformation of biomass – Biotransformation of marine processing wastes – Direct extraction of biochemicals from biomass – Plant biomass for industrial application

**UNIT III          BIOCONVERSION OF WASTES TO ENERGY****9**

Perspective of biofuels from wastes - Bioethanol production – Biohydrogen Production – dark and photofermentative process - Biobutanol production – Biogas and Biomethane production - Single stage anaerobic digestion, Two stage anaerobic digestion - Biodiesel production - Enzymatic hydrolysis technologies

**UNIT IV          CHEMICALS AND ENZYME PRODUCTION FROM WASTES****9**

Production of lactic acid, succinic acid, citric acid – Biopolymer synthesis – Production of Amylases - Lignocellulolytic enzymes - Pectinolytic enzymes - Proteases – Lipases

**UNIT V          BIOCUMPOSTING OF ORGANIC WASTES****9**

Overview of composting process - Benefits of composting, Role of microorganisms in composting - Factors affecting the composting process - Waste Materials for Composting, Fundamentals of composting process - Composting technologies, Composting systems – Nonreactor Composting, Reactor composting - Compost Quality

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

After completion of this course, the students should be able

**CO1:**To learn the various methods biological treatment

**CO2:**To know the details of waste biomass and its value addition

**CO3:**To develop the bioconversion processes to convert wastes to energy

**CO4:**To synthesize the chemicals and enzyme from wastes

**CO5:**To produce the biocompost from wastes

**CO6:**To apply the theoretical knowledge for the development of value added products

**TEXT BOOKS**

1. Antoine P. T., (2017) "Biofuels from Food Waste Applications of Saccharification Using Fungal Solid State Fermentation", CRC press
2. Joseph C A., (2019)"Anaerobic Waste-Wastewater Treatment and Biogas Plants-A Practical Handbook", CRC Press,

**REFERENCE BOOKS**

1. Palmiro P. and Oscar F.D'Urso, (2016) 'Biotransformation of Agricultural Waste and By-Products', The Food, Feed, Fibre, Fuel (4F) Economy, Elsevier



<b>UNIT I</b>	<b>PUBLIC HEALTH</b>	<b>9</b>
Definition and Concept of Public Health, Historical aspects of Public Health, Changing Concepts of Public Health, Public Health versus Medical Care, Unique Features of Public Health, Determinants of Health (Social, Economic, Cultural, Environmental, Education, Genetics, Food and Nutrition). Indicators of health, Burden of disease, Role of different disciplines in Public Health.		
<b>UNIT II</b>	<b>CLINICAL DISEASES</b>	<b>9</b>
Communicable diseases: Chickenpox / Shingles, COVID-19, Tuberculosis, Hepatitis B, Hepatitis C, HIV / AIDS, Influenza, Swine flu. Non Communicable diseases: Diabetes mellitus, atherosclerosis, fatty liver, Obesity, Cancer		
<b>UNIT III</b>	<b>VACCINOLOGY</b>	<b>9</b>
History of Vaccinology, conventional approaches to vaccine development, live attenuated and killed vaccines, adjuvants, quality control, preservation and monitoring of microorganisms in seed lot systems. Instruments related to monitoring of temperature, sterilization, environment.		
<b>UNIT IV</b>	<b>OUTPATIENT &amp; IN PATIENT SERVICES</b>	<b>9</b>
Radiotherapy, Nuclear medicine, surgical units, OT Medical units, G & Obs. units Pediatric, neonatal units, Critical care units, Physical medicine & Rehabilitation, Neurology, Gastroenterology, Endoscopy, Pulmonology, Cardiology.		
<b>UNIT V</b>	<b>BASICS OF IMAGING MODALITIES</b>	<b>9</b>
Diagnostic X-rays - Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography – Different types of biotelemetry systems.		

**TOTAL: 45 PERIODS**

#### **TEXT BOOKS**

1. Joseph J.carr and John M. Brown, Introduction to Biomedical Equipment Technology, John Wiley and sons, New York, 4th Edition, 2012.
2. Thomas M. Devlin.Textbook of Biochemistry with clinical correlations. Wiley Liss Publishers
3. The Vaccine Book (2nd Ed.), Rafi Ahmed, Roy M. Anderson et. al.Editor(s): Barry R. Bloom, PaulHenri Lambert, Academic Press, 2016, Pages xxi-xxiv.

#### **REFERENCE BOOKS**

1. Suh, Sang, Gurupur, Varadraj P., Tanik, Murat M., Health Care Systems, Technology and Techniques, Springer, 1st Edition, 2011
2. Burtis & Ashwood W.B. Tietz Textbook of Clinical chemistry. Saunders Company
3. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker

## VERTICAL 1: FINTECH AND BLOCK CHAIN

CMG331

FINANCIAL MANAGEMENT

L T P C  
3 0 0 3

### LEARNING OBJECTIVES

- To acquire the knowledge of the decision areas in finance.
- To learn the various sources of Finance
- To describe about capital budgeting and cost of capital.
- To discuss on how to construct a robust capital structure and dividend policy
- To develop an understanding of tools on Working Capital Management.

### UNIT I INTRODUCTION TO FINANCIAL MANGEMENT 9

Definition and Scope of Finance Functions - Objectives of Financial Management - Profit Maximization and Wealth Maximization- Time Value of money- Risk and return concepts.

### UNIT II SOURCES OF FINANCE 9

Long term sources of Finance -Equity Shares – Debentures - Preferred Stock – Features – Merits and Demerits. Short term sources - Bank Sources, Trade Credit, Overdrafts, Commercial Papers, Certificate of Deposits, Money market mutual funds etc

### UNIT III INVESTMENT DECISIONS: 9

Investment Decisions: capital budgeting – Need and Importance – Techniques of Capital Budgeting – Payback -ARR – NPV – IRR –Profitability Index.

Cost of Capital - Cost of Specific Sources of Capital - Equity -Preferred Stock- Debt - Reserves - Concept and measurement of cost of capital - Weighted Average Cost of Capital.

### UNIT IV FINANCING AND DIVIDEND DECISION 9

Operating Leverage and Financial Leverage- EBIT-EPS analysis. Capital Structure – determinants of Capital structure- Designing an Optimum capital structure .

Dividend policy - Aspects of dividend policy - practical consideration - forms of dividend policy - - Determinants of Dividend Policy

### UNIT V WORKING CAPITAL DECISION 9

Working Capital Management: Working Capital Management - concepts - importance - Determinants of Working capital. Cash Management: Motives for holding cash – Objectives and Strategies of Cash Management. Receivables Management: Objectives - Credit policies.

**TOTAL : 45 PERIODS**

### TEXT BOOKS

1. M.Y. Khan and P.K.Jain Financial management, Text, Tata McGraw Hill
2. M. Pandey Financial Management, Vikas Publishing House Pvt. Ltd

### REFERENCES .

1. James C. Vanhorne –Fundamentals of Financial Management– PHI Learning,.
2. Prasanna Chandra, Financial Management,
3. Srivatsava, Mishra, Financial Management, Oxford University Press, 2011



**COURSE OBJECTIVES:**

- Describe the investment environment in which investment decisions are taken.
- Explain how to Value bonds and equities
- Explain the various approaches to value securities
- Describe how to create efficient portfolios through diversification
- Discuss the mechanism of investor protection in India.

**UNIT I THE INVESTMENT ENVIRONMENT 9**

The investment decision process, Types of Investments – Commodities, Real Estate and Financial Assets, the Indian securities market, the market participants and trading of securities, security market indices, sources of financial information, Concept of return and risk, Impact of Taxes and Inflation on return.

**UNIT II FIXED INCOME SECURITIES 9**

Bond features, types of bonds, estimating bond yields, Bond Valuation types of bond risks, default risk and credit rating.

**UNIT III APPROACHES TO EQUITY ANALYSIS 9**

Introduction to Fundamental Analysis, Technical Analysis and Efficient Market Hypothesis, dividend capitalisation models, and price-earnings multiple approach to equity valuation.

**UNIT IV PORTFOLIO ANALYSIS AND FINANCIAL DERIVATIVES 9**

Portfolio and Diversification, Portfolio Risk and Return; Mutual Funds; Introduction to Financial Derivatives; Financial Derivatives Markets in India

**UNIT V INVESTOR PROTECTION 9**

Role of SEBI and stock exchanges in investor protection; Investor grievances and their redressal system, insider trading, investors' awareness and activism

**TOTAL : 45 PERIODS****REFERENCES**

1. Charles P. Jones, Gerald R. Jensen. Investments: analysis and management. Wiley, 14<sup>TH</sup> Edition, 2019.
2. Chandra, Prasanna. Investment analysis and portfolio management. McGraw-hill education, 5<sup>th</sup>, Edition, 2017.
3. Rustagi, R. P. Investment Management Theory and Practice. Sultan Chand & Sons, 2021.
4. Zvi Bodie, Alex Kane, Alan J Marcus, Pitabhus Mohanty, Investments, McGraw Hill Education (India), 11 Edition (SIE), 2019

**COURSE OBJECTIVES**

- Understand the Banking system in India
- Grasp how banks raise their sources and how they deploy it
- Understand the development in banking technology
- Understand the financial services in India
- Understand the insurance Industry in India

<b>UNIT I</b>	<b>INTRODUCTION TO INDIAN BANKING SYSTEM</b>	<b>9</b>
Overview of Banking system – Structure – Functions –Banking system in India - Key Regulations in Indian Banking sector –RBI. Relationship between Banker and Customer - Retail & Wholesale Banking – types of Accounts - Opening and operation of Accounts.		
<b>UNIT II</b>	<b>MANAGING BANK FUNDS/ PRODUCTS</b>	<b>9</b>
Liquid Assets - Investment in securities - Advances - Loans.Negotiable Instruments – Cheques, Bills of Exchange & Promissory Notes.Designing deposit schemes– Asset and Liability Management – NPA’s – Current issues on NPA’s – M&A’s of banks into securities market		
<b>UNIT III</b>	<b>DEVELOPMENT IN BANKING TECHNOLOGY</b>	<b>9</b>
Payment system in India – paper based – e payment –electronic banking –plastic money – e-money –forecasting of cash demand at ATM’s –The Information Technology Act, 2000 in India – RBI’s Financial Sector Technology vision document – security threats in e-banking & RBI’s Initiative.		
<b>UNIT IV</b>	<b>FINANCIAL SERVICES</b>	<b>9</b>
Introduction – Need for Financial Services – Financial Services Market in India – NBFC — Leasing and Hire Purchase — mutual funds. Venture Capital Financing –Bill discounting –factoring – Merchant Banking		
<b>UNIT V</b>	<b>INSURANCE</b>	<b>9</b>
Insurance –Concept - Need - History of Insurance industry in India. Insurance Act, 1938 –IRDA – Regulations – Life Insurance - Annuities and Unit Linked Policies - Lapse of the Policy – revival – settlement of claim		

**TOTAL : 45 PERIODS**

**REFERENCES :**

1. Padmalatha Suresh and Justin Paul, “Management of Banking and Financial Services, Pearson, Delhi, 2017.
2. Meera Sharma, “Management of Financial Institutions – with emphasis on Bank and Risk Management”, PHI Learning Pvt. Ltd., New Delhi 2010
3. Peter S. Rose and Sylvia C. and Hudgins, “Bank Management and Financial Services”, Tata McGraw Hill, New Delhi, 2017

<b>CMG334</b>	<b>INTRODUCTION TO BLOCKCHAIN AND ITS APPLICATIONS</b>	<b>LT P C</b>
		<b>3 0 0 3</b>

<b>UNIT I</b>	<b>INTRODUCTION TO BLOCKCHAIN</b>	<b>9</b>
Blockchain: The growth of blockchain technology - Distributed systems - The history of blockchain and Bitcoin - Features of a blockchain - Types of blockchain, Consensus: Consensus mechanism - Types of consensus mechanisms - Consensus in blockchain. Decentralization: Decentralization using blockchain - Methods of decentralization - Routes to decentralization- Blockchain and full ecosystem decentralization - Smart contracts - Decentralized Organizations- Platforms for decentralization.		

<b>UNIT II</b>	<b>INTRODUCTION TO CRYPTOCURRENCY</b>	<b>9</b>
Bitcoin – Digital Keys and Addresses – Transactions – Mining – Bitcoin Networks and Payments – Wallets – Alternative Coins – Theoretical Limitations – Bitcoin limitations – Name coin – Prime coin – Zcash – Smart Contracts – Ricardian Contracts- Deploying smart contracts on a blockchain		
<b>UNIT III</b>	<b>ETHEREUM</b>	<b>9</b>
Introduction - The Ethereum network - Components of the Ethereum ecosystem - Transactions and messages - Ether cryptocurrency / tokens (ETC and ETH) - The Ethereum Virtual Machine (EVM), Ethereum Development Environment: Test networks - Setting up a private net - Starting up the private network		
<b>UNIT IV</b>	<b>WEB3 AND HYPERLEDGE</b>	<b>9</b>
Introduction to Web3 – Contract Deployment – POST Requests – Development Frameworks – Hyperledger as a Protocol – The Reference Architecture – Hyperledger Fabric – Distributed Ledger – Corda.		
<b>UNIT V</b>	<b>EMERGING TRENDS</b>	<b>9</b>
Kadena – Ripple – Rootstock – Quorum – Tendermint – Scalability – Privacy – Other Challenges – Blockchain Research – Notable Projects – Miscellaneous Tools.		
		<b>TOTAL : 45 PERIODS</b>

**REFERENCE**

1. Imran. Bashir. Mastering block chain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained. Packt Publishing, 2<sup>nd</sup> Edition, 2018
2. Peter Borovykh , Blockchain Application in Finance, Blockchain Driven, 2nd Edition, 2018
3. ArshdeepBahga, Vijay Madiseti, “Blockchain Applications: A Hands On Approach”, VPT, 2017.

<b>CMG335</b>	<b>FINTECH PERSONAL FINANCE AND PAYMENTS</b>	<b>LT P C</b>
		<b>3 0 0 3</b>

<b>UNIT I</b>	<b>CURRENCY EXCHANGE AND PAYMENT</b>	<b>9</b>
Understand the concept of Crypto currency- Bitcoin and Applications -Cryptocurrencies and Digital Crypto Wallets -Types of Cryptocurrencies - Cryptocurrencies and Applications, block chain, Artificial Intelligence, machine learning. Fintech users, Individual Payments, RTGS Systems, Immediate Page 54 of 90 Payment Service (IMPS), Unified Payments Interface (UPI).Legal and Regulatory Implications of Crypto currencies, Payment systems and their regulations.Digital Payments Smart Cards, Stored-Value Cards, EC Micropayments, Payment Gateways, Mobile Payments, Digital and Virtual Currencies, Security, Ethical, Legal, Privacy, and Technology Issues		
<b>UNIT II</b>	<b>DIGITAL FINANCE AND ALTERNATIVE FINANCE</b>	<b>9</b>
A Brief History of Financial Innovation, Digitization of Financial Services, Crowd funding, Charity and Equity,. Introduction to the concept of Initial Coin Offering		
<b>UNIT III</b>	<b>INSURETECH</b>	<b>9</b>
InsurTech Introduction , Business model disruption AI/ML in InsurTech • IoT and InsurTech ,Risk Modeling ,Fraud Detection Processing claims and Underwriting Innovations in Insurance Services		

**UNIT IV PEER TO PEER LENDING 9**  
 P2P and Marketplace Lending, New Models and New Products in market place lending P2P Infrastructure and technologies , Concept of Crowdfunding Crowdfunding Architecture and Technology ,P2P and Crowdfunding unicorns and business models , SME/MSME Lending: Unique opportunities and Challenges, Solutions and Innovations

**UNIT V REGULATORY ISSUES 9**  
 FinTech Regulations: Global Regulations and Domestic Regulations, Evolution of RegTech, RegTech Ecosystem: Financial Institutions, RegTech Ecosystem: StartupsRegTech, Startups: Challenges, RegTech Ecosystem: Regulators, Use of AI in regulation and Fraud detection

**TOTAL : 45 PERIODS**

**REFERENCE**

1. Swanson Seth, Fintech for Beginners: Understanding and Utilizing the power of technology, Createspace Independent Publishing Platform,2016.
2. Models AuTanda, Fintech Bigtech And Banks Digitalization and Its Impact On Banking Business, Springer, 2019
3. Henning Diedrich, Ethereum: Blockchains, Digital Assets, Smart Contracts, Decentralized Autonomous Organizations, Wildfire Publishing, 2016
4. Jacob William, FinTech:TheBeginner's Guide to Financial Technology, Createspace Independent Publishing Platform, 2016
5. IIBF, Digital Banking, Taxmann Publication, 2016
6. Jacob William, Financial Technology, Create space Independent Pub, 2016
7. Luke Sutton, Financial Technology: Bitcoin & Blockchain, Createspace Independent Pub, 2016

**CMG336 INTRODUCTION TO FINTECH LT P C  
 3 0 0 3**

**COURSE OBJECTIVES:**

- To learn about history, importance and evolution of Fintech
- To acquire the knowledge of Fintech in payment industry
- To acquire the knowledge of Fintech in insurance industry
- To learn the Fintech developments around the world
- To know about the future of Fintech

**UNIT I INTRODUCTION 9**  
 Fintech - Definition, History, concept, meaning, architecture, significance, Goals, key areas in Fintech, Importance of Fintech, role of Fintech in economic development, opportunities and challenges in Fintech, Evolution of Fintech in different sectors of the industry - Infrastructure, Banking Industry, Startups and Emerging Markets, recent developments in FinTech, future prospects and potential issues with Fintech.

**UNIT II PAYMENT INDUSTRY 9**  
 FinTech in Payment Industry-Multichannel digital wallets, applications supporting wallets, onboarding and KYC application, FinTech in Lending Industry- Formal lending, Informal lending, P2P lending, POS lending, Online lending, Payday lending, Microfinance, Crowdfunding.

**UNIT III INSURANCE INDUSTRY 9**

FinTech in Wealth Management Industry-Financial Advice, Automated investing, Socially responsible investing, Fractional Investing, Social Investing. FinTech in Insurance Industry- P2P insurance, On-Demand Insurance, On-Demand Consultation, Customer engagement through Quote to sell, policy servicing, Claims Management, Investment linked health insurance.

**UNIT IV FINTECH AROUND THE GLOBE 9**

FinTech developments - US, Europe and UK, Germany, Sweden, France, China, India, Africa, Australia, New Zealand, Brazil and Middle East, Regulatory and Policy Assessment for Growth of FinTech. FinTech as disruptors, Financial institutions collaborating with FinTech companies, The new financial world.

**UNIT V FUTURE OF FINTECH 9**

How emerging technologies will change financial services, the future of financial services, banking on innovation through data, why FinTech banks will rule the world, The FinTech Supermarket, Banks partnering with FinTech start-ups, The rise of BankTech, Fintech impact on Retail Banking, A future without money, Ethics in Fintech.

**TOTAL : 45 PERIODS**

**REFERENCES**

1. Arner D., Barbers J., Buckley R, The evolution of FinTech: a new post crisis paradigm, University of New South Wales Research Series, 2015
2. Susanne Chishti, Janos Barberis, The FINTECH Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries, Wiley Publications, 2016
3. Richard Hayen, FinTech: The Impact and Influence of Financial Technology on Banking and the Finance Industry, 2016
4. Parag Y Arjunwadkar, FinTech: The Technology Driving Disruption in the financial service industry CRC Press, 2018
5. Sanjay Phadke, Fintech Future : The Digital DNA of Finance Paperback .Sage Publications, 2020
6. Pranay Gupta, T. Mandy Tham, Fintech: The New DNA of Financial Services Paperback, 2018

**VERTICAL 2: ENTREPRENEURSHIP**

**CMG337 FOUNDATIONS OF ENTREPRENEURSHIP**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES**

- To develop and strengthen the entrepreneurial quality and motivation of learners.
- To impart the entrepreneurial skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of entrepreneurship and management in Technology oriented businesses.
- To empower the learners to run a Technology driven business efficiently and effectively

**UNIT I INTRODUCTION TO ENTREPRENEURSHIP 9**

Entrepreneurship- Definition, Need, Scope - Entrepreneurial Skill & Traits - Entrepreneur vs. Intrapreneur; Classification of entrepreneurs, Types of entrepreneurs -Factors affecting entrepreneurial development – Achievement Motivation – Contributions of Entrepreneurship to Economic Development.

**UNIT II BUSINESS OWNERSHIP & ENVIRONMENT 9**

Types of Business Ownership – Business Environmental Factors – Political-Economic-Sociological-Technological-Environmental-Legal aspects – Human Resources Mobilisation-Basics of Managing Finance- Essentials of Marketing Management - Production and Operations Planning – Systems Management and Administration

**UNIT III FUNDAMENTALS OF TECHNOPRENEURSHIP 9**

Introduction to Technopreneurship - Definition, Need, Scope- Emerging Concepts- Principles - Characteristics of a technopreneur - Impacts of Technopreneurship on Society – Economy- Job Opportunities in Technopreneurship - Recent trends

**UNIT IV APPLICATIONS OF TECHNOPRENEURSHIP 9**

Technology Entrepreneurship - Local, National and Global practices - Intrapreneurship and Technology interactions, Networking of entrepreneurial activities – Launching - Managing Technology based Product / Service entrepreneurship – Success Stories of Technopreneurs - Case Studies

**UNIT V EMERGING TRENDS IN ENTREPRENEURSHIP 9**

Effective Business Management Strategies For Franchising - Sub-Contracting- Leasing- Technopreneurs – Agripreneurs - Netpreneurs- Portfolio entrepreneurship - NGO Entrepreneurship – Recent Entrepreneurial Developments - Local – National – Global perspectives.

**TOTAL45 : PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the student should be able to:

CO 1 Learn the basics of Entrepreneurship

CO 2 Understand the business ownership patterns and environment

CO 3 Understand the Job opportunities in Industries relating to Technopreneurship

CO 4 Learn about applications of technopreneurship and successful technopreneurs

CO 5 Acquaint with the recent and emerging trends in entrepreneurship

**TEXT BOOKS:**

- 1) S.S.Khanka, "Entrepreneurial Development" S.Chand & Co. Ltd. Ram Nagar New Delhi, 2021.
- 2) Donal F Kuratko Entrepreneurship (11th Edition) Theory, Process, Practice by Published 2019 by Cengage Learning,

**REFERENCES :**

- 1) Daniel Mankani. 2003. Technopreneurship: The successful Entrepreneur in the new Economy. Prentice Hall
- 2) Edward Elgar. 2007. Entrepreneurship, Cooperation and the Firm: The Emergence and Survival of High-Technology Ventures in Europe. Edi: Jan Ulijn, Dominique Drillon, and Frank Lasch. Wiley Pub.
- 3) Lang, J. 2002, The High Tech Entrepreneur's Handbook, Ft.com.
- 4) David Sheff 2002, China Dawn: The Story of a Technology and Business Revolution,
- 5) HarperBusiness, <https://fanny.staff.uns.ac.id/files/2013/12/Technopreneur-BASED-EDUCATION-REVOLUTION.pdf>

- 6) JumpStart: A Technopreneurship Fable, Dennis Posadas, (Singapore: Pearson Prentice Hall, 2009
- 7) Basics of Technopreneurship: Module 1.1-1.2, Frederico Gonzales, President-PESO Inc; M. Barcelon, UP
- 8) Journal articles pertaining to Entrepreneurship

**CMG338 TEAM BUILDING & LEADERSHIP MANAGEMENT FOR BUSINESS**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- To develop and strengthen the Leadership qualities and motivation of learners.
- To impart the Leadership skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of Team Building in managing Technology oriented businesses.
- To empower the learners to build robust teams for running and leading a business efficiently and effectively

**UNIT I INTRODUCTION TO MANAGING TEAMS 9**

Introduction to Team - Team Dynamics - Team Formation – Stages of Team Development - Enhancing teamwork within a group - Team Coaching - Team Decision Making - Virtual Teams - Self Directed Work Teams (SDWTs) -Multicultural Teams.

**UNIT II MANAGING AND DEVELOPING EFFECTIVE TEAMS 9**

Team-based Organisations- Leadership roles in team-based organisations - Offsite training and team development - Experiential Learning - Coaching and Mentoring in team building - Building High-Performance Teams - Building Credibility and Trust - Skills for Developing Others - Team Building at the Top - Leadership in Teamwork Effectiveness.

**UNIT III INTRODUCTION TO LEADERSHIP 9**

Introduction to Leadership - Leadership Myths – Characteristics of Leader, Follower and Situation - Leadership Attributes - Personality Traits and Leadership- Intelligence Types and Leadership - Power and Leadership - Delegation and Empowerment .

**UNIT IV LEADERSHIP IN ORGANISATIONS 9**

Leadership Styles – LMX Theory- Leadership Theory and Normative Decision Model - Situational Leadership Model - Contingency Model and Path Goal Theory – Transactional and Transformational Leadership - Charismatic Leadership - Role of Ethics and Values in Organisational Leadership.

**UNIT V LEADERSHIP EFFECTIVENESS 9**

Leadership Behaviour - Assessment of Leadership Behaviors - Destructive Leadership - Motivation and Leadership - Managerial Incompetence and Derailment Conflict Management - Negotiation and Leadership - Culture and Leadership - Global Leadership – Recent Trends in Leadership.

**TOTAL 45 : PERIODS**

**COURSE OUTCOMES**

Upon completion of this course, the student should be able to:  
CO 1 Learn the basics of managing teams for business.

- CO 2 Understand developing effective teams for business management.  
 CO 3 Understand the fundamentals of leadership for running a business.  
 CO 4 Learn about the importance of leadership for business development.  
 CO 5 Acquaint with emerging trends in leadership effectiveness for entrepreneurs.”

**REFERENCES :**

1. Hughes, R.L., Ginnett, R.C., & Curphy, G.J., Leadership: Enhancing the lessons of experience ,9th Ed, McGraw Hill Education, Chennai, India. (2019).
2. Katzenback, J.R., Smith, D.K., The Wisdom of Teams: Creating the High Performance Organisations, Harvard Business Review Press, (2015).
3. Haldar, U.K., Leadership and Team Building, Oxford University Press, (2010).
4. Daft, R.L., The Leadership Experience, Cengage, (2015).
5. Daniel Levi, Group Dynamics for Teams ,4th Ed, (2014), Sage Publications.
6. Dyer, W. G., Dyer, W. G., Jr., & Dyer, J. H..Team building: Proven strategies for improving team performance, 5th ed, Jossey-Bass, (2013).

**CMG339 CREATIVITY & INNOVATION IN ENTREPRENEURSHIP**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- To develop the creativity skills among the learners
- To impart the knowledge of creative intelligence essential for entrepreneurs
- To know the applications of innovation in entrepreneurship.
- To develop innovative business models for business.

**UNIT I CREATIVITY 9**

Creativity: Definition- Forms of Creativity-Essence, Elaborative and Expressive Creativities- Quality of Creativity-Existential, Entrepreneurial and Empowerment Creativities – Creative Environment-Creative Technology- - Creative Personality and Motivation.

**UNIT II CREATIVE INTELLIGENCE 9**

Creative Intelligence: Convergent thinking ability – Traits Congenial to creativity – Creativity Training--Criteria for evaluating Creativity-Credible Evaluation- Improving the quality of our creativity – Creative Tools and Techniques - Blocks to creativity- fears and Disabilities- Strategies for Unblocking- Designing Creativity Enabling Environment.

**UNIT III INNOVATION 9**

Innovation: Definition- Levels of Innovation- Incremental Vs Radical Innovation-Product Innovation and Process- Technological, Organizational Innovation – Indicators- Characteristics of Innovation in Different Sectors. Theories in Innovation and Creativity- Design Thinking and Innovation- Innovation as Collective Change-Innovation as a system

**UNIT IV INNOVATION AND ENTREPRENEURSHIP 9**

Innovation and Entrepreneurship: Entrepreneurial Mindset , Motivations and Behaviours- Opportunity Analysis and Decision Making- Industry Understanding - Entrepreneurial Opportunities- Entrepreneurial Strategies – Technology Pull/Market Push – Product -Market fit





**UNIT III PRODUCT AND PRICING MANAGEMENT 9**

Product- Meaning, Classification, Levels of Products – Product Life Cycle (PLC) - Product Strategies - Product Mix - Packaging and Labelling - New Product Development - Brand and Branding - Advantages and disadvantages of branding Pricing - Factors Affecting Price Decisions - Cost Based Pricing - Value Based and Competition Based Pricing - Pricing Strategies - National and Global Pricing.

**UNIT IV PROMOTION AND DISTRIBUTION MANAGEMENT 9**

Introduction to Promotion – Marketing Channels- Integrated Marketing Communications (IMC) - Introduction to Advertising and Sales Promotion – Basics of Public Relations and Publicity - Personal Selling - Process - Direct Marketing - Segmentation, Targeting and Positioning (STP)- Logistics Management- Introduction to Retailing and Wholesaling.

**UNIT V CONTEMPORARY ISSUES IN MARKETING MANAGEMENT 9**

Introduction - Relationship Marketing Vs. Relationship Management - Customer Relationship Management (CRM) - Forms of Relationship Management - CRM practices - Managing Customer Loyalty and Development – Buyer-Seller Relationships- Buying Situations in Industrial / Business Market - Buying Roles in Industrial Marketing - Factors that Influence Business - Services Marketing - E-Marketing or Online Marketing.

**TOTAL 45 : PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the students will be able to :

CO1 Have the awareness of marketing management process

CO 2 Understand the marketing environment

CO 3 Acquaint about product and pricing strategies

CO 4 Knowledge of promotion and distribution in marketing management.

CO 5 Comprehend the contemporary marketing scenarios and offer solutions to marketing issues.

**REFERENCES:**

1. Marketing Management, Sherlekar S.A, Himalaya Publishing House, 2016.
2. Marketing Management , Philip Kotler and Kevin Lane Keller, PHI 15th Ed, 2015.
- 3 Marketing Management- An Indian perspective, Vijay Prakash Anand, Biztantra, Second edition, 2016.
4. Marketing Management Global Perspective, Indian Context, V.S.Ramaswamy & S.Namakumari, Macmillan Publishers India,5th edition, 2015.
5. Marketing Management, S.H.H. Kazmi, 2013, Excel Books India.
6. Marketing Management- text and Cases, Dr. C.B.Gupta & Dr. N.Rajan Nair, 17th edition, 2016.

**CMG341 HUMAN RESOURCE MANAGEMENT FOR ENTREPRENEURS**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce the basic concepts, structure and functions of human resource management for entrepreneurs.
- To create an awareness of the roles, functions and functioning of human resource department.
- To understand the methods and techniques followed by Human Resource Management practitioners.

<b>UNIT I INTRODUCTION TO HRM</b>	<b>9</b>
Concept, Definition, Objectives- Nature and Scope of HRM - Evolution of HRM - HR Manager Roles- Skills - Personnel Management Vs. HRM - Human Resource Policies - HR Accounting - HR Audit - Challenges in HRM.	
<b>UNIT II HUMAN RESOURCE PLANNING</b>	<b>9</b>
HR Planning - Definition - Factors- Tools - Methods and Techniques - Job analysis- Job rotation- Job Description - Career Planning - Succession Planning - HRIS - Computer Applications in HR - Recent Trends	
<b>UNIT III RECRUITMENT AND SELECTION</b>	<b>9</b>
Sources of recruitment- Internal Vs. External - Domestic Vs. Global Sources -eRecruitment - Selection Process- Selection techniques -eSelection- Interview Types- Employee Engagement.	
<b>UNIT IV TRAINING AND EMPLOYEE DEVELOPMENT</b>	<b>9</b>
Types of Training - On-The-Job, Off-The-Job - Training Needs Analysis – Induction and Socialisation Process - Employee Compensation - Wages and Salary Administration – Health and Social Security Measures- Green HRM Practices	
<b>UNIT V CONTROLLING HUMAN RESOURCES</b>	<b>9</b>
Performance Appraisal – Types - Methods - Collective Bargaining - Grievances Redressal Methods – Employee Discipline – Promotion – Demotion - Transfer – Dismissal - Retrenchment - Union Management Relationship - Recent Trends	
<b>TOTAL 45 : PERIODS</b>	

**COURSE OUTCOMES:**

Upon completion of this course the learners will be able:

- CO 1 To understand the Evolution of HRM and Challenges faced by HR Managers
- CO 2 To learn about the HR Planning Methods and practices.
- CO 3 To acquaint about the Recruitment and Selection Techniques followed in Industries.
- CO 4 To known about the methods of Training and Employee Development.
- CO 5 To comprehend the techniques of controlling human resources in organisations.

**REFERENCES**

- 1) Gary Dessler and Biju Varkkey, Human Resource Management, 14e , Pearson, 2015.
- 2) Mathis and Jackson, Human Resource Management, Cengage Learning 15e, 2017.
- 3) David A. Decenzo, Stephen.P.Robbins, and Susan L. Verhulst, Human Resource Management, Wiley, International Student Edition, 11th Edition, 2014
- 4) R. Wayne Mondy, Human Resource Management, Pearson , 2015.
- 5) Luis R.Gomez-Mejia, David B.Balkin, Robert L Cardy. Managing Human Resource. PHI Learning. 2012
- 6) John M. Ivancevich, Human Resource Management,12e, McGraw Hill Irwin,2013.
- 7) K. Aswathappa, Sadhna Dash , Human Resource Management - Text and Cases , 9th Edition, McGraw Hill, 2021.
- 8) Uday Kumar Haldar, Juthika Sarkar. Human Resource management. Oxford. 2012

**COURSE OBJECTIVES**

- To develop the basics of business venture financing.
- To impart the knowledge essential for entrepreneurs for financing new ventures.
- To acquaint the learners with the sources of debt and equity financing.
- To empower the learners towards fund raising for new ventures effectively.

**UNIT I ESSENTIALS OF NEW BUSINESS VENTURE 9**

Setting up new Business Ventures – Need - Scope - Franchising - Location Strategy, Registration Process - State Directorate of Industries- Financing for New Ventures - Central and State Government Agencies - Types of loans – Financial Institutions - SFC, IDBI, NSIC and SIDCO.

**UNIT II INTRODUCTION TO VENTURE FINANCING 9**

Venture Finance – Definition – Historic Background - Funding New Ventures- Need – Scope – Types - Cost of Project - Means of Financing - Estimation of Working Capital - Requirement of funds – Mix of Debt and Equity - Challenges and Opportunities.

**UNIT III SOURCES OF DEBT FINANCING 9**

Fund for Capital Assets - Term Loans - Leasing and Hire-Purchase - Money Market instruments – Bonds, Corporate Papers – Preference Capital- Working Capital Management- Fund based Credit Facilities - Cash Credit - Over Draft.

**UNIT IV SOURCES OF EQUITY FINANCING 9**

Own Capital, Unsecured Loan - Government Subsidies , Margin Money- Equity Funding - Private Equity Fund- Schemes of Commercial banks - Angel Funding – Crowdfunding- Venture Capital.

**UNIT V METHODS OF FUND RAISING FOR NEW VENTURES 9**

Investor Decision Process - Identifying the appropriate investors- Targeting investors- Developing Relationships with investors - Investor Selection Criteria- Company Creation- Raising Funds - Seed Funding- VC Selection Criteria – Process- Methods- Recent Trends

**TOTAL 45 : PERIODS****COURSE OUTCOMES:**

Upon completion of this course, the students should be able to:

CO 1 Learn the basics of starting a new business venture.

CO 2 Understand the basics of venture financing.

CO 3 Understand the sources of debt financing.

CO 4 Understand the sources of equity financing.

CO 5 Acquaint with the methods of fund raising for new business ventures.

**REFERENCES :**

- 1) Principles of Corporate Finance by Brealey and Myers et al., 12<sup>TH</sup> ed, McGraw Hill Education (India) Private Limited, 2018
- 2) Prasanna Chandra, Projects : Planning ,Analysis, Selection ,Financing, Implementation and Review, McGraw Hill Education India Pvt Ltd ,New Delhi , 2019.
- 3) Introduction to Project Finance. Andrew Fight, Butterworth-Heinemann, 2006.
- 4) Metrick, Andrew; Yasuda, Ayako. Venture Capital And The Finance Of Innovation. Venture Capital And The Finance Of Innovation, 2nd Edition, Andrew Metrick And Ayako Yasuda, Eds., John Wiley And Sons, Inc, 2010.

- 5) Feld, Brad; Mendelson, Jason. Venture Deals. Wiley, 2011.
- 6) May, John; Simons, Cal. Every Business Needs An Angel: Getting The Money You Need To Make Your Business Grow. Crown Business, 2001.
- 7) Gompers, Paul Alan; Lerner, Joshua. The Money Of Invention: How Venture Capital Creates New Wealth. Harvard Business Press, 2001.
- 8) Camp, Justin J. Venture Capital Due Diligence: A Guide To Making Smart Investment Choices And Increasing Your Portfolio Returns. John Wiley & Sons, 2002.
- 9) Byers, Thomas. Technology Ventures: From Idea To Enterprise. Mcgraw-Hill Higher Education, 2014.
- 10) Lerner, Josh; Leamon, Ann; Hardyman, Felda. Venture Capital, Private Equity, And The Financing Of Entrepreneurship. 2012.

### **VERTICAL 3: PUBLIC ADMINISTRATION**

#### **CMG343            PRINCIPLES OF PUBLIC ADMINISTRATION**

**L T P C**  
**3 0 0 3**

#### **UNIT-I** **(9)**

1. Meaning, Nature and Scope of Public Administration
2. Importance of Public Administration
3. Evolution of Public Administration

#### **UNIT-II** **(9)**

1. New Public Administration
2. New Public Management
3. Public and Private Administration

#### **UNIT-III** **(9)**

1. Relationships with Political Science, History and Sociology
2. Classical Approach
3. Scientific Management Approach

#### **UNIT-IV** **(9)**

1. Bureaucratic Approach: Max Weber
2. Human Relations Approach : Elton Mayo
3. Ecological Approach : Riggs

#### **UNIT-V** **(9)**

1. Leadership: Leadership - Styles - Approaches
2. Communication: Communication Types - Process - Barriers
3. Decision Making: Decision Making - Types, Techniques and Processes.

**TOTAL: 45 PERIODS**

#### **REFERENCES:**

1. Avasthi and Maheswari: Public Administration in India, Agra:Lakshmi Narain Agarwal,2013.
2. Ramesh K Arora: Indian Public Administration, New Delhi: Wishwa Prakashan, 2012.
3. R.B. Jain: Public Administration in India,21st Century Challenges for Good Governance, New Delhi: Deep and Deep, 2002.

4. Rumki Basu: Public Administration: Concept and Theories, New Delhi: Sterling, 2013.
5. R. Tyagi, Public Administration, Atma Ram & Sons, New Delhi, 1983.

**CMG344**

**CONSTITUTION OF INDIA**

**L T P C**  
**3 0 0 3**

**UNIT-I**

**(9)**

1. Constitutional Development Since 1909 to 1947
2. Making of the Constitution.
3. Constituent Assembly

**UNIT-II**

**(9)**

1. Fundamental Rights
2. Fundamental Duties
3. Directive Principles of State Policy

**UNIT-III**

**(9)**

1. President
2. Parliament
3. Supreme Court

**UNIT-IV**

**(9)**

1. Governor
2. State Legislature
3. High Court

**UNIT-V**

**(9)**

1. Secularism
2. Social Justice
3. Minority Safeguards

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Basu. D.D.: Introduction to Indian Constitution ; Prentice Hall; New Delhi.
2. Kapur. A.C: Indian Government and Political System; S.Chand and Company Ltd., New Delhi.
3. Johari J.C.: Indian Politics, Vishal Publications Ltd, New Delhi
4. Agarwal R.C: Indian Political System; S.Chand & Co., New Delhi

**UNIT-I****(9)**

1. Meaning, Scope and Importance of Personnel Administration
2. Types of Personnel Systems: Bureaucratic, Democratic and Representative systems

**UNIT-II****(9)**

1. Generalist Vs Specialist
2. Civil Servants' Relationship with Political Executive
3. Integrity in Administration.

**UNIT-III****(9)**

1. Recruitment: Direct Recruitment and Recruitment from Within
2. Training: Kinds of Training
3. Promotion

**UNIT-IV****(9)**

1. All India Services
2. Service Conditions
3. State Public Service Commission

**UNIT-V****(9)**

1. Employer Employee Relations
2. Wage and Salary Administration
3. Allowances and Benefits

**TOTAL: 45 PERIODS****REFERENCES:**

1. Stahl Glean O: Public Personnel Administration
2. Parnandikar Pai V.A: Personnel System for Development Administration.
3. Bhambhiru . P: Bureaucracy and Policy in India.
4. Dwivedi O.P and Jain R.B: India's Administrative state.
5. Muttalis M.A: Union Public Service Commission.
6. Bhakara Rao .V: Employer Employee Relations in India.
7. Davar R.S. Personnel Management & Industrial Relations

**CMG346**

**ADMINISTRATIVE THEORIES**

**L T P C**  
**3 0 0 3**

**UNIT I**

**(9)**

Meaning, Scope and significance of Public Administration, Evolution of Public Administration as a discipline and Identity of Public Administration

**UNIT II**

**(9)**

Theories of Organization: Scientific Management Theory, Classical Model, Human Relations Theory

**UNIT III**

**(9)**

Organization goals and Behaviour, Groups in organization and group dynamics, Organizational Design.

**UNIT IV**

**(9)**

Motivation Theories, content, process and contemporary; Theories of Leadership: Traditional and Modern: Process and techniques of decision-making

**UNIT V**

**(9)**

Administrative thinkers: Kautilya, Woodrow Willson, C.I. Barnard . Peter Drucker

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Crozier M : The Bureaucratic phenomenon (Chand)
2. Blau. P.M and Scott. W : Formal Organizations (RKP)
3. Presthus. R : The Organizational Society (MAC)
4. Alvi, Shum Sun Nisa : Eminent Administrative Thinkers.
5. Keith Davis : Organization Theory (MAC)

**CMG347**

**INDIAN ADMINISTRATIVE SYSTEM**

**L T P C**  
**3 0 0 3**

**UNIT I**

**(9)**

Evolution and Constitutional Context of Indian Administration, Constitutional Authorities: Finance Commission, Union Public Services Commission, Election Commission, Comptroller and Auditor General of India, Attorney General of India

**UNIT II**

**(9)**

Role & Functions of the District Collector, Relationship between the District Collector and Superintendent of Police, Role of Block Development Officer in development programmes, Local Government

**UNIT III**

**(9)**

Main Features of 73rd Constitutional Amendment Act 1992, Salient Features of 74th Constitutional Amendment Act 1992

**UNIT IV**

**(9)**

Coalition politics in India, Integrity and Vigilance in Indian Administration



**UNIT V****(9)**

Corruption – Ombudsman, Lok Pal &amp; Lok Ayuktha

**TOTAL: 45 PERIODS****REFERENCES:**

1. S.R. Maheswari : Indian Administration
2. Khera. S.S : Administration in India
3. Ramesh K. Arora : Indian Public Administration
4. T.N. Chaturvedi : State administration in India
5. Basu, D.D : Introduction to the Constitution of India

**CMG348****PUBLIC POLICY ADMINISTRATION****L T P C  
3 0 0 3****UNIT-I****(9)**

Meaning and Definition of Public Policy - Nature, Scope and Importance of public policy – Public policy relationship with social sciences especially with political science and Public Administration.

**UNIT-II****(9)**

Approaches in Policy Analysis - Institutional Approach – Incremental Approach and System's Approach – Dror's Optimal Model

**UNIT-III****(9)**

Major stages involved in Policy making Process – Policy Formulation – Policy Implementation – Policy Evaluation.

**UNIT-IV****(9)**

Institutional Framework of Policy making – Role of Bureaucracy – Role of Interest Groups and Role of Political Parties.

**UNIT-V****(9)**

Introduction to the following Public Policies – New Economic Policy – Population Policy – Agriculture policy - Information Technology Policy.

**TOTAL: 45 PERIODS****REFERENCES:**

1. Rajesh Chakrabarti & Kaushik Sanyal : Public Policy in India, Oxford University Press, 2016.
2. Kuldeep Mathur : Public Policy and Politics in India, Oxford University Press, 2016.
3. Bidyutv Chakrabarty: Public Policy: Concept, Theory and Practice, 2015.
4. Pradeep Saxena : Public Policy Administration and Development
5. Sapru R.K. : Public Policy: Formulation, Implementation and Evaluation, Sterling Publishers, 2016.

## VERTICAL 4: BUSINESS DATA ANALYTICS

CMG349

STATISTICS FOR MANAGEMENT

L T P C  
3 0 0 3

### COURSE OBJECTIVE:

- To learn the applications of statistics in business decision making.

### UNIT I INTRODUCTION

9

Basic definitions and rules for probability, Baye's theorem and random variables, Probability distributions: Binomial, Poisson, Uniform and Normal distributions.

### UNIT II SAMPLING DISTRIBUTION AND ESTIMATION

9

Introduction to sampling distributions, Central limit theorem and applications, sampling techniques, Point and Interval estimates of population parameters.

### UNIT III TESTING OF HYPOTHESIS - PARAMETIRC TESTS

9

Hypothesis testing: one sample and two sample tests for means of large samples (z-test), one sample and two sample tests for means of small samples (t-test), ANOVA one way.

### UNIT IV NON-PARAMETRIC TESTS

9

Chi-square tests for independence of attributes and goodness of fit, Kolmogorov-Smirnov – test for goodness of fit, Mann – Whitney U test and Kruskal Wallis test.

### UNIT V CORRELATION AND REGRESSION

9

Correlation –Rank Correlation – Regression – Estimation of Regression line – Method of Least Squares – Standard Error of estimate.

**TOTAL:45 PERIODS**

### COURSE OUTCOMES:

- To facilitate objective solutions in business decision making.
- To understand and solve business problems
- To apply statistical techniques to data sets, and correctly interpret the results.
- To develop skill-set that is in demand in both the research and business environments
- To enable the students to apply the statistical techniques in a work setting.

### REFERENCES:

- Richard I. Levin, David S. Rubin, Masood H.Siddiqui, Sanjay Rastogi, Statistics for Management, Pearson Education, 8th Edition, 2017.
- Prem. S. Mann, Introductory Statistics, Wiley Publications, 9th Edition, 2015.
- T N Srivastava and Shailaja Rego, Statistics for Management, Tata McGraw Hill, 3rd Edition 2017.
- Ken Black, Applied Business Statistics, 7th Edition, Wiley India Edition, 2012.
- David R. Anderson, Dennis J. Sweeney, Thomas A.Williams, Jeffrey D.Camm, James J.Cochran, Statistics for business and economics, 13th edition, Thomson (South – Western) Asia, Singapore, 2016.
- N. D. Vohra, Business Statistics, Tata McGraw Hill, 2017.

**COURSE OBJECTIVES :**

- To know how to derive meaning from huge volume of data and information.
- To understand how knowledge discovering process is used in business decision making.

**UNIT I INTRODUCTION**

9

Data mining, Text mining, Web mining, Data ware house.

**UNIT II DATA MINING PROCESS**

9

Datamining process – KDD, CRISP-DM, SEMMA  
Prediction performance measures**UNIT III PREDICTION TECHNIQUES**

9

Data visualization, Time series – ARIMA, Winter Holts,

**UNIT IV CLASSIFICATION AND CLUSTERING TECHNIQUES**

9

Classification, Association, Clustering.

**UNIT V MACHINE LEARNING AND AI**

9

Genetic algorithms, Neural network, Fuzzy logic, Ant Colony optimization, Particle Swarm optimization

**TOTAL: 45 PERIODS****COURSE OUTCOMES:****CO1:** Learn to apply various data mining techniques into various areas of different domains.**CO2:** Be able to interact competently on the topic of data mining for business intelligence.**CO3:** Apply various prediction techniques.**CO4:** Learn about supervised and unsupervised learning technique.**CO5:** Develop and implement machine learning algorithms**REFERENCES :**

1. Jaiwei Ham and Micheline Kamber, Data Mining concepts and techniques, Kauffmann Publishers 2006
2. Efraim Turban, Ramesh Sharda, Jay E. Aronson and David King, Business Intelligence, Prentice Hall, 2008.
3. W.H.Inmon, Building the Data Warehouse, fourth edition Wiley India pvt. Ltd. 2005.
4. Ralph Kimball and Richard Merz, The data warehouse toolkit, John Wiley, 3rd edition, 2013.
5. Michel Berry and Gordon Linoff, Mastering Data mining, John Wiley and Sons Inc, 2nd Edition, 2011
6. Michel Berry and Gordon Linoff, Data mining techniques for Marketing, Sales and Customer support, John Wiley, 2011
7. G. K. Gupta, Introduction to Data mining with Case Studies, Prentice hall of India, 2011
8. Giudici, Applied Data mining – Statistical Methods for Business and Industry, John Wiley. 2009
9. Elizabeth Vitt, Michael Luckevich Stacia Misner, Business Intelligence, Microsoft, 2011
10. Michalewicz Z., Schmidt M. Michalewicz M and Chiriack C, Adaptive Business Intelligence, Springer – Verlag, 2007
11. Galit Shmueli, Nitin R. Patel and Peter C. Bruce, Data Mining for Business Intelligence – Concepts, Techniques and Applications Wiley, India, 2010.

**COURSE OBJECTIVE:**

- To develop the ability of the learners to define and implement HR metrics that are aligned with the overall business strategy.
- To know the different types of HR metrics and understand their respective impact and application.
- To understand the impact and use of HR metrics and their connection with HR analytics.
- To understand common workforce issues and resolving them using people analytics.

**UNIT I - INTRODUCTION TO HR ANALYTICS****9**

People Analytics - stages of maturity - Human Capital in the Value Chain : impact on business – HR metrics and KPIs.

**UNIT II - HR ANALYTICS I: RECRUITMENT****9**

Recruitment Metrics : Fill-up ratio - Time to hire - Cost per hire - Early turnover - Employee referral hires - Agency hires - Lateral hires - Fulfillment ratio- Quality of hire.

**UNIT III - HR ANALYTICS - TRAINING AND DEVELOPMENT****9**

Training & Development Metrics : Percentage of employees trained- Internally and externally trained -Training hours and cost per employee - ROI.

**UNIT IV - HR ANALYTICS EMPLOYEE ENGAGEMENT AND CAREER PROGRESSION****9**

Employee Engagement Metrics :Talent Retention index - Voluntary and involuntary turnover-grades, performance, and service tenure - Internal hired index Career Progression Metrics: Promotion index - Rotation index - Career path index.

**UNIT V - HR ANALYTICS IV: WORKFORCE DIVERSITY AND DEVELOPMENT****9**

Workforce Diversity and Development Metrics : Employees per manager – Workforce age profiling - Workforce service profiling - Churnover index - Workforce diversity index - Gender mix

**TOTAL: 45 PERIODS****COURSE OUTCOME:**

- The learners will be conversant about HR metrics and ready to apply at work settings.
- The learners will be able to resolve HR issues using people analytics.

**REFERENCES:**

1. JacFitzenz , The New HR Analytics, AMACOM , 2010.
2. Edwards M. R., & Edwards K, Predictive HR Analytics: Mastering the HR Metric.London: Kogan Page.2016.
3. Human Resources kit for Dummies – 3 rd edition – Max Messmer, 2003
4. Dipak Kumar Bhattacharyya, HR Analytics ,Understanding Theories and Applications, SAGE Publications India ,2017.
5. Sesil, J. C. , Applying advanced analytics to HR management decisions: Methods fo selection, developing incentives, and improving collaboration. Upper Saddle River,New Jersey: Pearson Education,2014.

6. Pease, G., & Beresford, B, Developing Human Capital: Using Analytics to Plan and Optimize Your Learning and Development Investments. Wiley ,2014.
7. Phillips, J., & Phillips, P.P, Making Human Capital Analytics Work: Measuring the ROI of Human Capital Processes and OUTCOME. McGraw-Hill,2014.
8. HR Scorecard and Metrics, HBR, 2001.

**CMG352**

**MARKETING AND SOCIAL MEDIA WEB ANALYTICS**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVE:**

- To showcase the opportunities that exist today to leverage the power of the web and social media

**UNIT I - MARKETING ANALYTICS**

**9**

Marketing Budget and Marketing Performance Measure, Marketing - Geographical Mapping, Data Exploration, Market Basket Analysis

**UNIT II - COMMUNITY BUILDING AND MANAGEMENT**

**9**

History and Evolution of Social Media-Understanding Science of Social Media –Goals for using Social Media- Social Media Audience and Influencers - Digital PR- Promoting Social Media Pages- Linking Social Media Accounts-The Viral Impact of Social Media.

**UNIT III - SOCIAL MEDIA POLICIES AND MEASUREMENTS**

**9**

Social Media Policies-Etiquette, Privacy- ethical problems posed by emerging social media technologies - The Basics of Tracking Social Media.

**UNIT IV - WEB ANALYTICS**

**9**

Data Collection, Overview of Qualitative Analysis, Business Analysis, KPI and Planning, Critical Components of a Successful Web Analytics Strategy, Proposals & Reports, Web Data Analysis.

**UNIT V - SEARCH ANALYTICS**

**9**

Search engine optimization (SEO), user engagement, user-generated content, web traffic analysis, online security, online ethics, data visualization.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

- The Learners will understand social media, web and social media analytics and their potential impact.

**REFERENCES:**

1. K. M. Shrivastava, Social Media in Business and Governance, Sterling Publishers Private Limited, 2013
2. Christian Fuchs, Social Media a critical introduction, SAGE Publications Ltd, 2014
3. Bittu Kumar, Social Networking, V & S Publishers, 2013
4. Avinash Kaushik, Web Analytics - An Hour a Day, Wiley Publishing, 2007
5. Ric T. Peterson, Web Analytics Demystified, Celilo Group Media and CafePress 2004
6. Takeshi Moriguchi, Web Analytics Consultant Official Textbook, 7th Edition, 2016

**COURSE OBJECTIVE:**

- To treat the subject in depth by emphasizing on the advanced quantitative models and methods in operations and supply chain management and its practical aspects and the latest developments in the field.

**UNIT I - INTRODUCTION**

9

Descriptive, predictive and prescriptive analytics, Data Driven Supply Chains – Basics, transforming supply chains.

**UNIT II - WAREHOUSING DECISIONS**

9

P-Median Methods - Guided LP Approach, Greedy Drop Heuristics, Dynamic Location Models, Space Determination and Layout Methods.

**UNIT III - INVENTORY MANAGEMENT**

9

Dynamic Lot sizing Methods, Multi-Echelon Inventory models, Aggregate Inventory system and LIMIT, Risk Analysis in Supply Chain, Risk pooling strategies.

**UNIT IV - TRANSPORTATION NETWORK MODELS**

9

Minimal Spanning Tree, Shortest Path Algorithms, Maximal Flow Problems, Transportation Problems, Set covering and Set Partitioning Problems, Travelling Salesman Problem, Scheduling Algorithms.

**UNIT V - MCDM MODELS**

9

Analytic Hierarchy Process(AHP), Data Envelopment Analysis (DEA), Fuzzy Logic and Techniques, the analytical network process (ANP), TOPSIS.

**TOTAL: 45 PERIODS****COURSE OUTCOME:**

- To enable quantitative solutions in business decision making under conditions of certainty, risk and uncertainty.

**REFERENCES:**

1. Nada R. Sanders, Big data driven supply chain management: A framework for implementing analytics and turning information into intelligence, Pearson Education, 2014.
2. Michael Watson, Sara Lewis, Peter Cacioppi, Jay Jayaraman, Supply Chain Network Design: Applying Optimization and Analytics to the Global Supply Chain, Pearson Education, 2013.
3. Anna Nagurney, Min Yu, Amir H. Masoumi, Ladimer S. Nagurney, Networks Against Time: Supply Chain Analytics for Perishable Products, Springer, 2013.
4. Muthu Mathirajan, Chandrasekharan Rajendran, Sowmyanarayanan Sadagopan, Arunachalam Ravindran, Parasuram Balasubramanian, Analytics in Operations/Supply Chain Management , I.K. International Publishing House Pvt. Ltd., 2016.
5. Gerhard J. Plenert, Supply Chain Optimization through Segmentation and Analytics, CRC Press, Taylor & Francis Group, 2014.

**COURSE OBJECTIVE:**

- This course introduces a core set of modern analytical tools that specifically target finance applications.

**UNIT I - CORPORATE FINANCE ANALYSIS****9**

Basic corporate financial predictive modelling- Project analysis- cash flow analysis- cost of capital, Financial Break even modelling, Capital Budget model-Payback, NPV, IRR.

**UNIT II - FINANCIAL MARKET ANALYSIS****9**

Estimation and prediction of risk and return ( bond investment and stock investment) –Time series-examining nature of data, Value at risk, ARMA, ARCH and GARCH.

**UNIT III - PORTFOLIO ANALYSIS****9**

Portfolio Analysis – capital asset pricing model, Sharpe ratio, Option pricing models- binomial model for options, Black Scholes model and Option implied volatility.

**UNIT IV - TECHNICAL ANALYSIS****9**

Prediction using charts and fundamentals – RSI, ROC, MACD, moving average and candle charts, simulating trading strategies. Prediction of share prices.

**UNIT V - CREDIT RISK ANALYSIS****9**

Credit Risk analysis- Data processing, Decision trees, logistic regression and evaluating credit risk model.

**TOTAL: 45 PERIODS****COURSE OUTCOME**

- The learners should be able to perform financial analysis for decision making using excel, Python and R.

**REFERENCES:**

1. Financial analytics with R by Mark J. Bennett, Dirk L. Hugen, Cambridge university press.
2. Haskell Financial Data Modeling and Predictive Analytics Paperback – Import, 25 Oct 2013 by Pavel Ryzhov.
3. Quantitative Financial Analytics: The Path To Investment Profits Paperback – Import, 11 Sep 2017 by Edward E Williams (Author), John A Dobelman.
4. Python for Finance - Paperback – Import, 30 Jun 2017 by Yuxing Yan (Author).
5. Mastering Python for Finance Paperback – Import, 29 Apr 2015 by James Ma Weiming.

## VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY

**CES331 SUSTAINABLE INFRASTRUCTURE DEVELOPMENT**

**L T P C  
3 0 0 3**

### **COURSE OBJECTIVE:**

- To impart knowledge about sustainable Infrastructure development goals, practices and to understand the concepts of sustainable planning, design, construction, maintenance and decommissioning of infrastructure projects.

### **UNIT I SUSTAINABLE DEVELOPMENT GOALS 9**

Definitions, principles and history of Sustainable Development - Sustainable development goals (SDG): global and Indian – Infrastructure Demand and Supply - Environment and Development linkages - societal and cultural demands – Sustainability indicators - Performance indicators of sustainability and Assessment mechanism - Policy frameworks and practices: global and Indian – Infrastructure Project finance – Infrastructure project life cycle - Constraints and barriers for sustainable development - future directions.

### **UNIT II SUSTAINABLE INFRASTRUCTURE PLANNING 9**

Overview of Infrastructure projects: Housing sector, Power sector, Water supply, road, rail and port transportation sector, rural and urban infrastructure. Environmental Impact Assessment (EIA), Land acquisition -Legal aspects, Resettlement & Rehabilitation and Development - Cost effectiveness Analysis - Risk Management Framework for Infrastructure Projects, Economic, demand, political, socio-environmental and cultural risks. Shaping the Planning Phase of Infrastructure Projects to mitigate risks, Designing Sustainable Contracts, Negotiating with multiple Stakeholders on Infrastructure Projects. Use of ICT tools in planning – Integrated planning - Clash detection in construction - BIM (Building Information Modelling).

### **UNIT III SUSTAINABLE CONSTRUCTION PRACTICES AND TECHNIQUES 9**

Sustainability through lean construction approach - Enabling lean through information technology – Lean in planning and design - IPD (Integrated Project Delivery) - Location Based Management System - Geospatial Technologies for machine control, site management, precision control and real time progress monitoring - Role of logistics in achieving sustainable construction – Data management for integrated supply chains in construction - Resource efficiency benefits of effective logistics - Sustainability in geotechnical practice – Design considerations, Design Parameters and Procedures – Quality control and Assurance - Use of sustainable construction techniques: Precast concrete technology, Pre-engineered buildings.

### **UNIT IV SUSTAINABLE CONSTRUCTION MATERIALS 9**

Construction materials: Concrete, steel, glass, aluminium, timber and FRP - No/Low cement concrete - Recycled and manufactured aggregate - Role of QC and durability - Sustainable consumption – Eco-efficiency - green consumerism - product stewardship and green engineering - Extended producer responsibility – Design for Environment Strategies, Practices, Guidelines, Methods, And Tools. Eco-design strategies –Design for Disassembly - Dematerialization, rematerialization, transmaterialization – Green procurement and green distribution - Analysis framework for reuse and recycling – Typical constraints on reuse and recycling - Communication of Life Cycle Information - Indian Eco mark scheme - Environmental product declarations – Environmental marketing- Life cycle Analysis (LCA), Advances in LCA: Hybrid LCA, Thermodynamic LCA - Extending LCA - economic dimension, social dimension - Life cycle costing (LCC) - Combining LCA and LCC – Case studies



## **UNIT V SUSTAINABLE MAINTENANCE OF INFRASTRUCTURE PROJECTS**

**9**

Case Studies - Sustainable projects in developed countries and developing nations - An Integrated Framework for Successful Infrastructure Planning and Management - Information Technology and Systems for Successful Infrastructure Management, - Structural Health Monitoring for Infrastructure projects - Innovative Design and Maintenance of Infrastructure Facilities - Capacity Building and Improving the Governments Role in Infrastructure Implementation, Infrastructure Management Systems and Future Directions. – Use of Emerging Technologies – IoT, Big Data Analytics and Cloud Computing, Artificial Intelligences, Machine and Deep Learning, Fifth Generation (5G) Network services for maintenance .

**TOTAL: 45 PERIODS**

### **COURSE OUTCOME:**

On completion of the course, the student is expected to be able to

**CO1** Understand the environment sustainability goals at global and Indian scenario.

**CO2** Understand risks in development of projects and suggest mitigation measures.

**CO3** Apply lean techniques, LBMS and new construction techniques to achieve sustainability in infrastructure construction projects.

**CO4** Explain Life Cycle Analysis and life cycle cost of construction materials.

**CO5** Explain the new technologies for maintenance of infrastructure projects.

### **REFERENCES:**

1. Charles J Kibert, Sustainable Construction : Green Building Design & Delivery, 4th Edition , Wiley Publishers 2016.
2. Steve Goodhew, Sustainable Construction Process, Wiley Blackwell,UK, 2016.
3. Craig A. Langston & Grace K.C. Ding, Sustainable Practices in the Built Environment, Butterworth Heinemann Publishers, 2011.
4. William P Spence, Construction Materials, Methods & Techniques (3e), Yesdee Publication Pvt. Ltd, 2016.
5. New Building Materials and Construction World magazine
6. Kerry Turner. R, "Sustainable Environmental Management", Principles and Practice Publisher:Belhaven Press,ISBN:1852930039.
7. Munier N, "Introduction to Sustainability", Springer2005
8. Sharma, "Sustainable Smart Cities In India: Challenges And Future Perspectives", SPRINGER, 2022.
9. Ralph Horne, Tim Grant, KarliVerghese, Life Cycle Assessment: Principles, Practice and Prospects, Csiro Publishing,2009
10. European Commission - Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. Luxembourg. European Union;2010
11. Hudson, Haas, Uddin, Infrastructure management: integrating design, construction, maintenance, rehabilitation, and renovation, McGraw Hill, (1997).
12. GregerLundesjö, Supply Chain Management and Logistics in Construction: Delivering Tomorrow's Built Environment, Kogan Page Publishers, 2015.

### CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2		1	1		2	3	1	1		2	1	1	2	1
2	3	1	3	2	1	2	2		1	1	1	2	2	2	2
3	2	2	3	1	1	1	1				1	1	1	3	1
4	3	1	3	2	2	1	3	1	1	1	1	2	2	2	2
5	3	1	2	2	2	2	3	1		1	1	2	2	3	2
Avg.	3	1	3	2	2	2	3	1	1	1	1	2	2	3	2

1 - low, 2 - medium, 3 - high, '-' - no correlation

**CES332 SUSTAINABLE AGRICULTURE AND ENVIRONMENTAL MANAGEMENT L T P C  
3 0 0 3**

#### **COURSE OBJECTIVES:**

- To educate the students about the issues of sustainability in agroecosystems, introduce the concepts and principles of agroecology as applied to the design and management of sustainable agricultural systems for a changing world.

#### **UNIT I AGROECOLOGY, AGROECOSYSTEM AND SUSTAINABLE AGRICULTURE CONCEPTS 9**

Ecosystem definition - Biotic Vs. abiotic factors in an ecosystem - Ecosystem processes - Ecological services and agriculture - Problems associated with industrial agriculture/food systems - Defining sustainability - Characteristics of sustainable agriculture - Difference between regenerative and sustainable agriculture systems

#### **UNIT II SOIL HEALTH, NUTRIENT AND PEST MANAGEMENT 9**

Soil health definition - Factors to consider (physical, chemical and biological) - Composition of healthy soils - Soil erosion and possible control measures - Techniques to build healthy soil - Management practices for improving soil nutrient - Ecologically sustainable strategies for pest and disease control

#### **UNIT III WATER MANAGEMENT 9**

Soil water storage and availability - Plant yield response to water - Reducing evaporation in agriculture - Earthworks and tanks for rainwater harvesting - Options for improving the productivity of water - Localized irrigation - Irrigation scheduling - Fertigation - Advanced irrigation systems and agricultural practices for sustainable water use

#### **UNIT IV ENERGY AND WASTE MANAGEMENT 9**

Types and sources of agricultural wastes - Composition of agricultural wastes - Sustainable technologies for the management of agricultural wastes - Useful and high value materials produced using different processes from agricultural wastes - Renewable energy for sustainable agriculture

**UNIT V EVALUATING SUSTAINABILITY IN AGROECOSYSTEMS****9**

Indicators of sustainability in agriculture - On-farm evaluation of agroecosystem sustainability - Alternative agriculture approaches/ farming techniques for sustainable food production - Goals and components of a community food system - Case studies

**TOTAL: 45 PERIODS****COURSE OUTCOME**

- On completion of the course, the student is expected to be able to

**CO1** Have an in-depth knowledge about the concepts, principles and advantages of sustainable agriculture

**CO2** Discuss the sustainable ways in managing soil health, nutrients, pests and diseases

**CO3** Suggest the ways to optimize the use of water in agriculture to promote an ecological use of resources

**CO4** Develop energy and waste management plans for promoting sustainable agriculture in non-sustainable farming areas

**CO5** Assess an ecosystem for its level of sustainability and prescribe ways of converting to a sustainable system through the redesign of a conventional agroecosystem

**REFERENCES:**

1. Approaches to Sustainable Agriculture – Exploring the Pathways Towards the Future of Farming, Oberc, B.P. & Arroyo Schnell, A., IUCN, Belgium, 2020
2. Natural bioactive products in sustainable agriculture, Singh, J. & Yadav, A.N., Springer, 2020
3. Organic Farming for Sustainable Agriculture, Nandwani, D., Springer, 2016
4. Principles of Agronomy for Sustainable Agriculture, Villalobos, F.J. & Fereres, E., Springer, 2016
5. Sustainable Agriculture for Food Security: A Global Perspective, Balkrishna, A., CRC Press, 2021
6. Sustainable Energy Solutions in Agriculture, Bundschuh, J. & Chen, G., CRC Press, 2014

**CO's-PO's & PSO's MAPPING- SUSTAINABLE AGRICULTURE PRACTICES**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		2						2		2			2	2	
2		2		2	2	2							3	2	
3				2		2							3	2	3
4	3	2			2			2	2	2	2		3	2	3
5		2	3	2			1					1		2	
<b>Avg.</b>	3	2	3	2	2	2	1	2	2	2	2	1	3	2	3

1 – Low; 2 – Medium; 3 – High; ‘- ‘– No correlation

**CES333****SUSTAINABLE BIOMATERIALS****L T P C  
3 0 0 3****COURSE OBJECTIVES**

- To Impart knowledge of biomaterials and their properties
- To learn about Fundamentals aspects of Biopolymers and their applications
- To learn about bioceramics and biopolymers
- To introduce the students about metals as biomaterials and their usage as implants
- To make the students understand the significance of bionanomaterials and its applications.

**UNIT-I INTRODUCTION TO BIOMATERIALS 9**

Introduction: Definition of biomaterials, requirements & classification of biomaterials- Types of Biomaterials- Degradable and resorbable biomaterials- engineered natural materials- Biocompatibility-Hydrogels-pyrolitic carbon for long term medical implants-textured and porous materials-Bonding types- crystal structure-imperfection in crystalline structure-surface properties and adhesion of materials –strength of biological tissues-performance of implants-tissue response to implants- Impact and Future of Biomaterials

**UNIT-II BIO POLYMERS 9**

Molecular structure of polymers -Molecular weight - Types of polymerization techniques–Types of polymerization reactions- Physical states of polymers- Common polymeric biomaterials - Polyethylene -Polymethylmethacrylate (PMMA)-Polylactic acid (PLA) and polyglycolic acid (PGA) - Polycaprolactone (PCL) - Other biodegradable polymers –Polyurethan- reactions polymers for medical purposes - Collagens- Elastin- Cellulose and derivatives-Synthetic polymeric membranes and their biological applications

**UNIT-III BIO CERAMICS AND BIOCOSITES 9**

General properties- Bio ceramics -Silicate glass - Alumina (Al<sub>2</sub>O<sub>3</sub>) -Zirconia (ZrO<sub>2</sub>)-Carbon-Calcium phosphates (CaP)- Resorbable Ceramics- surface reactive ceramics- Biomedical Composites-Polymer Matrix Composite(PMC)-Ceramic Matrix Composite(CMC)-Metal Matrix Composite (MMC)–glass ceramics - Orthopedic implants-Tissue engineering scaffolds

**UNIT-IV METALS AS BIOMATERIALS 9**

Biomedical metals-types and properties-stainless steel-Cobalt chromium alloys-Titanium alloys-Tantalum-Nickel titanium alloy (Nitinol)- magnesium-based biodegradable alloys-surface properties of metal implants for osteointegration-medical application-corrosion of metallic implants – biological tolerance of implant metals

**UNIT-V NANOBIMATERIALS 9**

Meatllcnanobiomaterials–Nanopolymers-Nanoceramics- Nanocomposites -Carbon based nanobiomaterials - transport of nanoparticles- release rate-positive and negative effect of nanosize-nanofibres-Nano and micro features and their importance in implant performance- Nanosurface and coats-Applications nanoantibiotics-Nanomedicines- Biochips – Biomimetics- BioNEMs -Biosensor-Bioimaging/Molecular Imaging- challenges and future perspective.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES**

- CO1:**Students will gain familiarity with Biomaterials and they will understand their importance.
- CO2:**Students will get an overview of different biopolymers and their properties
- CO3:**Students gain knowledge on some of the important Bioceramics and Biocomposite materials
- CO4:**Students gain knowledge on metals as biomaterials
- CO5:**Student gains knowledge on the importance of nanobiomaterials in biomedical applications.

**REFERENCES**

1. C. Mauli Agrawal, Joo L. Ong, Mark R. Appleford, Gopinath Mani “Introduction to Biomaterials Basic Theory with Engineering Applications” Cambridge University Press, 2014.
2. Donglu shi “Introduction to Biomaterials” Tsinghua University press, 2006.
3. Joon Park, R.S.Lakes “Biomaterials An Introduction” third edition, Springer 2007.
4. M.Jaffe,W.Hammond, P.Tolias and T.Arinzeh “Characterization of Biomaterials” Wood head publishing, 2013.

5. Buddy D.Ratner and Allan S.Hoffman Biomaterials Science “An Introduction to Material in Medicine” Third Edition, 2013.
6. VasifHasirci, NesrinHasirci “Fundamentals of Biomaterials” Springer, 2018
7. Leopoldo Javier Rios Gonzalez. “Handbook of Research on Bioenergy and Biomaterials: Consolidated and green process” Apple academic press, 2021.
8. Devarajan Thangadurai, Jeyabalan Sangeetha, Ram Prasad “Functional Bionanomaterials” springer, 2020.
9. Sujata.V.Bhat Biomaterials; Narosa Publishing house, 2002.

**CES334**

**MATERIALS FOR ENERGY SUSTAINABILITY**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES**

- To familiarize the students about the challenges and demands of energy sustainability
- To provide fundamental knowledge about electrochemical devices and the materials used.
- To introduce the students to various types of fuel cell
- To enable students to appreciate novel materials and their usage in photovoltaic application
- To introduce students to the basic principles of various types Supercapacitors and the materials used.

**UNIT-I SUSTAINABLE ENERGY SOURCES**

**9**

Introduction to energy demand and challenges ahead – sustainable source of energy (wind, solar etc.) – electrochemical energy systems for energy harvesting and storage – materials for sustainable electrochemical systems building – India centric solutions based on locally available materials – Economics of wind and solar power generators vs. conventional coal plants – Nuclear energy

**UNIT-II ELECTROCHEMICAL DEVICES**

**9**

Electrochemical Energy – Difference between primary and secondary batteries – Secondary battery (Li-ion battery, Sodium-ion battery, Li-S battery, Li-O<sub>2</sub> battery, Nickel Cadmium, Nickel Metal Hydride) – Primary battery (Alkaline battery, Zinc-Carbon battery) – Materials for battery (Anode materials – Lithiated graphite, Sodiated hard carbon, Silicon doped graphene, Lithium Titanate) (Cathode Materials – S, LiCoO<sub>2</sub>, LiFePO<sub>4</sub>, LiMn<sub>2</sub>O<sub>4</sub>) – Electrolytes for Lithium-ion battery (ethylene carbonate and propylene carbonate based)

**UNIT-III FUEL CELLS**

**9**

Principle of operation of fuel cells – types of fuel cells (Proton exchange membrane fuel cells, alkaline fuel cell, direct methanol fuel cells, direct borohydride fuel cells, phosphoric acid fuel cells, solid oxide fuel cells, and molten carbonate fuel cells) – Thermodynamics of fuel cell – Fuel utilization – electrolyte membrane ( proton conducting and anion conducting) – Catalysts ( Platinum, Platinum alloys, carbon supported platinum systems and metal oxide supported platinum catalysts) – Anatomy of fuel cells (gas diffusion layer, catalyst layer, flow field plate, current conductors, bipolar plates and monopolar plates).

**UNIT-IV PHOTOVOLTAICS**

**9**

Physics of the solar cell – Theoretical limits of photovoltaic conversion – bulk crystal growth of Si and wafering for photovoltaic application - Crystalline silicon solar cells – thin film silicon solar cells – multijunction solar cells – amorphous silicon based solar cells – photovoltaic concentrators –

Cu(InGa)Se<sub>2</sub> solar cells – Cadmium Telluride solar cells – dye sensitized solar cells – Perovskite solar cells – Measurement and characterization of solar cells - Materials used in solar cells (metallic oxides, CNT films, graphene, OD fullerenes, single-multi walled carbon nanotubes, two-dimensional Graphene, organic or Small molecule-based solar cells materials - copper-phthalocyanine and perylenetetracarboxylicbis - benzene – fullerenes - boron subphthalocyanine-tin (II) phthalocyanine)

## UNIT-V SUPERCAPACITORS

9

Supercapacitor –types of supercapacitors (electrostatic double-layer capacitors, pseudo capacitors and hybrid capacitors) - design of supercapacitor-three and two electrode cell-parameters of supercapacitor- Faradaic and non - Faradaic capacitance – electrode materials (transition metal oxides (MO), mixed metal oxides, conducting polymers (CP), Mxenes, nanocarbons, non-noble metal, chalcogenides, hydroxides and 1D-3D metal-organic frame work (MOF), activated carbon fibres (ACF)- Hydroxides-Based Materials - Polyaniline (PANI), a ternary hybrid composite-conductive polypyrrole hydrogels – Different types of nanocomposites for the SC electrodes (carbon–carbon composites, carbon-MOs composites, carbon-CPs composites and MOs-CPs composites) - Two-Dimensional (2D) Electrode Materials - 2D transition metal carbides, carbonitrides, and nitrides.

**TOTAL : 45 PERIODS**

## COURSE OUTCOMES

**CO1:**Students will acquire knowledge about energy sustainability.

**CO2:**Students understand the principles of different electrochemical devices.

**CO3:**Students learn about the working of fuel cells and their application.

**CO4:**Students will learn about various Photovoltaic applications and the materials used.

**CO5:**The students gain knowledge on different types of supercapacitors and the performance of various materials

## REFERENCES

1. Functional materials for sustainable energy applications; John A. Kilner, Stephen J. Skinner, Stuart J. C. Irvine and Peter P. Edwards.
2. Hand Book of Fuel Cells: Fuel Cell Technology and Applications, Wolf Vielstich, Arnold Lamm, Hubert Andreas Gasteiger, Harumi Yokokawa, Wiley, London 2003.
3. B.E. Conway, Electrochemical supercapacitors: scientific fundamentals and technological applications, Kluwer Academic / Plenum publishers, New York, 1999.
4. T.R. Crompton, Batteries reference book, Newners, 3rd Edition, 2002.
5. Materials for Supercapacitor applications; B.Viswanathan. M.Aulice Scibioh
6. Electrode Materials for Supercapacitors: A Review of Recent Advances, Parnia Forouzandeh, Vignesh Kumaravel and Suresh C. Pillai, catalysts 2020.
7. Recent advances, practical challenges, and perspectives of intermediate temperature solid oxide fuel cell cathodes Amanda Ndubuisi, Sara Abouali, Kalpana Singh and VenkataramanThangadurai, J. Mater. Chem. A, 2022.
8. Review of next generation photovoltaic solar cell technology and comparative materialistic development Neeraj Kant, Pushpendra Singh, Materials Today: Proceedings, 2022.

**COURSE OBJECTIVE:**

- To acquire knowledge on green systems and the environment, energy technology and efficiency, and sustainability.
- To provide green engineering solutions to energy demand, reduced energy footprint.

**UNIT I PRINCIPLES OF GREEN CHEMISTRY 9**

Historical Perspectives and Basic Concepts. The twelve Principles of Green Chemistry and green engineering. Green chemistry metrics- atom economy, E factor, reaction mass efficiency, and other green chemistry metrics, application of green metrics analysis to synthetic plans.

**UNIT II POLLUTION TYPES 9**

Pollution – types, causes, effects, and abatement. Waste – sources of waste, different types of waste, chemical, physical and biochemical methods of waste minimization and recycling.

**UNIT III GREEN REAGENTS AND GREEN SYNTHESIS 9**

Environmentally benign processes- alternate solvents- supercritical solvents, ionic liquids, water as a reaction medium, energy-efficient design of processes- photo, electro and sono chemical methods, microwave-assisted reactions

**UNIT IV DESIGNING GREEN PROCESSES 9**

Safe design, process intensification, in process monitoring. Safe product and process design – Design for degradation, Real-time Analysis for pollution prevention, inherently safer chemistry for accident prevention

**UNIT V GREEN NANOTECHNOLOGY 9**

Nanomaterials for water treatment, nanotechnology for renewable energy, nanotechnology for environmental remediation and waste management, nanotechnology products as potential substitutes for harmful chemicals, environmental concerns with nanotechnology

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

CO1: To understand the principles of green engineering and technology

CO2: To learn about pollution using hazardous chemicals and solvents

CO3: To modify processes and products to make them green and safe.

CO4: To design processes and products using green technology

CO5 – To understand advanced technology in green synthesis

**TEXT BOOKS**

1. Green technology and design for the environment, Samir B. Billatos, Nadia A. Basaly, Taylor & Francis, Washington, DC, ©1997
2. Green Chemistry – An introductory text - M. Lancaster, RSC, 2016.
3. Green chemistry metrics - Alexi Lapkin and David Constable (Eds) , Wiley publications, 2008

**REFERENCE BOOKS**

1. Environmental chemistry, Stanley E Manahan, Taylor and Francis, 2017

**COURSE OBJECTIVES:**

- to understand and study the complexity of the environment in relation to pollutants generated due to industrial activity.
- To analyze the quality of the environmental parameters and monitor the same for the purpose of environmental risk assessment.

**UNIT I: ENVIRONMENTAL MONITORING AND STANDARDS****9**

Introduction- Environmental Standards- Classification of Environmental Standards- Global Environmental Standards- Environmental Standards in India- Ambient air quality standards- water quality standard- Environmental Monitoring-Need for environmental monitoring- Concepts of environmental monitoring- Techniques of Environmental Monitoring.

**UNIT II: MONITORING OF ENVIRONMENTAL PARAMETERS****9**

Current Environmental Issues- Global Environmental monitoring programme-International conventions- Application of Environmental Monitoring- Atmospheric Monitoring - screening parameters – Significance of environmental sampling- sampling methods – water sampling - sampling of ambient air-sampling of flue gas.

**UNIT III: ANALYTICAL METHODS FOR ENVIRONMENTAL MONITORING****9**

Classification of Instrumental Method- Analysis of Organic Pollutants by Spectrophotometric methods -Determination of nitrogen, phosphorus and, chemical oxygen demand (COD) in sewage; Biochemical oxygen demand (BOD)- Sampling techniques for air pollution measurements; analysis of particulates and air pollutants like oxides of nitrogen, oxides of sulfur, carbon monoxide, hydrocarbon; Introduction to advanced instruments for environmental analysis

**UNIT IV : ENVIRONMENTAL MONITORING PROGRAMME (EMP) & RISKASSESSMENT****9**

Water quality monitoring programme- national water quality monitoring- Parameters for National Water Quality Monitoring- monitoring protocol; Process of risk assessment- hazard identification- exposure assessment- dose-response assessment; risk characterization.

**UNIT V: AUTOMATED DATA ACQUISITION AND PROCESSING****9**

Data Acquisition for Process Monitoring and Control - The Data Acquisition System - Online Data Acquisition, Monitoring, and Control - Implementation of a Data Management System - Review of Observational Networks -Sensors and transducers- classification of transducers- data acquisition system- types of data acquisition systems- data management and quality control; regulatory overview.

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

After completion of this course, the students will know

CO1	Basic concepts of environmental standards and monitoring.
CO2	the ambient air quality and water quality standards;
CO3	the various instrumental methods and their principles for environmental monitoring
CO4	The significance of environmental standards in monitoring quality and sustainability of the environment.



CO5	the various ways of raising environmental awareness among the people.
CO6	Know the standard research methods that are used worldwide for monitoring the environment.

### TEXTBOOKS

1. Environmental monitoring Handbook, Frank R. Burden, © 2002 by The McGraw-Hill Companies, Inc.
2. Handbook of environmental analysis: chemical pollutants in the air, water, soil, and soil wastes / Pradyot Patnaik, © 1997 by CRC Press, Inc

### REFERENCES

1. Environmental monitoring / edited by G. Bruce Wiersma, © 2004 by CRC Press LLC.
2. H. H. Willard, L. L. Merit, J. A. Dean and F. A. Settle, Instrumental Methods of Analysis, CBP Publishers and Distributors, New Delhi, 1988.
3. Heaslip, G. (1975) Environmental Data Handling. John Wiley & Sons. New York.

### CO's-PO's & PSO's MAPPING

Course Outcomes	Program Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	1	1	1	-	-	-	-	-	-	-	-	-	3	-	-
CO2	1	1	1	1	1	-	-	-	1	-	2	2	2	1	1
CO3	1	1	2	1	1	-	-	-	2	-	1	1	1	-	-
CO4	1	2	3	3	1	-	-	-	2	-	3	3	1	-	-
CO5	1	1	3	2	1	-	-	-	3	-	3	1	2	-	-
CO6	3	2	3	3	2	-	-	-	3	-	3	3	3	1	1
Over all	3	2	3	3	2	-	-	-	3	-	3	3	3	1	1

1 - low, 2 - medium, 3 - high, '-' - no correlation

### CES337 INTEGRATED ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT

L T P C  
3 0 0 3

#### COURSE OBJECTIVES:

- To create awareness on the energy scenario of India with respect to world
- To understand the fundamentals of energy sources, energy efficiency and resulting environmental implications of energy utilisation
- Familiarisation on the concept of sustainable development and its benefits
- Recognize the potential of renewable energy sources and its conversion technologies for attaining sustainable development
- Acquainting with energy policies and energy planning for sustainable development

#### UNIT I ENERGY SCENARIO

9

Comparison of energy scenario – India and World (energy sources, generation mix, consumption pattern, T&D losses, energy demand, per capita energy consumption) – energy pricing – Energy security

**UNIT II ENERGY AND ENVIRONMENT 9**

Conventional Energy Sources - Emissions from fuels – Air, Water and Land pollution – Environmental standards - measurement and controls

**UNIT III SUSTAINABLE DEVELOPMENT 9**

Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG) - Social development: Poverty, conceptual issues and measures, impact of poverty. Globalization and Economic growth - Economic development: Economic inequalities, Income and growth.

**UNIT IV RENEWABLE ENERGY TECHNOLOGY 9**

Renewable Energy – Sources and Potential – Technologies for harnessing from Solar, Wind, Hydro, Biomass and Oceans – Principle of operation, relative merits and demerits

**UNIT V ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT 9**

National & State Energy Policy - National solar mission - Framework of Central Electricity Authority - National Hydrogen Mission - Energy and climate policy - State Energy Action Plan, RE integration, Road map for ethanol blending, Energy Efficiency and Energy Mix

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

**CO1:** Understand the world and Indian energy scenario

**CO2:** Analyse energy projects, its impact on environment and suggest control strategies

**CO3:** Recognise the need of Sustainable development and its impact on human resource development

**CO4:** Apply renewable energy technologies for sustainable development

**CO5:** Fathom Energy policies and planning for sustainable development.

**REFERENCES:**

1. Energy Manager Training Manual (4Volumes) available at [http://www.em-  
ea.org/gbook1.asp](http://www.em-<br/>ea.org/gbook1.asp), a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004
2. Robert Ristirer and Jack P. Kraushaar, “Energy and the environment”, Willey, 2005.
3. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 2012
4. Twidell, J.W. & Weir A., “Renewable Energy Resources”, EFNSpon Ltd., UK, 2015.
5. Dhandapani Alagiri, Energy Security in India Current Scenario, The ICFAI University Press, 2006.
6. M.H. Fulekar, Bhawana Pathak, R K Kale, “Environment and Sustainable Development” Springer, 2016
7. <https://www.niti.gov.in/verticals/energy>

**CES338 ENERGY EFFICIENCY FOR SUSTAINABLE DEVELOPMENT L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the types of energy sources, energy efficiency and environmental implications of energy utilisation
- To create awareness on energy audit and its impacts
- To acquaint the techniques adopted for performance evaluation of thermal utilities

- To familiarise on the procedures adopted for performance evaluation of electrical utilities
- To learn the concept of sustainable development and the implication of energy usage

**UNIT I ENERGY AND ENVIRONMENT 9**

Primary energy sources - Coal, Oil, Gas – India Vs World with respect to energy production and consumption, Climate Change, Global Warming, Ozone Depletion, UNFCCC, COP

**UNIT II ENERGY AUDITING 9**

Need and types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments

**UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES 9**

Energy conservation avenues in steam generation and utilisation, furnaces, Thermic Fluid Heaters. Insulation and Refractories - Commercial waste heat recovery devices: recuperator, regenerator, heat pipe, heat exchangers (Plate, Shell & Tube), heat pumps, and thermocompression

**UNIT IV ENERGY CONSERVATION IN ELECTRICAL UTILITIES 9**

Demand side management - Power factor improvement – Energy efficient transformers - Energy conservation avenues in Motors, HVAC, fans, blowers, pumps, air compressors, illumination systems and cooling towers

**UNIT V SUSTAINABLE DEVELOPMENT 9**

Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG). Globalization and Economic growth. Economic development: Economic inequalities, Income and growth. Social development: Poverty, conceptual issues and measures, impact of poverty,

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

- CO1:** Understand the prevailing energy scenario
- CO2:** Familiarise on energy audits and its relevance
- CO3:** Apply the concept of energy audit on thermal utilities
- CO4:** Employ relevant techniques for energy improvement in electrical utilities
- CO5:** Understand Sustainable development and its impact on human resource development

**REFERENCES:**

1. Energy Manager Training Manual (4Volumes) available at [http://www.em-  
ea.org/gbook1.asp](http://www.em-<br/>ea.org/gbook1.asp), a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004
2. Eastop.T.D& Croft D.R, “Energy Efficiency for Engineers and Technologists”, Logman Scientific & Technical, ISBN-0-582-03184, 1990
3. W.R. Murphy and G. McKay “Energy Management” Butterworths, London 1987
4. Pratap Bhattacharyya, “Climate Change and Greenhouse Gas Emission”, New India Publishing Agency- Nipa,2020
5. Matthew John Franchetti , Defne Apul “Carbon Footprint Analysis: Concepts, Methods, Implementation, and Case Studies” CRC Press,2012
6. Robert A. Ristinen, Jack J. Kraushaar, Jeffrey T. Brack, “Energy and the Environment”, 4th Edition,Wiley,2022

7. M.H. Fulekar, Bhawana Pathak, R K Kale, "Environment and Sustainable Development" Springer, 2016
8. Sustainable development in India: Stocktaking in the run up to Rio+20: Report prepared by TERI for MoEF, 2011.



**ANNA UNIVERSITY, CHENNAI**  
**NON-AUTONOMOUS AFFILIATED COLLEGES**  
**REGULATIONS 2021**  
**CHOICE BASED CREDIT SYSTEM**

**B. E. MECHANICAL ENGINEERING**

**PROGRAM EDUCATIONAL OBJECTIVES (PEOs)**

- I. Effectuating success in careers by exploring with the design, digital and computational analysis of engineering systems, experimentation and testing, smart manufacturing, technical services, and research.
- II. Amalgamating effectively with stakeholders to update and improve their core competencies and abilities to ethically compete in the ever-changing multicultural global enterprise.
- III. To encourage multi-disciplinary research and development to foster advanced technology, and to nurture innovation and entrepreneurship in order to compete successfully in the global economy.
- IV. To globally share and apply technical knowledge to create new opportunities that proactively advances our society through team efforts and to solve various challenging technical, environmental and societal problems.
- V. To create world class mechanical engineers capable of practice engineering ethically with a solid vision to become great leaders in academia, industries and society.

**PROGRAM OUTCOMES (POs)**

**PO**

**GRADUATE ATTRIBUTE**

- 1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- 2 **Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- 4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- 5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- 6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

- 7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- 8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- 9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- 11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- 12 **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

### PROGRAM SPECIFIC OUTCOMES (PSOs)

On successful completion of the Mechanical Engineering Degree programme, the Graduates shall exhibit the following:

1. Apply the knowledge gained in Mechanical Engineering for design and development and manufacture of engineering systems.
2. Apply the knowledge acquired to investigate research-oriented problems in mechanical engineering with due consideration for environmental and social impacts.
3. Use the engineering analysis and data management tools for effective management of multidisciplinary projects.

### PEO / PO MAPPING:

PEOs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
I.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
II.	3	2	2	2	2	1	1	1	3		2	1	2	3	3	3
III.	3	1	2	1	2	2	1		1	2		3	3	2	2	2
IV.	2	2	2	2	2		2				1	2	2	3	3	3
V.	3	2	2	2	1	3	2	2	2	1	1	3	3	2	2	2

## Mapping of Course Outcome and Programme Outcome

Year	Semester	Course name	PO												PSO				
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3		
I	I	Professional English- I	1.6	2.2	1.8	2.2	1.5	3	3	3	1.6	3	3	3	-	-	-		
		Matrices and Calculus	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-		
		Engineering Physics	3	3	1.6	1.2	1.8	1	-	-	-	-	-	1	-	-	-		
		Engineering Chemistry	2.8	1.3	1.6	1	-	1.5	1.8	-	-	-	-	1.5	-	-	-		
		Problem Solving and Python Programming	2	3	3	3	2	-	-	-	-	-	-	2	2	3	3	-	
		தமிழர் மரபு /Heritage of Tamils	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
		Problem Solving and Python Programming Laboratory	2	3	3	3	2	-	-	-	-	-	-	2	2	3	3	-	
		Physics and Chemistry Laboratory	3	2.4	2.6	1	1	-	-	-	-	-	-	-	-	-	-	-	
	II	English Laboratory <sup>s</sup>	2.6	1.3	1.6	1	1	1.4	1.8	-	-	-	-	1.3	-	-	-		
		Professional English- II	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-		
		Statistics and Numerical Methods	3	3	3	3	2.75	3	3	3	2.2	3	3	3	-	-	-		
		Materials Science	3	2	1.6	1.4	1.8	1.2	1	-	-	-	-	1	-	-	-		
		Basic Electrical and Electronics Engineering	2	1.8	1					1				2			1		
		Engineering Graphics	3	1	2	-	2	-	-	-	-	-	3	-	2	2	2	-	
		தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
		Engineering Practices Laboratory	3	2	-		1	1	1	-	-	-	-	2	2	1	1		
		Basic Electrical and Electronics Engineering Laboratory	3	3	2	1	1	-	-	1.5	2			-	-	-	-	1	
		Communication Laboratory / Foreign Language <sup>s</sup>	2.4	2.8	3	3	1.8	3	3	3	3	3	3	3	3	-	-	-	
		II	III	Transforms and Partial Differential Equations	3	3	2	2	1	-	-	-	1	-	-	1	3	3	1
				Engineering Mechanics	3	2	3	1	2	-	-	-	-	-	-	2	3	1	2
Engineering Thermodynamics	3			3	2			1			1		1	2	3	2	3		
Fluid Mechanics and Machinery	3			2	3	2	2	2	2	1	-	-	-	2	2	2	2		
Engineering Materials and Metallurgy	3			1	3	2	2	2	2	1	-	-	-	2	2	1	2		
Manufacturing Processes	3				2		2	2	2	1	1	-	-	1	3	1	2		
Professional Development	-			-	-	-	-	-	-	-	-	-	-	-	-	-	-		
IV	Theory of Machines		3	2	2		2	-	-	1	-	-	-	1	3		1		
	Thermal Engineering		3	2	1	1	-	-	-	-	-	-	-	1	2	1	1		
	Hydraulics and Pneumatics		2	1	1	1	-	-	-	-	-	-	-	1	2	1	1		
	Manufacturing Technology		3	3	3	1	1	1	3	-	-	3	-	-	3	2	2		
	Strength of Materials		3	3	3	3	2	3	1	3	2	3	1	3	2	1	1		
Environmental Sciences and Sustainability	1	1	1	-	-	3	-	1	-	2	1	2	2	1	-				
III	V	Design of Machine Elements	2	2	3	-	-	-	-	1	1	-	-	2	3	2	2		
		Metrology and Measurements	3	2	2	2	-	-	-	-	1	-	-	1	3	2	1		

	<b>VI</b>	Heat and Mass Transfer	3	3	3	2	-	-	-	-	1	-	-	1	3	2	1	
<b>IV</b>	<b>VII</b>	Mechatronics and IoT	3	2	2	2	2	-	1	-	1	-	-	2	1	2	3	
		Computer Integrated Manufacturing	3	2	2	1	2	-	-	-	1	-	-	1	2	1	3	
		Human Values and Ethics	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Industrial Management	-	-	1	1	-	3	2	3	2	3	2	3	1	1	1	





**ANNA UNIVERSITY, CHENNAI**  
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**REGULATIONS 2021**  
**CHOICE BASED CREDIT SYSTEM**  
**B. E. MECHANICAL ENGINEERING**  
**CURRICULUM AND SYLLABI FOR I TO VIII SEMESTERS**  
**SEMESTER I**

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IP3151	Induction Programme	-	-	-	-	-	0
<b>THEORY</b>								
2.	HS3152	Professional English - I	HSMC	3	0	0	3	3
3.	MA3151	Matrices and Calculus	BSC	3	1	0	4	4
4.	PH3151	Engineering Physics	BSC	3	0	0	3	3
5.	CY3151	Engineering Chemistry	BSC	3	0	0	3	3
6.	GE3151	Problem Solving and Python Programming	ESC	3	0	0	3	3
7.	GE3152	தமிழர் மரபு/Heritage of Tamils	HSMC	1	0	0	1	1
<b>PRACTICAL</b>								
7	GE3171	Problem Solving and Python Programming Laboratory	ESC	0	0	4	4	2
8	BS3171	Physics and Chemistry Laboratory	BSC	0	0	4	4	2
9	GE3172	English Laboratory §	EEC	0	0	2	2	1
<b>TOTAL</b>				<b>16</b>	<b>1</b>	<b>10</b>	<b>27</b>	<b>22</b>

§ Skill Based Course

**SEMESTER II**

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	HS3252	Professional English - II	HSMC	2	0	0	2	2
2.	MA3251	Statistics and Numerical Methods	BSC	3	1	0	4	4
3.	PH3251	Materials Science	BSC	3	0	0	3	3
4.	BE3251	Basic Electrical and Electronics Engineering	ESC	3	0	0	3	3
5.	GE3251	Engineering Graphics	ESC	2	0	4	6	4
6.	GE3252	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	HSMC	1	0	0	1	1
7.		NCC Credit Course Level 1#	-	2	0	0	2	2
<b>PRACTICAL</b>								
8.	GE3271	Engineering Practices Laboratory	ESC	0	0	4	4	2
9.	BE3271	Basic Electrical and Electronics Engineering Laboratory	ESC	0	0	4	4	2
10.	GE3272	Communication Laboratory / Foreign Language §	EEC	0	0	4	4	2
<b>TOTAL</b>				<b>14</b>	<b>1</b>	<b>16</b>	<b>31</b>	<b>23</b>

# NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

§ Skill Based Course

### SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	MA3351	Transforms and Partial Differential Equations	BSC	3	1	0	4	4
2.	ME3351	Engineering Mechanics	ESC	3	0	0	3	3
3.	ME3391	Engineering Thermodynamics	PCC	3	0	0	3	3
4.	CE3391	Fluid Mechanics and Machinery	ESC	3	1	0	4	4
5.	ME3392	Engineering Materials and Metallurgy	PCC	3	0	0	3	3
6.	ME3393	Manufacturing Processes	PCC	3	0	0	3	3
<b>PRACTICALS</b>								
7.	ME3381	Computer Aided Machine Drawing	ESC	0	0	4	4	2
8.	ME3382	Manufacturing Technology Laboratory	PCC	0	0	4	4	2
9.	GE3361	Professional Development <sup>§</sup>	EEC	0	0	2	2	1
<b>TOTAL</b>				<b>18</b>	<b>2</b>	<b>10</b>	<b>30</b>	<b>25</b>

§ Skill Based Course

### SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	ME3491	Theory of Machines	PCC	3	0	0	3	3
2.	ME3451	Thermal Engineering	PCC	4	0	0	4	4
3.	ME3492	Hydraulics and Pneumatics	PCC	3	0	0	3	3
4.	ME3493	Manufacturing Technology	PCC	3	0	0	3	3
5.	CE3491	Strength of Materials	PCC	3	0	0	3	3
6.	GE3451	Environmental Sciences and Sustainability	BSC	2	0	0	2	2
7.		NCC Credit Course Level 2 <sup>#</sup>		3	0	0	3	3 <sup>#</sup>
<b>PRACTICALS</b>								
8.	CE3481	Strength of Materials and Fluid Machinery Laboratory	PCC	0	0	4	4	2
9.	ME3461	Thermal Engineering Laboratory	PCC	0	0	4	4	2
<b>TOTAL</b>				<b>18</b>	<b>0</b>	<b>8</b>	<b>26</b>	<b>22</b>

<sup>#</sup> NCC Credit Course level 2 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

**SEMESTER V**

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	ME3591	Design of Machine Elements	PCC	4	0	0	4	4
2.	ME3592	Metrology and Measurements	PCC	3	0	0	3	3
3.		Professional Elective I	PEC	-	-	-	-	3
4.		Professional Elective II	PEC	-	-	-	-	3
5.		Professional Elective III	PEC	-	-	-	-	3
6.		Mandatory Course-I <sup>&amp;</sup>	MC	3	0	0	3	0
<b>PRACTICALS</b>								
7.	ME3511	Summer Internship*	EEC	0	0	0	0	1
8.	ME3581	Metrology and Dynamics Laboratory	PCC	0	0	4	4	2
<b>TOTAL</b>				-	-	-	-	<b>19</b>

\*Two weeks Summer Internship carries one credit and it will be done during IV semester summer vacation and same will be evaluated in V semester.

<sup>&</sup> Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under MC- I)

**SEMESTER VI**

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	ME3691	Heat and Mass Transfer	PCC	3	1	0	4	4
2.		Professional Elective IV	PEC	-	-	-	-	3
3.		Professional Elective V	PEC	-	-	-	-	3
4.		Professional Elective VI	PEC	-	-	-	-	3
5.		Professional Elective VII	PEC	-	-	-	-	3
6.		Open Elective – I*	OEC	3	0	0	3	3
7.		Mandatory Course-II <sup>&amp;</sup>	MC	3	0	0	3	0
8.		NCC Credit Course Level 3 <sup>#</sup>		3	0	0	3	3 <sup>#</sup>
<b>PRACTICALS</b>								
9.	ME3681	CAD/CAM Laboratory	PCC	0	0	4	4	2
10.	ME3682	Heat Transfer Laboratory	PCC	0	0	4	4	2
<b>TOTAL</b>				-	-	-	-	<b>23</b>

\*Open Elective – I shall be chosen from the emerging technologies.

<sup>&</sup> Mandatory Course-II is a Non-credit Course (Student shall select one course from the list given under MC- II)

<sup>#</sup> NCC Credit Course level 3 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA

**SEMESTER VII / VIII\***

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	ME3791	Mechatronics and IoT	PCC	3	0	0	3	3
2.	ME3792	Computer Integrated Manufacturing	PCC	3	0	0	3	3
3.	GE3791	Human Values and Ethics	HSMC	2	0	0	2	2
4.	GE3792	Industrial Management	HSMC	3	0	0	3	3
5.		Open Elective – II**	OEC	3	0	0	3	3
6.		Open Elective – III***	OEC	3	0	0	3	3
7.		Open Elective – IV***	OEC	3	0	0	3	3
<b>PRACTICALS</b>								
8.	ME3781	Mechatronics and IoT Laboratory	PCC	0	0	4	4	2
9.	ME3711	Summer Internship <sup>#</sup>	EEC	0	0	0	0	1
<b>TOTAL</b>				<b>20</b>	<b>0</b>	<b>4</b>	<b>24</b>	<b>23</b>

#Two weeks Summer Internship carries one credit and it will be done during VI semester summer vacation and same will be evaluated in VII semester.

\*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

\*\*Open Elective – II shall be chosen from the emerging technologies.

\*\*\*Open Elective III and IV (Shall be chosen from the list of open electives offered by other Programmes).

**SEMESTER VIII /VII\***

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>PRACTICALS</b>								
1.	ME3811	Project Work / Internship	EEC	0	0	20	20	10
<b>TOTAL</b>				<b>0</b>	<b>0</b>	<b>20</b>	<b>20</b>	<b>10</b>

\*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

**TOTAL CREDITS:167**

**MANDATORY COURSES I**

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3081	Introduction to Women and Gender Studies	MC	3	0	0	3	0
2.	MX3082	Elements of Literature	MC	3	0	0	3	0
3.	MX3083	Film Appreciation	MC	3	0	0	3	0
4.	MX3084	Disaster Risk Reduction and Management	MC	3	0	0	3	0

**MANDATORY COURSES II**

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3085	Well Being with Traditional Practices - Yoga, Ayurveda and Siddha	MC	3	0	0	3	0
2.	MX3086	History of Science and Technology in India	MC	3	0	0	3	0
3.	MX3087	Political and Economic Thought for a Humane Society	MC	3	0	0	3	0
4.	MX3088	State, Nation Building and Politics in India	MC	3	0	0	3	0
5.	MX3089	Industrial Safety	MC	3	0	0	3	0

UNIVERSITY  
PROGRESS THROUGH KNOWLEDGE

## PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL 1	VERTICAL 2	VERTICAL 3	VERTICAL 4	VERTICAL 5	VERTICAL 6	VERTICAL 7	VERTICAL 8	VERTICAL 9	VERTICAL 10
<b>MODERN MOBILITY SYSTEMS</b>	<b>PRODUCT AND PROCESS DEVELOPMENT</b>	<b>ROBOTICS AND AUTOMATION</b>	<b>DIGITAL AND GREEN MANUFACTURING</b>	<b>PROCESS EQUIPMENT AND PIPING DESIGN</b>	<b>CLEAN AND GREEN ENERGY TECHNOLOGIES</b>	<b>COMPUTATIONAL ENGINEERING</b>	<b>DIVERSIFIED COURSES GROUP 1</b>	<b>DIVERSIFIED COURSES GROUP 2</b>	<b>DIVERSIFIED COURSES GROUP 3</b>
Automotive Materials, Components, Design & Testing	Value Engineering	Sensors and Instrumentation	Digital Manufacturing and IoT	Design of Pressure Vessels	Bioenergy Conversion Technologies	Computational Solid Mechanics	Automobile Engineering	Turbo Machines	Advanced Vehicle Engineering
Conventional and Futuristic Vehicle Technology	Additive Manufacturing	Electrical Drives and Actuators	Lean Manufacturing	Failure Analysis and NDT Techniques	Carbon Footprint estimation and reduction techniques	Computational Fluid Dynamics and Heat transfer	Measurements and Controls	Non-traditional Machining Processes	Advanced Internal Combustion Engineering
Renewable Powered Off Highway Vehicles and Emission Control Technology	CAD/CAM	Embedded Systems and Programming	Modern Robotics	Material Handling and solid processing Equipment	Energy Conservation in Industries	Theory on Computation and Visualization	Design Concepts in Engineering	Industrial safety	Casting and Welding Processes
Vehicle Health Monitoring, Maintenance and Safety	Design For X	Robotics	Green Manufacturing Design and Practices	Rotating Machinery Design	Energy Efficient Buildings	Computational Bio-Mechanics	Composite Materials and Mechanics	Design of Transmission System	Process Planning and Cost Estimation
CAE and CFD Approach in Future Mobility	Ergonomics in Design	Smart Mobility and Intelligent Vehicles	Environment Sustainability and Impact Assessment	Thermal and Fired Equipment design	Energy Storage Devices	Advanced Statistics and Data Analytics	Electrical Drives and Control	Thermal Power Engineering	Surface Engineering
Hybrid and Electric Vehicle Technology	New Product Development	Haptics and Immersive Technologies	Energy Saving Machinery and Components	Industrial Layout Design and Safety	Renewable Energy Technologies	CAD and CAE	Power Plant Engineering	Design for Manufacturing	Precision Manufacturing
Thermal Management of Batteries and Fuel Cells	Product Life Cycle Management	Drone Technologies	Green Supply Chain Management	Design Codes and Standards	Equipment for Pollution Control	Machine Learning for Intelligent Systems	Refrigeration and Air Conditioning	Power Generation Equipment Design	Gas Dynamics and Jet Propulsion
-	-	-	-	-	-	-	Dynamics of Ground Vehicles	-	Operational Research

### **Registration of Professional Elective Courses from Verticals:**

Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E./B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to the Regulations 2021, Clause 4.10 (Amendments).

## PROFESSIONAL ELECTIVE COURSES : VERTICALS

### VERTICAL 1 : MODERN MOBILITY SYSTEMS

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total Contact period	Credits
				L	T	P		
1.	CME331	Automotive Materials, Components, Design and Testing	PEC	2	0	2	4	3
2.	CME332	Conventional and Futuristic Vehicle Technology	PEC	3	0	0	3	3
3.	CME333	Renewable Powered Off Highway Vehicles and Emission Control Technology	PEC	3	0	0	3	3
4.	CME334	Vehicle Health Monitoring, Maintenance and Safety	PEC	3	0	0	3	3
5.	CME335	CAE and CFD Approach in Future Mobility	PEC	2	0	2	4	3
6.	CME336	Hybrid and Electric Vehicle Technology	PEC	3	0	0	3	3
7.	CME337	Thermal Management of Batteries and Fuel Cells	PEC	3	0	0	3	3

### VERTICAL 2 : PRODUCT AND PROCESS DEVELOPMENT

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total Contact period	Credits
				L	T	P		
1.	CME338	Value Engineering	PEC	3	0	0	3	3
2.	CME339	Additive Manufacturing	PEC	2	0	2	4	3
3.	CME340	CAD/CAM	PEC	3	0	0	3	3
4.	CME341	Design For X	PEC	3	0	0	3	3
5.	CME342	Ergonomics in Design	PEC	3	0	0	3	3
6.	CME343	New Product Development	PEC	3	0	0	3	3
7.	CME344	Product Life Cycle Management	PEC	3	0	0	3	3

### VERTICAL 3: ROBOTICS AND AUTOMATION

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total Contact Period	Credits
				L	T	P		
1.	MR3491	Sensors and Instrumentation	PEC	3	0	0	3	3
2.	MR3392	Electrical Drives and Actuators	PEC	3	0	0	3	3
3.	MR3492	Embedded Systems and Programming	PEC	2	0	2	4	3
4.	MR3691	Robotics	PEC	3	0	0	3	3
5.	CMR338	Smart Mobility and Intelligent Vehicles	PEC	3	0	0	3	3
6.	CME345	Haptics and Immersive Technologies	PEC	3	0	0	3	3
7.	CRA332	Drone Technologies	PEC	3	0	0	3	3

**VERTICAL 4: DIGITAL AND GREEN MANUFACTURING**

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total Contact Period	Credits
				L	T	P		
1.	CME346	Digital Manufacturing and IoT	PEC	2	0	2	4	3
2.	CME347	Lean Manufacturing	PEC	3	0	0	3	3
3.	CME348	Modern Robotics	PEC	2	0	2	4	3
4.	CME349	Green Manufacturing Design and Practices	PEC	3	0	0	3	3
5.	CME350	Environment Sustainability and Impact Assessment	PEC	3	0	0	3	3
6.	CME351	Energy Saving Machinery and Components	PEC	3	0	0	3	3
7.	CME352	Green Supply Chain Management	PEC	3	0	0	3	3

**VERTICAL 5: PROCESS EQUIPMENT AND PIPING DESIGN**

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total Contact Period	Credits
				L	T	P		
1.	CME353	Design of Pressure Vessels	PEC	3	0	0	3	3
2.	CME354	Failure Analysis and NDT Techniques	PEC	2	0	2	4	3
3.	CME355	Material Handling and Solid Processing Equipment	PEC	3	0	0	3	3
4.	CME356	Rotating Machinery Design	PEC	3	0	0	3	3
5.	CME357	Thermal and Fired Equipment Design	PEC	3	0	0	3	3
6.	CME358	Industrial Layout Design and Safety	PEC	2	0	2	4	3
7.	CME359	Design Codes and Standards	PEC	3	0	0	3	3

**VERTICAL 6: CLEAN AND GREEN ENERGY TECHNOLOGIES**

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total contact Periods	Credits
				L	T	P		
1.	CME360	Bioenergy Conversion Technologies	PEC	3	0	0	3	3
2.	CME361	Carbon Footprint Estimation and Reduction Techniques	PEC	3	0	0	3	3
3.	CME362	Energy Conservation in Industries	PEC	3	0	0	3	3
4.	CME363	Energy Efficient Buildings	PEC	3	0	0	3	3
5.	CME364	Energy Storage Devices	PEC	3	0	0	3	3
6.	CME365	Renewable Energy Technologies	PEC	3	0	0	3	3
7.	CME366	Equipment for Pollution Control	PEC	3	0	0	3	3



### VERTICAL 7: COMPUTATIONAL ENGINEERING

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total contact periods	Credits
				L	T	P		
1.	CME367	Computational Solid Mechanics	PEC	3	0	0	3	3
2.	CME368	Computational Fluid Dynamics and Heat transfer	PEC	3	0	0	3	3
3.	CME369	Theory on Computation and Visualization	PEC	3	0	0	3	3
4.	CME370	Computational Bio-Mechanics	PEC	3	0	0	3	3
5.	CME371	Advanced Statistics and Data Analytics	PEC	3	0	0	3	3
6.	CME372	CAD and CAE	PEC	2	0	2	4	3
7.	CRA342	Machine Learning for Intelligent Systems	PEC	3	0	0	3	3

### VERTICAL 8: DIVERSIFIED COURSES GROUP 1

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1.	CME380	Automobile Engineering	PEC	3	0	0	3	3
2.	ME3001	Measurements and Controls	PEC	3	0	0	3	3
3.	CME381	Design Concepts in Engineering	PEC	3	0	0	3	3
4.	CME382	Composite Materials and Mechanics	PEC	3	0	0	3	3
5.	CME383	Electrical Drives and Control	PEC	3	0	0	3	3
6.	CME384	Power Plant Engineering	PEC	3	0	0	3	3
7.	CME385	Refrigeration and Air Conditioning	PEC	3	0	0	3	3
8.	CAU332	Dynamics of Ground Vehicles	PEC	3	0	0	3	3

### VERTICAL 9: DIVERSIFIED COURSES GROUP 2

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1.	CAE353	Turbo Machines	PEC	3	0	0	3	3
2.	CME387	Non-traditional Machining Processes	PEC	3	0	0	3	3
3.	CME388	Industrial safety	PEC	3	0	0	3	3
4.	CME389	Design of Transmission System	PEC	3	0	0	3	3
5.	CME390	Thermal Power Engineering	PEC	3	0	0	3	3
6.	CME391	Design for Manufacturing	PEC	3	0	0	3	3
7.	CME392	Power Generation Equipment Design	PEC	3	0	0	3	3

**VERTICAL 10: DIVERSIFIED COURSES GROUP 3**

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total Contact periods	Credits
				L	T	P		
1.	CME393	Advanced Vehicle Engineering	PEC	3	0	0	3	3
2.	CME394	Advanced Internal Combustion Engineering	PEC	3	0	0	3	3
3.	CME395	Casting and Welding Processes	PEC	3	0	0	3	3
4.	CME396	Process Planning and Cost Estimation	PEC	3	0	0	3	3
5.	CME397	Surface Engineering	PEC	3	0	0	3	3
6.	CME398	Precision Manufacturing	PEC	3	0	0	3	3
7.	CME386	Gas Dynamics and Jet Propulsion	PEC	3	0	0	3	3
8.	CME399	Operational Research	PEC	3	0	0	3	3



### OPEN ELECTIVES

(Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories)

#### **OPEN ELECTIVE I AND II (EMERGING TECHNOLOGIES)**

To be offered other than Faculty of Information and Communication Engineering

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OCS351	Artificial Intelligence and Machine Learning Fundamentals	OEC	2	0	2	4	3
2.	OCS352	IoT Concepts and Applications	OEC	2	0	2	4	3
3.	OCS353	Data Science Fundamentals	OEC	2	0	2	4	3
4.	CCS333	Augmented Reality / Virtual Reality	OEC	2	0	2	4	3

#### **OPEN ELECTIVES – III**

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OCE353	Lean Concepts, Tools And Practices	OEC	3	0	0	3	3
2.	OHS351	English for Competitive Examinations	OEC	3	0	0	3	3
3.	OMG352	NGOs and Sustainable Development	OEC	3	0	0	3	3
4.	OMG353	Democracy and Good Governance	OEC	3	0	0	3	3
5.	OME354	Applied Design Thinking	OEC	3	0	0	3	3
6.	MF3003	Reverse Engineering	OEC	3	0	0	3	3
7.	OPR351	Sustainable Manufacturing	OEC	3	0	0	3	3
8.	AU3791	Electric and Hybrid Vehicles	OEC	3	0	0	3	3
9.	OAS352	Space Engineering	OEC	3	0	0	3	3
10.	OIM351	Industrial Management	OEC	3	0	0	3	3
11.	OIE354	Quality Engineering	OEC	3	0	0	3	3
12.	OSF351	Fire Safety Engineering	OEC	3	0	0	3	3
13.	OAE352	Fundamentals of Aeronautical engineering	OEC	3	0	0	3	3
14.	OML351	Introduction to non-destructive testing	OEC	3	0	0	3	3
15.	OMR351	Mechatronics	OEC	3	0	0	3	3
16.	ORA351	Foundation of Robotics	OEC	3	0	0	3	3

17.	OGI351	Remote Sensing Concepts	OEC	3	0	0	3	3
18.	OAI351	Urban Agriculture	OEC	3	0	0	3	3
19.	OEN351	Drinking Water Supply and Treatment	OEC	3	0	0	3	3
20.	OEE352	Electric Vehicle Technology	OEC	3	0	0	3	3
21.	OEI353	Introduction to PLC Programming	OEC	3	0	0	3	3
22.	OCH351	Nano Technology	OEC	3	0	0	3	3
23.	OCH352	Functional Materials	OEC	3	0	0	3	3
25.	OFD352	Traditional Indian Foods	OEC	3	0	0	3	3
26.	OFD353	Introduction to food processing	OEC	3	0	0	3	3
27.	OPY352	IPR for Pharma Industry	OEC	3	0	0	3	3
28.	OTT351	Basics of Textile Finishing	OEC	3	0	0	3	3
29.	OTT352	Industrial Engineering for Garment Industry	OEC	3	0	0	3	3
30.	OTT353	Basics of Textile Manufacture	OEC	3	0	0	3	3
31.	OPE351	Introduction to Petroleum Refining and Petrochemicals	OEC	3	0	0	3	3
32.	OPE334	Energy Conservation and Management	OEC	3	0	0	3	3
33.	OPT351	Basics of Plastics Processing	OEC	3	0	0	3	3
34.	OEC351	Signals and Systems	OEC	3	0	0	3	3
35.	OEC352	Fundamentals of Electronic Devices and Circuits	OEC	3	0	0	3	3
36.	CBM348	Foundation Skills in integrated product Development	OEC	3	0	0	3	3
37.	CBM333	Assistive Technology	OEC	3	0	0	3	3
38.	OMA352	Operations Research	OEC	3	0	0	3	3
39.	OMA353	Algebra and Number Theory	OEC	3	0	0	3	3
40.	OMA354	Linear Algebra	OEC	3	0	0	3	3
41.	OBT352	Basics of Microbial Technology	OEC	3	0	0	3	3
42.	OBT353	Basics of Biomolecules	OEC	3	0	0	3	3
43.	OBT354	Fundamentals of Cell and Molecular Biology	OEC	3	0	0	3	3

**OPEN ELECTIVES – IV**

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OCE354	Basics of Integrated Water Resources Management	OEC	3	0	0	3	3
2.	OHS352	Project Report Writing	OEC	3	0	0	3	3
3.	OMA355	Advanced Numerical Methods	OEC	3	0	0	3	3
4.	OMA356	Random Processes	OEC	3	0	0	3	3
5.	OMA357	Queueing and Reliability Modelling	OEC	3	0	0	3	3
6.	OMG354	Production and Operations Management for Entrepreneurs	OEC	3	0	0	3	3
7.	OMG355	Multivariate Data Analysis	OEC	3	0	0	3	3
8.	OME355	Industrial Design & Rapid Prototyping Techniques	OEC	3	0	0	3	3
9.	MF3010	Micro and Precision Engineering	OEC	3	0	0	3	3
10.	OMF354	Cost Management of Engineering Projects	OEC	3	0	0	3	3
11.	AU3002	Batteries and Management system	OEC	3	0	0	3	3
12.	AU3008	Sensors and Actuators	OEC	3	0	0	3	3
13.	OAS353	Space Vehicles	OEC	3	0	0	3	3
14.	OIM352	Management Science	OEC	3	0	0	3	3
15.	OIM353	Production Planning and Control	OEC	3	0	0	3	3
16.	OIE353	Operations Management	OEC	3	0	0	3	3
17.	OSF352	Industrial Hygiene	OEC	3	0	0	3	3
18.	OSF353	Chemical Process Safety	OEC	3	0	0	3	3
19.	OML352	Electrical, Electronic and Magnetic materials	OEC	3	0	0	3	3
20.	OML353	Nanomaterials and applications	OEC	3	0	0	3	3
21.	OMR353	Sensors	OEC	3	0	0	3	3
22.	ORA352	Concepts in Mobile Robots	OEC	3	0	0	3	3
23.	MV3501	Marine Propulsion	OEC	3	0	0	3	3
24.	OMV351	Marine Merchant Vessels	OEC	3	0	0	3	3
25.	OMV352	Elements of Marine Engineering	OEC	3	0	0	3	3
26.	CRA332	Drone Technologies	OEC	3	0	0	3	3

27.	OGI352	Geographical Information System	OEC	3	0	0	3	3
28.	OAI352	Agriculture Entrepreneurship Development	OEC	3	0	0	3	3
29.	OEN352	Biodiversity Conservation	OEC	3	0	0	3	3
30.	OEE353	Introduction to control systems	OEC	3	0	0	3	3
31.	OEI354	Introduction to Industrial Automation Systems	OEC	3	0	0	3	3
32.	OCH353	Energy Technology	OEC	3	0	0	3	3
33.	OCH354	Surface Science	OEC	3	0	0	3	3
34.	OFD354	Fundamentals of Food Engineering	OEC	3	0	0	3	3
35.	OFD355	Food safety and Quality Regulations	OEC	3	0	0	3	3
36.	OPY353	Nutraceuticals	OEC	3	0	0	3	3
37.	OTT354	Basics of Dyeing and Printing	OEC	3	0	0	3	3
38.	FT3201	Fibre Science	OEC	3	0	0	3	3
39.	OTT355	Garment Manufacturing Technology	OEC	3	0	0	3	3
40.	OPE353	Industrial Safety	OEC	3	0	0	3	3
41.	OPE354	Unit Operations in Petro Chemical Industries	OEC	3	0	0	3	3
42.	OPT352	Plastic Materials for Engineers	OEC	3	0	0	3	3
43.	OPT353	Properties and Testing of Plastics	OEC	3	0	0	3	3
44.	OEC353	VLSI Design	OEC	3	0	0	3	3
45.	CBM370	Wearable devices	OEC	3	0	0	3	3
46.	CBM356	Medical Informatics	OEC	3	0	0	3	3
47.	OBT355	Biotechnology for Waste Management	OEC	3	0	0	3	3
48.	OBT356	Lifestyle Diseases	OEC	3	0	0	3	3
49.	OBT357	Biotechnology in Health Care	OEC	3	0	0	3	3

## SUMMARY

<b>B.E. MECHANICAL ENGINEERING</b>										
S.No	Subject Area	Credits per Semester								Total Credits
		I	II	III	IV	V	VI	VII/VIII	VIII/VII	
1	HSMC	4	3					5		13
2	BSC	12	7	4	2					25
3	ESC	5	11	9						24
4	PCC			11	20	9	8	8		56
5	PEC					9	12			21
6	OEC						3	9		12
7	EEC	1	2	1		1		1	10	13
8	Non-Credit /(Mandatory)					√	√			
<b>Total</b>		<b>22</b>	<b>23</b>	<b>25</b>	<b>22</b>	<b>19</b>	<b>23</b>	<b>23</b>	<b>10</b>	<b>167</b>



### **ENROLLMENT FOR B.E. / B. TECH. (HONOURS) / MINOR DEGREE (OPTIONAL)**

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor Degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes, Moreover, for minor degree the student can register for courses from any one of the following verticals also.

Complete details are available in clause 4.10 (Amendments) of Regulations 2021.

### **VERTICALS FOR MINOR DEGREE(In addition to all the verticals of other programmes)**

<b>Vertical I</b>	<b>Vertical II</b>	<b>Vertical III</b>	<b>Vertical IV</b>	<b>Vertical V</b>
<b>Fintech and Block Chain</b>	<b>Entrepreneurship</b>	<b>Public Administration</b>	<b>Business Data Analytics</b>	<b>Environment and Sustainability</b>
Financial Management	Foundations of Entrepreneurship	Principles of Public Administration	Statistics for Management	Sustainable infrastructure Development
Fundamentals of Investment	Team Building and Leadership Management for Business	Constitution of India	Datamining for Business Intelligence	Sustainable Agriculture and Environmental Management
Banking, Financial Services and Insurance	Creativity and Innovation in Entrepreneurship	Public Personnel Administration	Human Resource Analytics	Sustainable Bio Materials
Introduction to Blockchain and its Applications	Principles of Marketing Management for Business	Administrative Theories	Marketing and Social Media Web Analytics	Materials for Energy Sustainability
Fintech Personal Finance and Payments	Human Resource Management for Entrepreneurs	Indian Administrative System	Operation and Supply Chain Analytics	Green Technology
Introduction to Fintech	Financing New Business Ventures	Public Policy Administration	Financial Analytics	Environmental Quality Monitoring and Analysis
-	-	-	-	Integrated Energy Planning for Sustainable Development
-	-	-	-	Energy Efficiency for Sustainable Development



(Choice of courses for Minor degree is to be made from any one vertical of other programmes or from anyone of the following verticals)

**VERTICAL 1: FINTECH AND BLOCK CHAIN**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG331	Financial Management	PEC	3	0	0	3	3
2.	CMG332	Fundamentals of Investment	PEC	3	0	0	3	3
3.	CMG333	Banking, Financial Services and Insurance	PEC	3	0	0	3	3
4.	CMG334	Introduction to Blockchain and its Applications	PEC	3	0	0	3	3
5.	CMG335	Fintech Personal Finance and Payments	PEC	3	0	0	3	3
6.	CMG336	Introduction to Fintech	PEC	3	0	0	3	3

**VERTICAL 2: ENTREPRENEURSHIP**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG337	Foundations of Entrepreneurship	PEC	3	0	0	3	3
2.	CMG338	Team Building and Leadership Management for Business	PEC	3	0	0	3	3
3.	CMG339	Creativity and Innovation in Entrepreneurship	PEC	3	0	0	3	3
4.	CMG340	Principles of Marketing Management for Business	PEC	3	0	0	3	3
5.	CMG341	Human Resource Management for Entrepreneurs	PEC	3	0	0	3	3
6.	CMG342	Financing New Business Ventures	PEC	3	0	0	3	3

**VERTICAL 3: PUBLIC ADMINISTRATION**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG343	Principles of Public Administration	PEC	3	0	0	3	3
2.	CMG344	Constitution of India	PEC	3	0	0	3	3
3.	CMG345	Public Personnel Administration	PEC	3	0	0	3	3
4.	CMG346	Administrative Theories	PEC	3	0	0	3	3
5.	CMG347	Indian Administrative System	PEC	3	0	0	3	3
6.	CMG348	Public Policy Administration	PEC	3	0	0	3	3

**VERTICAL 4: BUSINESS DATA ANALYTICS**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG349	Statistics for Management	PEC	3	0	0	3	3
2.	CMG350	Datamining for Business Intelligence	PEC	3	0	0	3	3
3.	CMG351	Human Resource Analytics	PEC	3	0	0	3	3
4.	CMG352	Marketing and Social Media Web Analytics	PEC	3	0	0	3	3
5.	CMG353	Operation and Supply Chain Analytics	PEC	3	0	0	3	3
6.	CMG354	Financial Analytics	PEC	3	0	0	3	3

**VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CES331	Sustainable infrastructure Development	PEC	3	0	0	3	3
2.	CES332	Sustainable Agriculture and Environmental Management	PEC	3	0	0	3	3
3.	CES333	Sustainable Bio Materials	PEC	3	0	0	3	3
4.	CES334	Materials for Energy Sustainability	PEC	3	0	0	3	3
5.	CES335	Green Technology	PEC	3	0	0	3	3
6.	CES336	Environmental Quality Monitoring and Analysis	PEC	3	0	0	3	3
7.	CES337	Integrated Energy Planning for Sustainable Development	PEC	3	0	0	3	3
8.	CES338	Energy Efficiency for Sustainable Development	PEC	3	0	0	3	3



This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

“Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed.”

“One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. “

Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

(i) Physical Activity

This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

(ii) Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

(iii) Universal Human Values

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and don't's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing.

Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

(iv) Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

(v) Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

(vi) Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

(vii) Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

(viii) Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix) Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering /Technology/Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

**Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.**

References:

Guide to Induction program from AICTE

**OBJECTIVES :**

- To improve the communicative competence of learners
- To learn to use basic grammatic structures in suitable contexts
- To acquire lexical competence and use them appropriately in a sentence and understand their meaning in a text
- To help learners use language effectively in professional contexts
- To develop learners' ability to read and write complex texts, summaries, articles, blogs, definitions, essays and user manuals.

**UNIT I INTRODUCTION TO EFFECTIVE COMMUNICATION 1**

What is effective communication? (Explain using activities) Why is communication critical for excellence during study, research and work? What are the seven C's of effective communication? What are key language skills? What is effective listening? What does it involve? What is effective speaking? What does it mean to be an excellent reader? What should you be able to do? What is effective writing? How does one develop language and communication skills? What does the course focus on? How are communication and language skills going to be enhanced during this course? What do you as a learner need to do to enhance your English language and communication skills to get the best out of this course?

**INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 8**

Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails. Writing - Writing emails / letters introducing oneself. Grammar - Present Tense (simple and progressive); Question types: Why/ Yes or No/ and Tags. Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).

**UNIT II NARRATION AND SUMMATION 9**

Reading - Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel & technical blogs. Writing - Guided writing-- Paragraph writing Short Report on an event (field trip etc.) Grammar –Past tense (simple); Subject-Verb Agreement; and Prepositions. Vocabulary - Word forms (prefixes& suffixes); Synonyms and Antonyms. Phrasal verbs.

**UNIT III DESCRIPTION OF A PROCESS / PRODUCT 9**

Reading – Reading advertisements, gadget reviews; user manuals. Writing - Writing definitions; instructions; and Product /Process description. Grammar - Imperatives; Adjectives; Degrees of comparison; Present & Past Perfect Tenses. Vocabulary - Compound Nouns, Homonyms; and Homophones, discourse markers (connectives & sequence words).

**UNIT IV CLASSIFICATION AND RECOMMENDATIONS 9**

Reading – Newspaper articles; Journal reports –and Non Verbal Communication (tables, pie charts etc.). Writing – Note-making / Note-taking (\*Study skills to be taught, not tested); Writing recommendations; Transferring information from non verbal ( chart , graph etc, to verbal mode) Grammar – Articles; Pronouns - Possessive & Relative pronouns. Vocabulary - Collocations; Fixed / Semi fixed expressions.

**UNIT V EXPRESSION 9**

Reading – Reading editorials; and Opinion Blogs; Writing – Essay Writing (Descriptive or narrative). Grammar – Future Tenses, Punctuation; Negation (Statements & Questions); and Simple, Compound & Complex Sentences. Vocabulary - Cause & Effect Expressions – Content vs Function words.

**TOTAL : 45 PERIODS**

## LEARNING OUTCOMES:

At the end of the course, learners will be able

- To use appropriate words in a professional context
- To gain understanding of basic grammatical structures and use them in right context.
- To read and infer the denotative and connotative meanings of technical texts
- To read and interpret information presented in tables, charts and other graphic forms
- To write definitions, descriptions, narrations and essays on various topics

## TEXT BOOKS :

1. English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition)
2. English for Science & Technology Cambridge University Press, 2021.  
Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

## REFERENCE BOOKS:

1. Technical Communication – Principles And Practices By Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2. A Course Book On Technical English By Lakshminarayanan, Scitech Publications (India) Pvt. Ltd.
3. English For Technical Communication (With CD) By Aysha Viswamohan, Mcgraw Hill Education, ISBN : 0070264244.
4. Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.
5. Learning to Communicate – Dr. V. Chellammal, Allied Publishing House, New Delhi, 2003.

## ASSESSMENT PATTERN

Two internal assessments and an end semester examination to test students' reading and writing skills along with their grammatical and lexical competence.

### CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	1	1	3	3	3	1	3	-	3	-	-	-
2	1	1	1	1	1	3	3	3	1	3	-	3	-	-	-
3	2	3	2	3	2	3	3	3	2	3	3	3	-	-	-
4	2	3	2	3	2	3	3	3	2	3	3	3	-	-	-
5	2	3	3	3	-	3	3	3	2	3	-	3	-	-	-
<b>AVg.</b>	<b>1.6</b>	<b>2.2</b>	<b>1.8</b>	<b>2.2</b>	<b>1.5</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>1.6</b>	<b>3</b>	<b>3</b>	<b>3</b>	-	-	-

- 1-low, 2-medium, 3-high, '-'- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.





## REFERENCES:

1. Anton. H, Bivens. I and Davis. S, " Calculus ", Wiley, 10<sup>th</sup> Edition, 2016
2. Bali. N., Goyal. M. and Watkins. C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.), New Delhi, 7<sup>th</sup> Edition, 2009.
3. Jain. R.K. and Iyengar. S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 5<sup>th</sup> Edition, 2016.
4. Narayanan. S. and Manicavachagom Pillai. T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6. Srimantha Pal and Bhunia. S.C, "Engineering Mathematics" Oxford University Press, 2015.
7. Thomas. G. B., Hass. J, and Weir. M.D, "Thomas Calculus ", 14<sup>th</sup> Edition, Pearson India, 2018.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO2	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO3	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO4	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO5	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
Avg	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-

PH3151

ENGINEERING PHYSICS

L T P C  
3 0 0 3

## COURSE OBJECTIVES

- To make the students effectively to achieve an understanding of mechanics.
- To enable the students to gain knowledge of electromagnetic waves and its applications.
- To introduce the basics of oscillations, optics and lasers.
- Equipping the students to be successfully understand the importance of quantum physics.
- To motivate the students towards the applications of quantum mechanics.

## UNIT I MECHANICS

9

Multi-particle dynamics: Center of mass (CM) – CM of continuous bodies – motion of the CM – kinetic energy of system of particles. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy and moment of inertia - theorems of M.I –moment of inertia of continuous bodies – M.I of a diatomic molecule - torque – rotational dynamics of rigid bodies – conservation of angular momentum – rotational energy state of a rigid diatomic molecule - gyroscope - torsional pendulum – double pendulum –Introduction to nonlinear oscillations.

## UNIT II ELECTROMAGNETIC WAVES

9

The Maxwell's equations - wave equation; Plane electromagnetic waves in vacuum, Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

## UNIT III OSCILLATIONS, OPTICS AND LASERS

9

Simple harmonic motion - resonance –analogy between electrical and mechanical oscillating systems - waves on a string - standing waves - traveling waves - Energy transfer of a wave - sound waves - Doppler effect. Reflection and refraction of light waves - total internal reflection - interference –Michelson interferometer –Theory of air wedge and experiment. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients - population inversion - Nd-YAG laser, CO<sub>2</sub> laser, semiconductor laser –Basic applications of lasers in industry.

**UNIT IV BASIC QUANTUM MECHANICS****9**

Photons and light waves - Electrons and matter waves –Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization –Free particle - particle in a infinite potential well: 1D,2D and 3D Boxes- Normalization, probabilities and the correspondence principle.

**UNIT V APPLIED QUANTUM MECHANICS****9**

The harmonic oscillator(qualitative)- Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope - Resonant diode - Finite potential wells (qualitative)- Bloch's theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.

**TOTAL : 45 PERIODS****COURSE OUTCOMES**

After completion of this course, the students should be able to

- Understand the importance of mechanics.
- Express their knowledge in electromagnetic waves.
- Demonstrate a strong foundational knowledge in oscillations, optics and lasers.
- Understand the importance of quantum physics.
- Comprehend and apply quantum mechanical principles towards the formation of energy bands.

**TEXT BOOKS:**

1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017.
2. E.M.Purcell and D.J.Morin, Electricity and Magnetism, Cambridge Univ.Press, 2013.
3. Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGraw-Hill (Indian Edition), 2017.

**REFERENCES:**

1. R.Wolfson. Essential University Physics. Volume 1 & 2. Pearson Education (Indian Edition), 2009.
2. Paul A. Tipler, Physic – Volume 1 & 2, CBS, (Indian Edition), 2004.
3. K.Thyagarajan and A.Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications, (Indian Edition), 2019.
4. D.Halliday, R.Resnick and J.Walker. Principles of Physics, Wiley (Indian Edition), 2015.
5. N.Garcia, A.Damask and S.Schwarz. Physics for Computer Science Students. Springer- Verlag, 2012.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1	3	3	2	1	1	1	-	-	-	-	-	-	-	-	-	-
2	3	3	2	1	2	1	-	-	-	-	-	-	-	-	-	-
3	3	3	2	2	2	1	-	-	-	-	-	1	-	-	-	-
4	3	3	1	1	2	1	-	-	-	-	-	-	-	-	-	-
5	3	3	1	1	2	1	-	-	-	-	-	-	-	-	-	-
AVG	3	3	1.6	1.2	1.8	1	-	-	-	-	-	1	-	-	-	-

1-Low,2-Medium,3-High,"-no correlation

Note: the average value of this course to be used for program articulation matrix.

**COURSE OBJECTIVES:**

- To inculcate sound understanding of water quality parameters and water treatment techniques.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To introduce the basic concepts and applications of phase rule and composites.
- To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
- To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

**UNIT I WATER AND ITS TREATMENT 9**

Water: Sources and impurities, Water quality parameters: Definition and significance of-color, odour, turbidity, pH, hardness, alkalinity, TDS, COD and BOD, fluoride and arsenic. Municipal water treatment: primary treatment and disinfection (UV, Ozonation, break-point chlorination). Desalination of brackish water: Reverse Osmosis. Boiler troubles: Scale and sludge, Boiler corrosion, Caustic embrittlement, Priming & foaming. Treatment of boiler feed water: Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralization and zeolite process.

**UNIT II NANOCHEMISTRY 9**

Basics: Distinction between molecules, nanomaterials and bulk materials; Size-dependent properties (optical, electrical, mechanical and magnetic); Types of nanomaterials: Definition, properties and uses of – nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro spinning. Applications of nanomaterials in medicine, agriculture, energy, electronics and catalysis.

**UNIT III PHASE RULE AND COMPOSITES 9**

Phase rule: Introduction, definition of terms with examples. One component system - water system; Reduced phase rule; Construction of a simple eutectic phase diagram - Thermal analysis; Two component system: lead-silver system - Pattinson process.

Composites: Introduction: Definition & Need for composites; Constitution: Matrix materials (Polymer matrix, metal matrix and ceramic matrix) and Reinforcement (fiber, particulates, flakes and whiskers). Properties and applications of: Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. Hybrid composites - definition and examples.

**UNIT IV FUELS AND COMBUSTION 9**

Fuels: Introduction: Classification of fuels; Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; Power alcohol and biodiesel.

Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; Ignition temperature: spontaneous ignition temperature, Explosive range; Flue gas analysis - ORSAT Method. CO<sub>2</sub> emission and carbon foot print.

**UNIT V ENERGY SOURCES AND STORAGE DEVICES 9**

Stability of nucleus: mass defect (problems), binding energy; Nuclear energy: light water nuclear power plant, breeder reactor. Solar energy conversion: Principle, working and applications of solar cells; Recent developments in solar cell materials. Wind energy; Geothermal energy; Batteries: Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion-battery; Electric vehicles – working principles; Fuel cells: H<sub>2</sub>-O<sub>2</sub> fuel cell, microbial fuel cell; Supercapacitors: Storage principle, types and examples.

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES

At the end of the course, the students will be able:

- To infer the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.
- To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.
- To apply the knowledge of phase rule and composites for material selection requirements.
- To recommend suitable fuels for engineering processes and applications.
- To recognize different forms of energy resources and apply them for suitable applications in energy sectors.

## TEXT BOOKS:

1. P. C. Jain and Monica Jain, "Engineering Chemistry", 17<sup>th</sup> Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2018.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3. S.S. Dara, "A Text book of Engineering Chemistry", S. Chand Publishing, 12<sup>th</sup> Edition, 2018.

## REFERENCES:

1. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, "Text book of nanoscience and nanotechnology", Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2. O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2<sup>nd</sup> Edition, 2017.
3. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.
4. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, Second Edition, 2019.
5. O.V. Roussak and H.D. Gesser, Applied Chemistry-A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013.

## CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	-	1	1	-	-	-	-	1	-	-	-
2	2	-	-	1	-	2	2	-	-	-	-	-	-	-	-
3	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
4	3	1	1	-	-	1	2	-	-	-	-	-	-	-	-
5	3	1	2	1	-	2	2	-	-	-	-	2	-	-	-
Avg.	2.8	1.3	1.6	1	-	1.5	1.8	-	-	-	-	1.5	-	-	-

1-low, 2-medium, 3-high, '-'- no correlation

**COURSE OBJECTIVES:**

- To understand the basics of algorithmic problem solving.
- To learn to solve problems using Python conditionals and loops.
- To define Python functions and use function calls to solve problems.
- To use Python data structures - lists, tuples, dictionaries to represent complex data.
- To do input/output with files in Python.

**UNIT I COMPUTATIONAL THINKING AND PROBLEM SOLVING 9**

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

**UNIT II DATA TYPES, EXPRESSIONS, STATEMENTS 9**

Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

**UNIT III CONTROL FLOW, FUNCTIONS, STRINGS 9**

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

**UNIT IV LISTS, TUPLES, DICTIONARIES 9**

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

**UNIT V FILES, MODULES, PACKAGES 9**

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

**TOTAL : 45 PERIODS****COURSE OUTCOMES:**

Upon completion of the course, students will be able to

CO1: Develop algorithmic solutions to simple computational problems.

CO2: Develop and execute simple Python programs.

CO3: Write simple Python programs using conditionals and looping for solving problems.

CO4: Decompose a Python program into functions.

CO5: Represent compound data using Python lists, tuples, dictionaries etc.

CO6: Read and write data from/to files in Python programs.

**TEXT BOOKS:**

1. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2<sup>nd</sup> Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and programming", 1st Edition, BCS Learning & Development Limited, 2017.

**REFERENCES:**

1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press 2021
4. Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.  
<https://www.python.org/>
6. Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

**COs- PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	2	-	-	-	-	-	2	2	3	3	-
2	3	3	3	3	2	-	-	-	-	-	2	2	3	-	-
3	3	3	3	3	2	-	-	-	-	-	2	-	3	-	-
4	2	2	-	2	2	-	-	-	-	-	1	-	3	-	-
5	1	2	-	-	1	-	-	-	-	-	1	-	2	-	-
AVg.	2	2	-	-	2	-	-	-	-	-	1	-	2	-	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

GE3152

தமிழர் மரபு

L T P C  
1 0 0 1

**அலகு I மொழி மற்றும் இலக்கியம்:**

3

இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை - சங்க இலக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துக்கள் - தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் - சிற்றிலக்கியங்கள் - தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி - தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

**அலகு II மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக் கலை:**

3

நடுகல் முதல் நவீன சிற்பங்கள் வரை - ஜம்பொன் சிலைகள்- பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளூர் சிலை - இசைக் கருவிகள் - மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

**அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்: 3**  
தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஓயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

**அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள்: 3**  
தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

**அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு: 3**  
இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்ச வரலாறு.

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருளை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

**UNIT I LANGUAGE AND LITERATURE 3**

Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

**UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3**

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

**UNIT III FOLK AND MARTIAL ARTS 3**

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

**UNIT IV THINAI CONCEPT OF TAMILS 3**

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

**UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3**

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

**TOTAL : 15 PERIODS****TEXT-CUM-REFERENCE BOOKS**

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.)
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies.)
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.



**COURSE OBJECTIVES:**

- To understand the problem solving approaches.
- To learn the basic programming constructs in Python.
- To practice various computing strategies for Python-based solutions to real world problems.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

**EXPERIMENTS:**

**Note: The examples suggested in each experiment are only indicative. The lab instructor is expected to design other problems on similar lines. The Examination shall not be restricted to the sample experiments listed here.**

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).
3. Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6. Implementing programs using Functions. (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings. (reverse, palindrome, character count, replacing characters)
8. Implementing programs using written modules and Python Standard Libraries (pandas, numpy. Matplotlib, scipy)
9. Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word)
10. Implementing real-time/technical applications using Exception handling. (divide by zero error, voter's age validity, student mark range validation)
11. Exploring Pygame tool.
12. Developing a game activity using Pygame like bouncing ball, car race etc.

**TOTAL: 60 PERIODS****COURSE OUTCOMES:**

On completion of the course, students will be able to:

CO1: Develop algorithmic solutions to simple computational problems

CO2: Develop and execute simple Python programs.

CO3: Implement programs in Python using conditionals and loops for solving problems.

CO4: Deploy functions to decompose a Python program.

CO5: Process compound data using Python data structures.

CO6: Utilize Python packages in developing software applications.

**TEXT BOOKS:**

1. Allen B. Downey, "Think Python : How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.

## REFERENCES:

1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press, 2021
4. Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.
5. <https://www.python.org/>
6. Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

## COs- PO's & PSO's MAPPING

CO's	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	3	3	3	-	-	-	-	-	3	2	3	3
2	3	3	3	3	3	-	-	-	-	-	3	2	3	-
3	3	3	3	3	2	-	-	-	-	-	2	-	3	-
4	3	2	-	2	2	-	-	-	-	-	1	-	3	-
5	1	2	-	-	1	-	-	-	-	-	1	-	2	-
6	2	-	-	-	2	-	-	-	-	-	1	-	2	-
AVg.	2	3	3	3	2	-	-	-	-	-	2	2	3	3

1 - low, 2 - medium, 3 - high, '-' - no correlation

BS3171

PHYSICS AND CHEMISTRY LABORATORY

L T P C

0 0 4 2

PHYSICS LABORATORY: (Any Seven Experiments)

### COURSE OBJECTIVES:

- To learn the proper use of various kinds of physics laboratory equipment.
- To learn how data can be collected, presented and interpreted in a clear and concise manner.
- To learn problem solving skills related to physics principles and interpretation of experimental data.
- To determine error in experimental measurements and techniques used to minimize such error.
- To make the student as an active participant in each part of all lab exercises.
  1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular and irregular objects.
  2. Simple harmonic oscillations of cantilever.
  3. Non-uniform bending - Determination of Young's modulus
  4. Uniform bending – Determination of Young's modulus
  5. Laser- Determination of the wave length of the laser using grating
  6. Air wedge - Determination of thickness of a thin sheet/wire
  7. a) Optical fibre -Determination of Numerical Aperture and acceptance angle  
b) Compact disc- Determination of width of the groove using laser.
  8. Acoustic grating- Determination of velocity of ultrasonic waves in liquids.
  9. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids
  10. Post office box -Determination of Band gap of a semiconductor.
  11. Photoelectric effect
  12. Michelson Interferometer.
  13. Melde's string experiment
  14. Experiment with lattice dynamics kit.

TOTAL: 30 PERIODS

## COURSE OUTCOMES:

Upon completion of the course, the students should be able to

- Understand the functioning of various physics laboratory equipment.
- Use graphical models to analyze laboratory data.
- Use mathematical models as a medium for quantitative reasoning and describing physical reality.
- Access, process and analyze scientific information.
- Solve problems individually and collaboratively.

## CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-
2	3	3	2	1	1	-	-	-	-	-	-	-	-	-	-
3	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-
4	3	3	2	1	1	-	-	-	-	-	-	-	-	-	-
5	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-
AVG	3	2.4	2.6	1	1										

- 1-Low,2-Medium,3-High,"-no correlation
- Note: the average value of this course to be used for program articulation matrix.

## CHEMISTRY LABORATORY: (Any seven experiments to be conducted)

### COURSE OBJECTIVES:

- To inculcate experimental skills to test basic understanding of water quality parameters, such as, acidity, alkalinity, hardness, DO, chloride and copper.
  - To induce the students to familiarize with electroanalytical techniques such as, pH metry, potentiometry and conductometry in the determination of impurities in aqueous solutions.
  - To demonstrate the analysis of metals and alloys.
  - To demonstrate the synthesis of nanoparticles
1. Preparation of  $\text{Na}_2\text{CO}_3$  as a primary standard and estimation of acidity of a water sample using the primary standard
  2. Determination of types and amount of alkalinity in water sample.
    - Split the first experiment into two
  3. Determination of total, temporary & permanent hardness of water by EDTA method.
  4. Determination of DO content of water sample by Winkler's method.
  5. Determination of chloride content of water sample by Argentometric method.
  6. Estimation of copper content of the given solution by Iodometry.
  7. Estimation of TDS of a water sample by gravimetry.
  8. Determination of strength of given hydrochloric acid using pH meter.
  9. Determination of strength of acids in a mixture of acids using conductivity meter.
  10. Conductometric titration of barium chloride against sodium sulphate (precipitation titration)
  11. Estimation of iron content of the given solution using potentiometer.
  12. Estimation of sodium /potassium present in water using flame photometer.
  13. Preparation of nanoparticles ( $\text{TiO}_2/\text{ZnO}/\text{CuO}$ ) by Sol-Gel method.
  14. Estimation of Nickel in steel
  15. Proximate analysis of Coal

**TOTAL : 30 PERIODS**

### COURSE OUTCOMES:

- To analyse the quality of water samples with respect to their acidity, alkalinity, hardness and DO.
- To determine the amount of metal ions through volumetric and spectroscopic techniques
- To analyse and determine the composition of alloys.
- To learn simple method of synthesis of nanoparticles

- To quantitatively analyse the impurities in solution by electroanalytical techniques

**TEXT BOOK:**

- J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas and B. Sivasankar, Vogel's Textbook of Quantitative Chemical Analysis (2009).

**CO-PO & PSO MAPPING**

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	-	1	-	-	2	2	-	-	-	-	2	-	-	-
2	3	1	2	-	-	1	2	-	-	-	-	1	-	-	-
3	3	2	1	1	-	-	1	-	-	-	-	-	-	-	-
4	2	1	2	-	-	2	2	-	-	-	-	-	-	-	-
5	2	1	2	-	1	2	2	-	-	-	-	1	-	-	-
Avg.	2.6	1.3	1.6	1	1	1.4	1.8	-	-	-	-	1.3	-	-	-

- 1-low, 2-medium, 3-high, '-'- no correlation

**GE3172**

**ENGLISH LABORATORY**

**L T P C**  
**0 0 2 1**

**OBJECTIVES :**

- To improve the communicative competence of learners
- To help learners use language effectively in academic /work contexts
- To develop various listening strategies to comprehend various types of audio materials like lectures, discussions, videos etc.
- To build on students' English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
- To use language efficiently in expressing their opinions via various media.

**UNIT I INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 6**

Listening for general information-specific details- conversation: Introduction to classmates - Audio / video (formal & informal); Telephone conversation; Listening to voicemail & messages; Listening and filling a form. Speaking - making telephone calls-Self Introduction; Introducing a friend; - politeness strategies- making polite requests, making polite offers, replying to polite requests and offers-understanding basic instructions( filling out a bank application for example).

**UNIT II NARRATION AND SUMMATION 6**

Listening - Listening to podcasts, anecdotes / stories / event narration; documentaries and interviews with celebrities. Speaking - Narrating personal experiences / events-Talking about current and temporary situations & permanent and regular situations\* - describing experiences and feelings-engaging in small talk- describing requirements and abilities.

**UNIT III DESCRIPTION OF A PROCESS / PRODUCT 6**

Listening - Listen to product and process descriptions; a classroom lecture; and advertisements about products. Speaking – Picture description- describing locations in workplaces- Giving instruction to use the product- explaining uses and purposes- Presenting a product- describing shapes and sizes and weights- talking about quantities(large & small)-talking about precautions.

**UNIT IV CLASSIFICATION AND RECOMMENDATIONS 6**

Listening – Listening to TED Talks; Listening to lectures - and educational videos. Speaking – Small Talk; discussing and making plans-talking about tasks-talking about progress- talking about positions and directions of movement-talking about travel preparations- talking about transportation-

**UNIT V EXPRESSION****6**

Listening – Listening to debates/ discussions; different viewpoints on an issue; and panel discussions.  
 Speaking –making predictions- talking about a given topic-giving opinions- understanding a website-  
 describing processes

**TOTAL : 30 PERIODS****LEARNING OUTCOMES:**

At the end of the course, learners will be able

- To listen to and comprehend general as well as complex academic information
- To listen to and understand different points of view in a discussion
- To speak fluently and accurately in formal and informal communicative contexts
- To describe products and processes and explain their uses and purposes clearly and accurately
- To express their opinions effectively in both formal and informal discussions

**ASSESSMENT PATTERN**

- One online / app based assessment to test listening /speaking
- End Semester **ONLY** listening and speaking will be conducted online.
- Proficiency certification is given on successful completion of listening and speaking internal test and end semester exam.

**CO-PO & PSO MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
2	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
3	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
4	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
5	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
AVg.	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-

1-low, 2-medium, 3-high, '-'- no correlation

**Note:** The average value of this course to be used for program articulation matrix.

**HS3252****PROFESSIONAL ENGLISH - II****L T P C****2 0 0 2****OBJECTIVES:**

- To engage learners in meaningful language activities to improve their reading and writing skills
- To learn various reading strategies and apply in comprehending documents in professional context.
- To help learners understand the purpose, audience, contexts of different types of writing
- To develop analytical thinking skills for problem solving in communicative contexts
- To demonstrate an understanding of job applications and interviews for internship and placements

<b>UNIT I</b>	<b>MAKING COMPARISONS</b>	<b>6</b>
Reading - Reading advertisements, user manuals, brochures; Writing – Professional emails, Email etiquette - Compare and Contrast Essay; Grammar – Mixed Tenses, Prepositional phrases		
<b>UNIT II</b>	<b>EXPRESSING CAUSAL RELATIONS IN SPEAKING AND WRITING</b>	<b>6</b>
Reading - Reading longer technical texts– Cause and Effect Essays, and Letters / emails of complaint, Writing - Writing responses to complaints. Grammar - Active Passive Voice transformations, Infinitive and Gerunds		
<b>UNIT III</b>	<b>PROBLEM SOLVING</b>	<b>6</b>
Reading - Case Studies, excerpts from literary texts, news reports etc. Writing – Letter to the Editor, Checklists, Problem solution essay / Argumentative Essay. Grammar – Error correction; If conditional sentences		
<b>UNIT IV</b>	<b>REPORTING OF EVENTS AND RESEARCH</b>	<b>6</b>
Reading –Newspaper articles; Writing – Recommendations, Transcoding, Accident Report, Survey Report Grammar – Reported Speech, Modals Vocabulary – Conjunctions- use of prepositions		
<b>UNIT V</b>	<b>THE ABILITY TO PUT IDEAS OR INFORMATION COGENTLY</b>	<b>6</b>
Reading – Company profiles, Statement of Purpose, (SOP), an excerpt of interview with professionals; Writing – Job / Internship application – Cover letter & Resume; Grammar – Numerical adjectives, Relative Clauses.		

**TOTAL : 30 PERIODS**

**OUTCOMES:**

At the end of the course, learners will be able

- To compare and contrast products and ideas in technical texts.
- To identify and report cause and effects in events, industrial processes through technical texts
- To analyse problems in order to arrive at feasible solutions and communicate them in the written format.
- To present their ideas and opinions in a planned and logical manner
- To draft effective resumes in the context of job search.

**TEXT BOOKS :**

1. English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.
2. English for Science & Technology Cambridge University Press 2021.
3. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

**REFERENCES:**

1. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.
2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, NewDelhi.
3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.

**ASSESSMENT PATTERN**

Two internal assessments and an end semester examination to test students' reading and writing skills along with their grammatical and lexical competence.

### CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3	3	3	3	2	3	3	3	-	-	-
2	3	3	3	3	3	3	3	3	2	3	3	3	-	-	-
3	3	3	3	3	3	3	3	3	2	3	3	3	-	-	-
4	3	3	3	3	2	3	3	3	2	3	3	3	-	-	-
5	-	-	-	-	-	-	-	-	3	3	3	3	-	-	-
AVg.	3	3	3	3	2.75	3	3	3	2.2	3	3	3	-	-	-

- 1-low, 2-medium, 3-high, '-'- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.

MA3251

**STATISTICS AND NUMERICAL METHODS**

**L T P C**  
**3 1 0 4**

**COURSE OBJECTIVES:**

- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

**UNIT I TESTING OF HYPOTHESIS**

**9+3**

Sampling distributions - Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.

**UNIT II DESIGN OF EXPERIMENTS**

**9+3**

One way and two way classifications - Completely randomized design – Randomized block design – Latin square design - 2<sup>2</sup> factorial design.

**UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS**

**9+3**

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.

**UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION**

**9+3**

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

**UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 9+3**

Single step methods: Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first order differential equations - Multi step methods: Milne's and Adams - Bash forth predictor corrector methods for solving first order differential equations.

**TOTAL: 60 PERIODS****COURSE OUTCOMES:**

Upon successful completion of the course, students will be able to:

- Apply the concept of testing of hypothesis for small and large samples in real life problems.
- Apply the basic concepts of classifications of design of experiments in the field of agriculture.
- Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.
- Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
- Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

**TEXT BOOKS:**

1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10<sup>th</sup> Edition, New Delhi, 2015.
2. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8<sup>th</sup> Edition, 2015.

**REFERENCES:**

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9<sup>th</sup> Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8<sup>th</sup> Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7<sup>th</sup> Edition, 2007.
4. Gupta S.C. and Kapoor V. K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 12<sup>th</sup> Edition, 2020.
5. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics ", Tata McGraw Hill Edition, 4<sup>th</sup> Edition, 2012.
6. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", 9<sup>th</sup> Edition, Pearson Education, Asia, 2010.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
<b>CO1</b>	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
<b>CO2</b>	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
<b>CO3</b>	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
<b>CO4</b>	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
<b>CO5</b>	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
<b>Avg</b>	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-



**COURSE OBJECTIVES:**

- To make the students to understand the basics of crystallography and its importance in studying materials properties.
- To understand the electrical properties of materials including free electron theory, applications of quantum mechanics and magnetic materials.
- To instil knowledge on physics of semiconductors, determination of charge carriers and device applications
- To establish a sound grasp of knowledge on different optical properties of materials, optical displays and applications
- To inculcate an idea of significance of nano structures, quantum confinement and ensuing nano device applications.

**UNIT I CRYSTALLOGRAPHY 9**

Crystal structures: BCC, FCC and HCP – directions and planes - linear and planar densities – crystal imperfections- edge and screw dislocations – grain and twin boundaries - Burgers vector and elastic strain energy- Slip systems, plastic deformation of materials - Polymorphism – phase changes – nucleation and growth – homogeneous and heterogeneous nucleation.

**UNIT II ELECTRICAL AND MAGNETIC PROPERTIES OF MATERIALS 9**

Classical free electron theory - Expression for electrical conductivity – Thermal conductivity, expression - Quantum free electron theory :Tunneling – degenerate states – Fermi- Dirac statistics – Density of energy states – Electron in periodic potential – Energy bands in solids – tight binding approximation - Electron effective mass – concept of hole. Magnetic materials: Dia, para and ferromagnetic effects – paramagnetism in the conduction electrons in metals – exchange interaction and ferromagnetism – quantum interference devices – GMR devices.

**UNIT III SEMICONDUCTORS AND TRANSPORT PHYSICS 9**

Intrinsic Semiconductors – Energy band diagram – direct and indirect band gap semiconductors – Carrier concentration in intrinsic semiconductors – extrinsic semiconductors - Carrier concentration in N-type & P-type semiconductors – Variation of carrier concentration with temperature – Carrier transport in Semiconductors: Drift, mobility and diffusion – Hall effect and devices – Ohmic contacts – Schottky diode.

**UNIT IV OPTICAL PROPERTIES OF MATERIALS 9**

Classification of optical materials – Optical processes in semiconductors: optical absorption and emission, charge injection and recombination, optical absorption, loss and gain. Optical processes in quantum wells – Optoelectronic devices: light detectors and solar cells – light emitting diode – laser diode - optical processes in organic semiconductor devices –excitonic state – Electro-optics and nonlinear optics: Modulators and switching devices – plasmonics.

**UNIT V NANO-ELECTRONIC DEVICES 9**

Quantum confinement – Quantum structures – quantum wells, wires and dots – Zener-Bloch oscillations – Resonant tunneling – quantum interference effects - mesoscopic structures - Single electron phenomena – Single electron Transistor. Semiconductor photonic structures – 1D, 2D and 3D photonic crystal. Active and passive optoelectronic devices – photo processes – spintronics – carbon nanotubes: Properties and applications.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

At the end of the course, the students should be able to

- know basics of crystallography and its importance for varied materials properties
- gain knowledge on the electrical and magnetic properties of materials and their applications
- understand clearly of semiconductor physics and functioning of semiconductor devices
- understand the optical properties of materials and working principles of various optical devices
- appreciate the importance of functional nanoelectronic devices.

**TEXT BOOKS:**

1. V.Raghavan. Materials Science and Engineering: A First Course, Prentice Hall India Learning Private Limited, 2015.
2. S.O. Kasap, Principles of Electronic Materials and Devices, Mc-Graw Hill, 2018.
3. Jasprit Singh, Semiconductor Devices: Basic Principles, Wiley (India), 2007.
4. Jasprit Singh, Semiconductor Optoelectronics: Physics and Technology, Mc-Graw Hill India (2019)
5. G.W.Hanson. Fundamentals of Nanoelectronics. Pearson Education (Indian Edition), 2009.

**REFERENCES:**

1. R.Balasubramaniam, Callister's Materials Science and Engineering. Wiley (Indian Edition), 2014.
2. Wendelin Wright and Donald Askeland, Essentials of Materials Science and Engineering, CL Engineering, 2013.
3. Robert F.Pierret, Semiconductor Device Fundamentals, Pearson, 2006
4. Pallab Bhattacharya, Semiconductor Optoelectronic Devices, Pearson, 2017
5. Ben Rogers, Jesse Adams and Sumita Pennathur, Nanotechnology: Understanding Small Systems, CRC Press, 2017.

**CO's-PO's & PSO's MAPPING**

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1	3	2	1	2	1	1	-	-	-	-	-	-	-	-	-	-
2	3	2	1	1	2	1	1	-	-	-	-	-	-	-	-	-
3	3	2	2	2	2	1	-	-	-	-	-	-	-	-	-	-
4	3	2	2	1	2	2	-	-	-	-	-	1	-	-	-	-
5	3	2	2	1	2	1	-	-	-	-	-	-	-	-	-	-
<b>AVG</b>	3	2	1.6	1.4	1.8	1.2	1	-	-	-	-	1	-	-	-	-

1-Low,2-Medium,3-High,"-no correlation

Note: the average value of this course to be used for program articulation matrix.

**BE3251****BASIC ELECTRICAL AND ELECTRONICS ENGINEERING**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

- To introduce the basics of electric circuits and analysis
- To impart knowledge in the basics of working principles and application of electrical machines
- To introduce analog devices and their characteristics
- To educate on the fundamental concepts of digital electronics
- To introduce the functional elements and working of measuring instruments

**UNIT I ELECTRICAL CIRCUITS****9**

DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm's Law - Kirchhoff's Laws –Independent and Dependent Sources – Simple problems- Nodal Analysis, Mesh analysis with Independent sources only (Steady state)

Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor – Steady state analysis of RLC circuits (Simple problems only)

**UNIT II ELECTRICAL MACHINES****9**

Construction and Working principle- DC Separately and Self excited Generators, EMF equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Construction, Working principle and Applications of Transformer, Three phase Alternator, Synchronous motor and Three Phase Induction Motor.

**UNIT III ANALOG ELECTRONICS****9**

Resistor, Inductor and Capacitor in Electronic Circuits- Semiconductor Materials: Silicon & Germanium – PN Junction Diodes, Zener Diode – Characteristics Applications – Bipolar Junction Transistor-Biasing, JFET, SCR, MOSFET, IGBT – Types, I-V Characteristics and Applications, Rectifier and Inverters

**UNIT IV DIGITAL ELECTRONICS****9**

Review of number systems, binary codes, error detection and correction codes, Combinational logic - representation of logic functions-SOP and POS forms, K-map representations - minimization using K maps (Simple Problems only)

**UNIT V MEASUREMENTS AND INSTRUMENTATION****9**

Functional elements of an instrument, Standards and calibration, Operating Principle, types -Moving Coil and Moving Iron meters, Measurement of three phase power, Energy Meter, Instrument Transformers-CT and PT, DSO- Block diagram- Data acquisition.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

After completing this course, the students will be able to

1. Compute the electric circuit parameters for simple problems
2. Explain the working principle and applications of electrical machines
3. Analyze the characteristics of analog electronic devices
4. Explain the basic concepts of digital electronics
5. Explain the operating principles of measuring instruments

**TEXT BOOKS:**

1. Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", Second Edition, McGraw Hill Education, 2020
2. S.K. Bhattacharya "Basic Electrical and Electronics Engineering", Pearson Education, Second Edition, 2017.
3. Sedha R.S., "A text book book of Applied Electronics", S. Chand & Co., 2008
4. James A. Svoboda, Richard C. Dorf, "Dorf's Introduction to Electric Circuits", Wiley, 2018.
5. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2015.

**REFERENCES:**

1. Kothari DP and I.J Nagrath, "Basic Electrical Engineering", Fourth Edition, McGraw Hill Education, 2019.
2. Thomas L. Floyd, 'Digital Fundamentals', 11<sup>th</sup> Edition, Pearson Education, 2017.
3. Albert Malvino, David Bates, 'Electronic Principles, McGraw Hill Education; 7<sup>th</sup> edition, 2017.
4. Mahmood Nahvi and Joseph A. Edminister, "Electric Circuits", Schaum' Outline Series, McGraw Hill, 2002.
5. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010

Mapping of COs with POs and PSOs															
COs/POs&PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	1					1				2			1
CO2	2	2	1					1				2			1
CO3	2	1	1					1				2			1
CO4	2	2	1					1				2			1
CO5	2	2	1					1				2			1
CO/PO & PSO Average	2	1.8	1					1				2			1

1 – Slight, 2 – Moderate, 3 – Substantial

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

1. Drawing engineering curves.
2. Drawing freehand sketch of simple objects.
3. Drawing orthographic projection of solids and section of solids.
4. Drawing development of solids
5. Drawing isometric and perspective projections of simple solids.

**CONCEPTS AND CONVENTIONS (Not for Examination)**

Importance of graphics in engineering applications - Use of drafting instruments - BIS conventions and specifications — Size, layout and folding of drawing sheets — Lettering and dimensioning.

**UNIT I PLANE CURVES****6+12**

Basic Geometrical constructions, Curves used in engineering practices: Conics — Construction of ellipse, parabola and hyperbola by eccentricity method — Construction of cycloid — construction of involutes of square and circle — Drawing of tangents and normal to the above curves.

**UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE****6+12**

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

**UNIT III PROJECTION OF SOLIDS AND FREEHAND SKETCHING****6+12**

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method. Visualization concepts and Free Hand sketching: Visualization principles —Representation of Three Dimensional objects — Layout of views- Freehand sketching of multiple views from pictorial views of objects. Practicing three dimensional modeling of simple objects by CAD Software (Not for examination)

**UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES****6 +12**

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other — obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids — Prisms, pyramids cylinders and cones. Practicing three dimensional modeling of simple objects by CAD Software (Not for examination)

**UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS****6+12**

Principles of isometric projection — isometric scale - Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method. Practicing three dimensional modeling of isometric projection of simple objects by CAD Software (Not for examination)

**TOTAL: (L=30; P=60) 90 PERIODS****OUTCOMES:**

On successful completion of this course, the student will be able to

- Use BIS conventions and specifications for engineering drawing.
- Construct the conic curves, involutes and cycloid.
- Solve practical problems involving projection of lines.
- Draw the orthographic, isometric and perspective projections of simple solids.
- Draw the development of simple solids.

**TEXT BOOK:**

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 53<sup>rd</sup> Edition, 2019.
2. Natrajan K.V., "A Text Book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2018.
3. Parthasarathy, N. S. and Vela Murali, "Engineering Drawing", Oxford University Press, 2015

**REFERENCES:**

1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill, 2<sup>nd</sup> Edition, 2019.
2. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Publications, Bangalore, 27<sup>th</sup> Edition, 2017.
3. Luzzader, Warren.J. and Duff, John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4. Parthasarathy N. S. and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.
5. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson Education India, 2<sup>nd</sup> Edition, 2009.
6. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.

**Publication of Bureau of Indian Standards:**

1. IS 10711 — 2001: Technical products Documentation — Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) — 2001: Technical products Documentation — Lettering.
3. IS 10714 (Part 20) — 2001 & SP 46 — 2003: Lines for technical drawings.
4. IS 11669 — 1986 & SP 46 — 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) — 2001: Technical drawings — Projection Methods.

**Special points applicable to University Examinations on Engineering Graphics:**

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	2		2					3		2	2	2	
2	3	1	2		2					3		2	2	2	
3	3	1	2		2					3		2	2	2	
4	3	1	2		2					3		2	2	2	
5	3	1	2		2					3		2	2	2	
Avg.	3	1	2		2					3		2	2	2	
Low (1) ;	Medium (2) ;		High (3)												

**அலகு I நெசவு மற்றும் பானைத் தொழில்நுட்பம்:**

3

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

**அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்:**

3

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

**அலகு III உற்பத்தித் தொழில் நுட்பம்:**

3

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

**அலகு IV வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்:**

3

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குழுவித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

**அலகு V அறிவியல் தமிழ் மற்றும் கணித்தமிழ்:**

3

அறிவியல் தமிழின் வளர்ச்சி – கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

**TOTAL : 15 PERIODS****TEXT-CUM-REFERENCE BOOKS**

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருறை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)

6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

**GE3252**

**TAMILS AND TECHNOLOGY**

**L T P C**

**1 0 0 1**

**UNIT I WEAVING AND CERAMIC TECHNOLOGY**

**3**

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

**UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY**

**3**

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

**UNIT III MANUFACTURING TECHNOLOGY**

**3**

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold-Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

**UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY**

**3**

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

**UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING**

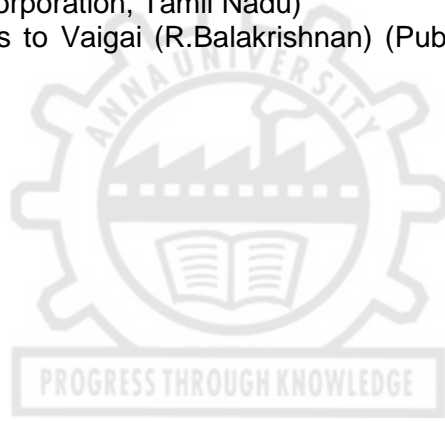
**3**

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

**TOTAL : 15 PERIODS**

## TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருறை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.





## NCC CREDIT COURSE LEVEL 1\*

<b>NX3251</b>	<b>(ARMY WING) NCC Credit Course Level - I</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>

<b>NCC GENERAL</b>					<b>6</b>
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NCC 1	Aims, Objectives & Organization of NCC				1
NCC 2	Incentives				2
NCC 3	Duties of NCC Cadet				1
NCC 4	NCC Camps: Types & Conduct				2

<b>NATIONAL INTEGRATION AND AWARENESS</b>					<b>4</b>
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NI 1	National Integration: Importance & Necessity				1
NI 2	Factors Affecting National Integration				1
NI 3	Unity in Diversity & Role of NCC in Nation Building				1
NI 4	Threats to National Security				1

<b>PERSONALITY DEVELOPMENT</b>					<b>7</b>
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PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving				2
PD 2	Communication Skills				3
PD 3	Group Discussion: Stress & Emotions				2

<b>LEADERSHIP</b>					<b>5</b>
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L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour ' Code				3
L 2	Case Studies: Shivaji, Jhasi Ki Rani				2

<b>SOCIAL SERVICE AND COMMUNITY DEVELOPMENT</b>					<b>8</b>
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SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth				3
SS 4	Protection of Children and Women Safety				1
SS 5	Road / Rail Travel Safety				1
SS 6	New Initiatives				2
SS 7	Cyber and Mobile Security Awareness				1

**TOTAL: 30 PERIODS**

## NCC Credit Course Level 1\*

<b>NX3252</b>	<b>(NAVAL WING) NCC Credit Course Level - I</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>

<b>NCC GENERAL</b>					<b>6</b>
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NCC 1	Aims, Objectives & Organization of NCC				1
NCC 2	Incentives				2
NCC 3	Duties of NCC Cadet				1
NCC 4	NCC Camps: Types & Conduct				2

<b>NATIONAL INTEGRATION AND AWARENESS</b>					<b>4</b>
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NI 1	National Integration: Importance & Necessity				1
NI 2	Factors Affecting National Integration				1
NI 3	Unity in Diversity & Role of NCC in Nation Building				1

NI 4	Threats to National Security	1
<b>PERSONALITY DEVELOPMENT</b>		<b>7</b>
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
<b>LEADERSHIP</b>		<b>5</b>
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
<b>SOCIAL SERVICE AND COMMUNITY DEVELOPMENT</b>		<b>8</b>
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

**TOTAL : 30 PERIODS**

**NCC Credit Course Level 1\***

<b>NX3253</b>	<b>(AIR FORCE WING) NCC Credit Course Level - I</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>

<b>NCC GENERAL</b>					<b>6</b>
NCC 1	Aims, Objectives & Organization of NCC				1
NCC 2	Incentives				2
NCC 3	Duties of NCC Cadet				1
NCC 4	NCC Camps: Types & Conduct				2

<b>NATIONAL INTEGRATION AND AWARENESS</b>					<b>4</b>
NI 1	National Integration: Importance & Necessity				1
NI 2	Factors Affecting National Integration				1
NI 3	Unity in Diversity & Role of NCC in Nation Building				1
NI 4	Threats to National Security				1

<b>PERSONALITY DEVELOPMENT</b>					<b>7</b>
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving				2
PD 2	Communication Skills				3
PD 3	Group Discussion: Stress & Emotions				2

<b>LEADERSHIP</b>					<b>5</b>
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code				3
L 2	Case Studies: Shivaji, Jhasi Ki Rani				2

<b>SOCIAL SERVICE AND COMMUNITY DEVELOPMENT</b>					<b>8</b>
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth				3
SS 4	Protection of Children and Women Safety				1
SS 5	Road / Rail Travel Safety				1
SS 6	New Initiatives				2
SS 7	Cyber and Mobile Security Awareness				1

**TOTAL : 30 PERIODS**

**COURSE OBJECTIVES:**

The main learning objective of this course is to provide hands on training to the students in:

1. Drawing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planing; making joints in wood materials used in common household wood work.
2. Wiring various electrical joints in common household electrical wire work.
3. Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts; Assembling simple mechanical assembly of common household equipments; Making a tray out of metal sheet using sheet metal work.
4. Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.

**GROUP – A (CIVIL & ELECTRICAL)****PART I CIVIL ENGINEERING PRACTICES 15****PLUMBING WORK:**

- a) Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
- b) Preparing plumbing line sketches.
- c) Laying pipe connection to the suction side of a pump
- d) Laying pipe connection to the delivery side of a pump.
- e) Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.

**WOOD WORK:**

- a) Sawing,
- b) Planing and
- c) Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.

**Wood Work Study:**

- a) Studying joints in door panels and wooden furniture
- b) Studying common industrial trusses using models.

**PART II ELECTRICAL ENGINEERING PRACTICES 15**

- a) Introduction to switches, fuses, indicators and lamps - Basic switch board wiring with lamp, fan and three pin socket
- b) Staircase wiring
- c) Fluorescent Lamp wiring with introduction to CFL and LED types.
- d) Energy meter wiring and related calculations/ calibration
- e) Study of Iron Box wiring and assembly
- f) Study of Fan Regulator (Resistor type and Electronic type using Diac/Triac/quadrac)
- g) Study of emergency lamp wiring/Water heater

**GROUP – B (MECHANICAL AND ELECTRONICS)**

**PART III**

**MECHANICAL ENGINEERING PRACTICES**

**15**

**WELDING WORK:**

- a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
- b) Practicing gas welding.

**BASIC MACHINING WORK:**

- a) (simple)Turning.
- b) (simple)Drilling.
- c) (simple)Tapping.

**ASSEMBLY WORK:**

- a) Assembling a centrifugal pump.
- b) Assembling a household mixer.
- c) Assembling an airconditioner.

**SHEET METAL WORK:**

- a) Making of a square tray

**FOUNDRY WORK:**

- a) Demonstrating basic foundry operations.

**PART IV**

**ELECTRONIC ENGINEERING PRACTICES**

**15**

**SOLDERING WORK:**

- a) Soldering simple electronic circuits and checking continuity.

**ELECTRONIC ASSEMBLY AND TESTING WORK:**

- a) Assembling and testing electronic components on a small PCB.

**ELECTRONIC EQUIPMENT STUDY:**

- a) Study an elements of smart phone.
- b) Assembly and dismantle of LED TV.
- c) Assembly and dismantle of computer/ laptop

**TOTAL = 60 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

1. Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.
2. Wire various electrical joints in common household electrical wire work.
3. Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical assembly of common household equipments; Make a tray out of metal sheet using sheet metal work.
4. Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2			1	1	1					2	2	1	1
2	3	2			1	1	1					2	2	1	1
3	3	2			1	1	1					2	2	1	1
Avg.	3	2			1	1	1					2	2	1	1
Low (1); Medium (2); High (3)															

**COURSE OBJECTIVES:**

- To train the students in conducting load tests on electrical machines
- To gain practical experience in characterizing electronic devices
- To train the students to use DSO for measurements.

**LIST OF EXPERIMENTS**

1. Verification of ohms and Kirchhoff's Laws.
2. Load test on DC Shunt Motor.
3. Load test on Self Excited DC Generator
4. Load test on Single phase Transformer
5. Load Test on Induction Motor
6. Characteristics of PN and Zener Diodes
7. Characteristics of BJT, SCR and MOSFET
8. Half wave and Full Wave rectifiers
9. Study of Logic Gates
10. Implementation of Binary Adder and Subtractor
11. Study of DSO

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

After completing this course, the students will be able to

1. Use experimental methods to verify the Ohm's and Kirchhoff's Laws.
2. Analyze experimentally the load characteristics of electrical machines
3. Analyze the characteristics of basic electronic devices
4. Use DSO to measure the various parameters

Mapping of COs with POs and PSOs															
COs/POs&P SOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	1	1			1.5	2						1
CO2	3	3	2	1	1			1.5	2						1
CO3	3	3	2	1	1			1.5	2						1
CO4	3	3	2	1	1			1.5	2						1
CO5	3	3	2	1	1			1.5	2						1
CO/PO & PSO Average	3	3	2	1	1			1.5	2						1

1 – Slight, 2 – Moderate, 3 – Substantial

**OBJECTIVES**

- To identify varied group discussion skills and apply them to take part in effective discussions in a professional context.
- To analyse concepts and problems and make effective presentations explaining them clearly and precisely.
- To be able to communicate effectively through formal and informal writing.
- To be able to use appropriate language structures to write emails, reports and essays
- To give instructions and recommendations that are clear and relevant to the context

**UNIT I**

**12**

Speaking-Role Play Exercises Based on Workplace Contexts, - talking about competition-discussing progress toward goals-talking about experiences- talking about events in life- discussing past events-Writing: writing emails (formal & semi-formal).

**UNIT II**

**12**

Speaking: discussing news stories-talking about frequency-talking about travel problems-discussing travel procedures- talking about travel problems- making arrangements-describing arrangements-discussing plans and decisions- discussing purposes and reasons- understanding common technology terms-Writing: - writing different types of emails.

**UNIT III**

**12**

Speaking: discussing predictions-describing the climate-discussing forecasts and scenarios- talking about purchasing-discussing advantages and disadvantages- making comparisons- discussing likes and dislikes- discussing feelings about experiences-discussing imaginary scenarios Writing: short essays and reports-formal/semi-formal letters.

**UNIT IV**

**12**

Speaking: discussing the natural environment-describing systems-describing position and movement- explaining rules-( example- discussing rental arrangements)- understanding technical instructions-Writing: writing instructions-writing a short article.

**UNIT V**

**12**

Speaking: describing things relatively-describing clothing-discussing safety issues (making recommendations) talking about electrical devices-describing controlling actions- Writing: job application (Cover letter + Curriculum vitae)-writing recommendations.

**TOTAL: 60 PERIODS**

**LEARNING OUTCOMES**

At the end of the course, learners will be able

- Speak effectively in group discussions held in a formal/semi formal contexts.
- Discuss, analyse and present concepts and problems from various perspectives to arrive at suitable solutions
- Write emails, letters and effective job applications.
- Write critical reports to convey data and information with clarity and precision
- Give appropriate instructions and recommendations for safe execution of tasks

**Assessment Pattern**

- One online / app based assessment to test speaking and writing skills
- Proficiency certification is given on successful completion of speaking and writing.

**CO-PO & PSO MAPPING**

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	3	3	1	3	3	3	3	3	3	3	-	-	-
2	2	3	3	3	1	3	3	3	3	3	3	3	-	-	-
3	2	2	3	3	1	3	3	3	3	3	3	3	-	-	-
4	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
5	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
AVg.	2.4	2.8	3	3	1.8	3	3	3	3	3	3	3	-	-	-

**COURSE OBJECTIVES:**

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To acquaint the student with Fourier, transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

**UNIT I PARTIAL DIFFERENTIAL EQUATIONS****9+3**

Formation of partial differential equations – Solutions of standard types of first order partial differential equations - First order partial differential equations reducible to standard types- Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

**UNIT II FOURIER SERIES****9+3**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series and cosine series – Root mean square value – Parseval's identity – Harmonic analysis.

**UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS****9+3**

Classification of PDE – Method of separation of variables - Fourier series solutions of one-dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two-dimensional equation of heat conduction (Cartesian coordinates only).

**UNIT IV FOURIER TRANSFORMS****9+3**

Statement of Fourier integral theorem– Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

**UNIT V Z - TRANSFORMS AND DIFFERENCE EQUATIONS****9+3**

Z-transforms - Elementary properties – Convergence of Z-transforms - – Initial and final value theorems - Inverse Z-transform using partial fraction and convolution theorem - Formation of difference equations – Solution of difference equations using Z - transforms.

**TOTAL: 60 PERIODS****OUTCOMES:**

Upon successful completion of the course, students should be able to:

1. Understand how to solve the given standard partial differential equations.
2. Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
3. Appreciate the physical significance of Fourier series techniques in solving one- and two-dimensional heat flow problems and one-dimensional wave equations.
4. Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.
5. Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems

**TEXT BOOKS:**

1. Grewal B.S., "Higher Engineering Mathematics", 44<sup>th</sup> Edition, Khanna Publishers, New Delhi, 2018.
2. Kreyszig E, "Advanced Engineering Mathematics ", 10<sup>th</sup> Edition, John Wiley, New Delhi, India, 2018.

**REFERENCES:**

1. Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers" SPIE Press, 1999.
2. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 10<sup>th</sup> Edition, Laxmi Publications Pvt. Ltd, 2021.
3. James. G., "Advanced Modern Engineering Mathematics", 4<sup>th</sup> Edition, Pearson Education, New Delhi, 2016.
4. Narayanan. S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.
6. Wylie. R.C. and Barrett. L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	0	0	0	0	2	0	0	3	-	-	-
CO2	3	3	1	1	0	0	0	0	2	0	0	3	-	-	-
CO3	3	3	1	1	0	0	0	0	2	0	0	3	-	-	-
CO4	3	3	1	1	0	0	0	0	2	0	0	3	-	-	-
CO5	3	3	1	1	0	0	0	0	2	0	0	3	-	-	-
Avg	3	3	1	1	0	0	0	0	2	0	0	3	-	-	-

**ME3351****ENGINEERING MECHANICS**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

- 1 To Learn the use scalar and vector analytical techniques for analysing forces in statically determinate structures
- 2 To introduce the equilibrium of rigid bodies, vector methods and free body diagram
- 3 To study and understand the distributed forces, surface, loading on beam and intensity.
- 4 To learn the principles of friction, forces and to determine the apply the concepts of frictional forces at the contact surfaces of various engineering systems.
- 5 To develop basic dynamics concepts – force, momentum, work and energy;

**UNIT I STATICS OF PARTICLES****9**

Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles -Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors. Equilibrium of a Particle- Newton's First Law of Motion, Space and Free-Body Diagrams, Forces in Space, Equilibrium of a Particle in Space.

**UNIT II EQUILIBRIUM OF RIGID BODIES****9**

Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point, Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple - Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force -Couple system, Further Reduction of a System of Forces, Equilibrium in Two and Three Dimensions - Reactions at Supports and Connections.

**UNIT III DISTRIBUTED FORCES****9**

Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration, Theorems of Pappus-Guldinus, Distributed Loads on Beams, Centre of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies, Determination of Centroids of Volumes by Integration. Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration, Polar Moment of Inertia, Radius of Gyration of an Area, Parallel-Axis Theorem, Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates, Determination of the Moment of Inertia of a Three-Dimensional Body by Integration.



**UNIT IV FRICTION****9**

The Laws of Dry Friction, Coefficients of Friction, Angles of Friction, Wedge friction, Wheel Friction, Rolling Resistance, Ladder friction.

**UNIT V DYNAMICS OF PARTICLES****9**

Kinematics - Rectilinear Motion and Curvilinear Motion of Particles. Kinetics- Newton's Second Law of Motion -Equations of Motions, Dynamic Equilibrium, Energy and Momentum Methods - Work of a Force, Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact of bodies.

**TOTAL: 45 PERIODS****OUTCOMES:**

At the end of the course the students would be able to

- Illustrate the vector and scalar representation of forces and moments
- Analyse the rigid body in equilibrium
- Evaluate the properties of distributed forces
- Determine the friction and the effects by the laws of friction
- Calculate dynamic forces exerted in rigid body

**TEXT BOOKS:**

Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, Sanjeev Sanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education., 12thEdition, 2019.  
Vela Murali, "Engineering Mechanics-Statics and Dynamics", Oxford University Press, 2018.

**REFERENCES:**

- 1 Boresi P and Schmidt J, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
- 2 Hibbeler, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
- 3 Irving H. Shames, Krishna Mohana Rao G, Engineering Mechanics – Statics and Dynamics, 4thEdition, Pearson Education Asia Pvt. Ltd., 2005.
- 4 Meriam J L and Kraige L G, Engineering Mechanics: Statics and Engineering Mechanics: Dynamics, 7th edition, Wiley student edition, 2013.
- 5 Timoshenko S, Young D H, Rao J V and SukumarPati, Engineering Mechanics, 5thEdition, McGraw Hill Higher Education, 2013.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	2							2	3	1	1
2	3	2	2	1	2							2	3	1	1
3	3	2	3	1	2							2	3	1	2
4	3	2	3	1	2							2	3	1	2
5	3	2	3	1	2							2	3	1	2
Low (1); Medium (2); High (3)															

**COURSE OBJECTIVES:**

- 1 Impart knowledge on the basics and application of zeroth and first law of thermodynamics.
- 2 Impart knowledge on the second law of thermodynamics in analysing the performance of thermal devices.
- 3 Impart knowledge on availability and applications of second law of thermodynamics
- 4 Teach the various properties of steam through steam tables and Mollier chart.
- 5 Impart knowledge on the macroscopic properties of ideal and real gases.

**UNIT I BASICS, ZEROTH AND FIRST LAW****9**

Review of Basics – Thermodynamic systems, Properties and processes Thermodynamic Equilibrium - Displacement work - P-V diagram. Thermal equilibrium - Zeroth law – Concept of temperature and Temperature Scales. First law – application to closed and open systems – steady and unsteady flow processes.

**UNIT II SECOND LAW AND ENTROPY****9**

Heat Engine – Refrigerator - Heat pump. Statements of second law and their equivalence & corollaries. Carnot cycle - Reversed Carnot cycle - Performance - Clausius inequality. Concept of entropy - T-s diagram - Tds Equations - Entropy change for a pure substance.

**UNIT III AVAILABILITY AND APPLICATIONS OF II LAW****9**

Ideal gases undergoing different processes - principle of increase in entropy. Applications of II Law. High- and low-grade energy. Availability and Irreversibility for open and closed system processes - I and II law Efficiency

**UNIT IV PROPERTIES OF PURE SUBSTANCES****9**

Steam - formation and its thermodynamic properties - p-v, p-T, T-v, T-s, h-s diagrams. PVT surface. Determination of dryness fraction. Calculation of work done and heat transfer in non-flow and flow processes using Steam Table and Mollier Chart.

**UNIT V GAS MIXTURES AND THERMODYNAMIC RELATIONS****9**

Properties of Ideal gas, real gas - comparison. Equations of state for ideal and real gases. vander Waal's relation - Reduced properties - Compressibility factor - Principle of Corresponding states - Generalized Compressibility Chart. Maxwell relations - Tds Equations - heat capacities relations - Energy equation, Joule-Thomson experiment - Clausius-Clapeyron equation.

**TOTAL: 45 PERIODS****OUTCOMES:**

At the end of the course the students would be able to

1. Apply the zeroth and first law of thermodynamics by formulating temperature scales and calculating the property changes in closed and open engineering systems.
2. Apply the second law of thermodynamics in analysing the performance of thermal devices through energy and entropy calculations.
3. Apply the second law of thermodynamics in evaluating the various properties of steam through steam tables and Mollier chart
4. Apply the properties of pure substance in computing the macroscopic properties of ideal and real gases using gas laws and appropriate thermodynamic relations.
5. Apply the properties of gas mixtures in calculating the properties of gas mixtures and applying various thermodynamic relations to calculate property changes.

**TEXTBOOKS:**

1. Nag.P.K., "Engineering Thermodynamics", 6th Edition, Tata McGraw Hill (2017), New Delhi.
2. Natarajan, E., "Engineering Thermodynamics: Fundamentals and Applications", 2nd Edition (2014), Anuragam Publications, Chennai.

**REFERENCES:**

1. Cengel, Y and M. Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill, 9th Edition, 2019.
2. Chattopadhyay, P, "Engineering Thermodynamics", 2nd Edition Oxford University Press, 2016.
3. Rathakrishnan, E., "Fundamentals of Engineering Thermodynamics", 2nd Edition, Prentice Hall of India Pvt. Ltd, 2006.
4. Claus Borgnakke and Richard E. Sonntag, "Fundamentals of Thermodynamics", 10th Edition, Wiley Eastern, 2019.
5. Venkatesh. A, "Basic Engineering Thermodynamics", Universities Press (India) Limited, 2007

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	1								2			
2	3	3	2	1								2			
3	3	3	2	1					1		1	2	3		3
4	3	3	2	1		1			2		1	2	3	2	
5	3	3	2	1		1			2		1	2	3	2	3
Low (1)    Medium (2) ;    High (3)															



**COURSE OBJECTIVES:**

1. To introduce the students about properties of the fluids, behaviour of fluids under static conditions.
2. To impart basic knowledge of the dynamics of fluids and boundary layer concept.
3. To expose to the applications of the conservation laws to a) flow measurements b) flow through pipes (both laminar and turbulent) and c) forces on pipe bends.
4. To exposure to the significance of boundary layer theory and its thicknesses.
5. To expose the students to basic principles of working of hydraulic machineries and to design Pelton wheel, Francis and Kaplan turbine, centrifugal and reciprocating pumps.

**UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS 10+3**

Properties of fluids – Fluid statics - Pressure Measurements - Buoyancy and floatation - Flow characteristics - Eulerian and Lagrangian approach - Concept of control volume and system - Reynold's transportation theorem - Continuity equation, energy equation and momentum equation - Applications.

**UNIT II FLOW THROUGH PIPES AND BOUNDARY LAYER 9+3**

Reynold's Experiment - Laminar flow through circular conduits - Darcy Weisbach equation - friction factor - Moody diagram - Major and minor losses - Hydraulic and energy gradient lines - Pipes in series and parallel - Boundary layer concepts - Types of boundary layer thickness.

**UNIT III DIMENSIONAL ANALYSIS AND MODEL STUDIES 8+3**

Fundamental dimensions - Dimensional homogeneity - Rayleigh's method and Buckingham Pi theorem - Dimensionless parameters - Similitude and model studies - Distorted and undistorted models.

**UNIT IV TURBINES 9+3**

Impact of jets - Velocity triangles - Theory of rotodynamic machines - Classification of turbines - Working principles - Pelton wheel - Modern Francis turbine - Kaplan turbine - Work done - Efficiencies - Draft tube - Specific speed - Performance curves for turbines - Governing of turbines.

**UNIT V PUMPS 9+3**

Classification of pumps - Centrifugal pumps - Working principle - Heads and efficiencies– Velocity triangles - Work done by the impeller - Performance curves - Reciprocating pump working principle - Indicator diagram and it's variations - Work saved by fitting air vessels - Rotary pumps.

**TOTAL: 60 PERIODS****OUTCOMES:**

On completion of the course, the student is expected to be able to

1. Understand the properties and behaviour in static conditions. Also, to understand the conservation laws applicable to fluids and its application through fluid kinematics and dynamics
2. Estimate losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel. Also, to understand the concept of boundary layer and its thickness on the flat solid surface.
3. Formulate the relationship among the parameters involved in the given fluid phenomenon and to predict the performances of prototype by model studies
4. Explain the working principles of various turbines and design the various types of turbines.
5. Explain the working principles of centrifugal, reciprocating and rotary pumps and design the centrifugal and reciprocating pumps

**TEXT BOOKS:**

1. Modi P.N. and Seth, S.M. Hydraulics and Fluid Mechanics, Standard Book House, New Delhi, 22nd edition (2019)
2. Jain A. K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2014.
3. Kumar K. L., Engineering Fluid Mechanics, Eurasia Publishing House(p) Ltd. New Delhi, 2016.

**REFERENCES:**

1. Fox W.R. and McDonald A.T., Introduction to Fluid Mechanics John-Wiley and Sons, Singapore, 2011.
2. Pani B S, Fluid Mechanics: A Concise Introduction, Prentice Hall of India Private Ltd, 2016.
3. Cengel Y A and Cimbala J M, Fluid Mechanics, McGraw Hill Education Pvt. Ltd., 2014.
4. S K Som; Gautam Biswas and S Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Education Pvt. Ltd., 2012.
5. Streeter, V. L. and Wylie E. B., Fluid Mechanics, McGraw Hill Publishing Co., 2010.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	1	2	2	1	2	1	1	2	3	2	3
2	3	3	3	2	1	2	2	1	2	1	1	2	3	2	3
3	3	3	3	3	1	2	2	1	2	1	1	2	3	3	3
4	3	3	3	3	1	2	2	1	2	1	1	3	3	2	2
5	3	3	3	3	1	2	2	1	2	1	1	3	3	2	2
Low (1); Medium (2) ; High (3)															

**ME3392****ENGINEERING MATERIALS AND METALLURGY**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

- 1 To learn the constructing the phase diagram and using of iron-iron carbide phase diagram for microstructure formation.
- 2 To learn selecting and applying various heat treatment processes and its microstructure formation.
- 3 To illustrate the different types of ferrous and non-ferrous alloys and their uses in engineering field.
- 4 To illustrate the different polymer, ceramics and composites and their uses in engineering field.
- 5 To learn the various testing procedures and failure mechanism in engineering field.

**UNIT I CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS****9**

Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions, Iron – Iron carbide equilibrium diagram. Classification of steel and cast-Iron microstructure, properties and application.

**UNIT II HEAT TREATMENT****9**

Definition – Full annealing, stress relief, recrystallisation and spheroidising –normalizing, hardening and tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram – continuous cooling Transformation (CCT) diagram – Austempering, Martempering – Hardenability, Jominy end quench test -case hardening, carburizing, Nitriding, cyaniding, carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening – Thermo-mechanical treatments- elementary ideas on sintering.

**UNIT III FERROUS AND NON-FERROUS METALS****9**

Effect of alloying additions on steel (Mn, Si, Cr, Mo, Ni, V, Ti & W) – stainless and tool steels – HSLA - Maraging steels – Grey, white, malleable, spheroidal – alloy cast irons, Copper and its alloys – Brass, Bronze and Cupronickel – Aluminium and its alloys; Al-Cu – precipitation strengthening treatment – Titanium alloys, Mg-alloys, Ni-based super alloys – shape memory alloys- Properties and Applications- overview of materials standards

**UNIT IV NON-METALLIC MATERIALS****9**

Polymers – types of polymers, commodity and engineering polymers – Properties and applications of PE, PP, PS, PVC, PMMA, PET, PC, PA, ABS, PAI, PPO, PPS, PEEK, PTFE, Thermoset polymers – Urea and Phenol formaldehydes –Nylon, Engineering Ceramics – Properties and applications of Al<sub>2</sub>O<sub>3</sub>, SiC, Si<sub>3</sub>N<sub>4</sub>, PSZ and SIALON – intermetallics- Composites- Matrix and reinforcement Materials- applications of Composites - Nano composites.

**UNIT V MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS****9**

Mechanisms of plastic deformation, slip and twinning – Types of fracture – fracture mechanics- Griffith's theory- Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell), Micro and nano-hardness tests, Impact test Izod and Charpy, fatigue and creep failure mechanisms.

**TOTAL: 45 PERIODS****OUTCOMES:**

At the end of the course the students would be able to

1. Explain alloys and phase diagram, Iron-Iron carbon diagram and steel classification.
2. Explain isothermal transformation, continuous cooling diagrams and different heat treatment processes.
3. Clarify the effect of alloying elements on ferrous and non-ferrous metals.
4. Summarize the properties and applications of non-metallic materials.
5. Explain the testing of mechanical properties.

**TEXT BOOKS:**

1. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 9<sup>th</sup> edition, 2018.
2. Sydney H. Avner, "Introduction to Physical Metallurgy", McGraw Hill Book Company, 1994

**REFERENCES:**

1. A. Alavudeen, N. Venkateshwaran, and J. T. Winowlinjappes, A Textbook of Engineering Materials and Metallurgy, Laxmi Publications, 2006.
2. Amandeep Singh Wadhwa, and Harvinder Singh Dhaliwal, A Textbook of Engineering Material and Metallurgy, University Sciences Press, 2008.
3. G.S. Upadhyay and Anish Upadhyay, "Materials Science and Engineering", Viva Books Pvt.Ltd, New Delhi, 2020.
4. Raghavan.V, "Materials Science and Engineering", Prentice Hall of India Pvt.Ltd. 6th edition, 2019.
5. Williams D Callister, "Material Science and Engineering" Wiley India Pvt Ltd, 2nd edition Re print 2019.

CO	PO												PSO		
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1	3	1	3	2								2	2	1	2
2	3	1	3	1		2		1				2	2	1	2
3	3	1	3									2	2	1	2
4	3	1	3				2					2	2	1	2
5	3	1	3	2	2							2	2	1	2
<b>Low (1) ; Medium (2) ; High (3)</b>															

**COURSE OBJECTIVES:**

1. To illustrate the working principles of various metal casting processes.
2. To learn and apply the working principles of various metal joining processes.
3. To analyse the working principles of bulk deformation of metals.
4. To learn the working principles of sheet metal forming process.
5. To study and practice the working principles of plastics molding.

**UNIT – I METAL CASTING PROCESSES****9**

Sand Casting – Sand Mould – Type of patterns - Pattern Materials – Pattern allowances – Molding sand Properties and testing – Cores –Types and applications – Molding machines – Types and applications– Melting furnaces – Principle of special casting processes- Shell, investment – Ceramic mould – Pressure die casting – low pressure, gravity- Tilt pouring, high pressure die casting- Centrifugal Casting – CO2 casting – Defects in Sand casting process-remedies

**UNIT II METAL JOINING PROCESSES****9**

Fusion welding processes – Oxy fuel welding – Filler and Flux materials–Arc welding, Electrodes, Coating and specifications – Gas Tungsten arc welding –Gas metal arc welding - Submerged arc welding – Electro slag welding– Plasma arc welding — Resistance welding Processes -Electron beam welding –Laser beam Welding Friction welding – Friction stir welding – Diffusion welding – Thermit Welding, Weld defects – inspection &remedies – Brazing - soldering – Adhesive bonding.

**UNIT III BULK DEFORMATION PROCESSES****9**

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – cold forging- Characteristics of the processes – Typical forging operations – rolling of metals – Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts – Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types – Hot and Cold extrusion. Introduction to shaping operations.

**UNIT IV SHEET METAL PROCESSES****9**

Sheet metal characteristics – Typical shearing, bending and drawing operations – Stretch forming operations – Formability of sheet metal – Test methods –special forming processes - Working principle and applications – Hydro forming – Rubber pad forming – Metal spinning – Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming – Incremental forming.

**UNIT V MANUFACTURE OF PLASTIC COMPONENTS****9**

Types and characteristics of plastics – Molding of thermoplastics & Thermosetting polymers– working principles and typical applications – injection molding – Plunger and screw machines – Compression molding, Transfer Molding – Typical industrial applications – introduction to blow molding – Rotational molding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics- duff moulding.

**TOTAL :45 PERIODS****OUTCOMES:**

At the end of the course the students would be able to

1. Explain the principle of different metal casting processes.
2. Describe the various metal joining processes.
3. Illustrate the different bulk deformation processes.
4. Apply the various sheet metal forming process.
5. Apply suitable molding technique for manufacturing of plastics components.

**TEXT BOOKS:**

1. Kalpakjian. S, “Manufacturing Engineering and Technology”, Pearson Education India,4<sup>th</sup> Edition, 2013
2. P.N.Rao Manufacturing Technology Volume 1 Mc Grawhill Education 5<sup>th</sup> edition,2018.

## REFERENCES:

1. Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.
2. S. Gowri P. Hariharan, A.Suresh Babu, Manufacturing Technology I, Pearson Education, 2008.
3. Paul Degarma E, Black J.T and Ronald A. Kosher, Elighth Edition, Materials and Processes, in Manufacturing, Eight Edition, Prentice – Hall of India, 1997.
4. Hajra Chouldhary S.K and Hajra Choudhury. AK., Elements of workshop Technology, volume I and II, Media promoters and Publishers Private Limited, Mumbai, 1997
5. Sharma, P.C., A Text book of production Technology, S.Chand and Co. Ltd., 2004

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
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2	3		2			2	3	1	1	-	-	1	3	1	2
3	3		2			2	2	1	1	-	-	1	3	1	2
4	3		2			2	2	1	1	-	-	1	3	1	2
5	3		2		2	2	2	1	1	-	-	1	3	1	2
Low (1) ; Medium (2) ; High (3)															

ME3381

COMPUTER AIDED MACHINE DRAWING

L T P C  
0 0 4 2

## COURSE OBJECTIVES:

- 1 To acquaint the skills and practical experience in handling 2D drafting and 3D modelling software systems, standard drawing practices using fits and tolerances.
- 2 To prepare assembly drawings both manually and using standard CAD packages.
- 3 To Preparing standard drawing layout for modeled parts, assemblies with BoM.

## PART I DRAWING STANDARDS & FITS AND TOLERANCES

12

Code of practice for Engineering Drawing, BIS specifications – Welding symbols, riveted joints, keys, fasteners – Reference to hand book for the selection of standard components like bolts, nuts, screws, keys etc. - Limits, Fits – Tolerancing of individual dimensions IS919- Specification of Fits – Preparation of production drawings and reading of part and assembly drawings, basic principles of Geometric Dimensioning &Tolerancing.

## PART II 2D DRAFTING

48

Drawing, Editing, Dimensioning, Layering, Hatching, Block, Array, Detailing, Detailed Drawing.

1. Bearings – Bush Bearing,
2. Valves – Safety and Non-return Valves.
3. Couplings – Flange, Oldham's, Muff, Gear couplings.
4. Joints – Universal, Knuckle, Gib & Cotter, Strap, Sleeve & Cotter joints.
5. Engine parts – Piston, Connecting Rod, Crosshead (vertical and horizontal), Stuffing box, multi-plate clutch.
6. Machine Components – Screw Jack, Machine Vice, Lathe Tail Stock, Lathe Chuck, Plummer Block, Vane and Gear pumps.

Total: 20% of classes for theory classes and 80% of classes for practice

Note: 25% of assembly drawings must be done manually and remaining 75% of assembly drawings must be done by using any CAD software. The above tasks can be performed manually and using standard commercial 2D CAD software.

**TOTAL:60 PERIODS**



**OUTCOMES:** At the end of the course the students would be able to

1. Prepare standard drawing layout for modelled assemblies with BoM.
2. Model orthogonal views of machine components.
3. Prepare standard drawing layout for modelled parts

**TEXT BOOKS:**

1. Gopalakrishna K.R., "Machine Drawing", 17<sup>th</sup> Edition, Subhas Stores Books Corner, Bangalore,2003.
2. N. D. Bhatt and V.M. Panchal, "Machine Drawing", 51<sup>st</sup> Edition, Charator Publishers,2022.

**REFERENCES:**

1. K. L Narayana, P.Kannaiah, K.Venkata Reddy, Machine Drawing , 15 Edition , New Age International Publication
2. Goutam Pohit and Goutam Ghosh, "Machine Drawing with AutoCAD", 1<sup>st</sup> Edition,Pearson Education, 2004
3. Junnarkar, N.D., "Machine Drawing", 1<sup>st</sup> Edition, Pearson Education, 2004
4. N. Siddeshwar, P. Kanniah, V.V.S. Sastri," Machine Drawing" , published by Tata McGrawHill,2006
5. S. Trymbaka Murthy, "A Text Book of Computer Aided Machine Drawing", CBS Publishers, New Delhi, 2007

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	2			3				3	2		3	2	2	2
2	1	2			3				3	2		3	2	2	2
3	1	2			3				3	2		3	2	2	2
Low (1) ; Medium (2) ; High (3)															

**ME3382**

**MANUFACTURING TECHNOLOGY LABORATORY**

**L T P C**  
**0 0 4 2**

**COURSE OBJECTIVES:**

- 1 To Selecting appropriate tools, equipment's and machines to complete a given job.
- 2 To Performing various welding process using GMAW and fabricating gears using gear making machines.
- 3 To Performing various machining process such as rolling, drawing, turning, shaping, drilling, milling and analysing the defects in the cast and machined components.

**LIST OF EXPERIMENTS**

1. Fabricating simple structural shapes using Gas Metal Arc Welding machine.
2. Preparing green sand moulds with cast patterns.
3. Taper Turning and Eccentric Turning on circular parts using lathe machine.
4. Knurling, external and internal thread cutting on circular parts using lathe machine.
5. Shaping – Square and Hexagonal Heads on circular parts using shaper machine.
6. Drilling and Reaming using vertical drilling machine.
7. Milling contours on plates using vertical milling machine.
8. Cutting spur and helical gear using milling machine.
9. Generating gears using gear hobbing machine.
10. Generating gears using gear shaping machine.
11. Grinding components using cylindrical and centerless grinding machine.
12. Grinding components using surface grinding machine.
13. Cutting force calculation using dynamometer in milling machine
14. Cutting force calculation using dynamometer in lathe machine

**TOTAL:60 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Demonstrate the safety precautions exercised in the mechanical workshop and join two metals using GMAW.
2. The students able to make the work piece as per given shape and size using machining process such as rolling, drawing, turning, shaping, drilling and milling.
3. The students become make the gears using gear making machines and analyze the defects in the cast and machined components

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3						1		2			1	1	2	2
2	3						1		2			1	1	2	2
3	3						1		2			1	1	2	2
Low (1) ; Medium (2) ; High (3)															

**GE3361**

**PROFESSIONAL DEVELOPMENT**

**L T P C**  
**0 0 2 1**

**OBJECTIVES:**

- To be proficient in important Microsoft Office tools: MS WORD, EXCEL, POWERPOINT.
- To be proficient in using MS WORD to create quality technical documents, by using standard templates, widely acceptable styles and formats, variety of features to enhance the presentability and overall utility value of content.
- To be proficient in using MS EXCEL for all data manipulation tasks including the common statistical, logical, mathematical etc., operations, conversion, analytics, search and explore, visualize, interlink, and utilizing many more critical features offered
- To be able to create and share quality presentations by using the features of MS PowerPoint, including: organization of content, presentability, aesthetics, using media elements and enhance the overall quality of presentations.

**MS WORD:**

**10 Hours**

Create and format a document  
 Working with tables  
 Working with Bullets and Lists  
 Working with styles, shapes, smart art, charts  
 Inserting objects, charts and importing objects from other office tools  
 Creating and Using document templates  
 Inserting equations, symbols and special characters  
 Working with Table of contents and References, citations  
 Insert and review comments  
 Create bookmarks, hyperlinks, endnotes footnote  
 Viewing document in different modes  
 Working with document protection and security  
 Inspect document for accessibility

**MS EXCEL:**

**10 Hours**

Create worksheets, insert and format data  
 Work with different types of data: text, currency, date, numeric etc.  
 Split, validate, consolidate, Convert data  
 Sort and filter data

Perform calculations and use functions: (Statistical, Logical, Mathematical, date, Time etc.)  
 Work with Lookup and reference formulae  
 Create and Work with different types of charts  
 Use pivot tables to summarize and analyse data  
 Perform data analysis using own formulae and functions  
 Combine data from multiple worksheets using own formulae and built-in functions to generate results  
 Export data and sheets to other file formats  
 Working with macros  
 Protecting data and Securing the workbook

**MS POWERPOINT:**

**10**

**Hours**

Select slide templates, layout and themes  
 Formatting slide content and using bullets and numbering  
 Insert and format images, smart art, tables, charts  
 Using Slide master, notes and handout master  
 Working with animation and transitions  
 Organize and Group slides  
 Import or create and use media objects: audio, video, animation  
 Perform slideshow recording and Record narration and create presentable videos

**TOTAL: 30 PERIODS**

**OUTCOMES:**

- On successful completion the students will be able to
- Use MS Word to create quality documents, by structuring and organizing content for their day to day technical and academic requirements
  - Use MS EXCEL to perform data operations and analytics, record, retrieve data as per requirements and visualize data for ease of understanding
  - Use MS PowerPoint to create high quality academic presentations by including common tables, charts, graphs, interlinking other elements, and using media objects.

**ME3491**

**THEORY OF MACHINES**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

- 1 To study the basic components of mechanisms, analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism and design cam mechanisms for specified output motions.
- 2 To study the basic concepts of toothed gearing and kinematics of gear trains
- 3 To Analyzing the effects of friction in machine elements
- 4 To Analyzing the force-motion relationship in components subjected to external forces and analyzing of standard mechanisms.
- 5 To Analyzing the undesirable effects of unbalances resulting from prescribed motions in mechanism and the effect of dynamics of undesirable vibrations.

**UNIT – I KINEMATICS OF MECHANISMS**

**9**

Mechanisms – Terminology and definitions – kinematics inversions of 4 bar and slide crank chain – kinematics analysis in simple mechanisms – velocity and acceleration polygons– Analytical methods – computer approach – cams – classifications – displacement diagrams - layout of plate cam profiles – derivatives of followers motion – circular arc and tangent cams.

**UNIT – II GEARS AND GEAR TRAINS****9**

Spur gear – law of toothed gearing – involute gearing – Interchangeable gears – Gear tooth action interference and undercutting – nonstandard teeth – gear trains – parallel axis gears trains – epicyclic gear trains – automotive transmission gear trains.

**UNIT – III FRICTION IN MACHINE ELEMENTS****9**

Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads – Bearings and lubrication – Friction clutches – Belt and rope drives – Friction aspects in brakes– Friction in vehicle propulsion and braking.

**UNIT – IV FORCE ANALYSIS****9**

Applied and Constrained Forces – Free body diagrams – static Equilibrium conditions – Two, Three and four members – Static Force analysis in simple machine members – Dynamic Force Analysis – Inertia Forces and Inertia Torque – D’Alembert’s principle – superposition principle – dynamic Force Analysis in simple machine members

**UNIT – V BALANCING AND VIBRATION****9**

Static and Dynamic balancing – Balancing of revolving and reciprocating masses – Balancing machines – free vibrations – Equations of motion – natural Frequency – Damped Vibration – bending critical speed of simple shaft – Torsional vibration – Forced vibration – harmonic Forcing – Vibration isolation. (Gyroscopic principles)

**TOTAL: 45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Discuss the basics of mechanism.
2. Solve problems on gears and gear trains.
3. Examine friction in machine elements.
4. Calculate static and dynamic forces of mechanisms.
5. Calculate the balancing masses and their locations of reciprocating and rotating masses. Computing the frequency of free vibration, forced vibration and damping coefficient.

**TEXT BOOKS:**

1. Uicker, J.J., Pennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”, Oxford University Press, 2017.
2. Ramamurthi. V, “Mechanics of Machines”, Narosa Publishing House, 3<sup>rd</sup> edition 2019.

**REFERENCES:**

1. AmitabhaGhosh and Asok Kumar Mallik, “Theory of Mechanisms and Machines”, Affiliated East-West Pvt. Ltd., 1988.
2. Rao.J.S. and Dukkipati.R.V. “Mechanism and Machine Theory”, New Age International Pvt. Ltd., 2<sup>nd</sup> edition,2014.
3. Rattan, S.S, “Theory of Machines”, McGraw-Hill Education Pvt. Ltd., 5<sup>th</sup> edition 2019.
4. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill, 2013.
5. Wilson and Sadler, Kinematics and Dynamics of Machinery, Pearson, 2008.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2		2			1				1	3		1
2	3	2	2		2			1				1	3		1
3	3	2	2		2			1				1	3		1
4	3	2	2		2			1				1	3		1
5	3	2	2		2			1				1	3		1
Low (1) ; Medium (2) ; High (3)															

**COURSE OBJECTIVES:**

- 1 To learn the concepts and laws of thermodynamics to predict the operation of thermodynamic cycles and performance of Internal Combustion(IC) engines and Gas Turbines.
- 2 To analyzing the performance of steam nozzle, calculate critical pressure ratio
- 3 To Evaluating the performance of steam turbines through velocity triangles, understand the need for governing and compounding of turbines
- 4 To analyzing the working of IC engines and various auxiliary systems present in IC engines
- 5 To evaluating the various performance parameters of IC engines

**UNIT I THERMODYNAMIC CYCLES****12**

Air Standard Cycles – Carnot, Otto, Diesel, Dual, Brayton – Cycle Analysis, Performance and Comparison, Basic Rankine Cycle, modified, reheat and regenerative cycles.

**UNIT II STEAM NOZZLES AND INJECTOR****12**

Types and Shapes of nozzles, Flow of steam through nozzles, Critical pressure ratio, Variation of mass flow rate with pressure ratio. Effect of friction. Metastable flow.

**UNIT III STEAM AND GAS TURBINES****12**

Types, Impulse and reaction principles, Velocity diagrams, Work done and efficiency – optimal operating conditions. Multi-staging, compounding and governing. Gas turbine cycle analysis – open and closed cycle. Performance and its improvement - Regenerative, Intercooled, Reheated cycles and their combination.

**UNIT IV INTERNAL COMBUSTION ENGINES – FEATURES AND COMBUSTION****12**

IC engine – Classification, working, components and their functions. Ideal and actual : Valve and port timing diagrams, p-v diagrams- two stroke & four stroke, and SI & CI engines – comparison. Geometric, operating, and performance comparison of SI and CI engines. Desirable properties and qualities of fuels. Air-fuel ratio calculation – lean and rich mixtures. Combustion in SI & CI Engines – Knocking – phenomena and control.

**UNIT V INTERNAL COMBUSTION ENGINE PERFORMANCE AND AUXILIARY SYSTEMS****12**

Performance and Emission Testing, Performance parameters and calculations. Morse and Heat Balance tests. Multipoint Fuel Injection system and Common rail direct injection systems. Ignition systems – Magneto, Battery and Electronic. Lubrication and Cooling systems. Concepts of Supercharging and Turbocharging – Emission Norms

**TOTAL :60 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Apply thermodynamic concepts to different air standard cycles and solve problems.
2. To solve problems in steam nozzle and calculate critical pressure ratio.
3. Explain the flow in steam turbines, draw velocity diagrams, flow in Gas turbines and solve problems.
4. Explain the functioning and features of IC engine, components and auxiliaries.
5. Calculate the various performance parameters of IC engines

**TEXT BOOKS:**

1. Mahesh. M. Rathore, "Thermal Engineering", 1st Edition, Tata McGraw Hill, 2010.
2. Ganesan.V, " Internal Combustion Engines" 4th Edition, Tata McGraw Hill, 2012.

**REFERENCES:**

1. Ballaney. P, "Thermal Engineering", 25th Edition, Khanna Publishers, 2017.
2. Domkundwar, Kothandaraman, & Domkundwar, "A Course in Thermal Engineering", 6th Edition, Dhanpat Rai & Sons, 2011.
3. Gupta H.N, "Fundamentals of Internal Combustion Engines", 2nd Edition Prentice Hall of India, 2013.
4. Mathur M.L and Mehta F.S., "Thermal Science and Engineering", 3rd Edition, Jain Brothers Pvt. Ltd, 2017.
5. Soman. K, "Thermal Engineering", 2nd Edition, Prentice Hall of India, 2011.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1								1	2	1	
2	3	2	2	1								1	2	1	
3	3	2	2	1								1	2	1	
4	3	2	1	1								1	2	1	
5	3	2	1	1								1	2	1	
Low (1) ; Medium (2) ; High (3)															

ME3492

**HYDRAULICS AND PNEUMATICS**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

1. To provide the knowledge on the working principles of fluid power systems.
2. To study the fluids and components used in modern industrial fluid power system.
3. To develop the design, construction and operation of fluid power circuits.
4. To learn the working principles of pneumatic power system and its components.
5. To provide the knowledge of trouble shooting methods in fluid power systems.

**UNIT I FLUID POWER PRINCIPLES AND HYDRAULIC PUMPS 9**

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal’s Law – Principles of flow - Friction loss – Work, Power and Torque- Problems, Sources of Hydraulic power: Pumping Theory-- Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of pumps – Fixed and Variable displacement pumps – Problems

**UNIT – II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS 9**

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Rotary Actuators-Hydraulic motors - Control Components: Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Accessories: Reservoirs, Pressure Switches – Filters –types and selection- Applications – Fluid Power ANSI Symbols – Problems

**UNIT – III HYDRAULIC CIRCUITS AND SYSTEMS 9**

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double-Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Deceleration circuits, Sizing of hydraulic systems, Hydrostatic transmission, Electro hydraulic circuits, –Servo and Proportional valves – Applications- Mechanical, hydraulic servo systems.

**UNIT – IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9**

Properties of air –Air preparation and distribution – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit –classification- single cylinder and multi cylinder circuits-Cascade method –Integration of fringe circuits, Electro Pneumatic System – Elements – Ladder diagram – timer circuits-Problems, Introduction to fluidics and pneumatic logic circuits

**UNIT – V TROUBLE SHOOTING AND APPLICATIONS 9**

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Conditioning of hydraulic fluids Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications- mobile hydraulics; Design of Pneumatic circuits for metal working, handling, clamping counter and timer circuits. – Low-cost Automation – Hydraulic and Pneumatic power packs, IOT in Hydraulics and pneumatics

Note: (Use of standard Design Data Book is permitted in the University examination)

**TOTAL: 45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Apply the working principles of fluid power systems and hydraulic pumps.
2. Apply the working principles of hydraulic actuators and control components.
3. Design and develop hydraulic circuits and systems.
4. Apply the working principles of pneumatic circuits and power system and its components.
5. Identify various troubles shooting methods in fluid power systems.

**TEXT BOOKS:**

1. Anthony Esposito, "Fluid Power with Applications", Prentice Hall, 2009.
2. James A. Sullivan, "Fluid Power Theory and Applications", Fourth Edition, Prentice Hall, 1997

**REFERENCES:**

1. Jagadeesha. T., "Pneumatics Concepts, Design and Applications ", Universities Press, 2015.
2. Joshi.P., "Pneumatic Control", Wiley India, 2008.
3. Majumdar, S.R., "Oil Hydraulics Systems – Principles and Maintenance", TataMcGraw Hill, 2001.
4. Shanmugasundaram.K., "Hydraulic and Pneumatic Controls". Chand & Co, 2006.
5. Srinivasan.R., "Hydraulic and Pneumatic Controls", Vijay Nicole Imprints, 3<sup>rd</sup> edition,2019.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	1	1								1	2	1	1
2	2	1	1	1								1	2	1	1
3	2	1	1	1								1	2	1	1
4	2	1	1	1								1	2	1	1
5	2	1	1	1								1	2	1	1
Low (1) ; Medium (2) ; High (3)															



**ME3493**

**MANUFACTURING TECHNOLOGY**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- 1 To study the concepts and basic mechanics of metal cutting and the factors affecting machinability
- 2 To learn working of basic and advanced turning machines.
- 3 To teach the basics of machine tools with reciprocating and rotating motions and abrasive finishing processes.
- 4 To study the basic concepts of CNC of machine tools and constructional features of CNC.
- 5 To learn the basics of CNC programming concepts to develop the part programme for Machine centre and turning centre

**UNIT – I MECHANICS OF METAL CUTTING**

**9**

Mechanics of chip formation, forces in machining, Types of chip, cutting tools – single point cutting tool nomenclature, orthogonal and oblique metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and Machinability.

**UNIT – II TURNING MACHINES**

**9**

Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, surface roughness in turning, machining time and power estimation. Special lathes - Capstan and turret lathes- tool layout – automatic lathes: semi-automatic – single spindle: Swiss type, automatic screw type – multi spindle

**UNIT – III RECIPROCATING MACHINE TOOLS****9**

Reciprocating machine tools: shaper, planer, slotter: Types and operations- Hole making: Drilling, reaming, boring, tapping, type of milling operations-attachments- types of milling cutters– machining time calculation - Gear cutting, gear hobbing and gear shaping – gear finishing methods Abrasive processes: grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centreless grinding, internal grinding - micro finishing methods

**UNIT – IV CNC MACHINES****9**

Computer Numerical Control (CNC) machine tools, constructional details, special features – Drives, Recirculating ball screws, tool changers; CNC Control systems – Open/closed, point-to-point/continuous - Turning and machining centres – Work holding methods in Turning and machining centres, Coolant systems, Safety features.

**UNIT – V PROGRAMMING OF CNC MACHINE TOOLS****9**

Coordinates, axis and motion, Absolute vs Incremental, Interpolators, Polar coordinates, Program planning, G and M codes, Manual part programming for CNC machining centers and Turning centers – Fixed cycles, Loops and subroutines, Setting up a CNC machine for machining.

**TOTAL 45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Apply the mechanism of metal removal process and to identify the factors involved in improving machinability.
2. Describe the constructional and operational features of centre lathe and other special purpose lathes.
3. Describe the constructional and operational features of reciprocating machine tools.
4. Apply the constructional features and working principles of CNC machine tools.
5. Demonstrate the Program CNC machine tools through planning, writing codes and setting up CNC machine tools to manufacture a given component.

**TEXT BOOKS:**

1. Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India, 7<sup>th</sup> Edition, 2018.
2. Michael Fitzpatrick, Machining and CNC Technology, McGraw-Hill Education; 4<sup>th</sup> edition, 2018.

**REFERENCES:**

1. Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.
2. Geoffrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", McGraw Hill, 1984.
3. Rao. P.N "Manufacturing Technology," Metal Cutting and Machine Tools, Tata McGraw- Hill, New Delhi, 2009.
4. A. B. Chattopadhyay, Machining and Machine Tools, Wiley, 2<sup>nd</sup> edition, 2017.
5. Peter Smid, CNC Programming Handbook, Industrial Press Inc.; Third edition, 2007.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	1	1	1	3			3		2	3	3	2
2	3	3	3	1	1	1	3			3		2	3	2	2
3	3	3	3	1	1	1	3			3		2	3	2	2
4	3	3	2	1	1	1	3			3		2	3	2	2
5	3	3	3	1	1	1	3			3		2	3	2	3
Low (1) ; Medium (2) ; High (3)															



CE3491

**STRENGTH OF MATERIALS**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

- To understand the concepts of stress, strain, principal stresses and principal planes.
- To study the concept of shearing force and bending moment due to external loads in determinate beams and their effect on stresses.
- To determine stresses and deformation in circular shafts and helical spring due to torsion.
- To compute slopes and deflections in determinate beams by various methods.
- To study the stresses and deformations induced in thin and thick shells.

**UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS**

**9**

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses - Deformation of simple and compound bars – Thermal stresses – Elastic constants - Volumetric strains – Stresses on inclined planes – Principal stresses and principal planes – Mohr's circle of stress.

**UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM**

**9**

Beams – Types - Transverse loading on beams – Shear force and Bending moment in beams – Cantilever, Simply supported and over hanging beams. Theory of simple bending – Bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stress distribution.

**UNIT III TORSION**

**9**

Theory of Torsion – Stresses and Deformations in Solid and Hollow Circular Shafts – Combined bending moment and torsion of shafts - Power transmitted to shaft – Shaft in series and parallel – Closed and Open Coiled helical springs – springs in series and parallel.

**UNIT IV DEFLECTION OF BEAMS**

**9**

Elastic curve – Governing differential equation - Double integration method - Macaulay's method - Area moment method - Conjugate beam method for computation of slope and deflection of determinant beams.

**UNIT V THIN CYLINDERS, SPHERES AND THICK CYLINDERS**

**9**

Stresses in thin cylindrical shell due to internal pressure - circumferential and longitudinal stresses - Deformation in thin cylinders – Spherical shells subjected to internal pressure – Deformation in spherical shells – Thick cylinders - Lamé's theory.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

At the end of the course the students would be able to

1. Understand the concepts of stress and strain in simple and compound bars, the importance of principal stresses and principal planes.
2. Understand the load transferring mechanism in beams and stress distribution due to shearing force and bending moment.
3. Apply basic equation of torsion in designing of shafts and helical springs
4. Calculate slope and deflection in beams using different methods.
5. Analyze thin and thick shells for applied pressures.

**TEXT BOOK**

1. Rajput R.K. "Strength of Materials (Mechanics of Solids)", S.Chand & company Ltd., New Delhi, 7<sup>th</sup> edition, 2018.
2. Rattan S.S., "Strength of Materials", Tata McGraw Hill Education Pvt .Ltd., New Delhi, 2017.

**REFERENCES:**

1. Singh. D.K., "Strength of Materials", Ane Books Pvt Ltd., New Delhi, 2021.
2. Egor P Popov, "Engineering Mechanics of Solids", 2<sup>nd</sup> edition, PHI Learning Pvt. Ltd., New Delhi, 2015.
3. Beer. F.P. & Johnston. E.R. "Mechanics of Materials", Tata McGraw Hill, 8<sup>th</sup> Edition, New Delhi 2019.
4. Vazirani. V.N, Ratwani. M.M, Duggal .S.K "Analysis of Structures: Analysis, Design and Detailing of Structures-Vol.1", Khanna Publishers, New Delhi 2014.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	2	3	1	3	2	3	1	3	3	2	3
2	3	3	3	3	2	3	1	3	2	3	1	3	3	2	3
3	3	3	3	3	2	3	1	3	2	3	1	3	3	2	3
4	3	3	3	3	2	3	1	3	2	3	1	3	3	2	3
5	3	3	3	3	2	3	1	3	2	3	1	3	3	2	3
Low (1) ; Medium (2) ; High (3)															

**GE3451****ENVIRONMENTAL SCIENCES AND SUSTAINABILITY****L T P C****2 0 0 2****OBJECTIVES:**

- To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation.
- To impart knowledge on the causes, effects and control or prevention measures of environmental pollution and natural disasters.
- To facilitate the understanding of global and Indian scenario of renewable and nonrenewable resources, causes of their degradation and measures to preserve them.
- To familiarize the concept of sustainable development goals and appreciate the interdependence of economic and social aspects of sustainability, recognize and analyze climate changes, concept of carbon credit and the challenges of environmental management.
- To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles and analyze the role of sustainable urbanization.

**UNIT I ENVIRONMENT AND BIODIVERSITY****6**

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

**UNIT II ENVIRONMENTAL POLLUTION****6**

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts.

**UNIT III RENEWABLE SOURCES OF ENERGY****6**

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

**UNIT IV SUSTAINABILITY AND MANAGEMENT****6**

Development, GDP, Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols-Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

**UNIT V SUSTAINABILITY PRACTICES****6**

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economical and technological change.

**TOTAL : 30 PERIODS****OUTCOMES:**

- To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.
- To identify the causes, effects of environmental pollution and natural disasters and contribute to the preventive measures in the society.
- To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.
- To recognize the different goals of sustainable development and apply them for suitable technological advancement and societal development.
- To demonstrate the knowledge of sustainability practices and identify green materials, energy cycles and the role of sustainable urbanization.

**TEXT BOOKS:**

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

**REFERENCES :**

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 . Edition 2010.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, Third Edition, 2015.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

### CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	-	-	-	2	3	-	-	-	-	2	-	-	-
2	3	2	-	-	-	3	3	-	-	-	-	2	-	-	-
3	3	-	1	-	-	2	2	-	-	-	-	2	-	-	-
4	3	2	1	1	-	2	2	-	-	-	-	2	-	-	-
5	3	2	1	-	-	2	2	-	-	-	-	1	-	-	-
<b>Avg.</b>	<b>2.8</b>	<b>1.8</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>2.2</b>	<b>2.4</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1.8</b>	<b>-</b>	<b>-</b>	<b>-</b>

1-low, 2-medium, 3-high, '-'- no correlation

**CE3481 STRENGTH OF MATERIALS AND FLUID MACHINERY LABORATORY**      **L T P C**  
**0 0 4 2**

**COURSE OBJECTIVE:**

- To study the mechanical properties of metals, wood and spring by testing in laboratory.
- To verify the principles studied in fluid mechanics and machinery theory by performing experiments in laboratory.

**UNIT – I STRENGTH OF MATERIALS** **30**

**LIST OF EXPERIMENTS**

- Tension test on mild steel rod
- Torsion test on mild steel rod
- Hardness test on metal (Rockwell and Brinell Hardness)
- Compression test on helical spring
- Deflection test on carriage spring

**UNIT – II FLUID MECHANICS AND MACHINES LABORATORY** **30**

**LIST OF EXPERIMENTS**

- (a) Determination of coefficient of discharge of a venturimeter  
(b) Determination of friction factor for flow through pipes
- (a) Determination of metacentric height  
(b) Determination of forces due to impact of jet on a fixed plate
- Characteristics of centrifugal pumps
- Characteristics of reciprocating pump
- Characteristics of Pelton wheel turbine

**TOTAL: 60 PERIODS**

**OUTCOMES: On completion of the course, the student is expected to be able to**

- Determine the tensile, torsion and hardness properties of metals by testing
- Determine the stiffness properties of helical and carriage spring
- Apply the conservation laws to determine the coefficient of discharge of a venturimeter and finding the friction factor of given pipe
- Apply the fluid static and momentum principles to determine the metacentric height and forces due to impact of jet
- Determine the performance characteristics of turbine, rotodynamic pump and positive displacement pump.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	3	3	1	1	1	3	1	1	2	2	2	1
2	3	2	1	3	3	1	1	1	3	1	1	2	3	2	1
3	3	3	2	3	2	1	1	1	3	1	1	2	3	2	1

Low (1) ;    Medium (2) ;    High (3)

**ME3461****THERMAL ENGINEERING LABORATORY**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

**COURSE OBJECTIVES**

- 1 To study the valve and port timing diagram and performance characteristics of IC engines
- 2 To study the Performance of refrigeration cycle / components
- 3 To study the Performance and Energy Balance Test on a Steam Generator.

45

**PART I IC ENGINES LABORATORY****List of Experiments**

1. Valve Timing and Port Timing diagrams.
2. Actual p-v diagrams of IC engines.
3. Performance Test on four – stroke Diesel Engine.
4. Heat Balance Test on 4 – stroke Diesel Engine.
5. Morse Test on Multi-Cylinder Petrol Engine.
6. Retardation Test on a Diesel Engine.
7. Determination of p-θ diagram and heat release characteristics of an IC engine.
8. Determination of Flash Point and Fire Point of various fuels / lubricants
9. Performance test on a two stage Reciprocating Air compressor
10. Determination of COP of a Refrigeration system

15

**PART II STEAM LABORATORY****List of Experiments:**

1. Study of Steam Generators and Turbines.
2. Performance and Energy Balance Test on a Steam Generator.
3. Performance and Energy Balance Test on Steam Turbine.

**TOTAL:60 PERIODS****OUTCOMES:**

At the end of the course the students would be able to

1. Conduct tests to evaluate performance characteristics of IC engines
2. Conduct tests to evaluate the performance of refrigeration cycle
3. Conduct tests to evaluate Performance and Energy Balance on a Steam Generator.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	1	1					1			1	1	1	1
2	2	2	1	1					1			1	1	1	1
3	2	2	1	1					1			1	1	1	1
Low (1) ; Medium (2) ; High (3)															

**ME3591****DESIGN OF MACHINE ELEMENTS**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**COURSE OBJECTIVES**

- 1 To learn the various steps involved in the Design Process.
- 2 To Learn designing shafts and couplings for various applications.
- 3 To Learn the design of temporary and permanent Joints.
- 4 To Learn designing helical, leaf springs, flywheels, connecting rods and crank shafts for various applications.
- 5 To Learn designing and select sliding and rolling contact bearings, seals and gaskets.  
(Use of PSG Design Data book is permitted)

- UNIT – I FUNDAMENTAL CONCEPTS IN DESIGN 12**  
Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers- Direct, Bending and torsional loading- Modes of failure - Factor of safety – Combined loads – Principal stresses – Eccentric loading – curved beams – crane hook and ‘C’ frame- theories of failure – Design based on strength and stiffness – stress concentration – Fluctuating stresses – Endurance limit –Design for finite and infinite life under variable loading - Exposure to standards.
- UNIT – II DESIGN OF SHAFTS AND COUPLINGS 12**  
Shafts and Axles - Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys and splines – Rigid and flexible couplings.
- UNIT – III DESIGN OF TEMPORARY AND PERMANENT JOINTS 12**  
Threaded fasteners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints- Butt, Fillet and parallel transverse fillet welds – welded joints subjected to bending, torsional and eccentric loads, riveted joints for structures - theory of bonded joints.
- UNIT – IV DESIGN OF ENERGY STORING ELEMENTS AND ENGINE COMPONENTS 12**  
Types of springs, design of helical and concentric springs–surge in springs, Design of laminated springs - rubber springs - Flywheels considering stresses in rims and arms for engines and punching machines-- Solid and Rimmed flywheels- connecting rods and crank shafts
- UNIT – V DESIGN OF BEARINGS AND MISCELLANEOUS ELEMENTS 12**  
Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi & Boyd graphs, -- Selection of Rolling Contact bearings –Design of Seals and Gaskets.

**TOTAL: 60 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Explain the design machine members subjected to static and variable loads.
2. Apply the concepts design to shafts, key and couplings.
3. Apply the concepts of design to bolted, Knuckle, Cotter, riveted and welded joints.
4. Apply the concept of design helical, leaf springs, flywheels, connecting rods and crank shafts.
5. Apply the concepts of design and select sliding and rolling contact bearings, seals and gaskets.

**TEXT BOOKS:**

1. Bhandari V B, “Design of Machine Elements”, 4th Edition , Tata McGraw-Hill Book Co, 2016
2. Joseph Shigley, Richard G. Budynas and J. Keith Nisbett “Mechanical Engineering Design”, 10th Edition, Tata McGraw-Hill , 2015.

**REFERENCES:**

1. Ansel C Ugural, “Mechanical Design – An Integral Approach”, 1st Edition, Tata McGraw-Hill Book Co, 2004.
2. Merhyle Franklin Spotts, Terry E. Shoup, and Lee EmreyHornberger, “Design of Machine Elements” 8th Edition, Printice Hall, 2004.
3. Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine component Design”,6th Edition, Wiley, 2017.
4. Sundararamoorthy T. V. and Shanmugam .N, “Machine Design”, Anuradha Publications, Chennai, 2003.
5. Design of Machine Elements | SI Edition | Eighth Edition | By Pearson by M. F. Spotts, Terry E. Shoup, et al. | 25 March 2019

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	3					1	1			2	3	2	2
2	2	2	3					1	1			2	3	2	2
3	2	2	3					1	1			2	3	2	2
4	2	2	3					1	1			2	3	2	2
5	2	2	3					1	1			2	3	2	2
Low (1) ; Medium (2) ; High (3)															

**COURSE OBJECTIVES**

- 1 To learn basic concepts of the metrology and importance of measurements.
- 2 To teach measurement of linear and angular dimensions assembly and transmission elements.
- 3 To study the tolerance analysis in manufacturing.
- 4 To develop the fundamentals of GD & T and surface metrology.
- 5 To provide the knowledge of the advanced measurements for quality control in manufacturing industries.

**UNIT – I BASICS OF METROLOGY****9**

Measurement – Need, Process, Role in quality control; Factors affecting measurement - SWIPE; Errors in Measurements – Types – Control – Measurement uncertainty – Types, Estimation, Problems on Estimation of Uncertainty, Statistical analysis of measurement data, Measurement system analysis, Calibration of measuring instruments, Principle of air gauging- ISO standards.

**UNIT – II MEASUREMENT OF LINEAR, ANGULAR DIMENSIONS, ASSEMBLY AND TRANSMISSION ELEMENTS****9**

Linear Measuring Instruments – Vernier caliper, Micrometer, Vernier height gauge, Depth Micrometer, Bore gauge, Telescoping gauge; Gauge blocks – Use and precautions, Comparators – Working and advantages; Opto-mechanical measurements using measuring microscope and Profile projector - Angular measuring instruments – Bevel protractor, Clinometer, Angle gauges, Precision level, Sine bar, Autocollimator, Angle dekkor, Alignment telescope. Measurement of Screw threads - Single element measurements – Pitch Diameter, Lead, Pitch. Measurement of Gears – purpose – Analytical measurement – Runout, Pitch variation, Tooth profile, Tooth thickness, Lead – Functional checking – Rolling gear test.

**UNIT – III TOLERANCE ANALYSIS****9**

Tolerancing– Interchangeability, Selective assembly, Tolerance representation, Terminology, Limits and Fits, Problems (using tables IS919); Design of Limit gauges, Problems. Tolerance analysis in manufacturing, Process capability, tolerance stackup, tolerance charting.

**UNIT – IV METROLOGY OF SURFACES****9**

Fundamentals of GD & T- Conventional vs Geometric tolerance, Datums, Inspection of geometric deviations like straightness, flatness, roundness deviations; Simple problems – Measurement of Surface finish – Functionality of surfaces, Parameters, Comparative, Stylus based and Optical Measurement techniques, Filters, Introduction to 3D surface metrology- Parameters.

**UNIT – V ADVANCES IN METROLOGY****9**

Lasers in metrology - Advantages of lasers – Laser scan micrometers; Laser interferometers – Applications – Straightness, Alignment; Ball bar tests, Computer Aided Metrology - Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Multi-sensor CMMs.

Machine Vision - Basic concepts of Machine Vision System – Elements – Applications - On-line and in-process monitoring in production - Computed tomography – White light Scanners.

**TOTAL: 45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Discuss the concepts of measurements to apply in various metrological instruments.
2. Apply the principle and applications of linear and angular measuring instruments, assembly and transmission elements.
3. Apply the tolerance symbols and tolerance analysis for industrial applications.
4. Apply the principles and methods of form and surface metrology.
5. Apply the advances in measurements for quality control in manufacturing Industries.

**TEXT BOOKS:**

1. Dotson Connie, "Dimensional Metrology", Cengage Learning, First edition, 2012.
2. Mark Curtis, Francis T. Farago, "Handbook of Dimensional Measurement", Industrial Press, Fifth edition, 2013.

**REFERENCES:**

1. AmmarGrous, J "Applied Metrology for Manufacturing Engineering", Wiley-ISTE, 2011.
2. Galyer, J.F.W. Charles Reginald Shotbolt, "Metrology for Engineers", Cengage Learning EMEA; 5th revised edition, 1990.
3. National Physical LaboratoryGuideNo. 40, No. 41, No. 42, No. 43, No. 80, No. 118, No. 130, No. 131. <http://www.npl.co.uk>.
4. Raghavendra N.V. and Krishnamurthy. L., Engineering Metrology and Measurements, Oxford University Press, 2013.
5. Venkateshan, S. P., "Mechanical Measurements", Second edition, John Wiley & Sons, 2015.

C O	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	2					1			1	3	2	1
2	3	2	2	2					1			1	3	2	1
3	3	2	2	2					1			1	3	2	1
4	3	2	2	2					1			1	3	2	1
5	3	2	2	2					1			1	3	2	1
Low (1) ; Medium (2) ; High (3)															

ME3581

METROLOGY AND DYNAMICS LABORATORY

L T P C  
0 0 4 2

**COURSE OBJECTIVES**

- 1 To study the different measurement equipment and use of this industry for quality inspection.
- 2 To supplements the principles learnt in dynamics of machinery.
- 3 To understand how certain measuring devices are used for dynamic testing.

**UNIT – I METROLOGY**

30

**LIST OF EXPERIMENTS**

1. Calibration and use of linear measuring instruments – Vernier caliper, micrometer, Vernier height gauge, depth micrometer, bore gauge, telescopic gauge, Comparators.
2. Measurement of angles using bevel protractor, sine bar, autocollimator, precision level.
3. Measurement of assembly and transmission elements - screw thread parameters – Screw thread Micrometers, Three wire method, Toolmaker’s microscope.
4. Measurement of gear parameters – Micrometers, Vernier caliper, Gear tester.
5. Measurement of features in a prismatic component using Coordinate Measuring Machine (CMM), Programming of CNC Coordinate Measuring Machines for repeated measurements of identical components.
6. Non-contact (Optical) measurement using Measuring microscope / Profile projector and Video measurement system.
7. Surface metrology - Measurement of form parameters – Straightness, Flatness, Roundness, Cylindricity, Perpendicularity, Runout, Concentricity – in the given component using Roundness tester.
8. Measurement of Surface finish in components manufactured using various processes (turning, milling, grinding, etc.,) using stylus based instruments.



**List of Experiments:**

1. Study of gear parameters.
2. Epicycle gear Train.
3. Determination of moment of inertia of flywheel and axle system.
4. Determination of mass moment of inertia of a body about its axis of symmetry.
5. Undamped free vibrations of a single degree freedom spring-mass system.
6. Torsional Vibration (Undamped) of single rotor shaft system.
7. Dynamic analysis of cam mechanism.
8. Experiment on Watts Governor.
9. Experiment on Porter Governor.
10. Experiment on Proell Governor.
11. Experiment on motorized gyroscope.
12. Determination of critical speed of shafts.

**TOTAL:60 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. The students able to measure the gear tooth dimensions, angle using sine bar, straightness.
2. Determine mass moment of inertia of mechanical element, governor effort and range of sensitivity.
3. Determine the natural frequency and damping coefficient, critical speeds of shafts,

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
<b>1</b>		2	2	3		2	2		1	2	2		3	2	2
<b>2</b>		2	2	3		2	2		1	2	2		2	2	2
<b>3</b>		2	2	3		2	2		1	2	2		3	2	2
<b>Avg</b>	-	2	2	3	-	2	2	-	1	2	2	-	2.6	2	2
Low (1) ; Medium (2) ; High (3)															

**ME3691**

**HEAT AND MASS TRANSFER**

**L T P C**  
**3 1 0 4**

**COURSE OBJECTIVES**

- 1 To Learn the principal mechanism of heat transfer under steady state and transient conditions.
- 2 To learn the fundamental concept and principles in convective heat transfer.
- 3 To learn the theory of phase change heat transfer and design of heat exchangers.
- 4 To study the fundamental concept and principles in radiation heat transfer.
- 5 To develop the basic concept and diffusion, convective di mass transfer.

**UNIT – I CONDUCTION**

**12**

General Differential equation – Cartesian, Cylindrical and Spherical Coordinates – One Dimensional Steady State Heat Conduction — plane and Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Semi Infinite and Infinite Solids –Use of Heisler’s charts – Methods of enhanced thermal conduction

**UNIT – II CONVECTION**

**12**

Conservation Equations, Boundary Layer Concept – Forced Convection: External Flow – Flow over Plates, Cylinders Spheres and Bank of tubes. Internal Flow – Entrance effects. Free Convection – Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and Spheres. Mixed Convection.

**UNIT – III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS**

**12**

Nusselt’s theory of condensation- Regimes of Pool boiling and Flow boiling - Correlations in boiling and condensation. Heat Exchanger Types – TEMA Standards - Overall Heat Transfer Coefficient – Fouling Factors. LMTD and NTU methods. Fundamentals of Heat Pipes and its applications.

**UNIT – IV RADIATION****12**

Introduction to Thermal Radiation - Radiation laws and Radiative properties - Black Body and Gray body Radiation - Radiosity - View Factor Relations. Electrical Analogy. Radiation Shields.

**UNIT – V MASS TRANSFER****12**

Basic Concepts – Diffusion Mass Transfer – Fick’s Law of Diffusion – Steady state and Transient Diffusion - Stefan flow –Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.

**TOTAL: 60 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Apply heat conduction equations to different surface configurations under steady state and transient conditions and solve problems.
2. Apply free and forced convective heat transfer correlations to internal and external flows through/over various surface configurations and solve problems.
3. Explain the phenomena of boiling and condensation, apply LMTD and NTU methods of thermal analysis to different types of heat exchanger configurations and solve problems.
4. Explain basic laws for Radiation and apply these principles to radiative heat transfer between different types of surfaces to solve problems.
5. Apply diffusive and convective mass transfer equations and correlations to solve problems for different applications.

**TEXT BOOKS:**

1. R.C. Sachdeva, “Fundamentals of Engineering Heat & Mass transfer”, New Age International Publishers, 2009
2. Yunus A. Cengel, “Heat Transfer A Practical Approach” – Tata McGraw Hill, 5<sup>th</sup>Edition – 2013

**REFERENCES:**

1. Frank P. Incropera and David P. Dewitt, “Fundamentals of Heat and Mass Transfer”, John Wiley & Sons, 7th Edition, 2014.
2. Holman, J.P., “Heat and Mass Transfer”, Tata McGraw Hill, 2010
3. Kothandaraman, C.P., “Fundamentals of Heat and Mass Transfer”, New Age International, New Delhi, 2012
4. Ozisik, M.N., “Heat Transfer”, McGraw Hill Book Co., 1994.
5. S.P. Venkateshan, “Heat Transfer”, Ane Books, New Delhi, 2014

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2					1			1	3	2	1
2	3	3	3	3					1			1	3	2	1
3	3	3	3	2					1			1	3	2	1
4	3	3	3	2					1			1	3	2	1
5	3	3	3	2					1			1	3	2	1
Low (1) ; Medium (2) ; High (3)															

**COURSE OBJECTIVES**

- 1 To gain practical experience in handling 2D drafting and 3D modelling software systems
- 2 Designing 3 Dimensional geometric model of parts, sub-assemblies, assemblies and exporting it to drawing
- 3 Programming G & M Code programming and simulate the CNC program and Generating part programming data through CAM software

**3D GEOMETRIC MODELLING****30**

## 1. CAD Introduction

Sketch:

Solid modeling: Extrude, Revolve, Sweep, Variational sweep and Loft.

Surface modeling: Extrude, Sweep, Trim, Mesh of curves and Free form.

Feature manipulation: Copy, Edit, Pattern, Suppress, History operations.

Assembly: Constraints, Exploded Views, Interference check

Drafting: Layouts, Standard &amp; Sectional Views, Detailing &amp; Plotting

## 2. Creation of 3D assembly model of following machine elements using 3D Modelling software

1. Flange Coupling
2. Plummer Block
3. Screw Jack
4. Lathe Tailstock
5. Universal Joint
6. Machine Vice
7. Stuffing box
8. Crosshead
9. Safety Valves
10. Non-return valves
11. Connecting rod
12. Piston
13. Crankshaft

\* Students may also be trained in manual drawing of some of the above components (specify the number – progressive arrangement of 3D)

**30****MANUAL PART PROGRAMMING**

## 1. CNC Machining Centre

- i) Linear Cutting.
- ii) Circular cutting.
- iii) Cutter Radius Compensation.
- iv) Canned Cycle Operations.

## 2. CNC Turning Centre

- i) Straight, Taper and Radial Turning.
- ii) Thread Cutting.
- iii) Rough and Finish Turning Cycle.
- iv) Drilling and Tapping Cycle.

## 3. COMPUTER AIDED PART PROGRAMMING

- i) Generate CL Data and Post process data using CAM packages for Machining and Turning Centre.
- ii) Application of CAPP in Machining and Turning

**TOTAL:60 PERIODS****OUTCOMES:** At the end of the course the students would be able to

1. Design experience in handling 2D drafting and 3D modelling software systems
2. Design 3 Dimensional geometric model of parts, sub-assemblies, assemblies and export it to drawing
3. Demonstrate manual part programming and simulate the CNC program and Generate part programming using G and M code through CAM software.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	2	2	3				2			1	3	3	1
2	2	2	2	2	3				2			1	3	3	1
3	2	2	2	2	3				2			1	3	3	1
<b>Low (1) ; Medium (2) ; High (3)</b>															

**ME3682**

**HEAT TRANSFER LABORATORY**

**L T P C**  
**0 0 4 2**

**COURSE OBJECTIVES**

- 1 To gain experimental knowledge of Predicting the thermal conductivity of solids and liquids.
- 2 To gain experimental knowledge of Estimating the heat transfer coefficient values of various fluids.
- 3 To gain experimental knowledge of Testing the performance of tubes in tube heat exchangers

**LIST OF EXPERIMENTS:**

1. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
2. Determination of thermal conductivity of a composite wall, insulating powder, oils, and water.
3. Determination of heat transfer coefficient of air under natural convection and forced convection.
4. Heat transfer from pin-fin under natural and forced convection.
5. Determination of heat flux under pool boiling and flow boiling in various regimes.
6. Determination of heat transfer coefficient in film-wise and drop-wise condensation.
7. Determination of friction factor, heat transfer coefficient of cold/hot fluid and effectiveness of a tube-in-tube heat exchanger.
8. Determination of Stefan – Boltzmann constant.
9. Determination of emissivity of a grey surface.
10. Calibration of thermocouples / RTDs at standard reference temperatures.

**TOTAL : 60 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Conduct experiment on Predict the thermal conductivity of solids and liquids
2. Conduct experiment on Estimate the heat transfer coefficient values of various fluids.
3. Conduct experiment on Test the performance of tubes in tube heat exchangers

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	3	2					1			1	2	2	3
2	1	1	3	2					1			1	2	2	3
3	1	1	3	2					1			1	2	2	3
<b>Low (1) ; Medium (2) ; High (3)</b>															

**COURSE OBJECTIVES**

- 1 To make students get acquainted with the sensors and the actuators, which are commonly used in mechatronics systems.
- 2 To provide insight into the signal conditioning circuits, and also to develop competency in PLC programming and control
- 3 To make students familiarize with the fundamentals of IoT and Embedded systems.
- 4 To impart knowledge about the Arduino and the Raspberry Pi.
- 5 To inculcate skills in the design and development of mechatronics and IoT based systems.

**UNIT – I SENSORS AND ACTUATORS****9**

Introduction to Mechatronics - Modular Approach, Sensors and Transducers: Static and Dynamic Characteristics, Transducers - Resistive, Capacitive, Inductive and Resonant, Optical Sensors – Photodetectors - Vision Systems – Laser - Fibre optic - Non-fibre Optic, Solid State Sensors, Piezoelectric and Ultrasonic Sensors. Actuators – Brushless Permanent Magnet DC Motor – PM, VR and Hybrid Stepper motors – DC and AC Servo Motors

**UNIT – II SIGNAL CONDITIONING CIRCUITS AND PLC****9**

Operational Amplifiers – Inverting and Non-Inverting Amplifier – Wheatstone bridge Amplifier – Instrumentation Amplifier – PID Controller, Protection Circuits, Filtering Circuits, Multiplexer, Data Logger and Data Acquisition System –, Switching Loads by Power Semiconductor Devices Circuits – Thyristors – TRIAC – Darlington Pair – MOSFET and Relays.  
PLC – Architecture – Input / Output Processing – Logic Ladder Programming – Functional Block Programming using Timers and Counters – Applications.

**UNIT – III FUNDAMENTALS OF IoT AND EMBEDDED SYSTEMS****9**

The Internet of Things ( IoT) - Introduction to the IoT Framework – IoT Enabling Technologies- The Effective Implementation of IoT: The Detailed Procedure. Embedded Systems: An Introduction - Single-Chip Microcontroller Systems - Single-Board Microcontroller Systems - Single-Board Computer Systems - Embedded Systems: Peripherals - Software Considerations

**UNIT – IV CONTROLLERS****9**

Foundation topics: Programming Languages: C++ and Python - The Linux Operating System. Arduino: The Arduino Boards - Arduino Peripherals- Arduino IDE – ESP8266 Wi-Fi module. Raspberry Pi: The Raspberry Pi Boards - The Raspberry Pi Peripherals - The Raspberry Pi Operating System. (typical peripherals) Interfacing and Controlling I/O devices by Arduino and Raspberry Pi: LEDs - Push buttons - Light intensity sensor - Ultrasonic distance sensor – Temperature sensor- Humidity sensor - Sensor and Actuator interactions

**UNIT – V MECHATRONICS AND IoT CASE STUDIES****9**

Mechatronics systems: Drone actuation and Control -Autonomous Robot with Vision System, Automotive Mechatronics: Electronic Ignition System - ABS - EBD - Adaptive Cruise Control. IoT case studies: Remote Monitoring Systems- Remotely Operated Autonomous Systems - Centralized Water Management System - IoT Enabled Robotic Camera Dolly - Portable, Wireless, Interactive IoT Sensors for Agriculture - IoT Vehicle Management System with Network Selection.

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Explain Select suitable sensors and actuators to develop mechatronics systems.
2. Discuss Devise proper signal conditioning circuit for mechatronics systems, and also able to implement PLC as a controller for an automated system.
3. Elucidate the fundamentals of IoT and Embedded Systems
4. Discuss Control I/O devices through Arduino and Raspberry Pi.
5. Design and develop an apt mechatronics/IoT based system for the given real-time application.

**TEXT BOOKS:**

1. Bradley D.A., Burd N.C., Dawson D., Loader A.J., "Mechatronics: Electronics in Products and Processes", Routledge, 2017.
2. Sami S.H and Kisheen Rao G "The Internet of Mechanical Things: The IoT Framework for Mechanical Engineers", CRC Press, 2022.

**REFERENCES:**

1. John Billingsley, "Essentials of Mechatronics", Wiley, 2006
2. David H., Gonzalo S., Patrick G., Rob B. and Jerome H., "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Pearson Education, 2018.
3. Nitin G and Sharad S, "Internet of Things: Robotic and Drone Technology", CRC Press, 2022
4. Newton C. Braga, "Mechatronics for The Evil Genius", McGrawHill, 2005.
5. Bell C., "Beginning Sensor Networks with Arduino and Raspberry Pi", Apress, 2013

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Low (1) ; Medium (2) ; High (3)															

**ME3792****COMPUTER INTEGRATED MANUFACTURING**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES**

- 1 To provide the overview of evolution of automation, CIM and its principles.
- 2 To learn the various Automation tools, include various material handling system.
- 3 To train students to apply group technology and FMS.
- 4 To familiarize the computer aided process planning in manufacturing.
- 5 To introduce to basics of data transaction, information integration and control of CIM.

**UNIT – I****INTRODUCTION****9**

Introduction to CAD, CAM, CAD/CAM and CIM - Evolution of CIM – CIM wheel and cycle – Production concepts and mathematical models – Simple problems in production models – CIM hardware and software – Major elements of CIM system – Three step process for implementation of CIM – Computers in CIM – Computer networks for manufacturing – The future automated factory – Management of CIM – safety aspects of CIM– advances in CIM

**UNIT – II****AUTOMATED MANUFACTURING SYSTEMS****9**

Automated production line – system configurations, work part transfer mechanisms – Fundamentals of Automated assembly system – System configuration, Part delivery at workstations – Design for automated assembly – Overview of material handling equipments – Consideration in material handling system design – The 10 principles of Material handling. Conveyor systems – Types of conveyors – Operations and features. Automated Guided Vehicle system – Types & applications – Vehicle guidance technology – Vehicle management and safety. Storage system performance – storage location strategies – Conventional storage methods and equipments – Automated storage/Retrieval system and Carousel storage system Deadlocks in Automated manufacturing systems – Petrinet models – Applications in Dead lock avoidance – smart manufacturing – Industry 4.0 - Digital manufacturing – Virtual manufacturing

**UNIT – III****GROUP TECHNOLOGY AND FMS****9**

Part families – Visual – Parts classification and coding – Production flow analysis – Grouping of parts and Machines by rank order clustering method – Benefits of GT – Case studies. FMS – Components – workstations – FMS layout configurations – Computer control systems – FMS planning and implementation issues – Architecture of FMS – flow chart showing various operations in FMS – Machine cell design – Composite part concept, Holier method, Key machine concept – Quantitative analysis of FMS – Bottleneck model – Simple and complicated problems – Extended Bottleneck model - sizing the FMS – FMS applications, Benefits.

**UNIT – IV****PROCESS PLANNING****9**

Process planning – Activities in process planning, Informations required. From design to process planning – classification of manufacturing processes – Selection of primary manufacturing processes – Sequencing of operations according to Anteriorities – various examples – forming of Matrix of Anteriorities – case study. Typical process sheet – case studies in Manual process planning. Computer Aided Process Planning – Process planning module and data base – Variant process planning – Two stages in VPP – Generative process planning – Flow chart showing various activities in generative PP – Semi generative process planning- Comparison of CAPP and Manual PP.

**UNIT – V****PROCESS CONTROL AND DATA ANALYSIS****9**

Introduction to process model formulation – linear feedback control systems – Optimal control – Adaptive control –Sequence control and PLC& SCADA. Computer process control – Computer process interface – Interface hardware – Computer process monitoring – Direct digital control and Supervisory computer control - Overview of Automatic identification methods – Bar code technology –Automatic data capture technologies.- Quality management (SPC) and automated inspection

**TOTAL :45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Discuss the basics of computer aided engineering.
2. Choose appropriate automotive tools and material handling systems.
3. Discuss the overview of group technology, FMS and automation identification methods.
4. Design using computer aided process planning for manufacturing of various components
5. Acquire knowledge in computer process control techniques.

**TEXT BOOKS:**

1. Shivanand H K, Benal M M and Koti V, Flexible Manufacturing System, New Age, 2016.
2. CIM: Computer Integrated Manufacturing: Computer Steered Industry Book by August-Wilhelm Scheer

**REFERENCES:**

1. Alavudeen and Venkateshwaran, Computer Integrated ManufacturingII, PHI Learning Pvt. Ltd., New Delhi, 2013.
2. Gideon Halevi and Ronald D. Weill, Principles of Process PlanningII, Chapman Hall, 1995.
3. James A. Retrg, Herry W. Kraebber, Computer Integrated ManufacturingII, Pearson Education, Asia,3rdEdition,2004.
4. Mikell P. Groover, Automation, Production system and Computer integrated Manufacturing, Prentice Hall of India Pvt. Ltd., 4thEdition, 2014.
5. Radhakrishnan P, Subramanian S and Raju V, CAD/CAM/CIM, New Age International Publishers, 3rd Edition, 2008.

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Low (1) ; Medium (2) ; High (3)															

**GE3792** **INDUSTRIAL MANAGEMENT** **L** **T** **P** **C**  
**3** **0** **0** **3**

**COURSE OBJECTIVES**

- 1 To study the basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.
- 2 To study the planning; organizing and staffing functions of management in professional organization.
- 3 To study the leading; controlling and decision making functions of management in professional organization.
- 4 To learn the organizational theory in professional organization.
- 5 To learn the principles of productivity and modern concepts in management in professional organization.

**UNIT – I INTRODUCTION TO MANAGEMENT** **9**

Management: Introduction; Definition and Functions – Approaches to the study of Management – Mintzberg’s Ten Managerial Roles – Principles of Taylor; Fayol; Weber; Parker – Forms of Organization: Sole Proprietorship; Partnership; Company (Private and Public); Cooperative – Public Sector Vs Private Sector Organization – Business Environment: Economic; Social; Political; Legal – Trade Union: Definition; Functions; Merits & Demerits.

**UNIT – II FUNCTIONS OF MANAGEMENT - I** **9**

Planning: Characteristics; Nature; Importance; Steps; Limitation; Planning Premises; Strategic Planning; Vision & Mission statement in Planning– Organizing: Organizing Theory; Principles; Types; Departmentalization; Centralization and Decentralization; Authority & Responsibility – Staffing: Systems Approach; Recruiting and Selection Process; Human Resource Development (HRD) Concept and Design.

**UNIT – III FUNCTIONS OF MANAGEMENT - II** **9**

Directing (Leading): Leadership Traits; Style; Morale; Managerial Grids (Blake-Mouton, Reddin) – Communication: Purpose; Model; Barriers – Controlling: Process; Types; Levels; Guidelines; Audit (External, Internal, Merits); Preventive Control – Decision Making: Elements; Characteristics; Nature; Process; Classifications.

**UNIT – IV ORGANIZATION THEORY** **9**

Organizational Conflict: Positive Aspects; Individual; Role; Interpersonal; Intra Group; Inter Group; Conflict Management – Maslow’s hierarchy of needs theory; Herzberg’s motivation-hygiene theory; McClelland’s three needs motivation theory; Vroom’s valence-expectancy theory – Change Management: Concept of Change; Lewin’s Process of Change Model; Sources of Resistance; Overcoming Resistance; Guidelines to managing Conflict.

**UNIT – V PRODUCTIVITY AND MODERN TOPICS** **9**

Productivity: Concept; Measurements; Affecting Factors; Methods to Improve – Modern Topics (concept, feature/characteristics, procedure, merits and demerits): Business Process Reengineering (BPR); Benchmarking; SWOT/SWOC Analysis; Total Productive Maintenance; Enterprise Resource Planning (ERP); Management of Information Systems (MIS), Industry 4.0.



**OUTCOMES:** At the end of the course the students would be able to

1. Discuss basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.
2. Discuss the planning; organizing and staffing functions of management in professional organization.
3. Apply the leading; controlling and decision making functions of management in professional organization.
4. Discuss the organizational theory in professional organization.
5. Apply principles of productivity and modern concepts in management in professional organization.

**TEXT BOOKS:**

1. M. Govindarajan and S. Natarajan, "Principles of Management", Prentice Hall of India, New Delhi, 2009.
2. Koontz. H. and Wehrich. H., "Essentials of Management: An International Perspective", 8<sup>th</sup> Edition, Tata McGrawhill, New Delhi, 2010.

**REFERENCES:**

1. Joseph J, Massie, "Essentials of Management", 4<sup>th</sup> Edition, Pearson Education, 1987.
2. Saxena, P. K., "Principles of Management: A Modern Approach", Global India Publications, 2009.
3. S.Chandran, "Organizational Behaviours", Vikas Publishing House Pvt. Ltd., 1994.
4. Richard L. Daft, "Organization Theory and Design", South Western College Publishing, 11<sup>th</sup> Edition, 2012.
5. S. TrevisCerto, "Modern Management Concepts and Skills", Pearson Education, 2018.

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4			1	1		3	2	3	2	3	2	3	1	1	1
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<b>Low (1) ; Medium (2) ; High (3)</b>															



**ME3781**

**MECHATRONICS AND IoT LABORATORY**

**L T P C**  
**0 0 4 2**

**Course Objectives**

1. To study the concept of mechatronics to design, modelling and analysis of basic electrical hydraulic systems.
2. To provide the hands on-training in the control of linear and rotary actuators.
3. To study the concepts and fundamentals of IoT, sensors, actuators and IoT boards

**MECHATRONICS**

**LIST OF EXPERIMENTS:**

1. Measurement of Linear/Angular of Position, Direction and Speed using Transducers.
2. Measurement of Pressure, Temperature and Force using Transducers.
3. Speed and Direction control of DC Servomotor, AC Servomotor and Induction motors.
4. Addition, Subtraction and Multiplication Programming in 8051.
5. Programming and Interfacing of Stepper motor and DC motor using 8051/PLC.
6. Programming and Interfacing of Traffic Light Interface using 8051.
7. Sequencing of Hydraulic and Pneumatic circuits.
8. Sequencing of Hydraulic, Pneumatic and Electro-pneumatic circuits using Software.

9. Electro-pneumatic/hydraulic control using PLC.
10. Vision based image acquisition and processing technique for inspection and classification.

### INTERNET OF THINGS

1. Familiarization with concept of IoT and its open source microcontroller/SBC.
2. Write a program to turn ON/OFF motor using microcontroller/SBC through internet.
3. Write a program to interface sensors to display the data on the screen through internet.
4. Interface the sensors with microcontroller/SBC and write a program to turn ON/OFF Solenoid valve through internet when sensor data is detected.
5. To interface sensor with microcontroller/SBC and write a program to turn ON/OFF Linear/Rotary Actuator through IoT when sensor data is detected.
6. To interface Bluetooth/Wifi with microcontroller/SBC and write a program to send sensor data to smart phone using Bluetooth/wifi.

**TOTAL : 60 PERIODS**

### **OUTCOMES: At the end of the course the students would be able to**

1. Demonstrate the functioning of mechatronics systems with various pneumatic, hydraulic and electrical systems.
2. Demonstrate the microcontroller and PLC as controllers in automation systems by executing proper interfacing of I/O devices and programming
3. Demonstrate of IoT based Home automation, CNC router, Robotic arm.

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Low (1) ; Medium (2) ; High (3)												

PROGRESS THROUGH KNOWLEDGE

<b>CME331</b>	<b>AUTOMOTIVE MATERIALS, COMPONENTS, DESIGN AND TESTING</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>2</b>	<b>0</b>	<b>2</b>	<b>3</b>

### **COURSE OBJECTIVES**

1. To study the functional requirements of engine components and suitable materials
2. To learn to design of cylinder and piston components
3. To learn to design of connecting rod and crank shaft
4. To learn to design of flywheel and valve train
5. To study the Engine Testing cycles, Emission measurement technologies

#### **UNIT – I                    FUNCTIONAL REQUIREMENTS OF ENGINE COMPONENTS AND SUITABLE MATERIALS                    6**

Functional requirements of engine components – Piston, piston pin, cylinder liner, connecting rod, crank shaft, valves, spring, engine block, cylinder head, and flywheel. Suitable materials for engine components.

#### **UNIT – II                    DESIGN OF CYLINDER AND PISTON COMPONENTS                    6**

Design of cylinder, cylinder head, piston, piston rings and piston pin – more details in necessary

#### **UNIT – III                    DESIGN OF CONNECTING ROD AND CRANK SHAFT                    6**

Design of connecting rod – Shank design – small end design – big end design – bolts design. Design of overhang crank shaft under bending and twisting – Crank pin design – Crank web design – Shaft design.

#### **UNIT – IV                    DESIGN OF FLYWHEEL AND VALVE TRAIN                    6**

Design of valve – inlet valve – exhaust valve - Valve springs – tappet – rocker arm. Determination of mass of flywheel for a given coefficient of fluctuation of speed. Design of flywheel - rim - hub - arm.

#### **UNIT – V                    ENGINE TESTING                    6**

Engine test cycles – WLTC – WHSC – WHVC – NRTC – ISO 8178. Dynamometer - Chassis dynamometer - transient dynamometer. Emission measurement technologies and instruments - NOX – Smoke – Particulate matter – CO – CO2 - HC.-Particle counter

**TOTAL=30 PERIODS**

### **EXPERIMENTS**

1. Design and animate Piston Cylinder assembly and motion study using CAD software.
2. Design and simulate Connecting rod and crank shaft
3. Design flywheel and valve
4. Design and simulate Two Cylinder Engine assembly using CAD software.
5. Conduct the engine performance test using analysis software
6. Conduct the emission test using analysis software

**TOTAL = 30 PERIODS**

### **OUTCOMES:**

At the end of the course the students would be able to

1. Discuss the requirements of engine components and select suitable materials.
2. Apply the concept of design to cylinder and piston components and solve problems.
3. Apply the concept of design to Connecting rod and crank shaft and solve problems.
4. Apply the concept of design to flywheel and valve train and solve problems.
5. Discuss engine teste cycles, dynamometer and emission measurement technologies and instruments

### **TEXT BOOKS:**

1. Khurmi. R.S. & Gupta. J.K., "A text book of Machine Design", Eurasia Publishing House (Pvt) Ltd, 2001.
2. The Automotive Chassis: Volume 1: Components Design (Mechanical Engineering Series) by Giancarlo Genta and Lorenzo Morello | 24 December 2019

**REFERENCES:**

- Hiroshima Yamagata, "The science and technology of materials in automotive engines", Woodhead Publishing Limited, Cambridge, England
- Jain.R.K, "Machine Design", Khanna Publishers, New Delhi, 2005.
- Manufacturing Automotive Components from Sustainable Natural Fiber Composites (SpringerBriefs in Materials) by Lobna A. Elseify, Mohamad Midani, et al. | 9 August 2021
- Mechanical and Materials Engineering of Modern Structure and Component Design (Advanced Structured Materials Book 70) by Andreas Öchsner and Holm Altenbach | 6 June 2015
- Advanced Technology for Design and Fabrication of Composite Materials and Structures: Applications to the Automotive, Marine, Aerospace and ... Applications of Fracture Mechanics) by George C. Sih, Alberto Carpinteri, et al. | 15 December 2010

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<b>Low (1) ; Medium (2) ; High (3)</b>															

**CME332**

**CONVENTIONAL AND FUTURISTIC VEHICLE TECHNOLOGY**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- To study the advanced engine technologies
- To learn various advanced combustion technologies and its benefits
- To learn the methods of using low carbon fuels and its significance
- To learn and understand the hybrid and electric vehicle configurations
- To study the application of fuel cell technology in automotives

**UNIT – I ADVANCED ENGINE TECHNOLOGY**

**9**

Gasoline Direct Injection, Common Rail Direct Injection, Variable Compression Ratio Turbocharged Engines, Electric Turbochargers, VVT, Intelligent Cylinder De-activation, After Treatment Technologies, Electric EGR, Current EMS architecture.

**UNIT – II COMBUSTION TECHNOLOGY**

**9**

Spark Ignition combustion, Compression Ignition Combustion, Conventional Dual Fuel Combustion, Low Temperature Combustion Concepts– Controlled Auto Ignition, Homogeneous Charge Compression Ignition, Premixed Charge Compression Ignition, Partially Premixed Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition.

**UNIT – III LOW CARBON FUEL TECHNOLOGY**

**9**

Alcohol Fuels, Ammonia Fuel and Combustion, Methane Technology, Dimethyl Ether, Hydrogen Fuel Technology, Challenges, and way forward

**UNIT – IV HYBRID AND ELECTRIC VEHICLE (BATTERY POWERED)**

**9**

Conventional Hybrids (Conventional ICE + Battery), Modern Hybrids (RCCI/GDCI Engine + Battery), Pure Electric Vehicle Technology – Challenges and Way forward

**UNIT – V FUEL CELL TECHNOLOGY****9**

Fuel cells for automotive applications - Technology advances in fuel cell vehicle systems - Onboard hydrogen storage - Liquid hydrogen and compressed hydrogen - Metal hydrides, Fuel cell control system - Alkaline fuel cell - Road map to market.

**TOTAL :45 PERIODS****OUTCOMES:** At the end of the course the students would be able to

1. Discuss the latest trends in engine technology
2. Discuss the need of advanced combustion technologies and its impact on reducing carbon foot-print on the environment.
3. Analyzing the basic characteristics of low carbon fuels, its impact over conventional fuels and in achieving sustainable development goals.
4. Discuss the working and energy flow in various hybrid and electric configurations.
5. Analyzing the need for fuel cell technology in automotive applications.

**TEXT BOOKS:**

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2. Rakesh Kumar Maurya, Characteristics and Control of Low Temperature Combustion Engines. ISBN 978-3-319-68507-6 , SPRINGER

**REFERENCES:**

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
3. Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998
4. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
5. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003

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Low (1) ; Medium (2) ; High (3)															

<b>CME333</b>	<b>RENEWABLE POWERED OFF HIGHWAY VEHICLES AND EMISSION CONTROL TECHNOLOGY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

### **COURSE OBJECTIVES**

- 1 To study the low and zero carbon fuels suitability and methods of use in off-road vehicles.
- 2 To learn and understand the green energy production methodologies and its use in off-road vehicle categories.
- 3 To learn various fuel cell types and its suitability in off-highway vehicles applications
- 4 To illustrate the impact of in-cylinder technologies on engine out emissions control.
- 5 To study the existing after-treatment technologies used in off-highway vehicle applications.

### **UNIT – I                    LOW AND ZERO CARBON FUELS POWERED OFF-HIGHWAY                    9 VEHICLES**

Ethanol, Methanol, Butanol, Biodiesel, CNG, LNG, DME, Polyoxymethylene Dimethyl Ether (PODE), Ammonia and Hydrogen Fuels suitability, methods, and technologies for powering off-road vehicles.

### **UNIT – II                    GREEN ENERGY POWERED OFF-HIGHWAY VEHICLES                    9**

Solar Technology for Green Electricity, Green Electricity for Hydrogen Production, Hydrogen Smart Grid Technologies, Hydrogen to ICE powered vehicles, Hydrogen to Fuel Cell Powered Vehicles.

### **UNIT – III                    FUEL CELL POWERED OFF-HIGHWAY VEHICLES                    9**

Fuel Cell, Types, Applications, Fuel Cell Requirement, Sizing and Design for Off-Highway applications, Merits and Demerits, Pathway to overcome the limitations. Scope of the fuel cell research on Off-road vehicle applications.

### **UNIT – IV                    IN-CYLINDER TREATMENT TECHNOLOGIES                    9**

Low temperature Combustion Modes - Homogeneous Charge Compression Ignition, Premixed-Charge Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition, Water Injection Technologies.

### **UNIT – V                    AFTER TREATMENT TECHNOLOGIES                    9**

Diesel Oxidation Catalyst, Diesel Particulate Filter, Selective Catalytic Reduction, Ammonia slip / clean up catalyst. CO<sub>2</sub> absorption techniques, Waste Heat Recovery and Organic Rankine Cycle.

**TOTAL :45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Evaluate the availability, suitability, and its role in off-road vehicle categories in reducing the carbon footprint on the environment.
2. Gain the knowledge on various green energy production methods and its impact on meeting energy demand of off-road vehicle applications.
3. Develop the working of fuel cell, various fuel cell types, and its design for off-road vehicle applications.
4. Gain the knowledge on various in-cylinder low temperature combustion technologies and its key role in controlling the engine-out emissions.
5. Develop the working of various existing aftertreatment systems in controlling the engine out emissions.

### **TEXT BOOKS:**

1. John Twidell, and Tony Weir. Renewable Energy Sources – 3<sup>rd</sup> Edition 2015,
2. Rakesh Kumar Maurya, Characteristics and Control of Low Temperature Combustion Engines.

### **REFERENCES:**

1. Daniel J Holt. Fuel Cell Powered Vehicles: Automotive Technology of the Future. Society of Automotive Engineers, 2001 - Technology & Engineering,

2. W. Addy Majewski, Magdi K. Khair. Diesel Emissions and Their Control.
3. Toward Zero Carbon: The Chicago Central Area DeCarbonization Plan by Adrian Smith and Gordon Gill | 1 June 2011
4. Transportation in a Net Zero World: Transitioning Towards Low Carbon Public Transport (Green Energy and Technology) by Kathryn G. Logan, Astley Hastings, et al. | 7 April 2022
5. The Political Economy of Low Carbon Transformation: Breaking the habits of capitalism (Routledge Studies in Low Carbon Development) by Harold Wilhite | 21 December 2017

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Low (1) ; Medium (2) ; High (3)															

**CME334 VEHICLE HEALTH MONITORING, MAINTENANCE AND SAFETY** **L 3 T 0 P 0 C 3**

#### COURSE OBJECTIVES

- 1 To enable the student to understand the principles, functions and practices adapted in maintenance activities of vehicles.
- 2 To study the powertrain maintenance, fault diagnosis, maintenance of Batteries
- 3 To develop vehicle system maintenance and service of clutch, brake.
- 4 To study the concepts of vehicle safety and regulations.
- 5 To study and understand the simulation of safety concepts

#### UNIT – I INTRODUCTION 9

Need for Maintenance – importance, classification of maintenance work-basic problem diagnosis. Maintenance of vehicle systems – power pack, tyres, safety systems. Scheduled maintenance services – service intervals – On-board diagnostics, Computerized engine analyzer study and practice- OBD and scan tools;

#### UNIT – II POWERTRAIN MAINTENANCE 9

Exhaust emission test of petrol and diesel engine; - Electronic fuel injection and engine management service - fault diagnosis- OBD-III and scan tool, identifying DTC and servicing emission controls, Maintenance of Batteries, Starting System, Charging System and Body Electrical -Fault Diagnosis Using Scan Tools.

#### UNIT – III VEHICLE SYSTEM MAINTENANCE 9

Clutch- adjustment and service, Maintenance and Service of Hydraulic brake, Bleeding of brakes, Checking ABS and components. Maintenance and Service of McPherson strut, coil spring. tyre wear, measurement of read depth and tyre rotation, Computerized wheel balancing & wheel alignment, Maintenance and Service of steering linkage, steering column, Rack and pinion steering

#### UNIT – IV VEHICLE SAFETY 9

Concepts of vehicle safety -Seat belt, regulations, automatic seat belt tightener system, collapsible steering column, air bags, electronic system for activating air bags, bumper design for safety, Active Safety - ABS, EBD, CSC, Traction control system, Modern electronic features in vehicles like tyre pressure monitoring, Automatic headlamp ON, Rain sensing wipers.

**UNIT – V SIMULATION OF SAFETY CONCEPTS****9**

Active safety: driving safety, conditional safety, perceptibility safety, operating safety passive safety: exterior safety, interior safety, deformation behavior of vehicle body, speed and acceleration characteristics of passenger compartment on impact. Collision warning system, causes of rear end collision, frontal object detection, rear vehicle object detection system, object detection system with braking system Interactions.

**TOTAL:45 PERIODS****OUTCOMES:** At the end of the course the students would be able to

1. The students have the knowledge of vehicle health monitoring, maintenance and safety.
2. The students able to maintenance of powertrain.
3. The students can ability to maintenance of Vehicle system.
4. Explain and awareness of vehicle safety.
5. Explain the simulation of safety concepts.

**TEXT BOOKS:**

1. 5th Edition, "Advanced Automotive Fault Diagnosis Automotive Technology: Vehicle Maintenance and Repair" By Tom Denton
2. Safety Management System and Documentation Training Programme Handbook by S. V. Paul ISBN: 9788123923444

**REFERENCES:**

1. Ed May, "Automotive Mechanics Volume One" and Two, Mc Graw Hill Publications, Tenth edition, 2018
2. Bosch Automotive Handbook, Tenth Edition, 2018
3. Jack Erjavek, "A systems approach to Automotive Technology", Cengage Learning, 5<sup>th</sup> Edition, 2012
4. William H. Crouse and Donald L. Anglin, "Automotive Mechanics", Tata McGraw Hill, 10th Edition, 2004.
5. Vehicle Service Manuals of Reputed Indian Manufacturers.

CO	PO												PSO		
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<b>Low (1) ; Medium (2) ; High (3)</b>															

**CME335****CAE AND CFD APPROACH IN FUTURE MOBILITY****L****T****P****C****2****0****2****3****COURSE OBJECTIVES**

- 1 To study the use of computer in mobility software or mobility.
- 2 To study the concepts computer aided design and rapid prototyping
- 3 To introduce the basic concepts of the finite elements methods.
- 4 To introduce basics and fundamental of the computational fluid dynamics
- 5 To introduce Turbulence Modelling and various simulation techniques.



**UNIT – I INTRODUCTION TO CAE /CFD****6**

Introduction to use of computer in Mobility Product Life Cycle, Software for mobility. Introduction to design process and role of computers in the design process, use of modern computational tools used for design and analysis, Concept of modelling and simulation. CFD as a design and research tool, Applications of CFD in mobility engineering

**UNIT – II CAD AND RAPID PROTOTYPING****6**

Curves and Surfaces: Geometric modelling curves and surfaces, Wire frame models, Parametric representations, Parametric curves and surfaces, Solid modelling: Fundamentals of solid modelling, Different solid representation schemes, Boundary representation (B-rep), Constructive solid geometry (CSG). Mechanism design and assembly. CAD/CAM Data Exchange Formats: Types of file formats & their exchange, Graphics standards. CAD Data and Programming Techniques for RP: Transformations, Solid modelling for RP, Surface modelling, STL file generation, Defects in STL files and repairing algorithms, Interface formats

**UNIT – III INTRODUCTION TO FEA****6**

Basic Concept of Finite Element Method, Ritz and Rayleigh Ritz methods, Method of weighed residuals, Galerkin method. Governing differential equations of one- and two dimensional problems, One Dimensional Second Order Equations – Discretization – Linear and Higher order Elements – Interpolation and shape functions, Derivation of Shape functions and Stiffness matrices and force vectors-Assembly of Matrices - Solution of static problems and case studies in stress analysis of mechanical components using 2D and 3D elements

**UNIT – IV INTRODUCTION TO CFD****6**

CFD vs. experimentation; continuity, navier-stokes and energy equations; modelling and discretization techniques; basic steps in CFD computation Various simplifications, Dimensionless equations and parameters, Incompressible inviscid flows, Source panel method, and Vortex panel method. Conservation form of the equations, shock fitting and shock capturing, Time marching and space marching. 3-D structured and unstructured grid generation, mesh smoothing and sensitivity checks

**UNIT – V PROBLEM SOLVING USING CFD****6**

Turbulence Modelling, different turbulent modelling scheme. Incompressible Viscous Flows:, Applications to internal flows and boundary layer flows. Eddy viscosity and non-eddy viscosity models; Vehicle Aerodynamic Simulation Wind tunnel and on-road simulation of vehicles; Simulation of Ahmed and Windsor bodies; Vorticity based grid-free simulation technique; simulation in climatic and acoustic wind tunnels; velocity vector and pressure contour simulation

**TOTAL :30 PERIODS****CAE AND CFD LABORATORY**

1. Coupled analysis of structural / thermal
2. buckling analysis
3. CFD simulation of flow analysis over a Cylinder Surface 3D
4. CFD simulation of Intermixing of Fluids in a Bent-Pipe 3D
5. CFD simulation of flow and heat transfer analysis of Double Pipe Counter Flow Heat Exchanger
6. Design & processing of Engine components by RPT

**OUTCOMES:** At the end of the course the students would be able to

1. discuss the basic concept of the CAE /CFD
2. Develop the computer aided design and rapid prototyping.
3. Discuss the basic concept of Finite Element methods.
4. discuss the concepts of computational fluid dynamics
5. solving the problem and simulation using computational fluid dynamics.

**TEXT BOOKS:**

1. Computational Fluid Dynamics: A Practical Approach by Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu
2. Applied Computational Fluid Dynamics by S. C. Gupta



**UNIT – V DRIVE SIZING AND ENERGY MANAGEMENT STRATEGIES 9**

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selection of appropriate energy storage technology, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification, and comparison of energy management strategies, Implementation issues.

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Discuss Characterise and configure hybrid drivetrains requirement for a vehicle
2. Design and apply appropriate hybrid and electric drive trains in a vehicle
3. Design and install suitable AC and DC drives for electric vehicles.
4. Discuss arrive at a suitable energy storage system for a hybrid / electric vehicle
5. Apply energy management strategies to ensure better economy and efficiency

**TEXT BOOKS:**

1. Iqbal Husain, —Electric and Hybrid Vehicles: Design Fundamentalsll, Third Edition, 2021
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003

**REFERENCES:**

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2. Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998
3. Hybrid, Electric and Fuel-Cell Vehicles, International Edition by Jack Erjavec | 6 June 2012
4. Energy Management in Hybrid Electric Vehicles using Co-Simulation by Christian Paar | 11 February 2011
5. Hybrid Electric Vehicle Design and Control: Intelligent Omnidirectional Hybrids (MECHANICAL ENGINEERING) by Yangsheng Xu , Jingyu Yan, et al. | 16 December 2013

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Low (1) ; Medium (2) ; High (3)															

<b>CME337</b>	<b>THERMAL MANAGEMENT OF BATTERIES AND FUEL CELLS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

### **COURSE OBJECTIVES**

- 1 To study the working principle of Li-ion Batteries and Battery Packs.
- 2 To learn the thermal management system in Battery modules.
- 3 To develop the different case studies in Battery Thermal Management System.
- 4 To learn the working principle of Fuel Cells cooling methods.
- 5 To learn the inside components of Thermal Management Systems in various famous Electric and Fuel Cell Electric Vehicles.

### **UNIT – I ADVANCED BATTERIES 9**

Li-ion Batteries- chemistry, different formats, operating areas, efficiency, aging. Battery Management System- Configuration, Characteristics. Tesla Model S- 18650 Cell specifications, P85 Battery Pack mechanical structure, Texas Instruments BMS. Supercapacitors Vs batteries. Diamond battery concepts.

### **UNIT – II THERMAL MANAGEMENT IN BATTERIES 9**

Thermal Management Systems- impact, Types- Air, Liquid, Direct refrigerant, Heat pipe, Thermo Electric, Phase Change Material Cooling methods. Solid-liquid PCM Types- Organic, Inorganic, Eutectics. PCM Thermal properties and applications. Tesla Model-S Battery Module- bonding techniques, thermal management.

### **UNIT – III BATTERY THERMAL MANAGEMENT CASE STUDIES 9**

EV Battery Cooling- challenges and solutions. Heat Exchanger Design and Optimization Model for EV Batteries using PCMs- system set up, selection of PCMs. Chevrolet Volt Model Battery Thermal Management System- Case study. Modelling Liquid Cooling of a Li-Ion Battery Pack with COMSOL Multiphysics- simulation concepts.

### **UNIT – IV THERMAL MANAGEMENT IN FUEL CELLS 9**

Fuel Cells- operating principle, hydrogen-air fuel cell system characteristics, other fuel cell technologies, polarization curves, applications. Fuel cell thermal management- basic model, energy balance, governing equations, characteristic curve, sizing, cooling methods, advantages, restrictions.

### **UNIT – V FUEL CELL THERMAL MANAGEMENT CASE STUDIES 9**

Fuel cell system- balance of plant- components required. Fuel cell power plant sizing problems- Fuel Cell Electric Vehicle Fuel economy calculations-Battery EVs Vs Fuel Cell EVs. Toyota Mirai FCV- Operating principle, High pressure hydrogen tank, Boost convertor, NiMH Battery, Internal circulation system, Hydrogen refueling- Case studies.

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Discuss the different Li-ion Batteries and Fuel Cell performances.
2. Design a Battery Pack with appropriate PCM.
3. Apply Cooling Models using Simulation
4. Estimate fuel economy.
5. Utilize different Thermal Management System approaches during real world usage.

### **TEXT BOOKS:**

1. Ibrahim Dinçer, Halil S. Hamut, and Nader Javani, "Thermal Management of Electric Vehicle Battery Systems", Wiley, 2017.
2. Jiuchun Jiang and Caiping Zhang, "Fundamentals and applications of Lithium-Ion batteries in Electric Drive Vehicles", Wiley, 2015.
3. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles-Fundamentals, Theory, and Design", CRC Press, 2005.
4. John G. Hayes and G. Abas Goodarzi, "Electric Powertrain", Wiley, 2018
5. Davide Andrea, "Battery Management Systems for Large Lithium-Ion Battery Packs" ARTECH House, 2010.

## REFERENCES:

1. Nag.P.K, "Engineering Thermodynamics", 5th Edition, Tata McGraw Hill Education, New Delhi, 2013.
2. "Vehicle thermal Management Systems Conference Proceedings", 1st Edition; 2013, Coventry Techno centre, UK
3. Younes Shabany," Heat Transfer: Thermal Management of Electronics Hardcover" 2010, CRC Press.
4. T. Yomi Obidi, "Thermal Management in Automotive applications", 2015, SAE International.
5. Jerry Sergent, Al Krum, "Thermal Management Handbook: For Electronic Assemblies Hardcover", 1998, Mc Graw- Hill.

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**CME338**

**VALUE ENGINEERING**

**L T P C**  
**3 0 0 3**

### COURSE OBJECTIVES

- 1 To study the value engineering process and able to identify its functions within the process.
- 2 To determine the appropriate value engineering methodology for a given project and propose appropriate training to centralized and decentralized modes.
- 3 To learn various decision-making processes and cost evaluation models and apply them in appropriately in the product development life-cycle.
- 4 To explore in-depth understanding of various value engineering applications in human resources, manufacturing and marketing.
- 5 To demonstrate to implement value engineering solutions and propose to perfect them.

### UNIT – I VALUE ENGINEERING BASICS

**9**

Origin of value engineering - Meaning of value engineering - Definition of value engineering and Value analysis- Value Management - Value Analysis Versus Value Engineering - Value Analysis versus Traditional cost reduction techniques - Types of Value function – Basic and Secondary functions - concept of cost and worth - creativity In Value Engineering - uses, applications, advantages and limitations of Value analysis.

### UNIT – II VALUE ENGINEERING JOB PLAN AND PROCESS

**9**

Seven phases of job plan - FAST Diagramming as Value Engineering Tool - Behavioral and organizational aspects of Value Engineering - Ten principles of Value analysis - Benefits of Value Engineering.

### UNIT – III VALUE ENGINEERING TECHNIQUES

**9**

Creativity - Brain storming - Gordon technique - Morphological Analysis - ABC Analysis- Probabilistic approach - Make or Buy decisions – Function cost worth analysis (FCWA) - Function Analysis System technique (FAST) - Break Even Analysis - Life cycle cost(LCC)

### UNIT – IV WORKSHEETS AND GUIDELINES

**9**

Preparation of worksheets - general and information phase - Function Classification, relationship and summary - Meaningful costs - Cost analysis - idea listing and comparison - Feasibility ranking - Investigator phase, study summary - guidelines for writing value engineering proposal - Financial aspects - List cycle cost analysis - Oral presentation - Audit - Case studies and Discussion.

**UNIT – V VERSATILITY OF VALUE ENGINEERING****9**

Value engineering operation in maintenance and repair activities - value engineering in non hardware projects - Initiating a value engineering programme Introduction - training plan - career development for value engineering specialties.

**Total :45 Periods****OUTCOMES:** At the end of the course the students would be able to

1. Estimate a product cost based on value engineering principles in terms of its values, functions and worthiness.
2. Discuss the product and articulate it in various phases of value engineering
3. Discuss and select appropriate methods, standards and apply them on value engineering project and propose appropriate training
4. Apply querying theory and FAST to prefect a value engineering project implementation.
5. Develop various case studies related to value engineering project implementation.

**TEXT BOOKS:**

1. Iyer. S.S., "Value Engineering", New Age International (P) Limited, 9th Edition, 2009 3Ed", , 2009.
2. Anil Kumar. and Mukhopadhyaya., "Value Engineering: Concepts Techniques and applications", SAGE Publications, 1st Edition, 2003.

**REFERENCES:**

1. Del L. Younker., "Value Engineering: analysis and methodology", CRC Press, 2003.
2. Richard Park., "Value Engineering A Plan for Invention", CRC Press, 1998.
3. Arthur E. Mudge., "Value Engineering :A systematic approach", McGraw Hill, 1989.
4. Alphonse Dell'Isola., "Value Engineering: Practical Applications...for Design, Construction, Maintenance and Operations", R.S. Means Company, 1997.
5. Lawrence D. Miles., "Techniques of Value Analysis and Engineering", Lawrence D. Miles Value Foundation, 3rd Edition, 2015.

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5	1			1			1	2	1		3	1	1	2	1
Low (1) ; Medium (2) ; High (3)															

**CME339****ADDITIVE MANUFACTURING**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>2</b>	<b>0</b>	<b>2</b>	<b>3</b>

**COURSE OBJECTIVES:**

- To introduce the development of Additive Manufacturing (AM), various business opportunities and applications
- To familiarize various software tools, processes and techniques to create physical objects that satisfy product development / prototyping requirements, using AM.
- To be acquainted with vat polymerization and direct energy deposition processes
- To be familiar with powder bed fusion and material extrusion processes.
- To gain knowledge on applications of binder jetting, material jetting and sheet lamination processes

**UNIT I INTRODUCTION****6**

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain- ASTM/ISO 52900 Classification - Benefits. Applications: Building Printing - Bio Printing - Food Printing- Electronics Printing. Business Opportunities and Future Directions – Case studies: Automobile, Aerospace, Healthcare.

**UNIT II DESIGN FOR ADDITIVE MANUFACTURING (DfAM)****6**

Concepts and Objectives - AM Unique Capabilities - Part Consolidation – Topology Optimization- Generative design - Lattice Structures - Multi-Material Parts and Graded Materials - Data Processing: CAD Model Preparation - AM File formats: STL-Problems with STL- AMF Design for Part Quality Improvement: Part Orientation - Support Structure - Slicing - Tool Path Generation – Design rules for Extrusion based AM.

**UNIT III VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSITION****6**

Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process – top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications. Continuous Liquid Interface Production (CLIP)Technology. Directed Energy Deposition: Laser Engineered Net Shaping (LENS)- Process - Material Delivery - Materials -Benefits -Applications.

**UNIT IV POWDER BED FUSION AND MATERIAL EXTRUSION****6**

Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications. Material Extrusion: Fused Deposition Modeling (FDM)- Process-Materials -Applications and Limitations.

**UNIT V OTHER ADDITIVE MANUFACTURING PROCESSES****6**

Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits- Limitations - Applications. Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications. Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding- Materials-Application and Limitation.

**TOTAL: 30 PERIODS****ADDITIVE MANUFACTURING LABORATORY****Experiments**

1. Modelling and converting CAD models into STL file.
2. Manipulation and error fixing of STL file.
3. Design and fabrication of parts by varying part orientation and support structures.
4. Fabrication of parts with material extrusion AM process.
5. Fabrication of parts with vat polymerization AM process.
6. Design and fabrication of topology optimized parts.

**TOTAL: 30 PERIODS****Equipment required - lab**

1. Extrusion based AM machine
2. Resin based AM machine
3. Mechanical design software
4. Open-source AM software for STL editing, manipulation and slicing.

**COURSE OUTCOMES:**

At the end of this course students shall be able to:

CO1: Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.

- CO2: Acquire knowledge on process of transforming a concept into the final product in AM technology.
- CO3: Elaborate the vat polymerization and direct energy deposition processes and its applications.
- CO4: Acquire knowledge on process and applications of powder bed fusion and material extrusion.
- CO5: Evaluate the advantages, limitations, applications of binder jetting, material jetting and sheet lamination processes.

**TEXT BOOKS:**

1. Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani “Additive manufacturing technologies”. 3<sup>rd</sup> edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0
2. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.

**REFERENCES:**

1. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
2. Milan Brandt, “Laser Additive Manufacturing: Materials, Design, Technologies, and Applications”, Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1<sup>st</sup> Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.
4. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer., United States ,2006, ISBN: 978-1-4614-9842-1.
5. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press., United States, 2011, ISBN: 9780849334092.

**CME340**

**CAD/CAM**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES**

- 1 To Introduce and understand the Basic of Design.
- 2 To study the two dimensional drafting and bill of material creation.
- 3 To learn three dimensional modelling and its advantages.
- 4 To study the basic and purpose of assembling modeling.
- 5 To study the basics of computer aided machining and part programming.

**UNIT – I BASICS OF DESIGNS**

**9**

Understanding of Projections, Scales, units, GD & T; its 14 symbols, Special characteristics & Title Block readings. Revision / ECN status of drawings – Customer Specific requirements – Drawing Grid reading

**UNIT – II 2D DRAFTING**

**9**

Projection views – Orthographic view, Axillary view, Full & Half Section views, Broken Section view, Offset Section view – Title Block creation – BOM Creation – Notes creation – Ballooning of 2D drawing and its features for Inspection reporting

**UNIT – III 3D MODELING**

**9**

Conversion of Views – 2D to 3D & 3D to 2D – Parametric and Non-Parametric Modeling – Tree features of 3D Modeling and its advantages – Surface Modeling – BIW (Body In White) – Solid Modeling, Boolean operations like Unites, Subtraction, Intersect, etc.

**UNIT – IV ASSEMBLY MODELING**

**9**

Basics of Assembly modeling, Purpose of Assembly modeling & its advantages – Top to Down & BottomUp modeling approaches – Analysis of Clearances – Undercuts – Interferences – Stack up analysis –Cumulative effect of Tolerances in after assembly conditions.- motion analysis



**UNIT – V CAM****9**

Basics of CNC Machining – 3, 4 & 5 Axis machines - CNC and Part Programming, CAM programming 2D & 3D. Elements of CAM Orientation, Boundary Creation, Cutter Path Selection, Cutter Compensation – Machining Stocks, Roughing, Re-roughing, Semi Finishing & Finishing - Tool Path Generation, Isl and Milling Programming. Machining program simulation, integration of program with machine; Estimation of CNC Cycle time. – Post Process NC Code conversion and Setup Sheet Preparation.

**TOTAL : 45 PERIODS****OUTCOMES:** At the end of the course the students would be able to

1. Discuss the basics of the design and concepts.
2. Develop the two dimensional drafting and projection views.
3. Discuss the three dimensional modeling, parametric and Non-parametric modeling
4. Discuss the assembly modeling and top down, bottom up approaches.
5. Develop the computer aided machining and wiring part programming.

**TEXT BOOKS:**

1. Computer Aided Design & Manufacturing - Jacob Moses & Ruchi Agarwal
2. CAD / CAM Principles & Application - J. Srinivas

**REFERENCES:**

1. CAD / CAM - Ibrahim Zaid (Text & Reference Book)
2. CAD / CAM – Chandandeep Grewal
3. CAD CAM & Automation - Farzad Haideri (Text & Reference Book)
4. Computer Aided Design & Manufacturing – Anup Goel
5. CAD / CAM – PN Rao

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Low (1) ; Medium (2) ; High (3)															

**CME341****DESIGN FOR X**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES**

- 1 To introduce the economic process selection principles and general design principles for manufacturability in the development and design of products for various engineering applications. Also, apply design consideration principles of casting in the design of cast products.
- 2 To learn the design consideration principles of forming in the design of extruded, stamped, and forged products
- 3 To learn design consideration principles of machining in the design of turned, drilled, milled, planed, shaped, slotted, and ground products.
- 4 To learn design consideration principles of welding in the design of welded products.
- 5 To learn design consideration principles in additive manufacturing

**UNIT – I INTRODUCTION****9**

General design principles for manufacturability- strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric Tolerances - Assembly limits -Datum features - Tolerance stacks.

Design to minimize material usage – Design for disassembly – Design for recyclability – Design for manufacture – Design for energy efficiency – Design to regulations and standards.

**UNIT – II FACTORS INFLUENCING FORM DESIGN 9**

Working principle, Material, Manufacture, Design- Possible solutions - Materials choice –Influence of materials on form design - form design of welded members, forgings and castings.

**UNIT – III COMPONENT DESIGN - MACHINING CONSIDERATION 9**

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability – Design for accessibility - Design for assembly – Product design for manual assembly - Product design for automatic assembly – Robotic assembly.

**UNIT – IV COMPONENT DESIGN – CASTING CONSIDERATION 9**

Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA

**UNIT – V DESIGN FOR ADDITIVE MANUFACTURING 9**

Introduction to AM, DFMA concepts and objectives, AM unique capabilities, exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers.

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Elaborate the design principles for manufacturability
2. discuss the factors influencing in form design
3. Apply the component design features of various machine.
4. Discuss the design consideration principles of welding in the design of welded products.
5. Discuss the design consideration principles of additive manufacturing.

**TEXT BOOKS:**

1. James G. Bralla, “Design for Manufacturability Handbook”, McGraw Hill Professional, 1998.
2. O. Molloy, E.A. Warman, S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Springer, 1998.

**REFERENCES:**

1. CorradoPoli, Design for Manufacturing: A Structured Approach, Elsevier, 2001.
2. David M. Anderson, Design for Manufacturability & Concurrent Engineering: How to Design for Low Cost, Design in High Quality, Design for Lean Manufacture, and Design Quickly for Fast Production, CIM Press, 2004.
3. Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, Manufacturing and Design: Understanding the Principles of How Things Are Made, Elsevier, 2014.
4. Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.
5. Boothroyd, G, Hertz and Nike, Product Design for Manufacture, Marcel Dekker, 1994

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Low (1) ; Medium (2) ; High (3)															

**CME342**

**ERGONOMICS IN DESIGN**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES**

- 1 To introduce to industrial design based on ergonomics.
- 2 To consider ergonomics concept in manufacturing
- 3 To apply ergonomics in design of controls and display.
- 4 To apply environmental factors in ergonomics design.
- 5 To develop aesthetics applicable to manufacturing and product

**UNIT – I INTRODUCTION 9**

An approach to industrial design, Elements of design structure for industrial design in engineering application in modern manufacturing systems- Ergonomics and Industrial Design: Introduction to Ergonomics, Communication system, general approach to the man-machine relationship, Human component of work system, Machine component of work system, Local environment-light, Heat, Sound.

**UNIT – II ERGONOMICS AND PRODUCTION 9**

Introduction, Anthropometric data and its applications in ergonomic, working postures, Body Movements, Work Station Design, Chair Design. Visual Effects of Line and Form: The mechanics of seeing, Psychology of seeing, Figure on ground effect, Gestalt's perceptions - Simplicity, Regularity, Proximity, Wholeness. Optical illusions, Influences of line and form.

**UNIT – III DESIGN PRINCIPLES FOR DISPLAY AND CONTROLS 9**

Displays: Design Principles of visual Displays, Classification, Quantitative displays, Qualitative displays, check readings, Situational awareness, Representative displays, Design of pointers, Signal and warning lights, colour coding of displays, Design of multiple displays Controls: Design considerations, Controls with little efforts – Push button, Switches, rotating Knobs. Controls with muscular effort – Hand wheel, Crank, Heavy lever, Pedals. Design of controls in automobiles, Machine Tools

**UNIT – IV ENVIRONMENTAL FACTORS 9**

Colour: Colour and light, Colour and objects, Colour and the eye – after Image, Colour blindness, Colour constancy, Colour terms – Colour circles, Munsel colour notation, reactions to colour and colour combination – colour on engineering equipments, Colour coding, Psychological effects, colour and machine form, colour and style

**UNIT – V AESTHETIC CONCEPTS 9**

Concept of unity, Concept of order with variety, Concept of purpose, Style and environment, Aesthetic expressions - Symmetry, Balance, Contrast, Continuity, Proportion. Style - The components of style, House style, Style in capital good. Introduction to Ergonomic and plant layout software's, total layout design.

**TOTAL: 45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Appreciate ergonomics need in the industrial design.
2. Apply ergonomics in creation of manufacturing system
3. Discuss on design of controls and display.
4. Consider environmental factors in ergonomics design.
5. Report on importance of aesthetics to manufacturing system and product

**TEXT BOOKS:**

1. Ergonomics in Design: Methods and Techniques (Human Factors and Ergonomics) by Marcelo M. Soares , Francisco Rebelo
2. Ergonomics in Product Design by Sendpoints Publishing Co. Ltd.

**REFERENCES:**

1. Benjamin W.Niebel, Motion and Time Study, Richard, D. Irwin Inc., 7thEdition, 2002
2. Brain Shakel, "Applied Ergonomics Hand Book", Butterworth Scientific London 1988.
3. Bridger, R.C., Introduction to Ergonomics, 2ndEdition, 2003, McGraw Hill Publications.
4. Martin Helander, A Guide to human factors and Ergonomics, Taylor and Francis, 2006
5. Mayall W.H. "Industrial design for Engineers", London Hiffee books Ltd., 1988.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		1	3		2		3		1			1	1	3	3
2		1	3		2		3		1			1	1	3	3
3		1	3		2		3		1			1	1	3	3
4		1	3		2		3		1			1	1	3	3
5		1	3		2		3		1			1	1	3	3
Low (1) ; Medium (2) ; High (3)															

**CME343**

**NEW PRODUCT DEVELOPMENT**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- 1 To introduce the fundamental concepts of the new product development
- 2 To develop material specifications, analysis and process.
- 3 To Learn the Feasibility Studies & reporting of new product development.
- 4 To study the New product qualification and Market Survey on similar products of new product development
- 5 To learn Reverse Engineering. Cloud points generation, converting cloud data to 3D model

**UNIT – I FUNDAMENTALS OF NPD**

**9**

Introduction – Reading of Drawing – Grid reading, Revisions, ECN (Engg. Change Note), Component material grade, Specifications, customer specific requirements – Basics of monitoring of NPD applying Gantt chart, Critical path analysis – Fundamentals of BOM (Bill of Materials), Engg. BOM & Manufacturing BOM. Basics of MIS software and their application in industries like SAP, MS Dynamics, Oracle ERP Cloud – QFD.

**UNIT – II MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS**

**9**

Material specification standards – ISO, DIN, JIS, ASTM, EN, etc. – Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis, ), Fabrications, Welding process. Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis.

**UNIT – III ESSENTIALS OF NPD**

**9**

RFQ (Request of Quotation) Processing – Feasibility Studies & reporting – CFT (Cross Function Team) discussion on new product and reporting – Concept design, Machine selection for tool making, Machining – Manufacturing Process selection, Machining Planning, cutting tool selection – Various Inspection methods – Manual measuring, CMM – GOM (Geometric Optical Measuring), Lay out marking and Cut section analysis. Tool Design and Detail drawings preparation, release of details to machine shop and CAM programing. Tool assembly and shop floor trials. Initial sample submission with PPAP documents.

**UNIT – IV CRITERIONS OF NPD**

**9**

New product qualification for Dimensions, Mechanical & Physical Properties, Internal Soundness proving through X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing

frequencies. Market Survey on similar products, Risk analysis, validating samples with simulation results, Lesson Learned & Horizontal deployment in NPD.

**UNIT – V REPORTING & FORWARD-THINKING OF NPD**

**9**

Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) – Purpose & documents, deployment in shop floor. Prototyping & RPT - Concepts, Application and its advantages, 3D Printing – resin models, Sand cores for foundries; Reverse Engineering. Cloud points generation, converting cloud data to 3D model – Advantages & Limitation of RE, CE (Concurrent Engineering) – Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost.)

**TOTAL :45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Discuss fundamental concepts and customer specific requirements of the New Product development
2. Discuss the Material specification standards, analysis and fabrication, manufacturing process.
3. Develop Feasibility Studies & reporting of New Product development
4. Analyzing the New product qualification and Market Survey on similar products of new product development
5. Develop Reverse Engineering. Cloud points generation, converting cloud data to 3D model

**TEXT BOOKS:**

1. Product Development – Sten Jonsson
2. Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger

**REFERENCES:**

1. Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark
2. Change by Design
3. Toyota Product Development System – James Morgan & Jeffrey K. Liker
4. Winning at New Products – Robert Brands 3rd Edition
5. Product Design & Value Engineering – Dr. M.A. Bulsara &Dr. H.R. Thakkar

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	3	1				1	1			1	1	3	2
2	1	1	3	1				1	1			1	1	3	2
3	1	1	3	1				1	1			1	1	3	2
4	1	1	3	1				1	1			1	1	3	2
5	1	1	3	1				1	1			1	1	3	2
<b>Low (1) ; Medium (2) ; High (3)</b>															

**CME344**

**PRODUCT LIFE CYCLE MANAGEMENT**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES**

- 1 To study about the history, concepts and terminology in PLM
- 2 To learn the functions and features of PLM/PDM
- 3 To develop different modules offered in commercial PLM/PDM tools
- 4 To demonstrate PLM/PDM approaches for industrial applications
- 5 To use PLM/PDM with legacy data bases, Coax& ERP systems

**UNIT – I HISTORY, CONCEPTS AND TERMINOLOGY OF PLM 9**

Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (cPDM), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM). PLM/PDM Infrastructure – Network and Communications, Data Management, Heterogeneous data sources and applications

**UNIT – II PLM/PDM FUNCTIONS AND FEATURES 9**

User Functions – Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions – Communication and Notification, data transport, data translation, image services, system administration and application integration

**UNIT – III DETAILS OF MODULES IN A PDM/PLM SOFTWARE 9**

Case studies based on top few commercial PLM/PDM tools – Teamcenter, Windchill, ENOVIA, Aras PLM, SAP PLM, Arena, Oracle Agile PLM and Autodesk Vault.-Architecture of PLM software- selection criterion of software for particular application - Brand name to be removed

**UNIT – IV ROLE OF PLM IN INDUSTRIES 9**

Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organisation, users, product or service, process performance- process compliance and process automation

**UNIT – V BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE 9**

PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP

**TOTAL: 45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Summarize the history, concepts and terminology of PLM
2. Develop the functions and features of PLM/PDM
3. Discuss different modules offered in commercial PLM/PDM tools.
4. Interpret the implement PLM/PDM approaches for industrial applications.
5. Integrate PLM/PDM with legacy data bases, CAX& ERP systems

**TEXT BOOKS:**

1. Product Lifecycle Management for a Global Market, Springer; 2014 edition (29 September 2016),ISBN-10 : 3662516330
2. Product Life Cycles and Product Management, Praeger Publishers Inc (27 March 1989)ISBN-10 : 0899303196

**REFERENCES:**

1. AnttiSaaksvuori and Anselmilmmonen, "Product Lifecycle Management", Springer Publisher, 2008 (3rd Edition)
2. IvicaCrnkovic, Ulf Asklund and AnnitaPerssonDahlqvist, "Implementing and Integrating Product Data Management and Software Configuration Management", Artech House Publishers, 2003.
3. John Stark, "Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question", Springer Publisher, 2007
4. John Stark, "Product Lifecycle Management: 21st Century Paradigm for Product Realisation", Springer Publisher, 2011 (2nd Edition).
5. Michael Grieves, "Product Life Cycle Management", Tata McGraw Hill, 2006.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	3	1				1	1			1	1	3	3
2	1	1	3	1				1	1			1	1	3	3
3	1	1	3	1				1	1			1	1	3	3
4	1	1	3	1				1	1			1	1	3	3
5	1	1	3	1				1	1			1	1	3	3

Low (1) ; Medium (2) ; High (3)

MR3491

**SENSORS AND INSTRUMENTATION**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

1. To understand the concepts of measurement technology.
2. To learn the various sensors used to measure various physical parameters.
3. To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development
4. To learn about the optical, pressure and temperature sensor
5. To understand the signal conditioning and DAQ systems

**UNIT I INTRODUCTION**

**9**

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

**UNIT II MOTION, PROXIMITY AND RANGING SENSORS**

**9**

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

**UNIT III FORCE, MAGNETIC AND HEADING SENSORS**

**8**

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclometers.

**UNIT IV OPTICAL, PRESSURE AND TEMPERATURE SENSORS**

**10**

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

**UNIT V SIGNAL CONDITIONING AND DAQ SYSTEMS****9**

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi-channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

CO1: Recognize with various calibration techniques and signal types for sensors.

CO2: Describe the working principle and characteristics of force, magnetic, heading, pressure and temperature, smart and other sensors and transducers.

CO3: Apply the various sensors and transducers in various applications

CO4: Select the appropriate sensor for different applications.

CO5: Acquire the signals from different sensors using Data acquisition systems.

**TEXT BOOKS:**

1. Ernest O Doebelin, "Measurement Systems – Applications and Design", Tata McGraw-Hill, 2009.
2. Sawney A K and Puneet Sawney, "A Course in Mechanical Measurements and Instrumentation and Control", Dhanpat Rai & Co, 12<sup>th</sup> edition New Delhi, 2013.

**REFERENCES**

1. C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001.
2. Hans Kurt Tönshoff (Editor), Ichiro, "Sensors in Manufacturing" Volume 1, Wiley-VCH April 2001.
3. John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford Science Publications, 1999.
4. Patranabis D, "Sensors and Transducers", 2<sup>nd</sup> Edition, PHI, New Delhi, 2011.
5. Richard Zurawski, "Industrial Communication Technology Handbook" 2<sup>nd</sup> edition, CRC Press, 2015.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	2	2	1						1	2	1	3
CO2	3	2	1	2	2	1						1	2	1	3
CO3	3	2	1	1	2	1						1	2	1	3
CO4	3	2	1	3	2	1						1	2	1	3
CO5	3	2	1	3	2	1						1	2	1	3
CO/PO & PSO Average	3	2	1	2.2	2	1						1	2	1	3
1 – Slight, 2 – Moderate, 3 – Substantial															



MR3392

ELECTRICAL DRIVES AND ACTUATORS

L T P C  
3 0 0 3

COURSE OBJECTIVES:

1. To familiarize a relay and power semiconductor devices
2. To get a knowledge on drive characteristics
3. To obtain the knowledge on DC motors and drives.
4. To obtain the knowledge on AC motors and drives.
5. To obtain the knowledge on Stepper and Servo motor.

UNIT – I RELAY AND POWER SEMI-CONDUCTOR DEVICES 9

Study of Switching Devices – Relay and Types, Switching characteristics -BJT, SCR, TRIAC, GTO, MOSFET, IGBT and IGCT-: SCR, MOSFET and IGBT - Triggering and commutation circuit - Introduction to Driver and snubber circuits

UNIT – II DRIVE CHARACTERISTICS 9

Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, torque, and Direction starting & stopping – Selection of motor.

UNIT – III DC MOTORS AND DRIVES 9

DC Servomotor - Types of PMDC & BLDC motors - principle of operation- emf and torque equations - characteristics and control – Drives- H bridge - Single and Three Phases – 4 quadrant operation – Applications

UNIT – IV AC MOTORS AND DRIVES 9

Introduction – Induction motor drives – Speed control of 3-phase induction motor – Stator voltage control – Stator frequency control – Stator voltage and frequency control – Stator current control – Static rotor resistance control – Slip power recovery control.

UNIT – V STEPPER AND SERVO MOTOR 9

Stepper Motor: Classifications- Construction and Principle of Operation – Modes of Excitation- Drive System-Logic Sequencer - Applications. Servo Mechanism – DC Servo motor-AC Servo motor – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES

At the end of the course, the student able to:

- CO 1: Recognize the principles and working of relays, drives and motors.
- CO 2: Explain the working and characteristics of various drives and motors.
- CO 3: Apply the solid state switching circuits to operate various types of Motors and Drivers
- CO 4: Interpret the performance of Motors and Drives.
- CO 5: Suggest the Motors and Drivers for given applications.

Mapping of COs with POs and PSOs															
COs/Pos&PS Os	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1	1	2	1							1	1		3
CO2	3	1	2	2	1							1	1		3
CO3	3	1	2	2	1							1	1		3
CO4	3	1	1	2	2							1	1		3
CO5	3	1	1	2	2							1	1		3
CO/PO & PSO Average	3	1	1.4	2	1.4							1	1		3

1 – Slight, 2 – Moderate, 3 – Substantial

**TEXT BOOKS:**

1. Bimbhra B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2012.
2. Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S.Chand& Co. Ltd., New Delhi, 2016.

**REFERENCES**

1. Gopal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2001.
2. Theraja B.L. & Theraja A.K., "A Text Book of Electrical Technology", 2nd Edition, S.Chand& Co. Ltd., New Delhi, 2012.
3. Singh M.D. & Kanchandhani K.B., "Power Electronics", McGraw Hill, New Delhi, 2007

**MR3492****EMBEDDED SYSTEMS AND PROGRAMMING****L T P C****2 0 2 3****COURSE OBJECTIVES:**

1. To familiarize the architecture and fundamental units of microcontroller.
2. To know the microcontroller programming methodology and to acquire the interfacing skills and data exchange methods using various communication protocols.
3. To design the interface circuit and programming of I/O devices, sensors and actuators.
4. To understand ARM processor architecture and its functions to meet out the computational and interface needs of growing mechatronic systems.
5. To acquaint the knowledge of real time embedded operating system for advanced system developments.

**UNIT I INTRODUCTION TO MICROCONTROLLER****6**

Fundamentals Functions of ALU - Microprocessor - Microcontrollers – CISC and RISC – Types Microcontroller - 8051 Family - Architecture - Features and Specifications - Memory Organization - Instruction Sets – Addressing Modes.

**UNIT II PROGRAMMING AND COMMUNICATION****6**

Fundamentals of Assembly Language Programming – Instruction to Assembler – Compiler and IDE - C Programming for 8051 Microcontroller – Basic Arithmetic and Logical Programming - Timer and Counter - Interrupts – Interfacing and Programming of Serial Communication, I<sup>2</sup>C, SPI and CAN of 8051 Microcontroller – Bluetooth and WI-FI interfacing of 8051 Microcontroller.

**UNIT III PERIPHERAL INTERFACING****6**

I/O Programming – Interfacing of Memory, Key Board and Displays – Alphanumeric and Graphic, RTC, interfacing of ADC and DAC, Sensors - Relays - Solenoid Valve and Heater - Stepper Motors, DC Motors - PWM Programming – Closed Loop Control Programming of Servomotor – Traffic Light

**UNIT IV ARM PROCESSOR****6**

Introduction ARM 7 Processor - Internal Architecture – Modes of Operations – Register Set – Instruction Sets – ARM Thumb - Thumb State Registers – Pipelining – basic programming of ARM 7 - Applications.

**UNIT V SINGLE BOARD COMPUTERS AND PROGRAMMING****6**

System on Chip - Broadcom BCM2711 SoC – SBC architecture - Models and Languages – Embedded Design – Real Time Embedded Operating Systems - Real Time Programming Languages – Python for Embedded Systems- GPIO Programming – Interfacing

**TOTAL: 30 PERIODS**

## EMBEDDED SYSTEMS LAB

### LIST OF EXPERIMENTS

1. Assembly Language Programming and Simulation of 8051.
2. Alphanumeric and Graphic LCD Interfacing using 8051 Microcontroller.
3. Input switches and keyboard interfacing of 8051.
4. Sensor Interfacing with ADC to 8051 and DAC & RTC Interfacing with 8051. .
5. Timer, Counter and Interrupt Program Application for 8051.
6. Step Motor (Unipolar & Bipolar Motor) and PWM Servo Motor Control to Interfacing with 8051.
7. UART Serial and Parallel Port Programming of 8051.
8. I<sup>2</sup>C, SPI and CAN Programming of 8051.
9. Interfacing and Programming of Bluetooth and Wi-Fi with 8051
10. Programming of ARM Processor for Sensor Interface.
11. Stepper Motor and Servo Motor Control Using ARM Processor.
12. Serial Communication of ARM Processor with Computation Platform.
13. Wireless Communication of ARM Processor with Computation Platform.
14. GPIO Programming of Real Time Embedded Operating Systems.
15. IOT application using SBC.

(any 7 experiments)

**TOTAL: 30 PERIODS**

### COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO 1: Know the various functional units of microcontroller, processors and system-on-chip based on the features and specifications.

CO 2: Recognize the role of each functional units in microcontroller, processors and system-on-chip based on the features and specifications.

CO 3: Interface the sensors, actuators and other I/O's with microcontroller, processors and system on chip based interfacing

CO4: Design the circuit and write the programming microcontroller, processors and system on chip

CO 5: Develop the applications using Embedded system.

### TEXT BOOKS:

1. Frank Vahid and Tony Givagis, "Embedded System Design", 2011, Wiley.
2. Kenneth J. Aylala, "The 8051 Microcontroller, the Architecture and Programming Applications", 2003.

### REFERENCES:

1. Muhammad Ali Mazidi and Janice GillispicMazdi, "The 8051 Microcontroller and Embedded Systems", Pearson Education, 2006.
2. Simon Monk, Programming the Raspberry Pi, Second Edition: Getting Started with Python McGraw Hill TAB; 2nd edition,2015
3. James W. Stewart, "The 8051 Microcontroller Hardware, Software and Interfacing", Regents Prentice Hall, 2003.
4. John B. Peatman, "Design with Microcontrollers", McGraw Hill International, USA, 2005.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	1	2	2						1	3	1	3
CO2	3	2	1	1	2	2						1	3	1	3
CO3	3	2	1	1	2	2						1	3	1	3
CO4	3	2	1	1	2	2						1	3	1	3
CO5	3	2	1	1	2	2						1	3	1	3
CO/PO & PSO Average	3	2	1	1	2	2						1	3	1	3
1 – Slight, 2 – Moderate, 3 – Substantial															

**COURSE OBJECTIVES:**

1. To learn about basics of robots and their classifications
2. To understand the robot kinematics in various planar mechanisms
3. To learn about the concepts in robot dynamics
4. To understand the concepts in trajectory planning and programming
5. To know about the various applications of robots

**UNIT – I BASICS OF ROBOTICS****8**

Introduction- Basic components of robot-Laws of robotics- classification of robot- robot architecture, work space-accuracy-resolution –repeatability of robot.

**UNIT – II ROBOT KINMEATICS****11**

Robot kinematics: Introduction- Matrix representation- rigid motion & homogeneous transformation- D-H, forward & inverse kinematics of 2DOF and 3 DOF planar and spatial mechanisms

**UNIT – III ROBOT DYNAMICS****9**

Introduction - Manipulator dynamics – Lagrange - Euler formulation- Newton - Euler formulation

**UNIT – IV TRAJECTORY, PATH PLANNING AND PROGRAMMING****8**

Trajectory Planning- Joint space and Cartesian space technique, Introduction to robot control, Robot programming and Languages- Introduction to ROS

**UNIT – V ROBOT AND ROBOT APPLICATIONS****9**

Sensors and Actuators for Robots, Power transmission systems, Rotary to rotary motion, Rotary to linear motion, Harmonics drives – gear system - belt drives. Robot end effectors & Grippers: Introduction- types & classification- Mechanical gripper- gripper force analysis- other types & special purpose grippers. Robot Applications: pick and place, manufacturing, automotive, medical, space and underwater.

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

Upon completion of this course, the students can able to

CO1: State the basic concepts and terminologies of robots

CO2: Know the Procedures for Forward and Inverse Kinematics, Dynamics for Various Robots

CO3: Derive the Forward and Inverse Kinematics, Dynamics for Various Robots

CO4: Apply the various programming techniques in industrial applications

CO5: Analyze the use of various types of robots in different applications

Mapping of COs with POs and PSOs															
COs/POs&P SOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	3	1	2							1	2	1	3
CO2	3	2	3	1	2							1	2	1	3
CO3	3	2	3	1	2							1	2	1	3
CO4	3	2	3	1	2							1	2	2	3
CO5	3	2	3	1	3							1	2	2	3
CO/PO & PSO Average	3	2	3	1	2.2							1	2	1.4	3
1 – Slight, 2 – Moderate, 3 – Substantial															

**TEXT BOOKS:**

1. John.J.Craig, " Introduction to Robotics: Mechanics & control", Pearson Publication, Fourth edition, 2018.
2. K.S.Fu, R.C.Gonzalez, C.S.G.Lee, "Robotics: Sensing, Vision & Intelligence", Tata McGraw-Hill Publication, First Edition, 1987.

**REFERENCES:**

1. M.P.Groover, M.Weiss ,R.N. Nagal, N.G.Odrey, "Industrial Robotics - Technology, programming and Applications" Tata , McGraw-Hill Education Pvt Limited 2<sup>nd</sup>Edition, 2012.
2. Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer, 2<sup>nd</sup>Edition, 2010
3. S K Saha, Introduction to Robotics, Tata McGraw-Hill, ISBN: 9789332902800, Second Edition, 9789332902800
4. Sathya Ranjan Deb, "Robotics Technology & flexible Automation" Second edition, Tata McGraw-Hill Publication, 2009.

<b>CMR338</b>	<b>SMART MOBILITY AND INTELLIGENT VEHICLES</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

The objectives of the course are:

1. To introduce students to the various technologies and systems used to implement smart mobility and intelligent vehicles.
2. To learn Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, LIDAR Sensor Technology and Systems and other sensors for automobile vision system.
3. To learn Basic Control System Theory applied to Autonomous Automobiles.
4. To produce overall impact of automating like various driving functions, connecting the automobile to sources of information that assist with a task
5. To allow the automobile to make autonomous intelligent decisions concerning future actions of the vehicle that potentially impact the safety of the occupants through connected car & autonomous vehicle technology.

**UNIT – I INTRODUCTION TO AUTOMATED, CONNECTED, AND INTELLIGENT VEHICLES 9**

Concept of Automotive Electronics, Electronics Overview, History & Evolution, Infotainment, Body, Chassis, and Powertrain Electronics, Introduction to Automated, Connected, and Intelligent Vehicles. Case studies: Automated, Connected, and Intelligent Vehicles

**UNIT – II SENSOR TECHNOLOGY FOR SMART MOBILITY 9**

Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Other Sensors, Use of Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems

**UNIT – III CONNECTED AUTONOMOUS VEHICLE 9**

Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy

**UNIT – IV VEHICLE WIRELESS TECHNOLOGY & NETWORKING 9**

Wireless System Block Diagram and Overview of Components, Transmission Systems – Modulation/Encoding, Receiver System Concepts– Demodulation/Decoding, Wireless Networking and Applications to Vehicle Autonomy, Basics of Computer Networking – the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks

**UNIT – V CONNECTED CAR & AUTONOMOUS VEHICLE TECHNOLOGY****9**

Connectivity Fundamentals, Navigation and Other Applications, Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Autonomous Vehicles - Driverless Car Technology, Moral, Legal, Roadblock Issues, Technical Issues, Security Issues

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

CO1: Recognize the concept of cyber-physical control systems and their application to collision avoidance and autonomous vehicles

CO2: Select the concept of remote sensing and the types of sensor technology needed to implement remote sensing

CO3: Familiar with the concept of fully autonomous vehicles

CO4: Apply the basic concepts of wireless communications and wireless data networks

CO 5: Analyze the concept of the connected vehicle and its role in automated vehicles

Mapping of COs with POs and PSOs															
COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	1		1						1	2	1	1
CO2	3	2	1	1		1						1	2	1	1
CO3	3	2	1	1		1						1	2	1	1
CO4	3	2	1	1		1						1	2	1	1
CO5	3	2	1	1		1						1	2	1	1
CO/PO & PSO Average	3	2	1	1		1						1	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial															

**TEXT BOOKS**

1. "Intelligent Transportation Systems and Connected and Automated Vehicles", 2016, Transportation Research Board
2. Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems", 2019, Springer

**REFERENCE:**

1. Tom Denton, "Automobile Electrical and Electronic systems, Routledge", Taylor & Francis Group, 5<sup>th</sup> Edition, 2018.

**CME345 HAPTICS AND IMMERSIVE TECHNOLOGIES L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- 1 To learn various immersive technologies of VR, AR and MR.
- 2 To learn software related to immersive technologies.
- 3 To learn the concepts of developing AR applications.
- 4 To learn the concepts of developing VR and unreal engine.
- 5 To study the haptic perception and extended reality.

**UNIT – I INTRODUCTION TO IMMERSIVE TECHNOLOGIES 9**  
 Introduction on Virtual reality – Augmented reality – Mixed reality – Extended reality – VR Devices – AR Devices – Applications

**UNIT – II SOFTWARE TOOLS 9**  
 Intro to Unity – Unity editor workspace – Intro to C# and visual studio - Programming in Unity – Intro to Unreal Engine – UE4 Editor workspace – Intro to Blueprint programming – Programming in Ue4

**UNIT – III BUILDING AR APPLICATION WITH UNITY 9**  
 AR SDKs for unity and unreal engine – Working with SDKs for unity – Developing AR application in unity - Building AR application

**UNIT – IV BUILDING VR APPLICATION WITH UNREAL ENGINE 9**  
 VR SDKs for unity and unreal engine – Developing VR application in Ue4 – Building VR application

**UNIT – V HAPTIC PERCEPTION AND EXTENDED REALITY 9**  
 Extended Reality - Introduction to Haptics – Devices and possibilities – Custom Device development – Device Integration

**TOTAL – 45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Apply detailed knowledge about immersive technology
2. Gaining the knowledge of different types of Tools and Devices
3. Acquiring the knowledge about Unity and Unreal Engine
4. Explain the developing application in immersive technologies
5. Discuss about haptics in immersive technologies

**TEXT BOOKS:**

1. Immersive Multimodal Interactive Presence, by Angelika Peer (Editor), Christos D. Giachritsis (Editor), Springer; 2012th edition (13 April 2014), ISBN-10 : 1447162137
2. XR Haptics, Implementation & Design Guidelines, by Eric Vezzoli , Chris Ullrich , Gijs den Butter , Rafal Pijewski, March 13, 2022

**REFERENCES:**

1. Practical Augmented Reality, by Steve Aukstakalnis, Addison-Wesley Professional; 1st edition (8 September 2016)
2. Augmented Reality - Theory, Design and Development, by Chetankumar G Shetty.
3. Strategic Communication and AI, by Simon Moore , Roland Hübscher, Routledge; 1st edition (10 September 2021), ISBN-10 : 0367627795
4. Immersive Analytics, by Kim Marriott , Falk Schreiber, Springer; 1st ed. 2018 edition (15 October 2018).
5. Immersive Analytics A Clear and Concise Reference, by Gerardus Blokdyk, 5STARCooks (5 September 2018).

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	2		2				1			1	1	2	2
2	2	2	2		2				1			1	1	2	2
3	2	2	2		2				1			1	1	2	2
4	2	2	2		2				1			1	1	2	2
5	2	2	2		2				1			1	1	2	2
Low (1) ; Medium (2) ; High (3)															

**COURSE OBJECTIVES:**

1. To understand the basics of drone concepts
2. To learn and understand the fundamentals of design, fabrication and programming of drone
3. To impart the knowledge of an flying and operation of drone
4. To know about the various applications of drone
5. To understand the safety risks and guidelines of fly safely

**UNIT – I INTRODUCTION TO DRONE TECHNOLOGY 9**

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

**UNIT – II DRONE DESIGN, FABRICATION AND PROGRAMMING 9**

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

**UNIT – III DRONE FLYING AND OPERATION 9**

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone controls Flight operations –management tool –Sensors-Onboard storage capacity - Removable storage devices- Linked mobile devices and applications

**UNIT – IV DRONE COMMERCIAL APPLICATIONS 9**

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

**UNIT – V FUTURE DRONES AND SAFETY 9**

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

CO1: Know about a various type of drone technology, drone fabrication and programming.

CO2: Execute the suitable operating procedures for functioning a drone

CO3: Select appropriate sensors and actuators for Drones

CO4: Develop a drone mechanism for specific applications

CO5: Create the programs for various drones

**CO-PO MAPPING:**

Mapping of COs with POs and PSOs															
COs/Pos&P SOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	1	3	2						1	2	1	3
CO2	1	2	3	1	3	2						1	2	1	3
CO3	1	2	3	1	3	2						1	2	1	3
CO4	1	2	3	1	3	2						1	2	1	3
CO5	1	2	3	1	3	2						1	2	1	3
CO/PO & PSO Average	1	2	3	1	3	2						1	2	1	3

1 – Slight, 2 – Moderate, 3 – Substantial



## TEXT BOOKS

1. Daniel Tal and John Altschuld, "Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation", 2021 John Wiley & Sons, Inc.
2. Terry Kilby and Belinda Kilby, "Make:Getting Started with Drones ",Maker Media, Inc, 2016

## REFERENCES

1. John Baichtal, "Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs", Que Publishing, 2016
2. Završnik, "Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance", Springer, 2018.

<b>CME346</b>	<b>DIGITAL MANUFACTURING AND IoT</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>2</b>	<b>0</b>	<b>2</b>	<b>3</b>

## COURSE OBJECTIVES

- 1 To study the various aspects of digital manufacturing.
- 2 To inculcate the importance of DM in Product Lifecycle Management and Supply chain Management.
- 3 To formulate of smart manufacturing systems in the digital work environment.
- 4 To interpret IoT to support the digital manufacturing.
- 5 To elaborate the significance of digital twin.

### **UNIT – I INTRODUCTION 6**

Introduction – Need – Overview of Digital Manufacturing and the Past – Aspects of Digital Manufacturing: Product life cycle, Smart factory, and value chain management – Practical Benefits of Digital Manufacturing – The Future of Digital Manufacturing.

### **UNIT – II DIGITAL LIFE CYCLE & SUPPLY CHAIN MANAGEMENT 6**

Collaborative Product Development, Mapping Requirements to specifications – Part Numbering, Engineering Vaulting, and Product reuse – Engineering Change Management, Bill of Material and Process Consistency – Digital Mock up and Prototype development – Virtual testing and collateral. Overview of Digital Supply Chain - Scope& Challenges in Digital SC - Effective Digital Transformation - Future Practices in SCM

### **UNIT – III SMART FACTORY 6**

Smart Factory – Levels of Smart Factories – Benefits – Technologies used in Smart Factory – Smart Factory in IoT- Key Principles of a Smart Factory – Creating a Smart Factory – Smart Factories and Cybersecurity

### **UNIT – IV INDUSTRY 4.0 6**

Introduction – Industry 4.0 –Internet of Things – Industrial Internet of Things – Framework: Connectivity devices and services – Intelligent networks of manufacturing – Cloud computing – Data analytics –Cyber physical systems –Machine to Machine communication – Case Studies.

### **UNIT – V STUDY OF DIGITAL TWIN 6**

Basic Concepts – Features and Implementation – Digital Twin: Digital Thread and Digital Shadow- Building Blocks – Types – Characteristics of a Good Digital Twin Platform – Benefits, Impact & Challenges – Future of Digital Twins.

**TOTAL :30 PERIODS**

## DIGITAL MANUFACTURING AND IoT LABORATORY

### Experiments

1. Measure the Distance Using Ultrasonic Sensor and Make Led Blink Using Arduino
2. Detect the Vibration of an Object Using Arduino
3. Sense a Finger When it is Placed on Board Using Arduino
4. Temperature Notification Using Arduino
5. Switch Light On and Off Based on the Input of User Using Raspberry Pi
6. Connect with the Available Wi-Fi Using Arduino

**TOTAL : 30 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Impart knowledge to use various elements in the digital manufacturing.
2. Differentiate the concepts involved in digital product development life cycle process and supply chain management in digital environment.
3. Select the proper procedure of validating practical work through digital validation in Factories.
4. Implementation the concepts of IoT and its role in digital manufacturing.
5. Analyse and optimize various practical manufacturing process through digital twin.

### TEXT BOOKS:

1. Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2012.
2. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", A press, 2016.

### REFERENCES:

1. Lihui Wang and Andrew YehChing Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2009.
2. Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, "Digital Twin Driven Smart Manufacturing", Elsevier Science., United States, 2019.
3. Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation", Springer Series in Advanced Manufacturing., Switzerland, 2017
4. Ronald R. Yager and Jordan Pascual Espada, "New Advances in the Internet of Things", Springer., Switzerland, 2018.
5. Ronald R. Yager and Jordan Pascual Espada, "New Advances in the Internet of Things", Springer., Switzerland, 2018.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3		1	1	3	3		1	2	2		2	3	2	1
2	3	2	3	1	3	3	2	2	2	2		2	3	2	3
3	3		3	1	3	3	2		3	2		2	3	2	3
4	3	2	2	2	3	3	2	2	2	2	2	2	3	2	3
5	3		2		1	3		2	2	2		2	3	2	2
Low (1) ; Medium (2) ; High (3)															

**COURSE OBJECTIVES**

- 1 To introduce the basics of 6 SIGMA
- 2 To learning about the lean manufacturing tools.
- 3 To study about the deeper understanding methodologies of Lean manufacturing.
- 4 To study the lean concepts and its elements.
- 5 To learn implementation and challenges of lean manufacturing.

**UNIT – I BASICS OF 6 SIGMA****9**

Introduction to 6 Sigma, basic tools of six sigma like problem solving approach, standard deviation, normal distribution, various sigma levels with some examples, value for the enterprise, Variation, and sources of variation, Mean and moving the mean, Various quality costs, cost of poor quality.

**UNIT – II INTRODUCTION TO LEAN MANUFACTURING TOOLS****9**

Process Capability Indices, Cause and Effect diagram, Control Charts, Introduction to FMEA, APQP, PPAP. 3 foundational 6 Sigma methodologies: DMAIC, DMEDI, and Process Management DMEDI for process creation, DMAIC for process improvement and PDCA for sustaining improvements.

**UNIT – III DEEPER UNDERSTADING METHODOLOGIES****9**

What is a process, Why Process management, Keys to process management, Difference between process management and 6 Sigma, Introduction to Deming cycle, PDCA, DMAIC and continuous improvement, DMEDI for creation process, DMAIC Vs DMEDI with examples, Introduction to Toyota Production System, Six Sigma and Production System integration.

**UNIT – IV LEAN ELEMENTS****9**

Introduction to Lean Concepts like In-Built Quality, Concept of Right Part at the Right Time, Lead Time reduction, Optimum utilization of Capital, Optimum utilization of People. Understanding the Zero-defect concept and Metrics, Focus on Human Resources, Quality, Delivery, Cost. Building Zero defect capabilities, Cultural and Organizational aspects

**UNIT – V IMPLEMENTATION AND CHALLENGES****9**

Implementing Checks and Balances in the process, Robust Information Systems, Dashboard, follow up and robust corrective and preventive mechanism. Concept of Audits, and continuous improvement from gap analysis, risk assessments etc.

**TOTAL :45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Discuss the basics of 6 SIGMA
2. Elaborate the lean manufacturing tools.
3. Illustrate about the deeper understanding methodologies of Lean manufacturing.
4. Discuss lean concepts and its elements.
5. Describe the implementation and challenges of lean manufacturing.

**TEXT BOOKS:**

1. Quality Planning and Analysis- JM Juran& FM Gryna. Tata Mc Graw Hill
2. Lean Manufacturing: Principles to Practice by Akhilesh N. Singh, Bibliophile SouthAsia
3. The Toyota Way: 14 Management Principles
4. Gemba Kaizen: A Commonsense Approach to a Continuous Improvement Strategy, Masaki Imai

**REFERENCES:**

1. Quality Council of India <https://qcin.org/> & its library. [https://qcin.org/nbqp/knowledge\\_bank/](https://qcin.org/nbqp/knowledge_bank/)
2. International Society of Six Sigma Professionals: <https://isssp.org/about-us/>
3. NPTEL / SWAYAM: <https://nptel.ac.in/courses/110105123> : Six Sigma, Prof. Jitesh J Thakkar, IIT Kharagpur, Certification course. (Self- Learning).
4. Older / Previous editions of AIAG manuals on APQP, FMEA and PPAP. These are great sources of information on Quality Planning and has basics of Project Management and required skills.
5. Quality Management for Organizations Using Lean Six Sigma Techniques- Erick C Jones

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	2	1	1				1		3	1	1	2	1
2	1	1	2	1	1				1		3	1	1	2	1
3	1	1	2	1	1				1		3	1	1	2	1
4	1	1	2	1	1				1		3	1	1	2	1
5	1	1	2	1	1				1		3	1	1	2	1
Low (1) ; Medium (2) ; High (3)															

**CME348**

**MODERN ROBOTICS**

**L T P C**  
**2 0 2 3**

**COURSE OBJECTIVES**

- 1 To introduce definition, history of robotics and robot anatomy.
- 2 To learn the simulation of robot kinematics
- 3 To study the grasping and manipulation of robots.
- 4 To study about mobile robot and manipulation.
- 5 To study the applications of industrial, service, domestic robots.

**UNIT – I INTRODUCTION**

**6**

Robot: Definition, History of Robotics, Robot Anatomy, Co-ordinate systems, types and classification, Configuration space and degrees of freedom of rigid bodies and robots, Configuration space topology and representation; configuration and velocity constraints; task space and workspace, Rigid-body motions, rotation matrices, angular velocities, and exponential coordinates of rotation, Homogeneous transformation matrices.

**UNIT – II SIMULATION OF ROBOT KINEMATICS**

**6**

Robot kinematics, Forward and inverse kinematics (two three four degrees of freedom), Forward and inverse kinematics of velocity, Homogeneous transformation matrices, translation and rotation matrices Denavit and Hartenberg (D-H) transformation, Dynamics of Open Chains, Trajectory Generation, motion planning, robot control: First- and second-order linear error dynamics, stability of a feedback control system.

**UNIT – III GRASPING AND MANIPULATION OF ROBOTS**

**6**

Kinematics of contact, contact types (rolling, sliding, and breaking), graphical methods for representing kinematic constraints in the plane, and form-closure grasping, Coulomb friction, friction cones, graphical methods for representing forces and torques in the plane, End effectors, grippers, types of gripper, gripper force analysis, and examples of manipulation and grasping.

**UNIT – IV MOBILE ROBOTS**

**6**

Mobile robot, Wheeled Mobile Robots: Kinematic models of omnidirectional and non-holonomic wheeled mobile robots, Controllability, motion planning, feedback control of non-holonomic wheeled mobile robots; odometry for wheeled mobile robots; and mobile manipulation. Reference Trajectory generation, feed forward control

**UNIT – V APPLICATIONS OF ROBOTS**

**6**

Application of robotic: industrial robots, Service robots, domestic and house hold robots, Medical robots, military robots, agricultural robots, space robots, Aerial robotics Role of robots in inspection, assembly, material handling, underwater, space and healthcare

**TOTAL :30 PERIODS**

**MODERN ROBOTICS LABORATORY**

**Experiments**

1. 3D modeling and motion simulation of rotational joint assembly
2. 3D modeling and motion simulation of prismatic joint assembly
3. 3D modeling and motion simulation of Cartesian robot
4. 3D modeling and motion simulation of articulated robot
5. 3D modeling and motion simulation of spherical robot
6. 3D modeling and motion simulation of cylindrical robot

**TOTAL :30 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Discuss the definition, history of robotics and robot anatomy.
2. Develop the simulation of robot kinematics
3. Describe the grasping and manipulation of robots.
4. Explain about mobile robot and manipulation.
5. Discuss the applications of industrial, service, domestic robots.

**TEXT BOOKS:**

1. Modern Robotics: Mechanics, Planning, and Control, by Kevin M. Lynch , Frank C. Park , Cambridge University Press; 1st edition (25 May 2017), ISBN-10 : 110715
2. Modern Robotics: Mechanics, Systems and Control, by Julian Evans, Larsen and Keller Education (27 June 2019), ISBN-10 : 1641720751

**REFERENCES:**

1. Modern Robotics: Designs, Systems and Control, by Jared Kroff, Willford Press (18 June 2019) ISBN-10 : 1682856763
2. Advanced Technologies in Modern Robotic Applications, by ChenguangYang , Hongbin Ma , Mengyin Fu, Springer; Softcover reprint of the original 1st ed. 2016 edition (30 May 2018), ISBN-10 : 981109263X
3. Modern Robotics: Building Versatile Machines, by Harry Henderson, Facts On File Inc; Illustrated edition (1 August 2006), ISBN-10 : 0816057451
4. Artificial Intelligence for Robotics, by Francis X. Govers, Packt Publishing Limited; Standard Edition (30 August 2018), ISBN-10 : 1788835441
5. Modern Robotics Hardcover by Lauren Barrett (Editor), Murphy & Moore Publishing (1 March 2022), ISBN-10 : 1639873732

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	3	1	2				1			1	1	2	3
2	2	1	3	1	2				1			1	1	2	3
3	2	1	3	1	2				1			1	1	2	3
4	2	1	3	1	2				1			1	1	2	3
5	2	1	3	1	2				1			1	1	2	3
Low (1) ; Medium (2) ; High (3)															

**CME349**

**GREEN MANUFACTURING DESIGN AND PRACTICES**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- 1 To introduce the concept of environmental design and industrial ecology.
- 2 To impart knowledge about air pollution and its effects on the environment.
- 3 To enlighten the students with knowledge about noise and its effects on the environment.
- 4 To enlighten the students with knowledge about water pollution and its effects on the environment.
- 5 To introduce the concept of green co-rating and its need

**UNIT – I**

**DESIGN FOR ENVIRONMENT AND LIFE CYCLE ASSESSMENT**

**9**

Environmental effects of design -selection of natural friendly material - Eco design - Environmental damage Material flow and cycles – Material recycling – Emission less manufacturing- Industrial Ecology – Pollution prevention – Reduction of toxic emission – design for recycle.

**UNIT – II**

**AIR POLLUTION SAMPLING AND MEASUREMENT**

**9**

Primary and Secondary Pollutants, Automobile Pollutants, Industrial Pollution, Ambient air quality Standards, Metrological aspects of air Pollution, Temperature lapse Rates and Stability-wind velocity and turbulence-Pump behavior dispersion of air Pollutants-solution to the atmosphere dispersion equation-the Gaussian Plume Model, Air pollution sampling-collection of gaseous air pollutants-collection of particulate pollutants-stock sampling, analysis of air pollutants-sulfur dioxide-nitrogen dioxide, carbon monoxide, oxidants and ozone.

**UNIT – III NOISE POLLUTION AND CONTROL 9**

Frequency and Sound Levels, Units of Noise based power radio, contours of Loudness. Effect of human, Environment and properties, Natural and Anthropogenic Noise Sources, Measuring Instruments for frequency and Noise levels, Masking of sound, Types, Kinetics, Selection of different reactors used for waste treatment, Treatment of noise at source, Path and Reception, Sources of noise, Effects of noise-Occupational Health hazards, thermal Comforts, Heat Island Effects, Radiation Effects.

**UNIT – IV WATER DEMAND AND WATER QUALITY 9**

Factors affecting consumption, Variation, Contaminants in water, Nitrates, Fluorides, Detergents, taste and odour, Radio activity in water, Criteria, for different impurities in water for portable and non-portable use, Point and non-point Source of pollution, Major pollutants of Water, Water Quality Requirement for different uses, Global water crisis issues.

**UNIT – V GREEN CO-RATING 9**

Ecological Footprint - Need For Green Co-Rating – Green Co-Rating System – Intent – System Approach – Weightage- Assessment Process – Types Of Rating – Green Co-Benefits – Case Studies Of Green Co-Rating

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Explain the environmental design and selection of eco-friendly materials.
2. Analyse manufacturing processes towards minimization or prevention of air pollution.
3. Analyse manufacturing processes towards minimization or prevention of noise pollution.
4. Analyse manufacturing processes towards minimization or prevention of water pollution.
5. Evaluate green co-rating and its benefits.

**TEXT BOOKS:**

1. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010
2. Rao M.N. and Dutta A.K. “Wastewater treatment”, Oxford & IBH publishing Co. Pvt. Ltd., New Delhi, Second Edition, 2006

**REFERENCES:**

1. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010
2. Frances Cairncross– Costing the Earth: The Challenge for Governments, the Opportunities for Business – Harvard Business School Press – 1993.
3. World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.
4. Rao M.N. and Dutta A.K. “Wastewater treatment”, Oxford & IBH publishing Co. Pvt. Ltd., New Delhi, Second Edition, 2006
5. Rao CS Environmental Pollution Control Engineering-, Wiley Eastern Ltd., New Delhi, 2006.
6. Lewis H Bell and Douglas H Bell, Industrial noise control, Fundamentals and applications, Marcel Decker, 1994.

<b>CO</b>	<b>PO</b>	<b>PSO</b>
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3	1	1	3	1			3		1			1	1	2	2
4	1	1	3	1			3		1			1	1	2	2
5	1	1	3	1			3		1			1	1	2	2
Low (1) ; Medium (2) ; High (3)															

**CME350 ENVIRONMENT SUSTAINABILITY AND IMPACT ASSESSMENT L T P C**  
**3 0 0 3**

### COURSE OBJECTIVES

- 1 To make the students to understand the concepts of Environmental Sustainability & Impact Assessment
- 2 To familiarize the students in environmental decision making procedure.
- 3 Make the students to identify, predict and evaluate the economic, environmental, and social impact of development activities
- 4 To provide information on the environmental consequences for decision making
- 5 To promote environmentally sound and sustainable development through the identification of appropriate alternatives and mitigation measures.

#### UNIT – I ENVIRONMENTAL IMPACT ASSESMENT 9

Environmental impact assessment objectives – rationale and historical development of EIA - Conceptual frameworks for EIA Legislative development – European community directive – Hungarian directive.

#### UNIT – II ENVIRONMENTAL DECISION MAKING 9

Strategic environmental assessment and sustainability appraisal – Mitigation, monitoring and management of environmental impacts- Socio economic impact assessment.

#### UNIT – III ENVIRONMENTAL POLICY, PLANNING AND LEGISLATION 9

Regional spatial planning and policy – Cumulative effects assessment – Planning for climate change, uncertainty and risk.

#### UNIT – IV LIFE CYCLE ASSESSMENT 9

Life cycle assessment; Triple bottom line approach; Industrial Ecology. Ecological foot printing, Design for Environment, Future role of LCA, Product stewardship, design, durability and justifiability, measurement techniques and reporting

#### UNIT – V SUSTAINABLE URBAN ECONOMIC DEVELOPMENT 9

Spatial economics – Knowledge economy and urban regions.

**TOTAL: 45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Explain the concepts of Environment Sustainability and trained to make decision related to Environment.
2. Make decision that has an effect on our environment
3. Evaluate the basics of environmental policy, planning and various legislation  
Get valuable information for exploring decisions in each life stage of materials, buildings, services and infrastructure.
4. Explain the Life cycle assessment of Environmental sustainability.
5. Explain sustainable urban economic development.

**TEXT BOOKS:**

1. The Application of Science in Environmental Impact Assessment, by Aaron J. MacKinnon, Peter I Duinker, Tony R. Walker, Routledge; 1st edition (14 May 2019), ISBN-10 : 0367340194
2. Routledge Handbook of Environmental Impact Assessment, by Kevin Hanna, Routledge; 1st edition (11 April 2022), ISBN-10 : 0367244470

**REFERENCES:**

1. Clive George, C. Collin, H. Kirkpatrik – Impact Assessment and sustainable development – Edward Elgar Publishing, 2007
2. Robert B Gibsan, Sustainability Assessment, Earth Scan publishers, 2005
3. Simon Dresner, The principle of sustainability – Earth Scan publishers, 2008
4. Canter, R.L., “Environmental Impact Assessment”, McGraw Hill Inc., New Delhi, 1996.
5. Shukla, S.K. And Srivastava, P.R., “Concepts In Environmental Impact Analysis”, Common Wealth Publishers, New Delhi, 1992.
6. John G. Rau And David C Hooten “Environmental Impact Analysis Handbook”, McGraw Hill Book Company, 1990.

CO	PO												PSO		
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5	1		2				3		1			1	1	2	1
Low (1) ; Medium (2) ; High (3)															

**CME351****ENERGY SAVING MACHINERY AND COMPONENTS**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES**

1. To introduce the various energy saving machineries and components to the students for the purpose of conserving energy.
2. To study the basics and principles of transforms, Pumps and motors.
3. To impart the knowledge about the methods of energy conservation.
4. To introduce the energy efficiency devices and concepts of ENCON.
5. To impart the knowledge about CO2 mitigation.

**UNIT – I BASICS OF ELECTRICAL ENERGY USAGE****9**

Fuel to Power : Cascade Efficiency – Electricity Billing : Components and Costs – kVA – Need and Control – Determination of kVA demand and Consumption – Time of Day Tariff – Power Factor Basics – Penalty Concept for PF – PF Correction – Demand Side Management ( a brief) - energy monitoring, measurement and analysis.

**UNIT – II TRANSFORMERS AND MOTORS****9**

Transformer – Basics and Types – AVR and OLTC Concepts – Selection of Transformers – Performance Prediction - Energy Efficient Transformers - Motors : Specification and Selection – Efficiency / Load Curve – Load Estimation – Assessment of Motor Efficiency under operating conditions – Factors affecting performance – ill effects of Rewinding and Over sizing - Energy Efficient Motors – ENCON Scope. Transmission Line Parameters – Transmission Line Losses- Kelvin’s Law Performance Calculation and Analysis



**UNIT – III FANS, PUMPS AND COMPRESSORS****9**

Basics – Selection – Performance Evaluation – Cause for inefficient operation – scope for energy conservation – methods adopted for effecting ENCON – Economics of ENCON adoption.

**UNIT – IV STUDY OF ILLUMINATION AND ENERGY EFFICIENT DEVICES****9**

Specification of luminaries - Types - Efficacy - Selection and Application - ENCON Avenues and Economic Proposition - New Generation Luminaries (LED - Induction Lighting) - Soft Starters- Auto Star - Delta - Star Starters- APFC - Variable Speed and Frequency Drives - Time Sensors - Occupancy Sensors.

**UNIT – V CO<sub>2</sub> MITIGATION AND CASE STUDIES****9**

Evaluation for 3 / 4 Typical Sectors – PAT Scheme (an introduction) – CO<sub>2</sub> Mitigation - Energy Conservation - Cost Factor. Case Studies on Industrial Energy Audit.

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Explain the various energy saving machinery and components.
2. Evaluate the various methods of conservation of energy.
3. Evaluate the performance and energy conservation of fans, pumps and compressors.
4. Discuss the various energy efficiency devices.
5. Explain the co2 mitigation and cost factor.

**TEXT BOOKS:**

1. Energy-Efficient Shutdown of Circuit Components and Computing Systems, by Ehsan Pakbazni: Proquest, Umi Dissertation Publishing (1 September 2011) ,ISBN-10 : 1243819898
2. Handbook on Energy Efficiency, TERI, New Delhi, 2001

**REFERENCES:**

1. Hamies, Energy Auditing and Conservation ; Methods Measurements, management and Case Study, Hemisphere, Washington, 1980
2. Trivedi, PR and Jolka KR, Energy Management, Commonwealth Publication, New Delhi, 1997
3. Handbook on Energy Efficiency, TERI, New Delhi, 2001
4. Peters, Kraushaar and Ristenen, Sustainable Energy, beta – test – draft, Energy and Problems of a Technical Society, 1993
5. Guide book for National Certification Examination for Energy Managers and Energy Auditors (www.energymanagertraining.com )
6. Nagrath IJ and Kothari DP, Power system engineering, TMH, 2007

CO	PO												PSO		
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<b>Low (1) ; Medium (2) ; High (3)</b>															

**COURSE OBJECTIVES**

- 1 To familiar the various standards and legislation of modern electronic manufacturing.
- 2 To know the conventional electronic processing and lead-free electronic manufacturing techniques.
- 3 To recognize the steps involved in assembly process and understand the need of recycle the electronics
- 4 To implement reliability and product life cycle estimation tools in green electronic manufacturing.
- 5 To demonstrate the green electronic manufacturing procedure in applications.

**UNIT – I INTRODUCTION TO GREEN ELECTRONICS 9**

Environmental concerns of the modern society- Overview of electronics industry and their relevant regulations in China, European Union and other key countries- global and regional strategy and policy on green electronics industry. Restriction of Hazardous substances (RoHS) - Waste Electrical and electronic equipment (WEEE - Energy using Product (EuP) and Registration - Evaluation, Authorization and Restriction of Chemical substances (REACH).

**UNIT – II GREEN ELECTRONICS MATERIALS AND PRODUCTS 9**

Basics of IC manufacturing and its process – Electronics with Lead (Pb) -free solder pastes, conductive adhesives, Introduction to green electronic materials and products - halogen-free substrates and components. Substitution of non-recyclable thermosetting polymer based composites with recyclable materials X-Ray Fluorescence (XRF) for identifying hazardous substances in electronic products

**UNIT – III GREEN ELECTRONICS ASSEMBLY AND RECYCLING 9**

Various processes in assembling electronics components - the life-cycle environmental impacts of the materials used in the processes - substrate interconnects. Components and process equipments - Technology and management on e-waste recycle system construction, global collaboration, and product disassembles technology.

**UNIT – IV PRODUCT DESIGN AND SUSTAINABLE ECO-DESIGN 9**

Stages of product development process in green design: Materials- Manufacturing - Packaging and use - End of Life and disposal - Design for recycling - Life Cycle Assessment (LCA), and Eco-design tools - Environmental management systems, and International standards - Eco-design in electronics industry.

**UNIT – V CASE STUDIES 9**

Reliability of green electronics systems , Reuse and recycle of End-of-Life(EOL) electrical and electronic equipment for effective waste management – Introduction of Green Supply Chain, and Modeling green products from Supply Chain point of view - A life-cycle assessment for eco-design of Cathode Ray Tube Recycling.

**TOTAL:45 PERIODS****OUTCOMES:** At the end of the course the students would be able to

1. Get concise awareness of standards and legislation of modern electronic manufacturing for green environment.
2. Explain the conventional electronic processing and lead free electronic manufacturing techniques.
3. Realize the assembly process and the need of recycle of electronics
4. Use reliability and product life cycle estimation tools for electronic manufacturing.
5. Validate the green electronic manufacturing procedures in applications.

**TEXT BOOKS:**

1. Green Supply Chain Management, by Charisios Achillas , Dionysis D. Bochtis , Dimitrios Aidonis, Routledge; 1st edition (16 November 2018), ISBN-10 : 1138644617
2. Sammy G. Shina, Green Electronics Design and Manufacturing, McGraw Hill., 2008.

**REFERENCES:**

1. David Austen, Green Electronic Morning, Ingleby Gallery, 2006.
2. John Hu. Mohammed Ismail, CMOS High Efficiency on – Chip Power Management, Springer Publications 4th edition, 2011.
3. Yuhang yang and Maode Ma, Green Communications and Networks, Springer Publication., 2014.
4. Sanka Ganesan, Michael Pecht, Lead free Electronics, John Wiley & Sons, 2006.
5. Charles A. Harper, Electronic Materials and Processes Hand book, McGraw-Hill, 2010.
6. Sammy G. Shina, Green Electronics Design and Manufacturing, McGraw Hill., 2008.

CO	PO												PSO		
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Low (1) ; Medium (2) ; High (3)															

**CME353****DESIGN OF PRESSURE VESSELS**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES**

- 1 To introduce the Mathematical knowledge to design pressure vessels and piping
- 2 To learn the ability to carry of stress analysis in pressure vessels and piping
- 3 To study the design of vessels and theory of reinforcement.
- 4 To study buckling and fracture analysis in vessels.
- 5 To learn piping layout and flow diagram.

**UNIT – I INTRODUCTION****9**

Methods for determining stresses – Terminology and Ligament Efficiency – Applications

**UNIT – II STRESSES IN PRESSURE VESSELS****9**

Introduction – Stresses in a circular ring, cylinder –Dilation of pressure vessels, Membrane stress Analysis of Vessel – Cylindrical, spherical and, conical heads – Thermal Stresses – Discontinuity stresses in pressure vessels.

**UNIT – III DESIGN OF VESSELS****9**

Design of Tall cylindrical self-supporting process columns – Supports for short vertical vessels – Stress concentration at a variable Thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of Reinforcement – Pressure Vessel Design.

**UNIT – IV BUCKLING AND FRACTURE ANALYSIS IN VESSELS****9**

Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

**UNIT – V PIPING****9**

Introduction – Flow diagram – piping layout and piping stress Analysis.

**TOTAL:45 PERIODS****OUTCOMES:** At the end of the course the students would be able to





3. Charles, J. Hellier, Handbook of Non destructive evaluation, McGraw Hill, New York 2001.
4. Paul E Mix, Introduction to Non-destructive testing: a training guide, Wiley, 2nd Edition New Jersey, 2005
5. J.Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition (2011).

CO	PO												PSO		
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Low (1) ; Medium (2) ; High (3)															

**CME355 MATERIAL HANDLING AND SOLID PROCESSING EQUIPMENT L T P C**  
**3 0 0 3**

#### **COURSE OBJECTIVES**

- 1 To provide knowledge on materials handling equipment.
- 2 To provide knowledge on Industrial Vehicles
- 3 To provide knowledge on conveyor equipment.
- 4 To provide knowledge on Auxiliary Equipment and Hoisting Equipment.
- 5 To provide knowledge on Bulk Handling Equipment and Systems

#### **UNIT – I INTRODUCTION TO MATERIALS HANDLING 9**

Basic principles & objectives in material handling and its benefits - Classification of material handling equipment - selection of material handling equipments - guidelines for effective utilisation of material handling equipments - unit load concept

#### **UNIT – II INDUSTRIAL VEHICLES 9**

Introduction and types - Hand trucks - Two wheel Hand Trucks - Multiple wheel Hand Trucks - Hand Lift Trucks - Power Trucks - Fixed Platform Truck - Platform Lift Truck - Pallet Lift Truck - Walkie Truck - Straddle Carrier - Fork Lift Trucks - Specifications of FLT - FLT Attachments - Tractors - Industrial Tractor-Trailer-Self-propelled trucks and fork trucks - Automated guided vehicles Theory

#### **UNIT – III CONVEYORS 9**

Classification of conveyors- Definition - Description - General Characteristics - types and uses of belt Conveyors - Roller conveyors - Haulage Conveyors - Screw Conveyors - Bucket Conveyors - Chain Conveyors - Cable Conveyors - Pneumatic and Hydraulic conveyors - Computer controlled conveyor system.

#### **UNIT – IV AUXILIARY EQUIPMENT AND HOISTING EQUIPMENT 9**

Hoppers - Gates- Feeders- Chutes-positioners- Ball Table- Weighing and Control Equipment- Pallet loaders and unloaders - applications and advancements. - Hoisting Equipment - parts of hoisting equipment - Description and uses of hoists - Description and uses of ropes - description and purpose of crane hooks - Elevators - Cranes - Derricks - and its types

#### **UNIT – V BULK HANDLING EQUIPMENT AND SYSTEMS 9**

Storage of bulk solids - bulk handling equipment - Robotic handling - Materials handling at the workplace - Robots and their classification - Major components of a robot - classification of Robotic manipulators - Robotic handling applications

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Discuss the basic concepts of material handling equipment.
2. Explain the basic working principles of various industrial Vehicles.
3. Develop the basic working principles of various conveyors.
4. Elaborate the basic working principles of various Auxiliary Equipment and Hoisting Equipment.
5. Explain the basic working principles of various Bulk Handling Equipment and Systems.

**TEXT BOOKS:**

1. Allegri (Sr.), T.H., Material Handling – Principles and Practices, CBS Publishers and Distributors, Delhi, 1987.
2. Siddharta Ray, Introduction to Materials Handling, New Age International Publishers

**REFERENCES:**

1. Bolz, H. A and Hagemann, G. E (ed.), “Materials Handling Handbook”, Ronald Press
2. 8005:1976, Classification of Unit Loads, Bureau of Indian Standards.
3. Apple, J.A., “Material Handling System Design”, John Wiley & Sons
4. Theodore H., Allegre Sr., Material Handling Principles and Practice, CBS Publishers and Distributors
5. Immer J. R., Material Handling, Tata McGraw Hill Publication.

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Low (1) ; Medium (2) ; High (3)															

**CME356**

**ROTATING MACHINERY DESIGN**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- 1 To familiarize the course member with various operations of gas turbines and other driven rotating machines.
- 2 To familiarize students with the common problems associated with the mechanical design and the lifting of the major rotating components of the gas turbine engine.
- 3 To study the failure criteria of rotating machinery.
- 4 To learn the design of discs, blades for rotating machinery.
- 5 To study about blade vibrations Damage Mechanisms.

**UNIT – I INTRODUCTION**

**9**

Overview of the different operational regimes for gas turbine applications: base load, peak load, standby and backup operations, alongside their individual operational requirements. Fundamentals of Creep and Fatigue damage mechanisms. Material, design and operational parameters that affect creep and fatigue. Experimental and test procedures to characterise creep and fatigue damage.

**UNIT – II DESIGNING FORCES**

**9**

Loads/forces/stresses in gas turbine engines: loads - rotational inertia, flight, precession of shafts, pressure gradient, torsion, seizure, blade release, engine mountings and bearings-Discussion of major loadings-rotating components and pressure casing components.

**UNIT – III FAILURE CRITERIA**

**9**

Monotonic failure criteria: proof, ultimate strength. Theories of failure - bi-axial loads. Other failure mechanisms - gas turbine engines including creep and fatigue. Fatigue properties - SN and RM diagrams. Stress concentration, mean stress, Cumulative fatigue, Goodman diagram and safety factor for gas turbine components. Larson-Miller time-temperature parameter.

**UNIT – IV BLADE DESIGN**

**9**

Design of discs, blades. Illustration of magnitude stresses in conventional axial flow blades- simple desk-top method -effects of leaning the blade. Design of flanges and bolted structures. Leakages through a flanged joint and failure from fatigue.

**UNIT – V BLADE VIBRATIONS AND DAMAGE MECHANISMS**

**9**

Natural frequencies turbomachine blades. Blade twist, centrifugal stiffening, Sources of blade excitation, Stationary flow disturbance, rotating stall and flutter. Campbell diagram and troublesome resonances. Allowances for temperature, pre-twist and centrifugal stiffening. Methods for dealing with resonances.

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Differentiate the operational regimes and requirements related to different gas turbine applications.
2. Describe and distinguish the design requirements and loads encountered by gas turbine components during normal operation;
3. Analyse, evaluate and assess the loads, stresses, failure criteria and factors of safety used in gas turbine engines
4. Evaluate impact of vibrations on design and operation of gas turbine;
5. Assess the creep and fatigue damage of gas turbine components based on design and operational parameters

**TEXT BOOKS:**

1. A S Rangawala, Turbomachinery Dynamics-Design and operations, McGraw-Hill, 2005, ISBN-13: 978-0071453691.
2. Design, Modeling and Reliability in Rotating Machinery, Robert X. Perez (Editor) ISBN: 978-1-119-63169-9

**REFERENCES:**

1. P.P Walsh and P. Peletcher, Gas Turbine Performance' Blackwell Science, 1998, ISBN0632047843.
2. Turbines, Compressors & Fans S. M. Yahya Tata McGraw Hill Co. Ltd 2nd edition, 2002
3. Principals of Turbo machines D. G. Shepherd The Macmillan Company 1964
4. Fluid Mechanics & Thermodynamics of Turbo machines S. L. Dixon Elsevier 2005
5. Shaft Alignment Handbook (Mechanical Engineering) by John Piotrowski | 2 November 2006

CO	PO												PSO		
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Low (1) ; Medium (2) ; High (3)



**COURSE OBJECTIVES**

- 1 To introduce the concepts of thermal and fired equipment.
- 2 To study the basis, design and construction of boilers.
- 3 To study of typical fuel firing systems in the boiler.
- 4 To study of materials requirements for pressure parts.
- 5 To study of various boiler auxiliaries system.

**UNIT – I INTRODUCTION 9**

Principal equipment in Thermal Power Plant, Historical developments of Boiler, Utility, Industrial boilers, Modern trends in boiler design, Basic knowledge of different types of Thermal Fired Equipment, sub critical and super critical boilers - Coal, Oil, Gas, Pulverised fuel cyclone, FBC, CFBC, MSW, and Stoker firing, Boiler efficiency, auxiliary power consumption, Performance data, Performance Correction Curves

**UNIT – II BASIS OF BOILERS AND DESIGN 9**

Codes- Design and Construction, IBR, ISO, ASME, BS, Heat balance diagram, Boiler parameters, Fuel analysis and variations, Site conditions, Furnace heat loadings, FOT, Plan area loading, Volumetric loading Balanced Draft and Pressurised Furnace, Natural / Controlled Circulation, Constant and Sliding Pressure, Boiler heat transfer surfaces, Flue gas velocities, boiler auxiliaries, Boiler schemes, Boiler Layouts

**UNIT – III FIRING SYSTEM- FUEL AND MILLING 9**

Coal / Oil / Natural Gas in any combination, Lignite, Blast Furnace Gas / Coke Oven Gas / Corex Gas Carbon Monoxide / Tail gas, Asphalt, Black Liquor, Bagasse, Rice Husk, Washery Rejects, Wheat / Rice straw MSW, wind box, Burner, Type of Stokers, Pulverisers - Bowl mill, Tube mill, Direct firing, Indirect firing, Wall firing (Turbulent / Vortex Burners), Tangential firing (Jet Burners), Fire Ball.

**UNIT – IV PRESSURE PARTS AND DESIGN AND MATERIALS 9**

Economiser, Drums, Water Walls, Headers, Links, Super Heater, Super Heaters, Reheaters, Tubes, Spiral Tubes, Surface area, Free Gas Area, Metal temperature, LMTD, Acid Dew Point Temperature, Carbon steel, Low alloy steel, Titanium alloy steel

**UNIT – V BOILER AUXILIARIES 9**

Air preheaters (APH) – bi sector APH, Tri sector APH, Cold PA System, Hot PA System, Tubular APH, Steam coil Air preheater, FANS – Axial, Radial, Performance curves, MILLS- Tube, Vertical mills, Air quality Control systems, Dust Collection System - Mechanical Precipitator, Electrostatic Precipitator, FGD, SCR, SNCR

**TOTAL:45 PERIODS****OUTCOMES:** At the end of the course the students would be able to

1. Explain the concepts of thermal and fired equipment.
2. Discuss the basis, design and construction of boilers.
3. Describe of typical fuel firing systems in the boiler.
4. Discuss the materials requirements for pressure parts.
5. Discuss of various boiler auxiliaries system.

**TEXT BOOKS:**

1. A Course in Power Plant Engineering; Dhanapat Rai and Sons - Domkundwar
2. Power Plant Engineering by B. Vijaya Ramnath C. Elanchezian, L. Saravanakumar

**REFERENCES:**

1. Elwakil M, Power Plant Technology, McGraw Hill, New York, 1964
2. Steam Generators and Waste Heat Boilers: For Process and Plant Engineers (Mechanical Engineering) by V. Ganapathy
3. Steam Generators: Description and Design by Donatello Annaratone

4. An Introduction to Coal and Wood Firing Steam Generators (Power Plants Engineering) by J Paul Guyer
5. Advances in Power Boilers (JSME Series in Thermal and Nuclear Power Generation) by Mamoru Ozawa and Hitoshi Asano | 28 January 2021

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Low (1) ; Medium (2) ; High (3)															

**CME358 INDUSTRIAL LAYOUT DESIGN AND SAFETY L T P C**  
**2 0 2 3**

### COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

- 1 To introduce the industrial facility layout design principles, process and material flow analysis and product and equipment analysis.
- 2 To learn the facilities layout design algorithms and selecting appropriate software.
- 3 To study the facilities layout problem modelling tools and algorithms for production, warehouse, and material handling.
- 4 To learn the safety planning and management principles in industries.
- 5 To learn the various safety management approaches in industries.

### UNIT – I INTRODUCTION 6

Industrial Facility Layout: Definition, Types of Layout Problems, Engineering Design Problem Approach – Product Analysis, Equipment Selection, Personnel Requirement Analysis, Space Requirement and Availability – Process and Material Flow Analysis, Data Requirement for Layout Decisions, Tools for Presenting Layout Designs.

### UNIT – II FACILITIES LAYOUT DESIGN & ALGORITHMS 6

Traditional Approaches to Facility Layout, Systematic Layout Planning, Special Considerations in Office Layout, Engineering Design Problem Approach, Code Compliance, OSHA, ADA Regulations, and Other Considerations in Facility Design – Algorithms for the Layout Problem, Construction Algorithms, Improvement Algorithms, Hybrid Algorithms, Layout Software (CRAFT, BLOCPLAN, PFAST, Layout-iQ, VIP-PLANOPT, Factory CAD, Factory FLOW, Plant Simulation)

### UNIT – III FACILITIES LAYOUT PROBLEM MODELS & ALGORITHMS 6

Models for the Layout Problem, Generic Modeling Tools, Models for the Single-Row Layout Problem, Models for the Multi row Layout Problem with Departments of Equal and Unequal Area – Material Handling, Principles, Types, Models for Material-Handling System Design – Storage and Warehousing, Warehouse Functions, Warehouse Design and Operation.

### UNIT – IV SAFETY PLANNING & MANAGEMENT 6

Introduction: Elements of Safety Programming, Safety Management. Upgrading Safety Developmental Programs: Safety Procedures, Arrangements and Performance Measures, Education, Training and Development in Safety. Safety Performance: An Overview of an Accident, Occupational Health and Industrial Hygiene. Understanding the Risks: Prevention of Accidents Involving Hazardous Substances. Indian Factories Act 1948 for Health and Safety.

**UNIT – V APPROACHES IN SAFETY MANAGEMENT****6**

Safeguarding against Common Potential Hazards: Trips, Slips and Falls, Preventing Electrocution, Static Electricity, Hazardous Energy Control. Specific Hazard Control Measures: Forklift Hazard Control, Tractor Hazard Control. Safe Handling and Storage: Material Handling, Compressed Gas Cylinders, Corrosive Substances, Hydrocarbons, Waste Drums and Containers.

**TOTAL:30 PERIODS****INDUSTRIAL LAYOUT DESIGN LABORATORY****Experiments**

1. Simulation of Manufacturing Shop
2. Simulation of Batch Production System
3. Simulation of Multi Machine Assignment System
4. Simulation of Manufacturing and Material Handling Systems
5. Simulation of a Shop Floor
6. Simulation of Material Handling Systems

**TOTAL:30 PERIODS****COURSE OUTCOMES:** At the end of the course the students would be able to

1. Explain the industrial facility layout design principles, process and material flow analysis and product and equipment analysis.
2. Discuss the facilities layout design algorithms and selecting appropriate software.
3. Describe the facilities layout problem modeling tools and algorithms for production, warehouse, and material handling.
4. Explain the safety planning and management principles in industries.
5. Illustrate the various safety management approaches in industries.

**TEXT BOOKS:**

1. Sunderesh S. Heragu, "Facilities Design", 3<sup>rd</sup> Edition, CRC Press Taylor & Francis Group, 2008.
2. L. M. Deshmukh, "Industrial Safety Management: Hazard Identification and Risk Control", Tata McGraw-Hill Publishing Co. Ltd., 2005.

**REFERENCES:**

1. Eric Teicholz, "Facility Design and Management Handbook", Tata McGraw-Hill Publishing Co. Ltd., 2001.
2. James A. Tompkins, John A. White, Yavuz A. Bozer, and J. M. A. Tanchoco, "Facilities Planning", 4<sup>th</sup> Edition, John Wiley & Sons, 2010.
3. Matthew P. Stevens and Fred E. Meyers, "Manufacturing Facilities Design and Material Handling", 5<sup>th</sup> Edition, Purdue University Press, 2013.
4. Charles D. Reese, Occupational Health and Safety Management: A Practical Approach, CRC Press, 2003.
5. J Maiti, Pradip Kumar Ray, Industrial Safety Management: 21st Century Perspectives of Asia, Springer, 2017.
6. Industrial Hazard and Safety Handbook: (Revised impression by Ralph W King and John Magid | 24 September 2013

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Low (1) ; Medium (2) ; High (3)															

**COURSE OBJECTIVES**

- 1 To study the Codes and Standards and Need for them in the Industry
- 2 To know the different sources and the bodies that publish Codes and Standards
- 3 To familiarize the Government Regulations and its applicability
- 4 To familiarize with different codes used in Different Industry
- 5 To familiarize the Codes and Standards used in Process Industry

**UNIT – I INTRODUCTION 9**

Introduction to Codes and Standards. What is code? What is Standard? Need for codes and standards. Objective of Codes and Standards. Codes, Standards and Good Engineering Practices.

**UNIT – II CODES 9**

Codes and Standards used in Different Industry. Material, Design, Inspection and Construction Codes. Process Industry Codes. Machinery Design codes. Codes used in Oil and Gas Industry. Welding Codes. Machine Design. Automotive. HVAC. Performance Test Codes. Other Discipline codes

**UNIT – III STANDARDS 9**

Sources of Codes and Standards. Who publishes Codes and Standards? International Societies and Professional Bodies. Process of Standardisation and Code publishing in Professional Bodies and Companies. Interdisciplinary Codes.

**UNIT – IV REGULATIONS 9**

Government and Federal Regulations. Need for them. Indian and International Regulations. Standards organisations. Weather and Climatic codes. IS, ISO, IBR, OISD. Certification Bodies. Authorities and Engineers to certify. PE, Chartered Engineers

**UNIT – V DESIGN CODES 9**

Codes and Standards applicable in Process Industry Equipment Design. Pressure Vessel Design Codes. Heat Exchanger Design Codes. Wind and Seismic Codes. Machinery Codes. Package Equipment Design Codes. Performance Test Codes. ASTM, ASME, API, AWS, ANSI, ISO, ASHRAE.

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Explain the need for codes and Standards in Industry.
2. Discuss the different codes and standards used in different industry.
3. Discuss the sources of different codes and standards and the societies that publish them and how these are evolved
4. Explain need for Government regulations and Certification authorities and familiar with common regulations in India and International
5. Discuss knowledge of codes and standards used in Process equipment design for Oil and Gas Industry.

**TEXT BOOKS:**

1. Mechanical Engg. Handbook. ASME. ASTM.API
2. Perrys Chemical Engg Handbook

**REFERENCES:**

1. ASME
2. API
3. ISO, IBR, OISD
4. AWS
5. ISHRAE



- Analyse the influence of process governing parameters in thermochemical conversion of biomass.
- Synthesize liquid biofuels for power generation from biomass.

#### TEXT BOOKS:

- Biomass for Bioenergy and Biomaterials, by Nidhi Adlakha, Rakesh Bhatnagar, Syed Shams Yazdani, CRC Press; 1st edition (22 October 2021), ISBN-10 : 0367745550
- Bioenergy and Biochemical Processing Technologies, by Augustine O. Ayeni, Samuel EshorameSanni, Solomon U. Oranus, Springer (30 June 2022).

#### REFERENCES:

- David Boyles, Bio Energy Technology Thermodynamics and costs, Ellis Hoknood Chichester, 1984.
- Iyer PVR et al, Thermochemical Characterization of Biomass, M N E S
- Khandelwal KC, Mahdi SS, Biogas Technology – A Practical Handbook, Tata McGraw Hill, 1986
- Mahaeswari, R.C. Bio Energy for Rural Energisation, Concepts Publication, 1997
- Tom B Reed, Biomass Gasification – Principles and Technology, Noyce Data Corporation, 1981

CO	PO												PSO		
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Low (1) ; Medium (2) ; High (3)															

**CME361**

### **CARBON FOOTPRINT ESTIMATION AND REDUCTION TECHNIQUES**

**L T P C**  
**3 0 0 3**

#### **COURSE OBJECTIVES**

- To introduce climate change and carbon footprint
- To study the principle of product life cycle and Green House Gas emissions accounting
- To study the Methodology for Carbon Footprint Calculation
- To learn emission mitigation and carbon sink
- To study the case study of carbon footprint.

#### **UNIT – I CLIMATE CHANGE AND CARBON FOOTPRINT**

**9**

Green House Effect and Climate Change - Causes and Impacts of Climate Change – Economic implications of Climate Change -IPCC Reports and Projected Climate Change Scenarios – Green House Gas (GHG) Emission – Carbon footprint of Activities, Processes, Products and Services of Organisations – GHG Emission factors and Calculations

#### **UNIT – II PRODUCT LIFE CYCLE AND GHG EMISSIONS**

**9**

Life-cycle GHG Accounting - Principles of Product Life Cycle GHG Accounting and Reporting - Fundamentals of Product Life Cycle GHG Accounting - Establishing the Scope of a Product Inventory- GHG Emission Inventories and Accounting - Collecting Data and Assessing Data Quality- Allocation and Assessing Uncertainty

**UNIT – III                    METHODOLOGICAL ASPECTS OF CARBON FOOTPRINT                    9**

Methodology for Carbon Footprint Calculation in Crop and Livestock Production, End of Life Scenarios and Carbon Footprint of Wood Cladding, Carbon Footprints and Greenhouse Gas Emission Savings of Alternative Synthetic Biofuels, Making Food Production GHG Efficient, Carbon Footprint of Wood-Based Products and Buildings, Challenges and Merits of Choosing Alternative Functional Units, modeling aspects of carbon footprint, Quantifying Spatial–Temporal Variability of Carbon Stocks and Fluxes

**UNIT – IV                    EMISSION MITIGATION AND CARBON SINK                    9**

Setting GHG Reduction Targets and Tracking Inventory Changes – Non-Fossil Fuel based Energy Systems - Carbon Dioxide capture and Storage Technologies –Mitigation potentials of different Sectors and systems – Innovation, Technology Development and Transfer, - Social aspects of mitigation –Policies, Institutions and international corporations – Carbon Pricing and Finance –GHG Offsetting and Green marketing.

**UNIT – V                    CASE STUDIES                    9**

Carbon Footprint Estimation from Building Sector - Urban Carbon Footprint Evaluation - Applications of carbon footprint in urban planning – Mechanical Equipment and Electronic Product Carbon Footprint - Carbon Footprint of Aqua and Agriculture products- GHG Emissions from Municipal Wastewater Treatment and Solid waste management

**TOTAL:45 PERIODS****OUTCOMES:** At the end of the course the students would be able to

1. Explain the climate change and carbon footprint
2. Discuss the principle of product life cycle and Green House Gas emissions accounting
3. Explain the Methodology for Carbon Footprint Calculation
4. Discuss emission mitigation and carbon sink
5. Explain the case study of carbon footprint.

**TEXT BOOKS:**

1. Assessment of Carbon Footprint in Different Industrial Sectors, Volume 1, by Subramanian Senthilkannan Muthu, Springer; Softcover reprint of the original 1st ed. 2014 edition (23 August 2016), ISBN-10 : 9811011737
2. Assessment of Carbon Footprint in Different Industrial Sectors, Volume 2, by Subramanian Senthilkannan Muthu, Springer Nature; 2014th edition (30 April 2014), ISBN-10 : 9814585742

**REFERENCES:**

1. Subramanian, Senthil Kannan, Muthu (2016), Carbon Foot Print Handbook, CRC Press
2. Subramanian, Senthil Kannan, Muthu (2016), Environmental Carbon Foot Print Industrial case Studies, Butterworth Heinemann Publishers
3. World Resources Institute, Green House Gas Protocol - Product Life Cycle Accounting and Reporting Standard
4. ISO 14067 -2018, Green House gases and carbon footprint, Requirements and Guidelines for Quantification, International Organisation for Standardisation.
5. IPCC (2022) –Sixth Assessment Reports – Intergovernmental Panel on Climate Change, United Framework convention on Climate Change.

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5	1	1	2				3		1			1	1	1	2
<b>Low (1) ; Medium (2) ; High (3)</b>															

**COURSE OBJECTIVES**

- 1 To learn Quantifying the energy demand and energy supply scenario of nation and explaining the need for energy auditing for becoming environmentally benign
- 2 To Analyzing factors behind energy billing and applying the concept of demand side management for lowering energy costs
- 3 To learn Computing the stoichiometric air requirement for any given fuel and quantifying the energy losses associated with thermal utilities of industries
- 4 To Diagnosing the causes for under performance of various electrical utilities and suggesting remedies for improving their efficiency
- 5 To Applying CUSUM and other financial evaluation techniques to estimating the accruable energy savings/monetary benefits for any energy efficiency project

**UNIT – I INTRODUCTION****9**

Energy scenario of World, India and TN - Environmental aspects of Energy Generation – Material and Energy balancing - Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Basic instruments for Energy Auditing.

**UNIT – II ELECTRICAL SUPPLY SYSTEMS****9**

Electricity Tariff structures – Typical Billing - Demand Side Management - HT and LT supply - Power Factor – Energy conservation in Transformers – Harmonics

**UNIT – III ENERGY CONSERVATION IN MAJOR THERMAL UTILITIES****9**

Stoichiometry - Combustion principles. Energy conservation in: Boilers - Steam Distribution Systems - Furnaces - Thermic Fluid Heaters – Cooling Towers – D.G. sets. Insulation and Refractories - Waste Heat Recovery Devices.

**UNIT – IV ENERGY CONSERVATION IN MAJOR ELECTRICAL UTILITIES****9**

Energy conservation in: Motors - Pumps – Fans – Blowers - Compressed Air Systems - Refrigeration and Air Conditioning Systems - Illumination systems

**UNIT – V ENERGY MONITORING, TARGETING, LABELLING AND ECONOMICS****9**

Elements of Monitoring & Targeting System – CUSUM - Energy / Cost index diagram – Energy Labelling - Energy Economics – Cost of production and Life Cycle Costing - Economic evaluation techniques – Discounting and Non-Discounting - ESCO concept – PAT scheme

**TOTAL :45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Discuss Quantify the energy demand and energy supply scenario of nation and appreciate the need for energy auditing for becoming environmentally benign
2. Analyse factors behind energy billing and apply the concept of demand side management for lowering energy costs
3. Compute the stoichiometric air requirement for any given fuel and quantify the energy losses associated with thermal utilities of industries
4. Diagnose the causes for under performance of various electrical utilities and suggest remedies for improving their efficiency
5. Apply CUSUM and other financial evaluation techniques to estimate the accruable energy savings/monetary benefits for any energy efficiency project

**TEXT BOOKS:**

1. Guide book for National Certification Examination for “Energy Managers and Energy Auditors” (4 Volumes). Available at <http://www.em-ea.org/gbook1.asp>. This website is administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.
2. K. Nagabhushan Raju, Industrial Energy Conservation Techniques: (concepts, Applications and Case Studies), Atlantic Publishers &Dist, 2007.



## REFERENCES:

1. Abbi Y P, Shashank Jain., Handbook on Energy Audit and Environment Management, TERI Press, 2006.
2. Albert Thumann and Paul Mehta D, "Handbook of Energy Engineering", 7th Edition, The Fairmont Press, 2013.
3. Murphy.W.R. and McKay.G, "Energy Management", Butterworth, London 1982.
4. Paul W.O'Callaghan, Design and management for energy conservation: A handbook for energy managers, plant engineers, and designers, Pergamon Press, 1981.
5. Steve Doty, Wayne Turner C, Energy Management Handbook 7th Edition, The Fairmont Press, 2009.

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Low (1) ; Medium (2) ; High (3)															

**CME363**

**ENERGY EFFICIENT BUILDINGS**

**L T P C**  
**3 0 0 3**

### COURSE OBJECTIVES

- 1 To learn the climate and buildings, building efficiency rating and standards
- 2 Developing energy efficiency in building envelopes through alternate methods
- 3 To study the thermal comfort, passive heating and cooling techniques
- 4 To apply various energy saving concepts in buildings.
- 5 To incorporate Renewable energy systems in buildings

### UNIT – I INTRODUCTION

**9**

Climate and Building, Historical perspective, Aspects of Net Zero building design – Sustainable Site, Water, Energy, Materials and IGBC, LEED, GRIHA, IEQ and ECBC Standards

### UNIT – II LANDSCAPE AND BUILDING ENVELOPES

**9**

Energy efficient landscape design – Micro climates – various methods – Shading, water bodies – Building envelope: Building materials, Envelope heat loss and heat gain and its evaluation, paints, insulation, Design methods and tools

### UNIT – III THERMAL COMFORT, PASSIVE HEATING AND COOLING

**9**

Thermal comfort, Psychrometry, Comfort indices – ASHRAE / ISHRAE Standards on thermal Comfort – Passive heating and cooling systems - HVAC Systems for build environment – Heat Pumps, Evaporative Cooling and Radiant Cooling.

### UNIT – IV ENERGY CONSERVATION IN BUILDING UTILITIES

**9**

Energy conservation in Hot water generator – Boiler, Heat Pumps, DG Sets, Motors , Pumps, Illumination Systems, Electrical distribution systems, Cooling Towers, Refrigeration and Air Conditioning Systems, Water and Waste Management systems

### UNIT – V RENEWABLE ENERGY IN BUILDINGS

**9**

Introduction of Renewable sources in buildings, , Stand-alone PV systems, BIPV, Solar water heating, Solar Air Conditioning in Buildings, Small wind turbines, Poly-generation systems in Buildings

**TOTAL :45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Familiar with climate responsive building design and basic concepts
2. Explain the basic terminologies related to buildings
3. Discuss the energy efficient air conditioning techniques
4. Evaluate the performance of buildings
5. Gets acquainted with Renewable energy systems in buildings

**TEXT BOOKS:**

1. Advanced Decision Making for HVAC Engineers, by Javad Khazaii, Springer; Softcover reprint of the original 1st ed. 2016 edition (23 June 2018), ISBN-10 : 3319814869
2. Thermal Comfort and Energy-Efficient Cooling of Nonresidential Buildings, by Doreen E. Kalz, Jens Pfafferott, Springer; 2014th edition (8 April 2014), ISBN-10 : 9783319045818.

**REFERENCES:**

1. ASHRAE Handbook – Fundamentals / Equipment’s/ Applications – ASHRAE 2021,2020, 2019 Editions
2. Baruch Givoni: Climate considerations in building and Urban Design, John Wiley & Sons, 1998
3. Baruch Givoni: Passive Low Energy Cooling of Buildings by, John Wiley & Sons, 15-Jul-1994
4. JA Duffie and WA Beckman: Solar Engineering of Thermal Processes, Third Edition, John Wiley & Sons, 2006.
5. Jan F. Kreider, Peter S. Curtiss, Ari Rabl, Heating and Cooling of buildings: Design for Efficiency, Revised Second Edition, CRC Press, 28-Dec-2009.

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Low (1) ; Medium (2) ; High (3)



**CME364**

**ENERGY STORAGE DEVICES**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- 1 To study the various types of energy storage devices and technologies and their comparison.
- 2 To learn the techniques of various energy storage devices and their performances.
- 3 To learn the basics of batteries and hybrid systems for EVs and other mobile applications.
- 4 To learn about the renewable energy storage systems and management systems.
- 5 To have an insight into other energy storage devices, hydrogen, and fuel cells.

**UNIT – I INTRODUCTION TO ENERGY STORAGE**

**9**

Need for Energy Storage – Types of Energy Storage – Various forms of Energy Storage – Mechanical– Thermal - Chemical– Electrochemical – Electrical - Other alternative energy storage technologies – Efficiency and Comparison.

**UNIT – II ENERGY STORAGE SYSTEMS****9**

Pumped Air Energy Storage – Compressed Air Energy Storage – Flywheel – Sensible and Latent Heat Storage – Storage Materials – Performance Evaluation - Thermochemical systems – Batteries – Types- Charging and Discharging – Battery testing and performance.

**UNIT – III MOBILE AND HYBRID ENERGY STORAGE SYSTEMS****9**

Batteries for electric vehicles - Battery specifications for cars, heart pacemakers, computer standby supplies – V2G and G2V technologies – HESS.

**UNIT – IV RENEWABLE ENERGY STORAGE AND ENERGY MANAGEMENT****9**

Storage of Renewable Energy Systems –Solar Energy – Wind Energy – Energy Storage in Micro grid– Smart Grid – Energy Conversion Efficiency - Battery Management Systems – EVBMS – Energy Audit and Management

**UNIT – V OTHER ENERGY DEVICES****9**

Superconducting Magnetic Energy Storage (SMES), Supercapacitors – MHD Power generation – Hydrogen Storage - Fuel Cells – Basic principle and classifications – PEMFC, AMFC, DMFC, SOFC, MCFC and Biofuel Cells – Biogas Storage.

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Discuss the need and identify the suitable energy storage devices for applications.
2. Explain the working of various energy storage devices and their importance.
3. Explain the basic characteristics of batteries for mobile and hybrid systems.
4. Discuss the storage of renewable energies and management systems.
5. Explain the need for other energy devices and their scope for applications.

**TEXT BOOKS:**

1. Rober Huggins, “Energy Storage: Fundamentals, Materials and Applications”, 2 nd Edition, Springer, 2015.
2. Dell, Ronald M Rand, David A J, “Understanding Batteries”, Royal Society of Chemistry, 2001

**REFERENCES:**

1. Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt,” Energy Storage in Power Systems” Wiley Publication, 2016.
2. Ibrahim Dincer and Mark A Rosen, “Thermal Energy Storage Systems and Applications”, John Wiley & amp; Sons, 2002.
3. Lindon David, “Handbook of Batteries”, McGraw Hill, 2002.
4. Aulice Scibioh M. and Viswanathan B, “Fuel Cells – principles and applications’, University Press(India), 2006
5. Ru-Shiliu, Leizhang, Sueliang Sun, “Electrochemical Technologies for Energy Storage and Conversion”, Wiley Publications, 2012.

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Low (1) ; Medium (2) ; High (3)															

<b>CME365</b>	<b>RENEWABLE ENERGY TECHNOLOGIES</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

### **COURSE OBJECTIVES**

- 1 To know the Indian and global energy scenario
- 2 To learn the various solar energy technologies and its applications.
- 3 To educate the various wind energy technologies.
- 4 To explore the various bio-energy technologies.
- 5 To study the ocean and geothermal technologies.

#### **UNIT – I ENERGY SCENARIO 9**

Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status- Potential of various renewable energy sources-Global energy status-Per capita energy consumption - Future energy plans

#### **UNIT – II SOLAR ENERGY 9**

Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications.

#### **UNIT – III WIND ENERGY 9**

Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.

#### **UNIT – IV BIO-ENERGY 9**

Bio resources – Biomass direct combustion – thermochemical conversion - biochemical conversion- mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration – Carbonisation – Pyrolysis - Biogas plants – Digesters –Biodiesel production – Ethanol production - Applications.

#### **UNIT – V OCEAN AND GEOTHERMAL ENERGY 9**

Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Discuss the Indian and global energy scenario.
2. Describe the various solar energy technologies and its applications.
3. Explain the various wind energy technologies.
4. Explore the various bio-energy technologies.
5. Discuss the ocean and geothermal technologies.

#### **TEXT BOOKS:**

1. Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, cGraw Hill; First edition (10 December 2020), ISBN-10 : 9390385636
2. Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 8120344707

#### **REFERENCES:**

1. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012.
2. Rai.G.D., "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2014.



**UNIT – V POLLUTION MONITORING EQUIPMENT****9**

Equipment's for sampling of water, solids and air- Sample preservation Equipment – incubators – Cold Storage systems- equipment for analysis of water and air samples- Ambient air and flue gas sampling and monitoring equipment

**TOTAL :45 PERIODS****OUTCOMES:** At the end of the course the students would be able to

1. Explain the different types of pollution, their sources and effects.
2. Discuss the pollution control regulations and standards
3. Design equipment for pollution control
4. Discuss different methods of pollution control from various sources in air, water and soil
5. Discuss the Conduct performance assessment of pollution control equipment.

**TEXT BOOKS:**

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, "Integrated Solid Waste Management, Mc-Graw Hill India, First edition, 2015.
2. Rao. C.S (2006)., "Environmental Pollution and Control Engineering", 2nd Edition, Revised, Wiley Eastern Limited, India.

**REFERENCES:**

1. Shyam Diwan and Armin Rosencranz, Enviromental Law and Policy in India, Oxford, 2001
2. Metcalf & Eddy, INC, „Wastewater Engineering – Treatment and Reuse, Fourth Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2014.
3. Noel de Nevers, "Air Pollution Control Engg", Mc Graw Hill, New York, 2016.
4. CPCB (2021), "Pollution Control Acts, Rules and Notifications issued thereunder, PCL Series- Central Pollution Control Board, Delhi
5. CPHEEO, "Manual on Municipal Solid waste management, Vol I, II and III, Central Public Health and Environmental Engineering Organisation , Government of India, New Delhi, 2016.

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Low (1) ; Medium (2) ; High (3)															

**CME367****COMPUTATIONAL SOLID MECHANICS**

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<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES**

- 1 To study the definition and basics on theory of elasticity
- 2 To learn finite element method and procedure for static linear elasticity
- 3 To study the Non Linear and History depend problems
- 4 To study time dependent and dynamic problems of Small and large strain visco-plasticity
- 5 To study Structural Elements & Interfaces and contact using penalty method.

**UNIT – I                    BASIC ON THEORY OF ELASTICITY****9**

Definitions- notations and sign conventions for stress and strain, Equations of equilibrium. Strain – displacement relations, Stress – strain relations, Lamé’s constant –cubical dilation, Compressibility of material, bulk modulus, Shear modulus, Compatibility equations for stresses and strains, Principal stresses and principal strains, Mohr’s circle, Saint Venant’s principle.

**UNIT – II                    FINITE ELEMENT METHOD FOR STATIC LINEAR ELASTICITY****9**

Derivation and implementation of a basic 2D FE code with triangular constant strain elements. Generalization of finite element procedures for linear elasticity: interpolation and numerical integration in 1D, 2D and 3D. Deriving finite element equations - constructing variational forms; mixed methods. Accuracy and convergence; the Patch test.

**UNIT – III                    NON LINEAR AND HISTORY DEPEND PROBLEMS****9**

Small strain hypo-elastic materials - Small strain visco-plasticity - Large strain elasticity -Large strain visco-plasticity.

**UNIT – IV                    TIME DEPENDENT AND DYNAMIC PROBLEMS****9**

First-order systems - the diffusion equation - Explicit time integration – the Newmark method - Implicit time integration - Modal analysis and modal time integration.

**UNIT – V                    STRUCTURAL ELEMENTS & INTERFACES AND CONTACT****9**

Continuum Beams – Shells – Cohesive Zones - Enforcing constraints using penalty methods and Lagrange Multipliers - Contact elements (in two dimensions)

**TOTAL: 45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Discuss the definition and basics on theory of elasticity
2. Derive the finite element method for static linear elasticity, solve problems.
3. Discuss the Non Linear and History depend problems, Solve problems.
4. Discuss time dependent and dynamic problems, solve problems.
5. Discuss Structural Elements & Interfaces and contact, solve problems.

**TEXT BOOKS:**

1. L.S.Srinath, Advanced Mechanics Of Solids, 3rd Edition 2008.( 0070139881 . 9780070139886).
2. J.N.Reddy, Introduction To Finite Element Method, 4th Edition 2020. (939038527X . 9789390385270).
3. R.D.Cook, Concepts and Applications of Finite Element Analysis, 4th Edition 2001 (978-0-471-35605-9).
4. S.Timoshenko, Theory of Elasticity, McGraw-Hill Education (India) Pvt Limited, 2010.( 9780070701229-0070701229)
5. G. Ramamurty, Applied Finite Element Analysis, I.K. International Publishing House Pvt. Limited,2013. (9789380578453- 9380578458)

**REFERENCES:**

1. The Mechanics of Solids and Structures - Hierarchical Modeling and the Finite Element Solution (Computational Fluid and Solid Mechanics)by Miguel Luiz Bucalem and Klaus-Jurgen Bathe | 25 February 2013
2. The Finite Element Analysis of Shells - Fundamentals (Computational Fluid and Solid Mechanics)by Dominique Chapelle and Klaus-Jurgen Bathe | 27 January 2013
3. Inelastic Analysis of Solids and Structures (Computational Fluid and Solid Mechanics)by M. Kojic and Klaus-Jurgen Bathe | 22 October 2010
4. High-Resolution Methods for Incompressible and Low-Speed Flows (Computational Fluid and Solid Mechanics)by D. Drikakis and W. Rider | 22 October 2010
5. Discontinuous Finite Elements in Fluid Dynamics and Heat Transfer (Computational Fluid and Solid Mechanics) by Ben Q. Li | 22 October 2010

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Low (1) ; Medium (2) ; High (3)															

CME368

**COMPUTATIONAL FLUID DYNAMICS  
AND HEAT TRANSFER**

**L    T    P    C**  
**3    0    0    3**

**COURSE OBJECTIVES**

- 1 To study the fluid flow simulation techniques and its mathematical behaviour
- 2 To learn the Discretise 1D and 2D systems using finite difference and finite volume techniques
- 3 To Formulate diffusion –convection problems using finite volume method
- 4 To study the flow field for different types of grids
- 5 To learn the need for turbulence models and its types

**UNIT – I INTRODUCTION**

**9**

Basics of Computational Fluid Dynamics – Governing equations– Continuity, Momentum and Energy equations – Boundary conditions & Types– Time-averaged equations for Turbulent Flow – Classification and Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations, comparison between Analytical, Experimental and Numerical techniques, Techniques of Discretisation and Numerical errors

**UNIT – II FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION**

**9**

Derivation of finite difference equations– General Methods for first and second order accuracy – Finite volume formulation for steady and transient diffusion 1D and 2D problems – Use of Finite Difference and Finite Volume methods, Accuracy of solution, optimum step-size, Euler, Crank-Nicolson, and pure implicit methods, stability of schemes.

**UNIT – III FINITE VOLUME METHOD FOR CONVECTION DIFFUSION**

**9**

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes, properties of discretization schemes, Hybrid, Power-law, QUICK Schemes, Computation of Boundary layer flow, von Neumann stability analysis.

**UNIT – IV FLOW FIELD ANALYSIS**

**9**

Stream function and vorticity, Representation of the pressure gradient term, Staggered grid – Momentum equations, Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms, Computation of internal and external thermal boundary layer.

**UNIT – V TURBULENCE MODELLING**

**9**

Turbulence model requirement and types, mixing length model, Two equation (k-ε) models – High and low Reynolds number models, LES, DNS, Mesh Generation and refinement Techniques-software tools, Stability of solver, Courant Fredrick Levy number, relaxation factor, and grid independence test.

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Apply the fundamentals of CFD, and develop case specific governing equations.





**UNIT – II                    REGULAR LANGUAGES AND FINITE AUTOMATA                    9**

Regular Expressions, Regular Languages, Application of Finite Automata, Automata with output – Moore machine & Mealy machine, Finite Automata, Memory requirement in a recognizer, Definitions, union-intersection and complement of regular languages, Non Deterministic Finite Automata, Conversion from NFA to FA, ??- Non Deterministic Finite Automata, Conversion of NFA- ? to NFA, Kleene’s Theorem, Minimization of Finite automata, Regular And Non Regular Languages – pumping lemma.

**UNIT – III                    CONTEXT FREE GRAMMAR (CFG) AND PUSHDOWN AUTOMATA                    9**

Definitions and Examples, Unions Concatenations And Kleene’s of Context free language, Regular Grammar for Regular Language, Derivations and Ambiguity , Unambiguous CFG and Algebraic Expressions, BacosNaur Form (BNF), Normal Form – CNF. Definitions, Deterministic PDA, Equivalence of CFG and PDA & Conversion, Pumping lemma for CFL, Intersections and Complements of CFL, Non-CFL.

**UNIT – IV                    VALUE OF VISUALIZATION                    9**

Information Visualization, In Readings in Information Visualization, Graphical Excellence, Graphical Integrity, Sources of Graphical Integrity In The Visual Display of Quantitative Information

**UNIT – V                    VISUALIZATION DESIGN                    9**

The Power of Representation, Data-Ink and Graphical Redesign, Data-Ink Maximization and Graphical Design, Data Density and Small Multiples

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Discussing the concepts and techniques of discrete mathematics for theoretical computer science.
2. Explain the different formal languages and their relationship.
3. Discussing to classify and construct grammars for different languages and vice-versa.
4. Explaining the Visualization, Graphical and Quantitative Information.
5. Applying the Visualization design and data Ink.

**TEXT BOOKS:**

1. Introduction to the Theory of Computation by Michael Sipser
2. Automata Theory, Languages, and Computation By John Hopcroft, Rajeev Motowani, and Jeffrey Ullman

**REFERENCES:**

1. Introduction to Languages and the Theory of Computation, 4th by John Martin, Tata Mc Graw Hill
2. An introduction to automata theory and formal languages By Adesh K. Pandey, Publisher: S.K. Kataria& Sons
3. Introduction to computer theory By Deniel I. Cohen , Joh Wiley & Sons, Inc
4. Computation: Finite and Infinite By Marvin L. Minsky Prentice-Hall.

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Low (1) ;    Medium (2) ;    High (3)															

**COURSE OBJECTIVES**

- 1 To Introduction of principles and concepts of bio-mechanics.
- 2 Focuses on the studies of tissues and structure of musculoskeletal system.
- 3 To study the mechanics of joints and human motion.
- 4 To explain the computational approaches in biomechanics.
- 5 To learn the quantification of forces and motion.

**UNIT – I INTRODUCTION TO BIOMECHANICS 9**

Perspective of biomechanics, Terminologies, Kinematic and kinetic concepts for analyzing human motion, Kinetic concepts for analyzing human motion, Linear kinetics of human movement, Equilibrium, Angular kinetics of human Movement, Mechanical properties of soft tissues, bones, and muscles

**UNIT – II BIOMECHANICS OF TISSUES AND STRUCTURES OF THE MUSCULOSKELETAL SYSTEM 9**

Biomechanics of Bone, Biomechanics of Articular Cartilage, Tendons and Ligaments, Peripheral Nerves and Spinal Nerve Roots, Skeletal Muscle

**UNIT – III BIOMECHANICS OF JOINTS AND HUMAN MOTION 9**

Knee, Hip, Foot and Ankle, Lumbar Spine, Cervical Spine, Shoulder, Elbow Wrist, and Hand, Linear kinematic and kinetic aspects of human movement, angular kinematic and kinetic aspects of human movement, equilibrium and human moment.

**UNIT – IV COMPUTATIONAL APPROACHES IN BIOMECHANICS 9**

Finite Element Analysis in Biomechanics, Computational modelling of Vancouver Periprosthetic Fracture in Femur, Scaffolds, artificial hip and knee joints, Aortic Valve.

**UNIT – V GAIT ANALYSIS 9**

Exoskeleton design, Ergonomics, Sports mechanics, Performance Analysis, Biomechanical analysis, 3D printing.

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Discuss the principles of mechanics.
2. Elaborate the tissues and structures of the musculoskeletal system
3. Discuss of joint mechanics and human motion.
4. Create Examples of computational mathematical modelling applied in biomechanics.
5. Describe the analysis of human motion.

**TEXT BOOKS:**

1. Susan J Hall, —Basic Biomechanics, 6th Edition, The McGraw-Hill Companies Inc., 2011
2. Jay D Humphrey and Sherry L Delange, —An Introduction to Biomechanics: Solids and Fluids, Analysis and Design, 1st edition, Springer-Verlag, 2010

**REFERENCES:**

1. Margareta Nordin and Victor H Frankel, —Basic Biomechanics of the Musculoskeletal System, 3rd Edition, Lippincott Williams and Wilkins, 2001.
2. Ozkaya, Nihat, Nordin, and Margareta, —Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation, 2nd Edition, Springer, 2009.
3. Pritam Pain, Sreerup Banerjee, Goutam Kumar Bose , Advances in Computational Approaches in Biomechanics, 2022
4. Kinetics and Dynamics: From Nano- to Bio-Scale: 12 (Challenges and Advances in Computational Chemistry and Physics)by Piotr Paneth and Agnieszka Dybala-Defratyka | 12 August 2010
5. Computational Approaches to Biochemical Reactivity: 19 (Understanding Chemical Reactivity) by Gábor Náray-Szabó and Arieh Warshel | 31 March 2002

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<b>Low (1) ; Medium (2) ; High (3)</b>															

<b>CME371</b>	<b>ADVANCED STATISTICS AND DATA ANALYTICS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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### COURSE OBJECTIVES

- 1 To introduce the basic concepts of linear regression and multiple regression
- 2 To introduce exploratory data analysis
- 3 To study logistic regression models for classification
- 4 To develop the forecasting techniques for the predictions
- 5 To introduce the time series analysis for the prediction of future behavior

### UNIT – I REGRESSION 9

Introduction – Linear regression - Correlation analysis -Limitations, errors, and caveats of using regression and correlation analyses - Multiple regression and correlation analysis - Inferences about population parameters – Modeling techniques. - Coefficient of determination, Interpretation of regression coefficients, Categorical variables, heteroscedasticity, Multi-co linearity outliers, Ridge regression.

### UNIT – II EXPLORATORY DATA ANALYSIS 9

Rise of statistics, Data Wrangling, Data Quality. Visual encoding – Mapping Data to Visual Variables, Encoding Effectiveness, Scales & Axes, Aspect Ratio, Regression Lines, Multidimensional Data, Parallel Coordinates, Dimensionality Reduction.

### UNIT – III LOGISTIC AND MULTINOMIAL REGRESSION 9

Logistic function, Estimation of probability using Logistic regression, Variance, Wald Test, Hosmer Lemshow Test, Classification Table, Gini Co-efficient.

### UNIT – IV FORECASTING AND CAUSAL MODELS 9

Moving average, Exponential Smoothing, Casual Models.

### UNIT – V TIME SERIES ANALYSIS 9

Auto regression (AR), Moving Average(MA) Models, ARMA, ARIMA models , Multivariate Models

**TOTAL 45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Develop how to do regression fit for the given data.
2. Visualize the data through explanatory data analysis
3. Classify the given data through logistic regression
4. Analyzing forecasting techniques and causal inferences.
5. Utilize the effective time series analysis to predict/forecast the future behavior of data.

### TEXT BOOKS:

1. Douglas C Montgomery and George C Runge, “Applied Statistics and Probability for Engineers”, John Wiley & Sons, 2014.
2. Douglas C. Montgomery, Cheryl L. Jennings, Murat Kulachi, “Introduction to Time Series Analysis and Forecasting” ,Wiley,2015

## REFERENCES:

1. David Forsyth, 'Probability and Statistics for Computer Science', Springer; 2018
2. Michael J. Evans, Jeffrey S. Rosenthal, 'Probability and Statistics - The Science of Uncertainty'. W H Freeman & Co, 2010
3. Max Kuhn, Kjell Johnson, "Applied Predictive Modeling", Springer, 2014.
4. Ronald E. Walpole, Raymond H. Meyers, Sharon L. Meyers, "Probability and Statistics for Engineers and Scientists", Pearson Education, 2014.
5. Daniel T. Larose, Chantal D. Larose "Data Mining and Predictive Analytics", Wiley, 2015
6. Thomas W. Miller, "Modeling Techniques in Predictive Analytics with Python and R: A guide to Data Science", Pearson Education, 2014.

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Low (1) ; Medium (2) ; High (3)

CME372

CAD AND CAE

L T P C  
2 0 2 3

### COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

- 1 Applying the fundamental concepts of computer graphics and its tools in a generic framework.
- 2 Creating and manipulating geometric models using curves, surfaces, and solids.
- 3 Applying concept of 3D modeling, visual realism, and CAD standard practices in engineering design
- 4 Developing mathematical models for Boundary Value Problems and their numerical solution.
- 5 Formulating solution techniques to solve non-linear problems

### UNIT – I FUNDAMENTALS OF COMPUTER GRAPHICS

6

Design process - Computer Aided Design – Computer graphics – co-ordinate systems- 2D and 3D transformations - Graphic primitives (point, line, circle drawing algorithms) - Clipping- viewing transformation. Standards for computer graphics

### UNIT – II GEOMETRIC MODELING

6

Representation of curves - Hermite cubic spline curve, Bezier curve, B-spline curves, Surface Modeling – Surface Entities, Representation of Surface, Bezier Surface, B-Spline Surface and Coons Surface. Solid Modeling - Solid Entities, Solid Representation, Boundary Representation (B-Rep), Sweeps Representation, Constructive Solid Geometry (CSG).

### UNIT – III VISUAL REALISM and CAD STANDARDS

6

Need for hidden surface removal, The Depth - Buffer Algorithm, Properties that help in reducing efforts, Scan Line coherence algorithm, Span - Coherence algorithm, Area-Coherence Algorithms, Warnock's Algorithm, Priority Algorithms– shading – coloring – computer animation.

Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange images- Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc.

**UNIT – IV FINITE ELEMENT ANALYSIS****6**

Historical Background – Weighted Residual Methods - Basic Concept of FEM – Variational Formulation of Boundary Value Problems – Ritz Method – Finite Element Modelling – Element Equations – Linear and Higher order Shape functions – Bar, Beam Elements –Applications to Heat Transfer problems.

**UNIT – V NON-LINEAR ANALYSIS****6**

Introduction to Non-linear problems - some solution techniques- computational procedure- material non-linearity-Plasticity and visco-plasticity, stress stiffening, contact interfaces- problems of gaps and contact - geometric non-linearity - modeling considerations - Free and Mapped meshing -Mesh quality- Error estimate- Introduction to Analysis Software.

**TOTAL:30 PERIODS****CAD & CAE LABORATORY****Experiments**

1. Design and animate Piston Cylinder assembly and motion study using CAD software.
2. Design and simulate Connecting rod and crank shaft using CAD software.
3. Design and simulate Two Cylinder Engine assembly using CAD software.
4. Coupled Simulation of structural /thermal analysis
5. Harmonic, Transient and spectrum analysis of simple systems.
6. buckling analysis

**TOTAL:30 PERIODS****OUTCOMES:** At the end of the course, the students would be able to

1. Discuss the fundamental concepts of computer graphics and its tools in a generic framework.
2. Create and manipulate geometric models using curves, surfaces and solids.
3. Discuss concept of 3D modeling , visual realism and standard CAD practices in engineering design.
4. Develop the mathematical models for one dimensional finite element problems and their numerical solutions.
5. Formulate solution techniques to solve non-linear problems.

**TEXT BOOKS:**

1. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill Publishing Co.2007
2. Seshu.P, “Textbook of Finite Element Analysis”, PHI Learning Pvt. Ltd., NewDelhi, 2012.

**REFERENCES:**

1. William M Neumann and Robert F.Sproul “Principles of Computer Graphics”, McGraw Hill Book Co. Singapore, 1989.
2. Donald Hearn and M. Pauline Baker “Computer Graphics”. Prentice Hall, Inc, 1992.
3. Foley, Wan Dam, Feiner and Hughes – “Computer graphics principles & practice”, Pearson Education - 2003
4. Rao, S.S., “The Finite Element Method in Engineering”, 6th Edition, Butterworth-Heinemann,2018.
5. Reddy,J.N. “Introduction to the Finite Element Method”, 4<sup>th</sup>Edition, Tata McGrawHill,2018.

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**CME380**

**AUTOMOBILE ENGINEERING**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- 1 To study the construction and working principle of various parts of an automobile.
- 2 To study the practice for assembling and dismantling of engine parts and transmission system
- 3 To study various transmission systems of automobile.
- 4 To study about steering, brakes and suspension systems
- 5 To study alternative energy sources

**UNIT – I VEHICLE STRUCTURE AND ENGINES 9**

Types of automobiles vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved), IC engines – components-functions and materials, variable valve timing (VVT).

**UNIT – II ENGINE AUXILIARY SYSTEMS 9**

Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT), Engine emission control by three way catalytic converter system, Emission norms (Euro and BS).

**UNIT – III TRANSMISSION SYSTEMS 9**

Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Overdrive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

**UNIT – IV STEERING, BRAKES AND SUSPENSION SYSTEMS 9**

Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS), electronic brake force distribution (EBD) and Traction Control.

**UNIT – V ALTERNATIVE ENERGY SOURCES 9**

Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles- Engine modifications required –Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels - Electric and Hybrid Vehicles, Fuel Cell Note: Practical Training in dismantling and assembling of Engine parts and Transmission Systems should be given to the students.

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Recognize the various parts of the automobile and their functions and materials.
2. Discuss the engine auxiliary systems and engine emission control.
3. Distinguish the working of different types of transmission systems.
4. Explain the Steering, Brakes and Suspension Systems.
5. Predict possible alternate sources of energy for IC Engines.

**TEXT BOOKS:**

1. Jain K.K. and Asthana .R.B, “Automobile Engineering” Tata McGraw Hill Publishers, New Delhi, 2002.



- Kirpal Singh, "Automobile Engineering", Vol 1 & 2, Seventh Edition, Standard Publishers, New Delhi, 13th Edition 2014.

**REFERENCES:**

- Ganesan V. "Internal Combustion Engines", Third Edition, Tata McGraw-Hill, 2012.
- Heinz Heisler, "Advanced Engine Technology," SAE International Publications USA, 1998.
- Joseph Heitner, "Automotive Mechanics," Second Edition, East-West Press, 1999.
- Martin W, Stockel and Martin T Stockle , "Automotive Mechanics Fundamentals," The Good heart - Will Cox Company Inc, USA ,1978.
- Newton, Steeds and Garet, "Motor Vehicles", Butterworth Publishers,1989.

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<b>Low (1) ; Medium (2) ; High (3)</b>															

**ME3001**

**MEASUREMENTS AND CONTROLS**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- To Identify measurement parameters and analyze errors of measurements.
- To Select and apply suitable transducer for a particular measurement.
- To identify measurement parameters and select the appropriate sensor for it.
- To Explain the working of various types of control systems of apply for specific applications.
- To apply the principle of automatic control systems to control various parameter(s).

**UNIT – I MEASUREMENTS AND ERROR ANALYSIS 9**

General concepts – Units and standards – Measuring instruments –sensitivity, readability, range, accuracy, precision – static and dynamic response – repeatability hysteresis – systematic and random errors –Statistical analysis of experimental data – Regression analysis – Curve fitting - calibration and Uncertainty.

**UNIT – II INSTRUMENTS 9**

Transducer, modifying (intermediate) and Terminal stages – Mechanical and electrical transducers, preamplifiers – charge amplifiers – filters – attenuators – D' Arsonval – CRO – Oscillographs – recorders – microprocessor-based data logging, processing and output

**UNIT – III PARAMETERS FOR MEASUREMENT 9**

Dimension, displacement, velocity, acceleration, Impact – Force, torque, power- Pressure, Temperature, Heat Flux, Heat Transfer Coefficients, Humidity – Flow – Velocity - Time, frequency and phase angle – noise and sound level.

**UNIT – IV CONTROL SYSTEMS 9**

Basic elements – feedback principle, implication of measurements – Error detectors – final actuating elements – Two position, multi-position, floating, proportional controls – relays – servo amplifiers – servo motors – Electrical, magnetic, electronic control systems

**UNIT – V APPLICATION OF CONTROL SYSTEMS 9**



Basic modules in design process-scientific method and design method-Need identification, importance of problem definition-structured problem, real life problem- information gathering -customer requirements-Quality Function Deployment (QFD)- product design specifications-generation of alternative solutions-Analysis and selection-Detail design and drawings-Prototype, modeling, simulation, testing and evaluation

**UNIT – III CREATIVITY IN DESIGN 9**

Creativity and problem solving-vertical and lateral thinking-invention-psychological view, mental blocks-Creativity methods-brainstorming, synectics, force fitting methods, mind map, concept map-Theory of innovative problem solving (TRIZ) - conceptual decomposition creating design concepts.

**UNIT – IV HUMAN AND SOCIETAL ASPECTS IN PRODUCT DEVELOPMENT 9**

Human factors in design, ergonomics, user friendly design-Aesthetics and visual aspects environmental aspects-marketing aspects-team aspects-legal aspects-presentation aspects

**UNIT – V MATERIAL AND PROCESSES IN DESIGN 9**

Material selection for performance characteristics of materials-selection for new design substitution for existing design-economics of materials-selection methods-recycling and material selection-types of manufacturing process, process systems- Design for Manufacturability (DFM) - Design for Assembly (DFA).

**Total:45 periods**

**OUTCOMES:** At the end of the course the students would be able to

1. Analyze the various design requirements and get acquainted with the processes involved in product development.
2. Apply the design processes to develop a successful product.
3. Apply scientific approaches to provide design solutions.
4. Design solution through relate the human needs and provide a solution.
5. Apply the principles of material selection, costing and manufacturing in design.

**TEXT BOOKS:**

1. Dieter. G. N., Linda C. Schmidt, "Engineering Design", McGraw Hill, 2013..
2. Horenstein, M. N., Design Concepts for Engineers, Prentice Hall, 2010.

**REFERENCES:**

1. Dhillon, B. S., Advanced Design Concepts for Engineers, Technomic Publishing Co., 1998.
2. Edward B. Magrab, Satyandra K. Gupta, F. Patrick McCluskey and Peter A. Sandborn, "Integrated Product and Process Design and Development", CRC Press, 2009.
3. James Garratt, "Design and Technology", Cambridge University Press, 1996.
4. Joseph E. Shigley, Charles R.Mische, and Richard G. Budynas, "Mechanical Engineering Design", McGraw Hill Professional, 2003.
5. Sumesh Krishnan and MukulSukla, Concepts in Engineering Design, Notion Press, 2016.

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Low (1) ; Medium (2) ; High (3)															

## **COURSE OBJECTIVES**

1. To study the fundamentals of composite material strength and its mechanical behavior
2. To study the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.
3. To study Thermo-mechanical behavior and study of residual stresses in Laminates during processing.
4. To Implementation of Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronic chips.
5. To study the fundamentals of composite material strength and its mechanical

### **UNIT – I INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS & MANUFACTURING 9**

Definition –Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramic and Aramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix ( $Q_{ij}$ ), Typical Commercial material properties, Rule of Mixtures. Generally Orthotropic Lamina –Transformation Matrix, Transformed Stiffness. Manufacturing: Bag Moulding Compression Moulding – Pultrusion – Filament Winding – Other Manufacturing Processes

### **UNIT – II FLAT PLATE LAMINATE CONSTITUTE EQUATIONS 9**

Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

### **UNIT – III LAMINA STRENGTH ANALYSIS 9**

Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure

### **UNIT – IV THERMAL ANALYSIS 9**

Assumption of Constant C.T. E's. Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T. E's. C.T. E's for special Laminate Configurations –Unidirectional, Off-axis, Symmetric Balanced Laminates, Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates

### **UNIT – V ANALYSIS OF LAMINATED FLAT PLATES 9**

Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Summarize the various types of Fibers, Equations and manufacturing methods for
2. Derive Flat plate Laminate equations
3. Analyze Lamina strength
4. Analyze the thermal behavior of Composite laminates
5. Analyze Laminate flat plates

### **TEXT BOOKS:**

1. Gibson, R.F., "Principles of Composite Material Mechanics", Second Edition, McGraw-Hill, CRC press in progress, 1994, -.
2. Hyer, M.W., "Stress Analysis of Fiber – Reinforced Composite Materials", McGraw Hill, 1998

### **REFERENCES:**

1. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 1990.
2. Halpin, J.C., "Primer on Composite Materials, Analysis", Technomic Publishing Co., 1984.
3. Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press-2006, First Indian Edition - 2007

4. Mallick, P.K., Fiber, " Reinforced Composites: Materials, Manufacturing and Design", Maneeel Dekker Inc, 1993.
5. Mallick, P.K. and Newman, S., (edition), "Composite Materials Technology: Processes and Properties", Hansen Publisher, Munish, 1990.

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	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	3	3		2	2					2	3		
2	2	2	2	2		2	2					2	3		
3	2	2	2	2		2	2					2	3		
4	2	2	2	2		2	2					2	3		
5	2	2	2	2		2	2					2	3		
<b>Low (1) ; Medium (2) ; High (3)</b>															

**CME383**

**ELECTRICAL DRIVES AND CONTROL**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- 1 To learn the basic concepts of different types of electrical machines and their performance.
- 2 To study the different methods of starting D.C motors and induction motors
- 3 To study the conventional and solid-state drives
- 4 To study the conventional and solid-state speed control of D.C. drives
- 5 To study the conventional and solid-state speed control of A.C. drives

**UNIT – I INTRODUCTION 9**

Basic Elements – Types of Electric Drives – factors influencing the choice of electrical drives– heating and cooling curves – Loading conditions and classes of duty – Selection of power rating for drive motors with regard to thermal overloading and Load variation factors

**UNIT – II DRIVE MOTOR CHARACTERISTICS 9**

Mechanical characteristics – Speed-Torque characteristics of various types of load and drive motors– Braking of Electrical motors – DC motors: Shunt, series, and compound - single phase and three phase induction motors.

**UNIT – III STARTING METHODS 9**

Types of D.C Motor starters – Typical control circuits for shunt and series motors – Three phases quirrel cage and slip ring induction motors.

**UNIT – IV CONVENTIONAL AND SOLID-STATE SPEED CONTROL OF D.C. DRIVES 9**

Speed control of DC series and shunt motors – Armature and field control, Ward-Leonard control system - Using controlled rectifiers and DC choppers –applications.

**UNIT – V CONVENTIONAL AND SOLID-STATE SPEED CONTROL OF A.C. DRIVES 9**

Speed control of three phase induction motor – Voltage control, voltage / frequency control, slip power recovery scheme – Using inverters and AC voltage regulators – applications.

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Discuss the basic concepts of different types of electrical machines and their performance.
2. Explain the different methods of starting D.C motors and induction motors
3. Discuss the conventional and solid-state drives
4. Describe the conventional and solid-state speed control of D.C. drives
5. Explain the conventional and solid-state speed control of A.C. drives

**TEXT BOOKS:**

1. Nagrath .I.J. & Kothari .D.P, “Electrical Machines”, Tata McGraw-Hill, 2006
2. VedamSubrahmaniam, “Electric Drives (Concepts and Applications)”, Tata McGraw-Hill, 2010

**REFERENCES:**

1. Partab. H., “Art and Science and Utilisation of Electrical Energy”, Dhanpat Rai and Sons, 2017
2. Pillai.S.K “A First Course on Electric Drives”, Wiley Eastern Limited, 2012
3. Singh. M.D., K.B.Khanchandani, “Power Electronics”, Tata McGraw-Hill, 2006.
4. Fundamentals Of Electric Drives And Control by B.R. Gupta and V. Singhal | 1 January 2013
5. Advanced Electrical Drives - Analysis Modeling Control by Rik De Doncker, Andre Veltman, et al. | 1 January 2014

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	1						1			1	2	1	1
2	2	1	1						1			1	2	1	1
3	2	1	1						1			1	2	1	1
4	2	1	1						1			1	2	1	1
5	2	1	1						1			1	2	1	1

Low (1) ; Medium (2) ; High (3)



**CME384**

**POWER PLANT ENGINEERING**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- 1 To study the coal based thermal power plants.
- 2 To study the diesel, gas turbine and combined cycle power plants.
- 3 To learn the basic of nuclear engineering and power plants.
- 4 To learn the power from renewable energy
- 5 To study energy, economic and environmental issues of power plants

**UNIT – I COAL BASED THERMAL POWER PLANTS**

**9**

Rankine cycle - improvisations, Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems.

**UNIT – II DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS**

**9**

Otto, Diesel, Dual & Brayton Cycle - Analysis & Optimisation. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems.

**UNIT – III NUCLEAR POWER PLANTS 9**

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors : Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium- Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.

**UNIT – IV POWER FROM RENEWABLE ENERGY 9**

Hydro Electric Power Plants – Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, Solar Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems.

**UNIT – V ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS 9**

Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants.

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Explain the layout, construction and working of the components inside a thermal power plant.
2. Explain the layout, construction and working of the components inside a Diesel, Gas and Combined cycle power plants.
3. Explain the layout, construction and working of the components inside nuclear power plants.
4. Explain the layout, construction and working of the components inside Renewable energy power plants
5. Explain the applications of power plants while extend their knowledge to power plant economics and environmental hazards and estimate the costs of electrical energy production.

**TEXT BOOKS:**

1. Nag. P.K., "Power Plant Engineering", Third Edition, Tata McGraw – Hill Publishing Company Ltd., 2008.
2. A Textbook of Power Plant Engineering by R.K. Rajput | 1 January 2016

**REFERENCES:**

1. El-Wakil. M.M., "Power Plant Technology", Tata McGraw – Hill Publishing Company Ltd., 2010.
2. Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.
3. Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, "Power Plant Engineering", Second Edition, Standard Handbook of McGraw – Hill, 1998.
4. Power Plant Engineering by B. Vijaya Ramnath C. Elanchezhian, L. Saravanakumar | 1 November 2019
5. Power Plant Engineering, As per AICTE: Theory and Practice by Dipak Kumar Mandal, Somnath Chakrabarti, et al. | 1 January 2019

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	1	1		1	3			1		1	2	2	1
2	3	1	1	1		1	3			1		1	2	2	1
3	3	1	1	1		1	3			1		1	2	2	1
4	3	1	1	1		1	3			1		1	2	2	1
5	3	1	1	1		1	3			1		1	2	2	1
Low (1) ; Medium (2) ; High (3)															

**COURSE OBJECTIVES**

- 1 To introduce the underlying principles of operations in different Refrigeration & Air conditioning systems and components.
- 2 To provide knowledge on design aspects of Refrigeration & Air conditioning systems.
- 3 To study the Vapour absorption and air refrigeration systems.
- 4 To learn the psychrometric properties and processes.
- 5 To study the air conditioning systems and load estimation.

**UNIT – I INTRODUCTION 9**

Introduction to Refrigeration - Unit of Refrigeration and C.O.P.– Ideal cycles- Refrigerants Desirable properties – Classification - Nomenclature - ODP & GWP.

**UNIT – II VAPOUR COMPRESSION REFRIGERATION SYSTEM 9**

Vapor compression cycle: p-h and T-s diagrams - deviations from theoretical cycle – subcooling and super heating- effects of condenser and evaporator pressure on COP- multipressure system -low temperature refrigeration - Cascade systems – problems. Equipments: Type of Compressors, Condensers, Expansion devices, Evaporators.

**UNIT – III OTHER REFRIGERATION SYSTEMS 9**

Working principles of Vapour absorption systems and adsorption cooling systems – Steam jet refrigeration- Ejector refrigeration systems- Thermoelectric refrigeration- Air refrigeration - Magnetic-Vortex and Pulse tube refrigeration systems.

**UNIT – IV PSYCHROMETRIC PROPERTIES AND PROCESSES 9**

Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature, Psychrometric chart; Psychrometric of air-conditioning processes, mixing of air streams.

**UNIT – V AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION 9**

Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Classifications, Layout of plants; Air distribution system;Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors,Actuators & Safety controls.

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Explain the basic concepts of Refrigeration
2. Explain the Vapor compression Refrigeration systems and to solve problems
3. Discuss the various types of Refrigeration systems
4. Calculate the Psychrometric properties and its use in psychrometric processes
5. Explain the concepts of Air conditioning and to solve problems

**TEXT BOOKS:**

1. Arora, C.P., "Refrigeration and Air Conditioning", 3rd edition, McGraw Hill, New Delhi, 2010
2. Textbook of Refrigeration And Air-Conditioning (M.E.)by R.S. Khurmi | 10 February 2019

**REFERENCES:**



1. ASHRAE Hand book, Fundamentals, 2010
2. Jones W.P., "Air conditioning engineering", 5th edition, Elsevier Butterworth-Heinemann, 2007
3. Roy J. Dossat, "Principles of Refrigeration", 4th edition, Pearson Education Asia, 2009.
4. Stoecker, W.F. and Jones J.W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi, 1986.
5. A Textbook of Refrigeration and Air-Conditioning by R.K. Rajput | 1 January 2013

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	1	1			2		1			1	2	2	1
2	2	1	1	1			2		1			1	2	2	1
3	2	1	1	1			2		1			1	2	2	1
4	2	1	1	1			2		1			1	2	2	1
5	2	1	1	1			2		1			1	2	2	1
Low (1) ; Medium (2) ; High (3)															

CAU332

## DYNAMICS OF GROUND VEHICLES

L T P C  
3 0 0 3

### COURSE OBJECTIVES:

The objective of this course is to make the students to Develop physical and mathematical models to predict the dynamic response of vehicles

### UNIT I CONCEPT OF VIBRATION

9

Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification factor, Transmissibility ratio, Base excitation. Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed

### UNIT II TYRES

9

Tyre axis system, tyre forces and moments, tyre marking, tyre structure, hydroplaning, wheel and rim. Rolling resistance, factors affecting rolling resistance, Longitudinal and Lateral force at various slip angles, Tractive and cornering property of tire. Performance of tire on wet surface. Ride property of tyres. Various test carried on a tyre.

### UNIT III VERTICAL DYNAMICS

9

Human response to vibration, Sources of Vibration. Suspension requirements – types. State Space Representation. Design and analysis of Passive, Semi active and Active suspension using Quarter car, Bicycle Model, half car and full car vibrating model. Influence of suspension stiffness, suspension damping, and tire stiffness. Control law. Suspension optimization techniques. Air suspension system and their properties.

### UNIT IV LONGITUDINAL DYNAMICS AND CONTROL

9

Aerodynamic forces and moments. Equation of motion. Load distribution for three-wheeler and four-wheeler. Calculation of maximum acceleration, tractive effort and reaction forces for different drive vehicles. Power limited acceleration and traction limited acceleration. Estimation of CG location. Stability of vehicles resting on slope. Driveline dynamics. Braking and Driving torque. Prediction of Vehicle performance. ABS, stability control, Traction control.

**UNIT V LATERAL DYNAMICS****9**

Steady state handling characteristics. Steady state response to steering input – Yaw velocity gain, Lateral acceleration gain, curvature response gain. Testing of handling characteristics. Transient response characteristics. Steering dynamics. Direction control of vehicles. Roll center, Roll axis. Stability of vehicle on banked road, during turn. Effect of suspension on cornering. Minuro Plot for Lateral Transient Response.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

At the end of the course, the students can able to

1. Develop physical and mathematical models to predict the dynamic response of vehicles
2. Apply vehicle design performance criteria and how to use the criteria to evaluate vehicle dynamic response
3. Use dynamic analyses in the design of vehicles.
4. Understand the principle behind the lateral dynamics.
5. Evaluate the longitudinal dynamics and control in an automobile

**TEXT BOOKS:**

1. J. Y. Wong, "Theory of Ground Vehicles", Fourth Edition, Wiley-Interscience, 2008
2. Singiresu S. Rao, "Mechanical Vibrations," Fifth Edition, Prentice Hall, 2010
3. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics," Society of Automotive Engineers Inc, 2014

**REFERENCES:**

1. Dean Karnopp, "Vehicle Dynamics, Stability, and Control", Second Edition, CRC Press, 2013
2. Hans B Pacejka, "Tyre and Vehicle Dynamics," Second edition, SAE International, 2005
3. John C. Dixon, "Tyres, Suspension, and Handling, " Second Edition, Society of Automotive Engineers Inc, 1996
4. Michael Blundell & Damian Harty, "The Multibody Systems Approach to Vehicle Dynamics", Elsevier Limited, 2004
5. R. Nakhaie Jazar, "Vehicle Dynamics: Theory and Application", Second edition, Springer, 2013

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3	3		2	2	3		3	2	2	2
2	3	3	3	3	3	3		2	2	3		3	2	2	2
3	3	3	3	3	3	3		2	2	3		3	2	3	3
4	3	2	2	2	2	2		2	1	3		3	2	3	3
5	3	3	3	3	3	3		2	2	3		3	2	3	3
<b>Avg.</b>	3	2.8	2.8	2.8	2.8	2.8		2	1.8	3		3	2	3	3

**CAE353****TURBO MACHINES**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES**

- 1 To study the energy transfer in rotor and stator parts of the turbo machines.
- 2 To study the function of various elements of centrifugal fans and blowers.
- 3 To evaluating the working and performance of centrifugal compressor
- 4 To analyzing flow behavior and flow losses in axial flow compressor.
- 5 To study the types and working of axial and radial flow turbines.

**UNIT – I WORKING PRINCIPLES****9**

Classification of Turbomachines. Energy transfer between fluid and rotor - Euler equation and its interpretation. Velocity triangles. Efficiencies in Compressor and Turbine stages. Degree of reaction. Dimensionless parameters for Turbomachines.

**UNIT – II CENTRIFUGAL FANS AND BLOWERS 9**

Types – components – working. Flow analysis in impeller blades-volute and diffusers. Velocity triangles - h-s diagram. Stage parameters in fans and blowers. Performance characteristic curves – various losses. Fan – bearings, drives and noise.

**UNIT – III CENTRIFUGAL COMPRESSOR 9**

Components - blade types. Velocity triangles - h-s diagram, stage work. Slip factor and Degree of Reaction. Performance characteristics and various losses. Geometry and performance calculation.

**UNIT – IV AXIAL FLOW COMPRESSOR 9**

Construction details. Work done factor. Velocity triangles - h-s diagram, stage work. Work done factor. Performance characteristics, efficiency and stage losses – Stalling and Surging. Free and Forced vortex flow.

**UNIT – V AXIAL AND RADIAL FLOW TURBINES 9**

Axial flow turbines - Types – Elements - Stage velocity diagrams - h-s diagram, stage work - impulse and reaction stages. Compounding of turbines. Performance coefficients and losses. Radial flow turbines: Types – Elements - Stage velocity diagrams - h-s diagram, stage work Performance coefficients and losses.

**TOTAL : 45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Explain the energy transfer in rotor and stator parts of the turbo machines.
2. Explain the function of various elements of centrifugal fans and blowers
3. Evaluate the working and performance of centrifugal compressor.
4. Analyze flow behavior and flow losses in axial flow compressor.
5. Explain the types and working of axial and radial flow turbines

**TEXT BOOKS:**

1. Ganesan, V., “Gas Turbines”, 3rd Edition, Tata McGraw Hill, 2011.
2. Yahya, S.M., “Turbines, Compressor and Fans”, 4th Edition, Tata McGraw Hill, 2011.

**REFERENCES:**

1. Dixon, S.L., “Fluid Mechanics and Thermodynamics of Turbomachinery”, 7th Edition, Butterworth-Heinemann, 2014.
2. Gopalakrishnan. G and Prithvi Raj. D,” A Treatise on Turbomachines”, Scitech Publications (India) Pvt. Ltd., 2nd Edition, 2008.
3. Lewis, R.I., “Turbomachinery Performance Analysis” 1st Edition, Arnold Publisher, 1996.
4. Saravanamutto, Rogers, Cohen, Straznicky., “Gas Turbine Theory” 6th Edition, Pearson Education Ltd, 2009.
5. Venkanna, B.K., “Fundamentals of Turbomachinery”, PHI Learning Pvt. Ltd., 2009.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	1	1					1			1	3	2	1
2	2	1	1	1					1			1	3	2	1
3	2	1	1	1					1			1	3	2	1
4	2	1	1	1					1			1	3	2	1
5	2	1	1	1					1			1	3	2	1
Low (1) ; Medium (2) ; High (3)															

**COURSE OBJECTIVES**

- 1 To classify non-traditional machining processes and describe mechanical energy based non-traditional machining processes.
- 2 To differentiate chemical and electro chemical energy-based processes.
- 3 To describe thermo-electric energy-based processes
- 4 To explain nano finishing processes.
- 5 To introduce hybrid non-traditional machining processes and differentiate hybrid non-traditional machining processes

**UNIT – I INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES 9**

Introduction - Need for non-traditional machining processes - Classification of non-traditional machining processes - Applications, advantages and limitations of non-traditional machining processes - Abrasive jet machining, Abrasive water jet machining, Ultrasonic machining their principles, equipment, effect of process parameters, applications, advantages and limitations.

**UNIT – II CHEMICAL AND ELECTRO CHEMICAL ENERGY BASED PROCESSES 9**

Principles, equipments, effect of process parameters, applications, advantages and limitations of Chemical machining, Electro-chemical machining, Electro-chemical honing, Electro-chemical grinding, Electro chemical deburring.

**UNIT – III THERMO-ELECTRIC ENERGY BASED PROCESSES 9**

Principles, equipments, effect of process parameters, applications, advantages and limitations of Electric discharge machining, Wire electric discharge machining, Laser beam machining, Plasma arc machining, Electron beam machining, Ion beam machining.

**UNIT – IV NANO FINISHING PROCESSES 9**

Principles, equipments, effect of process parameters, applications, advantages and limitations of Abrasive flow machining – Chemo mechanical polishing, Magnetic abrasive finishing, Magnetorheological finishing, Magneto rheological abrasive flow finishing.

**UNIT – V HYBRID NON-TRADITIONAL MACHINING PROCESSES 9**

Introduction - Various hybrid non-traditional machining processes, their working principles, equipments, effect of process parameters, applications, advantages and limitations. Selection and comparison of different non-traditional machining processes.

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Formulate different types of non-traditional machining processes and evaluate mechanical energy based non-traditional machining processes.
2. Illustrate chemical and electro chemical energy based processes.
3. Evaluate thermo-electric energy based processes.
4. Interpret nano finishing processes.
5. Analyse hybrid non-traditional machining processes and differentiate non- traditional machining processes.

**TEXT BOOKS:**

1. Adithan. M., "Unconventional Machining Processes", Atlantic, New Delhi, India, 2009. ISBN 13: 9788126910458
2. Anand Pandey, "Modern Machining Processes", Ane Books Pvt. Ltd., New Delhi, India, 2019.

**REFERENCES:**

1. Benedict, G.F., "Non-traditional Manufacturing Processes", Marcel Dekker Inc., New York 1987. ISBN-13: 978-0824773526.

2. Carl Sommer, "Non-Traditional Machining Handbook", Advance Publishing., United States, 2000, ISBN-13: 978-1575373256.
3. Golam Kibria, Bhattacharyya B. and Paulo Davim J., "Non-traditional Micromachining Processes: Fundamentals and Applications", Springer International Publishing., Switzerland, 2017, ISBN:978-3-319-52008-7.
4. Jagadeesha T., "Non-Traditional Machining Processes", I.K. International Publishing House Pvt. Ltd., New Delhi, India, 2017, ISBN-13: 978-9385909122.
5. Kapil Gupta, Neelesh K. Jain and Laubscher R.F., "Hybrid Machining Processes: Perspectives on Machining and Finishing", 1st edition, Springer International Publishing., Switzerland, 2016, ISBN-13: 978-3319259208.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3		1		1		1		1	1		1	2	2	2
2	3		1		1		1		1	1		1	2	2	2
3	3		1		1		1		1	1		1	2	2	2
4	3		2		1		1		1	1		1	2	2	2
5	3		3		3		1		1	1		1	3	3	3
Low (1) ; Medium (2) ; High (3)															

**CME388**

**INDUSTRIAL SAFETY**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- 1 To study the fundamental concept and principles of industrial safety
- 2 To study the principles of maintenance engineering.
- 3 To Analyzing the wear and its reduction.
- 4 To study the faults in various tools, equipments and machines.
- 5 To study the periodic maintenance procedures in preventive maintenance.

**UNIT – I INDUSTRIAL SAFETY**

**9**

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

**UNIT – II MAINTENANCE ENGINEERING**

**9**

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

**UNIT – III WEAR AND CORROSION AND THEIR PREVENTION**

**9**

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

**UNIT – IV FAULT TRACING**

**9**

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler,vi. Electrical motors, Types of faults in machine tools and their general causes.

**UNIT – V PERIODIC AND PREVENTIVE MAINTENANCE****9**

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: i. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, Advantages of preventive maintenance. Repair cycle concept and importance.

**TOTAL:45 PERIODS****OUTCOMES:** At the end of the course the students would be able to

1. Explain the fundamental concept and principles of industrial safety
2. Apply the principles of maintenance engineering.
3. Analyze the wear and its reduction.
4. Evaluate faults in various tools, equipments and machines
5. Apply periodic maintenance procedures in preventive maintenance.

**TEXT BOOKS:**

1. L M Deshmukh, Industrial Safety Management, Tata McGraw-Hill Education, 2005.
2. Charles D. Reese, Occupational Health and Safety Management: A Practical Approach, CRC Press, 2003.

**REFERENCES:**

1. Edward Ghali, V. S. Sastri, M. Elboudjaini, Corrosion Prevention and Protection: Practical Solutions, John Wiley & Sons, 2007.
2. Garg, HP, Maintenance Engineering, S. Chand Publishing.
3. J Maiti, Pradip Kumar Ray, Industrial Safety Management: 21st Century Perspectives of Asia, Springer, 2017.
4. R. Keith Mobley, Maintenance Fundamentals, Elsevier, 2011.
5. W. E. Vesely, F. F. Goldberg, Fault Tree Handbook, Create space Independent Pub, 2014

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	2			2	1					1	1	2	1
2	2	1	2			2	1					1	1	2	1
3	2	1	2			2	1					1	1	2	1
4	2	1	2			2	1					1	1	2	1
5	2	1	2			2	1					1	1	2	1
Low (1) ; Medium (2) ; High (3)															

**COURSE OBJECTIVES**

- 1 To gain knowledge on the principles and procedure for the design of Mechanical power Transmission components.
- 2 To understand the standard procedure available for Design of Transmission of Mechanical elements spur gears and parallel axis helical gears.
- 3 To learn the design bevel, worm and cross helical gears of Transmission system.
- 4 To learn the concepts of design multi and variable speed gear box for machine tool applications.
- 5 To learn the concepts of design to cams, brakes and clutches  
(Use of P S G Design Data Book permitted)

**UNIT – I DESIGN OF FLEXIBLE ELEMENTS 9**

Design of Flat belts and pulleys - Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Design of Transmission chains and Sprockets.

**UNIT – II SPUR GEARS AND PARALLEL AXIS HELICAL GEARS 9**

Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects – Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane-Equivalent number of teeth-forces for helical gears.

**UNIT – III BEVEL, WORM AND CROSS HELICAL GEARS 9**

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

**UNIT – IV GEAR BOXES 9**

Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications - Constant mesh gear box - Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.

**UNIT – V CAMS, CLUTCHES AND BRAKES 9**

Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches-Electromagnetic clutches. Band and Block brakes - external shoe brakes – Internal expanding shoe brake.

**Total:45 periods**

**OUTCOMES:** At the end of the course the students would be able to

1. Apply the concepts of design to belts, chains and rope drives.
2. Apply the concepts of design to spur, helical gears.
3. Apply the concepts of design to worm and bevel gears.
4. Apply the concepts of design to gear boxes.
5. Apply the concepts of design to cams, brakes and clutches

**TEXT BOOKS:**

1. Bhandari V, "Design of Machine Elements", 4th Edition, Tata McGraw-Hill Book Co, 2016.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 8th Edition, Tata McGraw-Hill, 2008.

**REFERENCES:**

1. Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, "Design of Machine Elements" 8th Edition, Printice Hall, 2003.
2. Orthwein W, "Machine Component Design", Jaico Publishing Co, 2003.
3. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2000.
4. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", 4th Edition, Wiley,2005
5. Sundararamoorthy T. V, Shanmugam .N, "Machine Design", Anuradha Publications,Chennai, 2003.

CO	PO												PSO		
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Low (1) ; Medium (2) ; High (3)															

**CME390**

**THERMAL POWER ENGINEERING**

**L T P C**  
**3 0 0 3**

**Course Objectives**

- 1 To study the fuel properties and arrive at proximate and ultimate analysis of fuels.
- 2 To study the different types of boilers and compute their performance parameters.
- 3 To study the performance parameters of an air compressor
- 4 To study the working principles of various refrigeration systems and perform cop calculations
- 5 To study the psychrometric properties and how they are utilized in arriving at calculations to determine heating loads

**UNIT – I FUELS AND COMBUSTION**

**9**

Fuels - Types and Characteristics of Fuels - Determination of Properties of Fuels – Fuels Analysis - Proximate and Ultimate Analysis - Moisture Determination - Calorific Value -Gross & Net Calorific Values

**UNIT – II BOILERS**

**9**

Types and comparison, Mountings and Accessories. Performance calculations, Boiler trial.

**UNIT – III AIR COMPRESSORS**

**9**

Classification and comparison, working principle, work of compression - with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency. Multistage air compressor with Intercooling. Working principle and comparison of Rotary compressors with reciprocating air compressors

**UNIT – IV REFRIGERATION SYSTEMS**

**9**

Vapour compression refrigeration cycle, Effect of Superheat and Sub-cooling, Performance calculations, Working principle of air cycle, vapour absorption system, and Thermoelectric refrigeration.

**UNIT – V PSYCHROMETRY AND AIR-CONDITIONING**

**9**

Psychrometric properties – Property calculations using Psychrometric chart and expressions. Psychrometric processes – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing Air conditioning systems, concept of RSHF, GSHF and ESHF, Cooling load calculations. Cooling towers – concept and types.

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Evaluate the fuel properties and arrive at proximate and ultimate analysis of fuels.
2. Analyze different types of boilers and compute their performance parameters.
3. Evaluate the performance parameters of an air compressor
4. Apply the working principles of various refrigeration systems and perform cop calculations
5. Analyze the psychrometric properties and how they are utilized in arriving at calculations to determine heating loads.



**TEXT BOOKS:**

1. Mahesh. M. Rathore, "Thermal Engineering", 1st Edition, Tata McGraw Hill, 2010.
2. Ballaney. P, "Thermal Engineering", 25th Edition, Khanna Publishers, 2017

**REFERENCES:**

1. Ananthanarayanan P.N, "Basic Refrigeration and Air-Conditioning", 4th Edition, Tata McGraw Hill, 2013.
2. Arora, "Refrigeration and Air-Conditioning", 2nd Edition, Prentice Hall of India, 2010.
3. Mathur M.L and Mehta F.S., "Thermal Science and Engineering", 3rd Edition, Jain Brothers Pvt. Ltd, 2017.
4. Nag P.K, "Basic and Applied Thermodynamics", 2nd Edition, Tata McGraw Hill, 2010
5. Soman. K, "Thermal Engineering", 2nd Edition, Prentice Hall of India, 2011

CO	PO												PSO		
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Low (1) ; Medium (2) ; High (3)															

**CME391****DESIGN FOR MANUFACTURING**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES**

- 1 To introduce economic process selection principles and general design principles for manufacturability in the development and design of products for various engineering applications. Also, apply design consideration principles of casting in the design of cast products.
- 2 To learn design consideration principles of forming in the design of extruded, stamped, and forged products.
- 3 To learn design consideration principles of machining in the design of turned, drilled, milled, planed, shaped, slotted, and ground products.
- 4 To learn design consideration principles of welding in the design of welded products.
- 5 To learn design consideration principles of assembly in the design of assembled products.

**UNIT – I INTRODUCTION AND CASTING****9**

Introduction - Economics of process selection - General design principles for manufacturability; Design considerations for: Sand cast – Die cast – Permanent mold cast parts.

**UNIT – II FORMING****9**

Design considerations for: Metal extruded parts – Impact/Cold extruded parts – Stamped parts –Forged parts.

**UNIT – III MACHINING****9**

Design considerations for: Turned parts – Drilled parts – Milled, planed, shaped and slotted parts– Ground parts.

**UNIT – IV WELDING****9**

Arc welding – Design considerations for: Cost reduction – Minimizing distortion – Weld strength – Weldment & heat treatment. Resistance welding – Design considerations for: Spot – Seam – Projection – Flash & Upset weldment.

**UNIT – V ASSEMBLY****9**

Design for assembly – General assembly recommendations – Minimizing the no. of parts – Design considerations for: Rivets – Screw fasteners – Gasket & Seals – Press fits – Snap fits – Automatic assembly.

**TOTAL:45 PERIODS****OUTCOMES:** At the end of the course the students would be able to

1. Discuss the economic process selection principles and general design principles for manufacturability in the development and design of products for various engineering applications. Also, apply design consideration principles of casting in the design of cast products.
2. Explain design consideration principles of forming in the design of extruded, stamped, and forged products.
3. Explain design consideration principles of machining in the design of turned, drilled, milled, planed, shaped, slotted, and ground products.
4. Explain design consideration principles of welding in the design of welded products.
5. Explain design consideration principles of assembly in the design of assembled products.

**TEXT BOOKS:**

1. James G. Bralla, "Handbook of Product Design for Manufacture", McGraw Hill, 1986.
2. O. Molloy, E.A. Warman, S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Springer, 1998.

**REFERENCES:**

1. CorradoPoli, Design for Manufacturing: A Structured Approach, Elsevier, 2001.
2. David M. Anderson, Design for Manufacturability & Concurrent Engineering: How to Design for Low Cost, Design in High Quality, Design for Lean Manufacture, and Design Quickly for Fast Production, CIM Press, 2004.
3. Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, Manufacturing and Design: Understanding the Principles of How Things Are Made, Elsevier, 2014.
4. Henry Peck, "Designing for Manufacture", Sir Isaac Pitman & Sons Ltd., 1973.
5. Matousek, "Engineering Design", Blackie & Sons, 1956.

CO	PO												PSO		
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3	3	3	3	1								1	2	2	1
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Low (1) ; Medium (2) ; High (3)															

**CME392****POWER GENERATION EQUIPMENT DESIGN**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES**

- 1 To introduce the power generation equipments types layouts working cycles.
- 2 To learn the fuels, combustion and burning methods of combustion system.
- 3 To study the various boilers and its boilers parts of steam power plant.
- 4 To study the basics of nuclear fuels and reactor classification.
- 5 To study of techno economics and operating cost and safety of power plant.

**UNIT – I INTRODUCTION****9**

Introduction to types, layouts and working cycles - Layouts of diesel-electric, hydro-electric, nuclear, gas turbine, steam, cogeneration, MHD and other power plants - Site selection - Reheat and regenerative steam cycles - Binary vapour cycle - Combined cycle - Topping cycle - Power plant instrumentation and control - air flow, furnace pressure, steam temperature control system - Governing system - Steam turbine.

**UNIT – II COMBUSTION SYSTEM****9**

Fuels, combustion and burning methods - Fuel classification - Solid, liquid and gaseous - Compositions and heating values - Classification of coal - Combustion process, atmosphere and control - ESP Furnace construction - Stokers - suspension firing - pulverised fuel firing - oil and gas burners and systems - Fuel control - Burner management system - FSSS - Ash handling system.

**UNIT – III STEAM POWER PLANT****9**

Steam generators - fire tube, water tube, forced circulation, once through, super charged, super critical, Lamont, Loeffler, Schilde, Hortmen and Velox boilers, Fluidised Bed & Circulated Fluidised Bed boilers - Natural, artificial, balanced and steam jet drafts - Simple problems - Functions of super heaters, economisers, air-heaters, deaerators, feed heaters, air ejectors - Feed pumps - Injectors - Feed water control- Condensers – Jet and surface type - Simple problems - Cooling towers.

**UNIT – IV NUCLEAR POWER PLANT****9**

Nuclear power plant - Basics of nuclear fuels - Fission and chain reaction - Reactor classification - Boiling water, pressurised water, homogeneous, gas cooled breeding and metal cooled

**UNIT – V TECHNO ECONOMICS OF POWER PLANT****9**

Economics and safety - Actual load curves - Fixed and operating costs - Tariff methods for electrical energy - Peak load and variable load operations - Selection of generation type and general equipment. Introduction to safety aspects in power plants - Environmental impacts - assessment for thermal power plant.

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Discuss the power generation equipments types layouts working cycles.
2. Explain the fuels, combustion and burning methods of combustion system.
3. Discuss the various boilers and its boilers parts of steam power plant.
4. Explain the basics of nuclear fuels and reactor classification.
5. Discuss of techno economics and operating cost and safety of power plant.

**TEXT BOOKS:**

1. Power Plant Engineering - PK Nag
2. A Textbook of Power Plant Engineering - Rajput

**REFERENCES:**

1. Basics of Boiler and HRSG Design - Brad Buecker
2. Steam Plant Operation-Everett B. Woodruff,Herbert B. Lammers,Thomas F. Lammers
3. Nuclear Power Plant Design and Analysis Codes Development Validation and Application 2020 Edition by Jun Wang, Xin Li, Chris Allison, Judy Hohorst , Elsevier
4. A Techno-Economic Analysis of Solar Thermal Power Plant by Malik Monu and Saini R P | 8 November 2012
5. Power Plant Engineering by Dilip Vairagkar | 1 January 2019

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
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4	2	1	1	1			2		1			1	1	2	2
5	2	1	1	1			2		1			1	1	2	2
Low (1) ; Medium (2) ; High (3)															

**COURSE OBJECTIVES**

1. To introduce the basic concepts of electric vehicle and their characteristics
2. To introduce different types of motors and the selection of motor for vehicle applications.
3. To acquaint the student with different sensors and systems used in autonomous and connected vehicles.
4. To give an overview of networking with sensors and systems.
5. To introduce the modern methods of diagnosing on-board the vehicle troubles.

**UNIT – I ELECTRIC VEHICLES****9**

EV architectures, advantages and disadvantages, Electrical and mechanical energy storage technologies, battery management. Performance of Electric Vehicles, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving.

**UNIT – II ELECTRIC VEHICLE MOTORS****9**

Electric Propulsion basics, motor capacity determination, Induction motor, DC motor, Permanent Magnet Motor, Switch Reluctance Motor, Configuration, Characteristics, Performance and control of Drives.

**UNIT – III AUTONOMOUS AND CONNECTED VEHICLES****9**

Vehicle-to-Vehicle Technology, Vehicle to Road and Vehicle to Vehicle Infrastructure, Basic Control System, Surroundings Sensing Systems, Role of Wireless Data Networks, Advanced Driver Assistance Systems, Basics of Radar System, Ultrasonic Sonar Systems, Lidar System, Camera Technology, Basics of Wireless Technology, Receiver System.

**UNIT – IV AUTOMOTIVE NETWORKING****9**

Bus Systems – Classification, Applications in the vehicle, Coupling of networks, networked vehicles, Buses - CAN Bus, LIN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces.

**UNIT – V ON-BOARD TESTING****9**

Integration of Sensor Data to On-Board Control Systems (OBD), OBD requirements, certification, enforcement, systems, testing, Catalytic converter and Exhaust Gas Recirculation system monitoring, Introduction to Cyber-physical system.

**TOTAL: 45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Acquire an overview of electric vehicles and their importance in automotive.
2. Discuss the characteristics and the selection of traction motor.
3. Comprehend the vehicle-to-vehicle and autonomous technology.
4. Explain the networking of various modules in automotive systems, communication protocols and diagnostics of the sub systems.
5. Be familiar with on-board diagnostics systems.

**TEXT BOOKS:**

- 1 John G Hayes and G Abaas Goodarzi, Electric Powertrain -, 1st Edition, John Wiley & Sons Ltd., 2018
- 2 Hussain T Mouftah, Melike Erol-kantarci and Samesh Sorour, Connected and Autonomous Vehicles in Smart Cities, CRC Press, 1st Edition, 2020.

**REFERENCES:**

- 1 Dominique Paret, Multiplexed Networks for Embedded Systems, John Wiley & Sons Ltd., 2007.
- 2 Hong Cheng, —Autonomous Intelligent Vehicles: Theory, Algorithms & Implementation, Springer, 2011
- 3 Advanced Technology Vehicles Manufacturing (ATVM) Loan Program (Energy Science, Engineering and Technology: Congressional Policies, Practices and Procedures) by Andrew M Wright and Harrison R Scott | 5 September 2012
- 4 Advanced Vehicle Technology by Heinz Heisler MSc BSc FIMI MIRTE MCIT | 17 July 2002
- 5 Advanced Motorsport Engineering: Units for Study at Level 3 by Andrew Livesey | 1 September 2011



**TEXT BOOKS:**

1. V. Ganesan, "Internal Combustion Engines", V Edition, Tata McGraw Hill, 2012.
2. John B. Heywood, "Internal Combustion Engines Fundamentals", McGraw-Hill, 1988.

**REFERENCES:**

1. B.P. Pundir, "IC Engines Combustion & Emission", Narosa Publishing House, 2014.
2. Duffy Smith, "Auto Fuel Systems", The Good Heart Wilcox Company, Inc., 2003.
3. EranSher, Handbook of Air Pollution from Internal Combustion Engines: Pollutant Formation and Control, Academic Press, 1998.
4. K.K. Ramalingam, "Internal Combustion Engine Fundamentals", SciTech Publications, 2011.
5. R.B. Mathur and R.P. Sharma, "Internal Combustion Engines", Dhanpat Rai& Sons, 2007

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Low (1) ; Medium (2) ; High (3)															

**CME395****CASTING AND WELDING PROCESSES**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES**

- 1 To study the ferrous casting metallurgy and its applications.
- 2 To study the nonferrous casting metallurgy and its applications.
- 3 To study the ferrous welding metallurgy and its applications.
- 4 To study the welding metallurgy of alloy steels and nonferrous metals and its applications
- 5 To Identifying the causes and remedies of various welding defects; applying welding standards and codes.

**UNIT – I FERROUS CAST ALLOYS****9**

Solidification of pure metals and alloys and eutectics -Nucleation - Growth Process, Critical nucleus size- Super cooling- Niyama Criterion -G/R ratio- Cell- Dendritic - Random dendritic structure-Segregation and Coring- Eutectics-Compositions and alloys in Cast Irons, FG-CGI- SG structures, Metallic Glass- Mold dilation, Mold metal reactions- Structure and Section sensitivity Cast irons- family & microstructures-Alloying effects- Malleable Iron, ADI, Charge calculations- Effect of normal elements and alloying elements in steels- Compositional aspects and properties of alloy steels- melting procedure and composition control for carbon steels- low alloy steels - stainless steels- composition control- slag-metal reactions-desulphurization-dephosphorization, specifications for carbon steels- low alloy steels and stainless steels

**UNIT – II NON-FERROUS CAST ALLOYS****9**

Copper- Aluminium- Magnesium- zinc - Nickel base alloys- melting practices - Al alloys, Mg alloys, Nickel alloys, Zinc alloys and copper alloys-modification and grain refinement of Al alloys- problems in composition control- degassing techniques -Heat Treatment of Aluminium alloys – Basics of Solution and Precipitation process. - Applications of Aluminium Alloy castings in various fields. Residual Stresses- defects in castings

**UNIT – III PHYSICAL METALLURGY OF WELDING****9**

Welding of ferrous materials: Iron- Iron carbide diagram, TTT and CCT diagrams, effects of steel composition, formation of different microstructural zones in welded plain-carbon steels. Welding of C-Mn and low-alloy

steels, phase transformations in weld and heat - affected zones, cold cracking, role of hydrogen and carbon equivalent, formation of acicular ferrite and effect on weld metal toughness.

**UNIT – IV WELDING OF ALLOY STEELS AND NON-FERROUS METALS 9**

Welding of stainless steels, types of stainless steels, overview of joining ferritic and martensitic types, welding of austenitic stainless steels, Sensitisation, hot cracking, sigma phase and chromium carbide formation, ways of overcoming these difficulties, welding of cast iron. Welding of non-ferrous materials: Joining of aluminium, copper, nickel and titanium alloys, problems encountered and solutions

**UNIT – V DEFECTS, WELDABILITY AND STANDARDS 9**

Defects in welded joints: Defects such as arc strike, porosity, undercut, slag entrapment and hot cracking, causes and remedies in each case. Joining of dissimilar materials, weldability and testing of weldments. Introduction to International Standards and Codes

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Explain the ferrous casting metallurgy and its applications.
2. Explain the non ferrous casting metallurgy and its applications.
3. Explain the ferrous welding metallurgy and its applications.
4. Explain the welding metallurgy of alloy steels and non ferrous metals and its applications.
5. Identify the causes and remedies of various welding defects; apply welding standards and codes.

**TEXT BOOKS:**

1. Heine R W, Loper C R and Rosenthal P C, "Principles of Metal Castings", Tata McGraw Hill, 2017.
2. A.K.Chakrabarthy, 'Casting Technology and Cast Alloys,Prentice Hall, 2005.

**REFERENCES:**

1. ASM International. Handbook Committee, ASM Handbook: Casting. Volume 15, ASM International, 2008.
2. Baldev Raj, Shankar V, Bhaduri A K, "Welding Technology for Engineers", Narosa Publications, 2009.
3. Beeley P, "Foundry Technology" Butterworth-Heinemann, 2001.
4. R.S.Parmar, 'Welding Engineering and Technology', Khanna Publishers, 2010
5. John Campbell, "Casting", Butterworth-Heinemann, 2003.



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<b>Low (1) ; Medium (2) ; High (3)</b>															

**CME396 PROCESS PLANNING AND COST ESTIMATION L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- 1 To introduce the process planning concepts to make cost estimation for various products after process planning
- 2 To Learn the various Process Planning Activities
- 3 To provide the knowledge of importance of costing and estimation.
- 4 To provide the knowledge of estimation of production costing.
- 5 To learn the knowledge of various Machining time calculations

**UNIT – I INTRODUCTION TO PROCESS PLANNING 9**  
 Introduction- methods of process planning-Drawing Interpretation-Material evaluation – steps in process selection-. Production equipment and tooling selection

**UNIT – II PROCESS PLANNING ACTIVITIES 9**  
 Process parameters calculation for various production processes-Selection jigs and fixture selection of quality assurance methods - Set of documents for process planning-Economics of process planning- case studies

**UNIT – III INTRODUCTION TO COST ESTIMATION 9**  
 Importance of costing and estimation –methods of costing-elements of cost estimation –Types of estimates – Estimating procedure- Estimation labor cost, material cost- allocation of overhead charges- Calculation of depreciation cost

**UNIT – IV PRODUCTION COST ESTIMATION 9**  
 Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop,Estimation of Foundry Shop

**UNIT – V MACHINING TIME CALCULATION 9**  
 Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations, Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding.

**Total:45 periods**

**OUTCOMES:** At the end of the course the students would be able to

1. Discuss select the process, equipment and tools for various industrial products.
2. Explain the prepare process planning activity chart.
3. Explain the concept of cost estimation.
4. Compute the job order cost for different type of shop floor.
5. Calculate the machining time for various machining operations.

**TEXT BOOKS:**

1. Peter scalon, “Process planning, Design/Manufacture Interface”, Elsevier science technology Books, Dec 2002.
2. Sinha B.P, “Mechanical Estimating and Costing”, Tata-McGraw Hill publishing co, 1995.

**REFERENCES:**

1. Chitale A.V. and Gupta R.C., “Product Design and Manufacturing”, 2nd Edition, PHI, 2002.
2. Ostwalal P.F. and Munez J., “Manufacturing Processes and systems”, 9th Edition, John Wiley, 1998.
3. Russell R.S and Tailor B.W, “Operations Management”, 4th Edition, PHI, 2003.
4. Mikell P. Groover, “Automation, Production, Systems and Computer Integrated Manufacturing”, Pearson Education 2001.
5. K.C. Jain & L.N. Aggarwal, “Production Planning Control and Industrial Management”, KhannaPublishers 1990.

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4	3	3	2	2					1		1	1	2	1	1
5	3	3	2	2					1		1	1	2	1	1

Low (1) ; Medium (2) ; High (3)



**COURSE OBJECTIVES**

- 1 To study the fundamentals of surface features and different types of friction associated with metals and non-metals
- 2 To study the different types of wear mechanism and its standard measurement.
- 3 To study the different types of corrosion and its preventive measures
- 4 To study the different types of surface properties and surface modification techniques
- 5 To study the various types of materials used in the friction and wear applications

**UNIT – I SURFACES AND FRICTION****9**

Basics of surfaces features – Roughness parameters – surface measurement - Cause of friction- Laws of friction – Static friction – Rolling Friction – Stick-slip Phenomenon - Friction properties of metal and nonmetals – Friction in extreme conditions – Thermal considerations in sliding contact.

**UNIT – II WEAR****9**

Laws of Wear - Types of Wear mechanism – wear debris analysis - Theoretical wear models - Wear of metals and nonmetals – International standards in friction and wear measurements

**UNIT – III CORROSION****9**

Introduction – Types of corrosion – Factors influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory testing – Prevention of Corrosion – Material selection, Alteration of environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors

**UNIT – IV SURFACE TREATMENTS****9**

Surface properties – Hydrophobic – Super hydrophobic – Hydrophilic - surface metallurgy –Surface coating Techniques – PVD – CVD – Physical CVD – Ion implantation – Surface welding – Thermal spraying – Laser surface hardening and alloying - New trends in coating technology – DLC – CNC – Thick coatings – Nano-engineered coatings – Other coatings, Corrosion resistant coatings

**UNIT – V ENGINEERING MATERIALS****9**

Introduction – High and low friction materials - Advanced alloys – Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys – Ceramics – Polymers – Biomaterials – Bio Tribology - Nano Tribology

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Describe the fundamentals of surface features and different types of friction associated with metals and non-metals
2. Analyze the different types of wear mechanism and its standard measurement.
3. Analyze the different types of corrosion and its preventive measures
4. Analyze the different types of surface properties and surface modification techniques
5. Analyze the various types of materials used in the friction and wear applications.

**TEXT BOOKS:**

1. G.W.Stachowiak and A.W.Batchelor, "Engineering Tribology", Butterworth-Heinemann, 2005.
2. S.K.Basu, S.N.Sengupta and B.B.Ahuja, "Fundamentals of Tribology", Prentice Hall of India, 2005.

**REFERENCES:**

1. Fontana G., "Corrosion Engineering", McGraw Hill, 1985.
2. Halling, J. (Editor), "Principles of Tribology", MacMillan, 1984.
3. Rabinowicz.E., "Friction and Wear of materials", John Willey & Sons, 1995.
4. Williams J.A., "Engineering Tribology", Oxford University Press, 1994.
5. Joseph R. Davis, Corrosion: Understanding the Basics, ASM International, 2000.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	2	2	2	2			2	1			2	3	2	1
2	2	2	2	2	2			2	1			2	3	2	1
3	1	2	2	2	2			2	1			2	2	3	1
4	1	2	2	2	3			2	1			2	2	3	1
5	1	1	2	2	1			2	1			3	1	2	1
Low (1) ; Medium (2) ; High (3)															

**CME398**

**PRECISION MANUFACTURING**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- 1 To study the need, significance and progress of precision manufacturing and the different levels of manufacturing.
- 2 To study the principle and working of different methods of precision machining.
- 3 To study the special construction requirements of precision machine tools.
- 4 To study the errors involved in precision machine tools and calculate the error budgets for a given situation.
- 5 To study the Selecting a suitable measurement solution to measure and characterize precision machined features.

**UNIT – I PRECISION ENGINEERING**

**9**

Introduction to Precision Engineering, Need for precision manufacturing, Taniguchi diagram, Four Classes of Achievable Machining Accuracy – Normal, Precision, High-precision, Ultra-precision Processes and Nanotechnology.

**UNIT – II PRECISION MACHINING**

**9**

Overview of Micro- and Nano-machining, Conventional micro machining techniques - micro-turning, micro-milling, micro-grinding, Ultra-precision diamond turning, Non-conventional micromachining techniques – abrasive jet and water jet micromachining, Ultrasonic micromachining, micro electrical discharge machining, photochemical machining, electro chemical micromachining, laser beam micromachining, Electron beam micromachining, Focused Ion Beam micromachining, etc.

**UNIT – III MACHINE DESIGN FOR PRECISION MANUFACTURING**

**9**

Philosophy of precision machine design, Ultra-Precision Machine Elements: Guide- ways, Drive Systems, Friction Drive, Linear Motor Drive, Spindle Drive. Bearings: Principle, construction and application of Rolling, Hydrodynamic and Hydrostatic Bearings, Aerostatic Bearings, Magnetic bearings.

**UNIT – IV MECHANICAL AND THERMAL ERRORS**

**9**

Sources of error, Principles of measurement, Errors due to machine elements, bearings, spindles, Kinematic design, Structural compliance. Vibration, Thermal errors – background, thermal effects, Environmental control of precision machinery. Error mapping and error budgets.

**UNIT – V MEASUREMENT AND CHARACTERISATION**

**9**

Optical dimensional metrology of precision features – Machine vision, Multi-sensor coordinate metrology, Laser Tracking Systems, Laser scanners, White-Light Interference 3D Microscopes, Focus-Based Optical Metrology- Fringe projection method, Measurement of Typical Nano features.

Surface metrology - 3D surface topography - Need, Measurement – Chromatic confocal Microscopy, Interferometry, Non-optical Scanning Microscopy – Scanning electron Microscopes, Scanning probe microscopes, Parameters for characterizing 3D surface topography.

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Explain the need, significance and progress of precision manufacturing and the different levels of manufacturing.
2. Explain the principle and working of different methods of precision machining.
3. Explain the special construction requirements of precision machine tools.
4. Explain the errors involved in precision machine tools and calculate the error budgets for a given situation.
5. Select a suitable measurement solution to measure and characterize precision machined features.

**TEXT BOOKS:**

1. Jain, V.K., Introduction to micromachining, Narosa publishers, 2018
2. Venkatesh V.C., Sudinlzman, Precision Engineering, Tata Mc.Graw Hill Publishing Company, New Delhi 2007.

**REFERENCES:**

1. David Dornfeld, Dae-Eun Lee, Precision Manufacturing, Springer, 2008.
2. Jain, V.K., Micro manufacturing Processes, CRC Press, 2012.
3. Joseph McGeough, Micromachining of Engineered Materials, Marcel Dekker Inc., 2002.
4. Kevin Harding, "Handbook of Optical Dimensional Metrology, Series: Series in Optics and optoelectronics", Taylor & Francis, 2013.
5. Murty, R.L., Precision Engineering in Manufacturing, New Age publishers, 2005.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	2	2	2				1			1	2	2	1
2	2	2	2	2	2				1			1	2	2	1
3	2	2	2	2	2				1			1	2	2	1
4	2	2	2	2	2				1			1	2	2	1
5	2	2	2	2	2				1			1	2	2	1
Low (1) ; Medium (2) ; High (3)															

**CME386**

**GAS DYNAMICS AND JET PROPULSION**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- 1 To study the fundamentals of compressible flow concepts and the use of gas tables.
- 2 To learn the compressible flow behaviour in constant area ducts.
- 3 To study the development of shock waves and its effects.
- 4 To study the types of jet engines and their performance parameters.
- 5 To learn the types of rocket engines and their performance parameters.

**UNIT – I BASIC CONCEPTS AND ISENTROPIC FLOWS**

**9**

Energy and momentum equations of compressible fluid flows, Concepts of compressible flow – Mach waves and Mach cone. Flow regimes, effect of Mach number on compressibility. Stagnation, static, critical properties and their interrelationship. Isentropic flow and its relations. Isentropic flow through variable area ducts – nozzles and diffusers. Use of Gas tables.

**UNIT – II COMPRESSIBLE FLOW THROUGH DUCTS**

**9**

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties. Choking. Isothermal flow with friction. Use of Gas tables.

**UNIT – III NORMAL AND OBLIQUE SHOCKS**

**9**

Governing equations - Rankine-Hugoniot Relation. Variation of flow parameters across the normal and oblique shocks. Prandtl – Meyer expansion and relation. Use of Gas tables.

**UNIT – IV JET PROPULSION****9**

Theory of jet propulsion – thrust equation – Performance parameters - thrust, power and efficiency. Operation, cycle analysis and performance of ram jet, turbojet, turbofan, turbo prop and pulse jet engines.

**UNIT – V SPACE PROPULSION****9**

Types of rocket engines and propellants. Characteristic velocity – thrust equation. Theory of single and multistage rocket propulsion. Liquid fuel feeding systems. Solid propellant geometries. Orbital and escape velocity. Rocket performance calculations.

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Apply the fundamentals of compressible flow concepts and the use of gas tables.
2. Analyze the compressible flow behaviour in constant area ducts.
3. Analyze the development of shock waves and its effects.
4. Explain the types of jet engines and their performance parameters.
5. Explain the types of rocket engines and their performance parameters.

**TEXT BOOKS:**

1. Anderson, J.D., “Modern Compressible flow”, Third Edition, McGraw Hill, 2003.
2. S.M. Yahya, “Fundamentals of Compressible Flow with Aircraft and Rocket propulsion”, New Age International (P) Limited, 4th Edition, 2012.

**REFERENCES:**

1. R. D. Zucker and O Biblarz, “Fundamentals of Gas Dynamics”, 2nd edition, Wiley, 2011.
2. Balachandran, P., “Fundamentals of Compressible Fluid Dynamics”, Prentice-Hall of India, 2007.
3. Radhakrishnan, E., “Gas Dynamics”, Printice Hall of India, 2006.
4. Hill and Peterson, “Mechanics and Thermodynamics of Propulsion”, Addison – Wesley, 1965.
5. Babu, V., “Fundamentals of Compressible Flow”, CRC Press, 1st Edition, 2008.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1					1			1	3	1	2
2	3	2	1	1					1			1	3	1	2
3	3	2	1	1					1			1	3	1	2
4	3	2	1	1					1			1	3	1	2
5	3	2	1	1					1			1	3	1	2

Low (1) ; Medium (2) ; High (3)

**OME399****OPERATIONAL RESEARCH**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

1. To learn Selecting the constraints on the availability of resources and developing a model and rendering an optimal solution for the given circumstances.
2. To study Appraising the challenges in the transportation and production problems and furnishing a rational solution to maximize the benefits.
3. To learn Planning the purchase/ manufacturing policies, managing the spares/ stocks and meeting the customer demands.
4. To Analysing the queue discipline and exploring the avenues for better customer service.
5. To Investigating the nature of the project and offering methodical assistance towards decision making in maintenance.



CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	3	2	2	1	1	1	1	1	2	2	2	2	2
2	2	3	3	2	2	1	1	1	1	1	2	2	2	2	2
3	2	3	3	2	2	1	1	1	1	1	2	2	2	2	2
4	2	3	3	2	2	1	1	1	1	1	2	2	2	2	2
5	2	3	3	2	2	1	1	1	1	1	2	2	2	2	2
Low (1); Medium (2); High (3)															



## MANDATORY COURSES I

<b>MX3081</b>	<b>INTRODUCTION TO WOMEN AND GENDER STUDIES</b>	<b>L T P C</b> <b>3 0 0 0</b>
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### **COURSE OUTLINE**

#### **UNIT I            CONCEPTS**

Sex vs. Gender, masculinity, femininity, socialization, patriarchy, public/ private, essentialism, binaryism, power, hegemony, hierarchy, stereotype, gender roles, gender relation, deconstruction, resistance, sexual division of labour.

#### **UNIT II            FEMINIST THEORY**

Liberal, Marxist, Socialist, Radical, Psychoanalytic, postmodernist, ecofeminist.

#### **UNIT III            WOMEN'S MOVEMENTS: GLOBAL, NATIONAL AND LOCAL**

Rise of Feminism in Europe and America.  
Women's Movement in India.

#### **UNIT IV            GENDER AND LANGUAGE**

Linguistic Forms and Gender.  
Gender and narratives.

#### **UNIT V            GENDER AND REPRESENTATION**

Advertising and popular visual media.

Gender and Representation in Alternative Media.  
Gender and social media.

**TOTAL : 45 PERIODS**

<b>MX3082</b>	<b>ELEMENTS OF LITERATURE</b>	<b>L T P C</b> <b>3 0 0 0</b>
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### **OBJECTIVE:**

- To make the students aware about the finer sensibilities of human existence through an art form. The students will learn to appreciate different forms of literature as suitable modes of expressing human experience.

### **1. COURSE CONTENTS**

Introduction to Elements of Literature

#### **1. Relevance of literature**

- a) Enhances Reading, thinking, discussing and writing skills.
- b) Develops finer sensibility for better human relationship.
- c) Increases understanding of the problem of humanity without bias.
- d) Providing space to reconcile and get a cathartic effect.

#### **2. Elements of fiction**

- a) Fiction, fact and literary truth.
- b) Fictional modes and patterns.
- c) Plot character and perspective.

#### **3. Elements of poetry**

- a) Emotions and imaginations.

- b) Figurative language.
- c) (Simile, metaphor, conceit, symbol, pun and irony).
- d) Personification and animation.
- e) Rhetoric and trend.

#### 4. Elements of drama

- a) Drama as representational art.
- b) Content mode and elements.
- c) Theatrical performance.
- d) Drama as narration, mediation and persuasion.
- e) Features of tragedy, comedy and satire.

## 2. READINGS:

1. An Introduction to the Study of English Literature, W.H. Hudson, Atlantic, 2007.
2. An Introduction to Literary Studies, Mario Klarer, Routledge, 2013.
3. The Experience of Poetry, Graham Mode, Open college of Arts with Open Unv Press, 1991.
4. The Elements of Fiction: A Survey, Ulf Wolf (ed), Wolfstuff, 2114.
5. The Elements of Drama, J.L.Styan, Literary Licensing, 2011.

### 3.1 Textbook:

3.2 \*Reference Books:: To be decided by the teacher and student, on the basis of individual student so as to enable him or her to write the term paper.

## 3. OTHER SESSION:

4.1\*Tutorials:

4.2\*Laboratory:

4.3\*Project: The students will write a term paper to show their understanding of a particular piece of literature

## 4. \*ASSESSMENT:

5.1HA:

5.2Quizzes-HA:

5.3Periodical Examination: one

5.4Project/Lab: one (under the guidance of the teachers the students will take a volume of poetry, fiction or drama and write a term paper to show their understanding of it in a given context; sociological, psychological, historical, autobiographical etc.

5.5Final Exam:

**TOTAL : 45 PERIODS**

## OUTCOME OF THE COURSE:

- Students will be able to understand the relevance of literature in human life and appreciate its aspects in developing finer sensibilities.

**MX3083**

**FILM APPRECIATION**

**L T P C  
3 0 0 0**

In this course on film appreciation, the students will be introduced broadly to the development of film as an art and entertainment form. It will also discuss the language of cinema as it evolved over a century. The students will be taught as to how to read a film and appreciate the various nuances of a film as a text. The students will be guided to study film joyfully.



### **Theme - A: The Component of Films**

- A-1: The material and equipment
- A-2: The story, screenplay and script
- A-3: The actors, crew members, and the director
- A-4: The process of film making... structure of a film

### **Theme - B: Evolution of Film Language**

- B-1: Film language, form, movement etc.
- B-2: Early cinema... **silent film** (Particularly French)
- B-3: The emergence of feature films: **Birth of a Nation**
- B-4: Talkies

### **Theme - C: Film Theories and Criticism/Appreciation**

- C-1: Realist theory; Auteurists
- C-2: Psychoanalytic, Ideological, Feminists
- C-3: How to read films?
- C-4: Film Criticism / Appreciation

### **Theme – D: Development of Films**

- D-1: Representative Soviet films
- D-2: Representative Japanese films
- D-3: Representative Italian films
- D-4: Representative Hollywood film and the studio system

### **Theme - E: Indian Films**

- E-1: The early era
- E-2: The important films made by the directors
- E-3: The regional films
- E-4: The documentaries in India

### **READING:**

A Reader containing important articles on films will be prepared and given to the students. The students must read them and present in the class and have discussion on these.

**MX3084**

**DISASTER RISK REDUCTION AND MANAGEMENT**

**L T P C  
3 0 0 0**

### **COURSE OBJECTIVE**

- To impart knowledge on concepts related to disaster, disaster risk reduction, disaster management
- To acquaint with the skills for planning and organizing disaster response

### **UNIT I HAZARDS, VULNERABILITY AND DISASTER RISKS**

**9**

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Types of Disasters: Natural, Human induced, Climate change induced –Earthquake, Landslide, Flood, Drought, Fire etc – Technological disasters- Structural collapse, Industrial accidents, oil spills -Causes, Impacts including social, Economic, political, environmental, health, psychosocial, etc.- Disaster vulnerability profile of India and Tamil Nadu - Global trends in disasters: urban disasters, pandemics, Complex emergencies, - , Inter relations between Disasters and Sustainable development Goals

### **UNIT II DISASTER RISK REDUCTION (DRR)**

**9**

Sendai Framework for Disaster Risk Reduction, Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community Based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Early Warning System – Advisories from Appropriate Agencies.- Relevance of indigenous Knowledge, appropriate technology and Local resources.

**UNIT III DISASTER MANAGEMENT****9**

Components of Disaster Management – Preparedness of rescue and relief, mitigation, rehabilitation and reconstruction- Disaster Risk Management and post disaster management – Compensation and Insurance- Disaster Management Act (2005) and Policy - Other related policies, plans, programmers and legislation - Institutional Processes and Framework at State and Central Level- (NDMA –SDMA-DDMA-NRDF- Civic Volunteers)

**UNIT IV TOOLS AND TECHNOLOGY FOR DISASTER MANAGEMENT****9**

Early warning systems -Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment. - Elements of Climate Resilient Development –Standard operation Procedure for disaster response – Financial planning for disaster Management

**UNIT V DISASTER MANAGEMENT: CASE STUDIES****9**

Discussion on selected case studies to analyse the potential impacts and actions in the contest of disasters-Landslide Hazard Zonation: Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.- Field work-Mock drill -

**TOTAL : 45 PERIODS****TEXT BOOKS:**

- 1 Taimpo (2016), Disaster Management and Preparedness, CRC Publications
- 2 Singh R (2017), Disaster Management Guidelines for earthquakes, Landslides, Avalanches and tsunami, Horizon Press Publications
- 3 Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
- 4 Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2012. ISBN-10: 1259007367, ISBN-13: 978-1259007361]

**REFERENCES**

1. Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005.
2. Government of India, National Disaster Management Policy, 2009.
3. Shaw R (2016), Community based Disaster risk reduction, Oxford University Press

**COURSE OUTCOME:**

**CO1:** To impart knowledge on the concepts of Disaster, Vulnerability and Disaster Risk reduction (DRR)

**CO2:** To enhance understanding on Hazards, Vulnerability and Disaster Risk Assessment prevention and risk reduction

**CO3:** To develop disaster response skills by adopting relevant tools and technology

**CO4:** Enhance awareness of institutional processes for Disaster response in the country and

**CO5:** Develop rudimentary ability to respond to their surroundings with potential Disaster response in areas where they live, with due sensitivity

**CO's – PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	3	-	-	2	2	-	-	2	-	2	-	1
2	3	3	3	3	-	-	2	1	-	-	2	-	2	-	1
3	3	3	3	3	-	-	2	2	-	-	-	-	2	-	1
4	3	3	2	3	-	-	2	1	-	-	2	-	2	-	1
5	3	3	2	3	-	-	2	2	-	-	2	-	3	-	1
AVG	3	3	3	3	-	-	2	2	-	-	2	-	2	-	1

## MANDATORY COURSES II

**MX3085**

**WELL-BEING WITH TRADITIONAL PRACTICES-YOGA, AYURVEDA AND  
SIDDHA**

**LT PC  
3 0 0 0**

### **COURSE OBJECTIVES:**

- To enjoy life happily with fun filled new style activities that help to maintain health also
- To adapt a few lifestyle changes that will prevent many health disorders
- To be cool and handbill every emotion very smoothly in every walk of life
- To learn to eat cost effective but healthy foods that are rich in essential nutrients
- To develop immunity naturally that will improve resistance against many health disorders

### **UNIT I HEALTH AND ITS IMPORTANCE**

**2+4**

**Health: Definition - Importance of maintaining health** - More importance on prevention than treatment

Ten types of health one has to maintain - Physical health - Mental health - Social health - Financial health - Emotional health - Spiritual health - Intellectual health - Relationship health - Environmental health - Occupational/Professional health.

**Present health status** - The life expectancy-present status - mortality rate - dreadful diseases - Non-communicable diseases (NCDs) the leading cause of death - 60% - heart disease – cancer – diabetes - chronic pulmonary diseases - risk factors – tobacco – alcohol - unhealthy diet - lack of physical activities.

**Types of diseases and disorders** - Lifestyle disorders – Obesity – Diabetes - Cardiovascular diseases – Cancer – Strokes – COPD - Arthritis - Mental health issues.

**Causes of the above diseases / disorders - Importance of prevention of illness** - Takes care of health - Improves quality of life - Reduces absenteeism - Increase satisfaction - Saves time

**Simple lifestyle modifications to maintain health** - Healthy Eating habits (Balanced diet according to age) Physical Activities (Stretching exercise, aerobics, resisting exercise) - Maintaining BMI-Importance and actions to be taken

### **UNIT II DIET**

**4+6**

**Role of diet in maintaining health** - energy one needs to keep active throughout the day - nutrients one needs for growth and repair - helps one to stay strong and healthy - helps to prevent diet-related illness, such as some cancers - keeps active and - helps one to maintain a healthy weight - helps to reduce risk of developing lifestyle disorders like diabetes – arthritis – hypertension – PCOD – infertility – ADHD – sleeplessness -helps to reduce the risk of heart diseases - keeps the teeth and bones strong.

**Balanced Diet and its 7 Components** - Carbohydrates – Proteins – Fats – Vitamins – Minerals - Fibre and Water.

**Food additives and their merits & demerits** - Effects of food additives - Types of food additives - Food additives and processed foods - Food additives and their reactions

#### **Definition of BMI and maintaining it with diet**

Importance - Consequences of not maintaining BMI - different steps to maintain optimal BM

#### **Common cooking mistakes**

Different cooking methods, merits and demerits of each method

### **UNIT III      ROLE OF AYURVEDA & SIDDHA SYSTEMS IN MAINTAINING HEALTH      4+4**

**AYUSH systems and their role in maintaining health** - preventive aspect of AYUSH - AYUSH as a soft therapy.

**Secrets of traditional healthy living** - Traditional Diet and Nutrition - Regimen of Personal and Social Hygiene - Daily routine (Dinacharya) - Seasonal regimens (Ritucharya) - basic sanitation and healthy living environment - Sadvritta (good conduct) - for conducive social life.

**Principles of Siddha & Ayurveda systems** - Macrocosm and Microcosm theory - Pancheekarana Theory / (Five Element Theory) 96 fundamental Principles - Uyir Thathukkal (Tri-Dosha Theory) - Udal Thathukkal

#### **Prevention of illness with our traditional system of medicine**

Primary Prevention - To decrease the number of new cases of a disorder or illness - Health promotion/education, and - Specific protective measures - Secondary Prevention - To lower the rate of established cases of a disorder or illness in the population (prevalence) - Tertiary Prevention - To decrease the amount of disability associated with an existing disorder.

### **UNIT IV      MENTAL WELLNESS      3+4**

**Emotional health** - Definition and types - Three key elements: the subjective experience - the physiological response - the behavioral response - Importance of maintaining emotional health - Role of emotions in daily life - Short term and long term effects of emotional disturbances - Leading a healthy life with emotions - Practices for emotional health - Recognize how thoughts influence emotions - Cultivate positive thoughts - Practice self-compassion - Expressing a full range of emotions.

**Stress management** - Stress definition - Stress in daily life - How stress affects one's life - Identifying the cause of stress - Symptoms of stress - Managing stress (habits, tools, training, professional help) - Complications of stress mismanagement.

**Sleep** - Sleep and its importance for mental wellness - Sleep and digestion.

**Immunity** - Types and importance - Ways to develop immunity

### **UNIT V      YOGA      2+12**

**Definition and importance of yoga** - Types of yoga - How to Choose the Right Kind for individuals according to their age - The Eight Limbs of Yoga - Simple yogasanas for cure and prevention of health disorders - What yoga can bring to our life.

**TOTAL : 45 PERIODS**

#### **TEXT BOOKS:**

1. Nutrition and Dietetics - Ashley Martin, Published by White Word Publications, New York, NY 10001, USA
2. Yoga for Beginners\_ 35 Simple Yoga Poses to Calm Your Mind and Strengthen Your Body, by Cory Martin, Copyright © 2015 by Althea Press, Berkeley, California

#### **REFERENCES:**

1. WHAT WE KNOW ABOUT EMOTIONAL INTELLIGENCE How It Affects Learning, Work, Relationships, and Our Mental Health, by Moshe Zeidner, Gerald Matthews, and Richard D. Roberts  
A Bradford Book, The MIT Press, Cambridge, Massachusetts, London, England
2. The Mindful Self-Compassion Workbook, Kristin Neff, Ph.D Christopher Germer, Ph.D, Published by The Guilford Press A Division of Guilford Publications, Inc. 370 Seventh Avenue, Suite 1200, New York, NY 10001

1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4799645/>
2. **Simple lifestyle modifications to maintain health**  
<https://www.niddk.nih.gov/health-information/diet-nutrition/changing-habits-better-health#:~:text=Make%20your%20new%20healthy%20habit,t%20have%20time%20to%20cook.>
3. **Read more:** <https://www.legit.ng/1163909-classes-food-examples-functions.html>
4. <https://www.yaclass.in/p/science-state-board/class-9/nutrition-and-health-5926>
5. **Benefits of healthy eating** <https://www.cdc.gov/nutrition/resources-publications/benefits-of-healthy-eating.html>
6. **Food additives** <https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/food-additives>
7. **BMI** <https://www.hsph.harvard.edu/nutritionsource/healthy-weight/>  
<https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle---who-recommendations>
8. **Yoga** <https://www.healthifyme.com/blog/types-of-yoga/>  
<https://yogamedicine.com/guide-types-yoga-styles/>  
**Ayurveda** : <https://vikaspedia.in/health/ayush/ayurveda-1/concept-of-healthy-living-in-ayurveda>
9. **Siddha** : [http://www.tkdil.res.in/tkdil/langdefault/Siddha/Sid\\_Siddha\\_Concepts.asp](http://www.tkdil.res.in/tkdil/langdefault/Siddha/Sid_Siddha_Concepts.asp)
10. **CAM** : <https://www.hindawi.com/journals/ecam/2013/376327/>
11. **Preventive herbs** : <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3847409/>

### COURSE OUTCOMES:

After completing the course, the students will be able to:

- Learn the importance of different components of health
- Gain confidence to lead a healthy life
- Learn new techniques to prevent lifestyle health disorders
- Understand the importance of diet and workouts in maintaining health

**MX3086**

**HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA**

**L T P C**  
**3 0 0 0**

### UNIT-I CONCEPTS AND PERSPECTIVES

Meaning of History

Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history  
Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation  
verses evidence, concept of historical inevitability, Historical Positivism.

Science and Technology-Meaning, Scope and Importance, Interaction of science, technology & society, Sources of history on science and technology in India.

### UNIT-II HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA

Introduction to the works of D.D. Kosambi, Dharmapal, Debiprasad Chattopadhyay, Rehman, S. Irfan Habib, Deepak Kumar, Dhruv Raina, and others.

### UNIT-III SCIENCE AND TECHNOLOGY IN ANCIENT INDIA

Technology in pre-historic period

Beginning of agriculture and its impact on technology

Science and Technology during Vedic and Later Vedic times

Science and technology from 1<sup>st</sup> century AD to C-1200.

### UNIT-IV SCIENCE AND TECHNOLOGY IN MEDIEVAL INDIA

Legacy of technology in Medieval India, Interactions with Arabs

Development in medical knowledge, interaction between Unani and Ayurveda and alchemy  
Astronomy and Mathematics: interaction with Arabic Sciences  
Science and Technology on the eve of British conquest

#### **UNIT-V SCIENCE AND TECHNOLOGY IN COLONIAL INDIA**

Science and the Empire  
Indian response to Western Science  
Growth of techno-scientific institutions

#### **UNIT-VI SCIENCE AND TECHNOLOGY IN A POST-INDEPENDENT INDIA**

Science, Technology and Development discourse  
Shaping of the Science and Technology Policy  
Developments in the field of Science and Technology  
Science and technology in globalizing India  
Social implications of new technologies like the Information Technology and Biotechnology

**TOTAL : 45 PERIODS**

**MX3087      POLITICAL AND ECONOMIC THOUGHT FOR A HUMANE SOCIETY      L T P C**  
**3 0 0 0**

Pre-Requisite: None. (Desirable: Universal Human Values 1, Universal Human Values 2)

#### **OBJECTIVES:**

- This course will begin with a short overview of human needs and desires and how different political-economic systems try to fulfill them. In the process, we will end with a critique of different systems and their implementations in the past, with possible future directions.

#### **COURSE TOPICS:**

Considerations for humane society, holistic thought, human being's desires, harmony in self, harmony in relationships, society, and nature, societal systems. **(9 lectures, 1 hour each)**

(Refs: A Nagaraj, M K Gandhi, JC Kumarappa)

Capitalism – Free markets, demand-supply, perfect competition, laissez-faire, monopolies, imperialism. Liberal democracy. **(5 lectures)**

(Refs: Adam Smith, J S Mill)

Fascism and totalitarianism. World war I and II. Cold war. **(2 lectures)**

Communism – Mode of production, theory of labour, surplus value, class struggle, dialectical materialism, historical materialism, Russian and Chinese models.

(Refs: Marx, Lenin, Mao, M N Roy) **(5 lectures)**

Welfare state. Relation with human desires. Empowered human beings, satisfaction. **(3 lectures)**

Gandhian thought. Swaraj, Decentralized economy & polity, Community. Control over one's lives. Relationship with nature. **(6 lectures)**

(Refs: M K Gandhi, Schumacher, Kumarappa)

Essential elements of Indian civilization. **(3 lectures)**

(Refs: Pt Sundarlal, R C Mazumdar, Dharampal)

Technology as driver of society, Role of education in shaping of society. Future directions. **(4 lectures)** (Refs: Nandkishore Acharya, David Dixon, Levis Mumford)

**Conclusion (2 lectures)**

**Total lectures: 39**

**Preferred Textbooks:** See Reference Books

**Reference Books:** Authors mentioned along with topics above. Detailed reading list will be provided.

**GRADING:**

Mid sems	30
End sem	20
Home Assign	10
Term paper	40

**TOTAL : 45 PERIODS**

**OUTCOME:**

- The students will get an understanding of how societies are shaped by philosophy, political and economic system, how they relate to fulfilling human goals & desires with some case studies of how different attempts have been made in the past and how they have fared.

**MX3088**

**STATE, NATION BUILDING AND POLITICS IN INDIA**

**L T P C  
3 0 0 0**

**OBJECTIVE:**

The objective of the course is to provide an understanding of the state, how it works through its main organs, primacy of politics and political process, the concept of sovereignty and its changing contours in a globalized world. In the light of this, an attempt will be made to acquaint the students with the main development and legacies of national movement and constitutional development in India, reasons for adopting a Parliamentary-federal system, the broad philosophy of the Constitution of India and the changing nature of Indian Political System. Challenges/ problems and issues concerning national integration and nation-building will also be discussed in the contemporary context with the aim of developing a future vision for a better India.

**TOPICS:**

Understanding the need and role of State and politics.

Development of Nation-State, sovereignty, sovereignty in a globalized world.

Organs of State – Executive, Legislature, Judiciary. Separation of powers, forms of government- unitary-federal, Presidential-Parliamentary, The idea of India.

1857 and the national awakening.

1885 Indian National Congress and development of national movement – its legacies. Constitution making and the Constitution of India.

Goals, objective and philosophy.  
Why a federal system?  
National integration and nation-building.

Challenges of nation-building – State against democracy (Kothari)  
New social movements.  
The changing nature of Indian Political System, the future scenario. What can we do?

**TOTAL : 45 PERIODS**

**OUTCOME OF THE COURSE:**

It is expected that this course will make students aware of the theoretical aspect of the state, its organs, its operationalization aspect, the background and philosophy behind the founding of the present political system, broad streams and challenges of national integration and nation-building in India. It will equip the students with the real understanding of our political system/ process in correct perspective and make them sit up and think for devising ways for better participation in the system with a view to making the governance and delivery system better for the common man who is often left unheard and unattended in our democratic setup besides generating a lot of dissatisfaction and difficulties for the system.

**SUGGESTED READING:**

- i. Sunil Khilnani, The Idea of India. Penguin India Ltd., New Delhi.
- ii. Madhav Khosla, The Indian Constitution, Oxford University Press. New Delhi, 2012.
- iii. Brij Kishore Sharma, Introduction to the Indian Constitution, PHI, New Delhi, latest edition.
- iv. Sumantra Bose, Transforming India: Challenges to the World's Largest Democracy, Picador India, 2013.
- v. Atul Kohli, Democracy and Discontent: India's Growing Crisis of Governability, Cambridge University Press, Cambridge, U. K., 1991.
- vi. M. P. Singh and Rekha Saxena, Indian Politics: Contemporary Issues and Concerns, PHI, New Delhi, 2008, latest edition.
- vii. Rajni Kothari, Rethinking Democracy, Orient Longman, New Delhi, 2005.



**MX3089**

**INDUSTRIAL SAFETY**

**L T P C**  
**3 0 0 0**

**OBJECTIVES**

- To Understand the Introduction and basic Terminologies safety.
- To enable the students to learn about the Important Statutory Regulations and standards.
- To enable students to Conduct and participate the various Safety activities in the Industry.
- To have knowledge about Workplace Exposures and Hazards.
- To assess the various Hazards and consequences through various Risk Assessment Techniques.

**UNIT I SAFETY TERMINOLOGIES**

Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators- lag Indicators-Flammability- Toxicity Time-weighted Average (TWA) - Threshold LimitValue (TLV) - Short Term Exposure Limit (STEL)- Immediately dangerous to life or health (IDLH)- acute and chronic Effects- Routes of Chemical Entry-Personnel Protective Equipment- Health and Safety Policy-Material Safety Data Sheet MSDS



## UNIT II STANDARDS AND REGULATIONS

Indian Factories Act-1948- Health- Safety- Hazardous materials and Welfare- ISO 45001:2018 occupational health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998- Hazard Identification and Risk Analysis- code of practice IS 15656:2006

## UNIT III SAFETY ACTIVITIES

Toolbox Talk- Role of safety Committee- Responsibilities of Safety Officers and Safety Representatives- Safety Training and Safety Incentives- Mock Drills- On-site Emergency Action Plan- Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment

## UNIT IV WORKPLACE HEALTH AND SAFETY

Noise hazard- Particulate matter- musculoskeletal disorder improper sitting poster and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety- Toxic gas Release

## UNIT V HAZARD IDENTIFICATION TECHNIQUES

Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment- Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment

Course outcomes on completion of this course the student will be able:

- Understand the basic concept of safety.
- Obtain knowledge of Statutory Regulations and standards.
- Know about the safety Activities of the Working Place.
- Analyze on the impact of Occupational Exposures and their Remedies
- Obtain knowledge of Risk Assessment Techniques.

## TEXTBOOKS

1. R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems KHANNA PUBLISHER
2. L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education

## REFERENCES

1. Frank Lees (2012) 'Lees' Loss Prevention in Process Industries. Butterworth-Heinemann publications, UK, 4th Edition.
2. John Ridley & John Channing (2008) Safety at Work: Routledge, 7th Edition.
3. Dan Petersen (2003) Techniques of Safety Management: A System Approach.
4. Alan Waring.(1996). Safety management system: Chapman & Hall, England
5. Society of Safety Engineers, USA

## ONLINE RESOURCES

ISO 45001:2018 occupational health and safety (OH&S) International Organization for Standardization <https://www.iso.org/standard/63787.html>

Indian Standard code of practice on occupational safety and health audit <https://law.resource.org/pub/in/bis/S02/is.14489.1998.pdf>

Indian Standard code of practice on Hazard Identification and Risk Analysis IS 15656:2006 <https://law.resource.org/pub/in/bis/S02/is.15656.2006.pdf>

Course Outcomes	Statement	Program Outcome														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	Understand the basic concept of safety.	3	3	3	1	1	3	2	2	3	3	1	3	3	3	3

CO2	Obtain knowledge of Statutory Regulations and standards.	2	3	2	2	1	3	2	3	3	2	1	3	3	3	3
CO3	Know about the safety Activities of the Working Place.	2	2	2	2	1	2	2	2	3	2	1	2	3	3	3
CO4	Analyze on the impact of Occupational Exposures and their Remedies	3	3	3	2	2	3	2	2	3	2	1	3	3	3	3
CO5	Obtain knowledge of Risk Assessment Techniques.	3	2	3	2	2	3	2	2	3	2	2	3	3	3	3
<b>Industrial safety</b>		3	3	3	2	1	3	2	2	3	2	1	3	3	3	3



## OPEN ELECTIVE I AND II

**OCS351 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FUNDAMENTALS L T P C**  
**2 0 2 3**

### **OBJECTIVES:**

The main objectives of this course are to:

1. Understand the importance, principles, and search methods of AI
2. Provide knowledge on predicate logic and Prolog.
3. Introduce machine learning fundamentals
4. Study of supervised learning algorithms.
5. Study about unsupervised learning algorithms.

### **UNIT I INTELLIGENT AGENT AND UNINFORMED SEARCH 6**

**Introduction** - Foundations of AI - History of AI - The state of the art - Risks and Benefits of AI - **Intelligent Agents** - Nature of Environment - Structure of Agent - Problem Solving Agents - Formulating Problems - **Uninformed Search** - Breadth First Search - Dijkstra's algorithm or uniform-cost search - Depth First Search - Depth Limited Search

### **UNIT II PROBLEM SOLVING WITH SEARCH TECHNIQUES 6**

**Informed Search** - Greedy Best First - A\* algorithm - Adversarial Game and Search - **Game theory** - Optimal decisions in game - Min Max Search algorithm - Alpha-beta pruning - **Constraint Satisfaction Problems (CSP)** - Examples - Map Coloring - Job Scheduling - Backtracking Search for CSP

### **UNIT III LEARNING 6**

Machine Learning: Definitions – Classification - Regression - approaches of machine learning models - Types of learning - Probability - Basics - Linear Algebra – Hypothesis space and inductive bias, Evaluation. Training and test sets, cross validation, Concept of over fitting, under fitting, Bias and Variance - **Regression**: Linear Regression - Logistic Regression

### **UNIT IV SUPERVISED LEARNING 6**

**Neural Network**: Introduction, Perceptron Networks – Adaline - Back propagation networks - **Decision Tree**: Entropy – Information gain - Gini Impurity - classification algorithm - Rule based Classification - **Naïve Bayesian classification** - **Support Vector Machines (SVM)**

### **UNIT V UNSUPERVISED LEARNING 6**

**Unsupervised Learning** – Principle Component Analysis - **Neural Network**: Fixed Weight Competitive Nets - Kohonen Self-Organizing Feature Maps – **Clustering**: Definition - Types of Clustering – Hierarchical clustering algorithms – k-means algorithm

**TOTAL : 30 PERIODS**

### **PRACTICAL EXERCISES: 30 PERIODS**

#### **Programs for Problem solving with Search**

1. Implement breadth first search
2. Implement depth first search
3. Analysis of breadth first and depth first search in terms of time and space
4. Implement and compare Greedy and A\* algorithms.

#### **Supervised learning**

5. Implement the non-parametric locally weighted regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs
6. Write a program to demonstrate the working of the decision tree based algorithm.
7. Build an artificial neural network by implementing the back propagation algorithm and test the same using appropriate data sets.
8. Write a program to implement the naïve Bayesian classifier.

## Unsupervised learning

9. Implementing neural network using self-organizing maps
10. Implementing k-Means algorithm to cluster a set of data.
11. Implementing hierarchical clustering algorithm.

Note:

- Installation of gnu-prolog, Study of Prolog (gnu-prolog).
- The programs can be implemented in using C++/JAVA/ Python or appropriate tools can be used by designing good user interface
- Data sets can be taken from standard repositories (<https://archive.ics.uci.edu/ml/datasets.html>) or constructed by the students.

## OUTCOMES:

CO1: Understand the foundations of AI and the structure of Intelligent Agents

CO2: Use appropriate search algorithms for any AI problem

CO3: Study of learning methods

CO4: Solving problem using Supervised learning

CO5: Solving problem using Unsupervised learning

**TOTAL: 60 PERIODS**

## TEXT BOOKS:

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Fourth Edition, 2021
2. S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India.3 rd ed,

## REFERENCES

1. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
2. I. Bratko, "Prolog: Programming for Artificial Intelligencell, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.
3. C. Muller & Sarah Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020.

**OCS352**

**IOT CONCEPTS AND APPLICATIONS**

**L T P C**

**2 0 2 3**

## OBJECTIVES:

- To apprise students with basic knowledge of IoT that paves a platform to understand physical and logical design of IOT
- To teach a student how to analyse requirements of various communication models and protocols for cost-effective design of IoT applications on different IoT platforms.
- To introduce the technologies behind Internet of Things(IoT).
- To explain the students how to code for an IoT application using Arduino/Raspberry Pi open platform.
- To apply the concept of Internet of Things in real world scenario.

## UNIT I INTRODUCTION TO INTERNET OF THINGS

**5**

Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT Models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT

## UNIT II COMPONENTS IN INTERNET OF THINGS

**5**

Functional Blocks of an IoT Ecosystem – Sensors, Actuators, and Smart Objects – Control Units - Communication modules (Bluetooth, Zigbee,Wifi, GPS, GSM Modules)

## UNIT III PROTOCOLS AND TECHNOLOGIES BEHIND IOT

**6**

IOT Protocols - IPv6, 6LoWPAN, MQTT, CoAP - RFID, Wireless Sensor Networks, BigData Analytics, Cloud Computing, Embedded Systems.

**UNIT IV OPEN PLATFORMS AND PROGRAMMING 7**  
IOT deployment for Raspberry Pi /Arduino platform-Architecture –Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud.

**UNIT V IOT APPLICATIONS 7**  
Business models for the internet of things, Smart city, Smart mobility and transport, Industrial IoT, Smart health, Environment monitoring and surveillance – Home Automation – Smart Agriculture  
**30 PERIODS**

**PRACTICAL EXERCISES: 30 PERIODS**

1. Introduction to Arduino platform and programming
2. Interfacing Arduino to Zigbee module
3. Interfacing Arduino to GSM module
4. Interfacing Arduino to Bluetooth Module
5. Introduction to Raspberry PI platform and python programming
6. Interfacing sensors to Raspberry PI
7. Communicate between Arduino and Raspberry PI using any wireless medium
8. Setup a cloud platform to log the data
9. Log Data using Raspberry PI and upload to the cloud platform
10. Design an IOT based system

**OUTCOMES:**

**CO 1:** Explain the concept of IoT.

**CO 2:** Understand the communication models and various protocols for IoT.

**CO 3:** Design portable IoT using Arduino/Raspberry Pi /open platform

**CO 4:** Apply data analytics and use cloud offerings related to IoT.

**CO 5:** Analyze applications of IoT in real time scenario.

**TOTAL:60 PERIODS**

**TEXTBOOKS**

1. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017
2. Samuel Greengard, The Internet of Things, The MIT Press, 2015

**REFERENCES**

1. Perry Lea, "Internet of things for architects", Packt, 2018
2. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012
3. IOT (Internet of Things) Programming: A Simple and Fast Way of Learning, IOT Kindle Edition.
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
5. ArshdeepBahga, Vijay Madiseti, "Internet of Things – A hands-on approach", Universities Press, 2015
6. <https://www.arduino.cc/>  
[https://www.ibm.com/smarterplanet/us/en/?ca=v\\_smarterplanet](https://www.ibm.com/smarterplanet/us/en/?ca=v_smarterplanet)

**OCS353**

**DATA SCIENCE FUNDAMENTALS**

**L T P C  
2 0 2 3**

**COURSE OBJECTIVES:**

- Familiarize students with the data science process.
- Understand the data manipulation functions in Numpy and Pandas.
- Explore different types of machine learning approaches.
- Understand and practice visualization techniques using tools.
- Learn to handle large volumes of data with case studies.

**UNIT I INTRODUCTION 6**  
Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – data preparation - Exploratory Data analysis – build the model – presenting findings and building applications - Data Mining - Data Warehousing – Basic statistical descriptions of Data

**UNIT II DATA MANIPULATION 9**  
Python Shell - Jupyter Notebook - IPython Magic Commands - NumPy Arrays-Universal Functions – Aggregations – Computation on Arrays – Fancy Indexing – Sorting arrays – Structured data – Data manipulation with Pandas – Data Indexing and Selection – Handling missing data – Hierarchical indexing – Combining datasets – Aggregation and Grouping – String operations – Working with time series – High performance

**UNIT III MACHINE LEARNING 5**  
The modeling process - Types of machine learning - Supervised learning - Unsupervised learning - Semi-supervised learning- Classification, regression - Clustering – Outliers and Outlier Analysis

**UNIT IV DATA VISUALIZATION 5**  
Importing Matplotlib – Simple line plots – Simple scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn

**UNIT V HANDLING LARGE DATA 5**  
Problems - techniques for handling large volumes of data - programming tips for dealing with large data sets- Case studies: Predicting malicious URLs, Building a recommender system - Tools and techniques needed - Research question - Data preparation - Model building – Presentation and automation.

**30 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

#### **LAB EXERCISES**

1. Download, install and explore the features of Python for data analytics.
2. Working with Numpy arrays
3. Working with Pandas data frames
4. Basic plots using Matplotlib
5. Statistical and Probability measures
  - a) Frequency distributions
  - b) Mean, Mode, Standard Deviation
  - c) Variability
  - d) Normal curves
  - e) Correlation and scatter plots
  - f) Correlation coefficient
  - g) Regression
6. Use the standard benchmark data set for performing the following:
  - a) Univariate Analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis.
  - b) Bivariate Analysis: Linear and logistic regression modelling.
7. Apply supervised learning algorithms and unsupervised learning algorithms on any data set.
8. Apply and explore various plotting functions on any data set.

**Note: Example data sets like: UCI, Iris, Pima Indians Diabetes etc.**

**COURSE OUTCOMES:****At the end of this course, the students will be able to:**

- CO1:** Gain knowledge on data science process.
- CO2:** Perform data manipulation functions using Numpy and Pandas.
- CO3:** Understand different types of machine learning approaches.
- CO4:** Perform data visualization using tools.
- CO5:** Handle large volumes of data in practical scenarios.

**TOTAL:60 PERIODS****TEXT BOOKS**

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications, 2016.
2. Jake VanderPlas, "Python Data Science Handbook", O'Reilly, 2016.

**REFERENCES**

1. Robert S. Witte and John S. Witte, "Statistics", Eleventh Edition, Wiley Publications, 2017.
2. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press, 2014.

**CCS333****AUGMENTED REALITY /VIRTUAL REALITY**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>2</b>	<b>0</b>	<b>2</b>	<b>3</b>

**OBJECTIVES:**

- To impart the fundamental aspects and principles of AR/VR technologies.
- To know the internals of the hardware and software components involved in the development of AR/VR enabled applications.
- To learn about the graphical processing units and their architectures.
- To gain knowledge about AR/VR application development.
- To know the technologies involved in the development of AR/VR based applications.

**UNIT I INTRODUCTION****7**

Introduction to Virtual Reality and Augmented Reality – Definition – Introduction to Trajectories and Hybrid Space-Three I's of Virtual Reality – Virtual Reality Vs 3D Computer Graphics – Benefits of Virtual Reality – Components of VR System – Introduction to AR-AR Technologies-Input Devices – 3D Position Trackers – Types of Trackers – Navigation and Manipulation Interfaces – Gesture Interfaces – Types of Gesture Input Devices – Output Devices – Graphics Display – Human Visual System – Personal Graphics Displays – Large Volume Displays – Sound Displays – Human Auditory System.

**UNIT II VR MODELING****6**

Modeling – Geometric Modeling – Virtual Object Shape – Object Visual Appearance – Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants –Object Hierarchies – Viewing the 3D World – Physical Modeling – Collision Detection – Surface Deformation – Force Computation – Force Smoothing and Mapping – Behavior Modeling – Model Management.

**UNIT III VR PROGRAMMING****6**

VR Programming – Toolkits and Scene Graphs – World ToolKit – Java 3D – Comparison of World ToolKit and Java 3D

**UNIT IV APPLICATIONS****6**

Human Factors in VR – Methodology and Terminology – VR Health and Safety Issues – VR and Society-Medical Applications of VR – Education, Arts and Entertainment – Military VR Applications – Emerging Applications of VR – VR Applications in Manufacturing – Applications of VR in Robotics – Information Visualization – VR in Business – VR in Entertainment – VR in Education.

**UNIT V AUGMENTED REALITY****5**

Introduction to Augmented Reality-Computer vision for AR-Interaction-Modelling and Annotation-Navigation-Wearable devices

**30 PERIODS**

**PRACTICAL EXERCISES:****30 PERIODS**

1. Study of tools like Unity, Maya, 3DS MAX, AR toolkit, Vuforia and Blender.
2. Use the primitive objects and apply various projection types by handling camera.
3. Download objects from asset store and apply various lighting and shading effects.
4. Model three dimensional objects using various modelling techniques and apply textures over them.
5. Create three dimensional realistic scenes and develop simple virtual reality enabled mobile applications which have limited interactivity.
6. Add audio and text special effects to the developed application.
7. Develop VR enabled applications using motion trackers and sensors incorporating full haptic interactivity.
8. Develop AR enabled applications with interactivity like E learning environment, Virtual walkthroughs and visualization of historic places.
9. Develop AR enabled simple applications like human anatomy visualization, DNA/RNA structure visualization and surgery simulation.
10. Develop simple MR enabled gaming applications.

**TOTAL:60 PERIODS****OUTCOMES:****On completion of the course, the students will be able to:****CO1:** Understand the basic concepts of AR and VR**CO2:** Understand the tools and technologies related to AR/VR**CO3:** Know the working principle of AR/VR related Sensor devices**CO4:** Design of various models using modeling techniques**CO5:** Develop AR/VR applications in different domains**TEXTBOOKS:**

1. Charles Palmer, John Williamson, "Virtual Reality Blueprints: Create compelling VR experiences for mobile", Packt Publisher, 2018
2. Dieter Schmalstieg, Tobias Hollerer, "Augmented Reality: Principles & Practice", Addison Wesley, 2016
3. John Vince, "Introduction to Virtual Reality", Springer-Verlag, 2004.
4. William R. Sherman, Alan B. Craig: Understanding Virtual Reality – Interface, Application, Design", Morgan Kaufmann, 2003



### OPEN ELCTIVE III

OHS351

ENGLISH FOR COMPETITIVE EXAMINATIONS

L T P C  
3 0 0 3

#### **COURSE DESCRIPTION:**

Students aspiring to take up competitive exams of which the English language is a vital component will find this course useful. Designed for students in the higher semesters, the course will help students to familiarise themselves with those aspects of English that are tested in these examinations.

#### **Objectives:**

- To train the students in the language components essential to face competitive examinations both at the national (UPSC, Banking, Railway, Defence) and the international level (GRE, TOEFL, IELTS).
- To enhance an awareness of the specific patterns in language testing and the respective skills to tackle verbal reasoning and verbal ability tests.
- To inculcate effective practices in language-learning in order to improve accuracy in usage of grammar and coherence in writing.
- To improve students' confidence to express their ideas and opinions in formal contexts
- To create awareness of accuracy and precision in communication

#### **UNIT I**

9

Orientation on different formats of competitive exams - Vocabulary – Verbal ability – Verbal reasoning - Exploring the world of words – Essential words – Meaning and their usage – Synonyms-antonyms – Word substitution – Word analogy – Idioms and phrases – Commonly confused words – Spellings – Word expansion – New words in use.

#### **UNIT II**

9

Grammar – Sentence improvement –Sentence completion – Rearranging phrases into sentences – Error identification –Tenses – Prepositions – Adjectives – Adverbs – Subject-verb agreement – Voice – Reported speech – Articles – Clauses – Speech patterns.

#### **UNIT III**

9

Reading - Specific information and detail – Identifying main and supporting ideas – Speed reading techniques – Improving global reading skills – Linking ideas – Summarising – Understanding argument – Identifying opinion/attitude and making inferences - Critical reading.

#### **UNIT IV**

9

Writing – Pre-writing techniques – Mindmap - Describing pictures and facts - Paragraph structure – organising points – Rhetoric writing – Improving an answer – Drafting, writing and developing an argument – Focus on cohesion – Using cohesive devices –Analytic writing – Structure and types of essay – Mind maps – Structure of drafts, letters, memos, emails – Statements of Purpose – Structure, Content and Style.

#### **UNIT V**

9

Listening and Speaking – Contextual listening – Listening to instructions – Listening for specific information – Identifying detail, main ideas – Following signpost words – Stress, rhythm and intonation - Speaking to respond and elicit ideas – Guided speaking – Opening phrases – Interactive communication – Dysfluency -Sentence stress – Speaking on a topic – Giving opinions – Giving an oral presentation – Telling a story or a personal anecdote – Talking about oneself - Utterance – Speech acts- Brainstorming ideas – Group discussion.

**TOTAL: 45 PERIODS**

#### **LEARNING OUTCOMES:**

At the end of the course, learners will be able

- Expand their vocabulary and gain practical techniques to read and comprehend a wide range of texts with the emphasis required

- Identify errors with precision and write with clarity and coherence
- Understand the importance of task fulfilment and the usage of task-appropriate vocabulary
- Communicate effectively in group discussions, presentations and interviews
- Write topic based essays with precision and accuracy

### CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	3	3	1	3	3	3	3	1	3	1	3	-	-	-
2	2	3	3	2	3	3	3	3	1	3	3	3	-	-	-
3	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
4	2	2	2	2	2	2	2	2	3	3	3	3	-	-	-
5	2	2	2	2	2	2	2	2	2	3	2	3	-	-	-
<b>AVg.</b>	<b>2</b>	<b>2.6</b>	<b>2.6</b>	<b>2</b>	<b>2.6</b>	<b>2.6</b>	<b>2.6</b>	<b>2.6</b>	<b>2</b>	<b>3</b>	<b>2.4</b>	<b>3</b>	-	-	-

1-low, 2-medium, 3-high, '-'- no correlation

**Note:** The average value of this course to be used for program articulation matrix.

#### Teaching Methods:

Instructional methods will involve discussions, taking mock tests on various question papers – Objective, multiple-choice and descriptive. Peer evaluation, self-check on improvement and peer feedback - Practice sessions on speaking assessments, interview and discussion – Using multimedia.

#### Evaluative Pattern:

Internal Tests – 50%

End Semester Exam - 50%

#### TEXTBOOKS:

1. R.P.Bhatnagar - *General English for Competitive Examinations*. Macmillan India Limited, 2009.

#### REFERENCES:

1. Educational Testing Service - *The Official Guide to the GRE Revised General Test*, Tata McGraw Hill, 2010.
2. *The Official Guide to the TOEFL Test*, Tata McGraw Hill, 2010.
3. R Rajagopalan- *General English for Competitive Examinations*, McGraw Hill Education (India) Private Limited, 2008.

#### Websites

<http://www.examenglish.com/>, <http://www.ets.org/>, <http://www.bankxams.com/>  
<http://civilservicesmentor.com/>, <http://www.educationobserver.com>  
<http://www.cambridgeenglish.org/in/>

**OMG352**

**NGOS AND SUSTAINABLE DEVELOPMENT**

**L T P C**  
**3 0 0 3**

#### COURSE OBJECTIVES

- To understand the importance of sustainable development
- To acquire a reasonable knowledge on the legal frameworks pertaining to pollution control and environmental management
- To comprehend the role of NGOs in attaining sustainable development

<b>UNIT I</b>	<b>ENVIRONMENTAL CONCERNS</b>	<b>9</b>
Introduction to sustainable development goals, Global responsibility of environmental concern, Importance of environmental preservation, Environmental threats, Pollution and its types, Effects of Pollution, Pollution control, Treatment of wastes		
<b>UNIT II</b>	<b>ROLE OF NGOS</b>	<b>9</b>
Role of NGO's in national development, NGO's and participatory management, Challenges and limitations of NGO's, Community Development programmes, Role of NGO's in Community Development programmes, Participation of NGO's in environment management, Corporate Social responsibility, NGO's and corporate social responsibility		
<b>UNIT III</b>	<b>SUSTAINABLE DEVELOPMENT</b>	<b>9</b>
Issues and Challenges of Sustainable Development, Bioenergy, Sustainable Livelihoods and Rural Poor in Sustainable Development, Protecting ecosystem services for sustainable development, Non-renewable sources of energy and its effect, Renewable sources of energy for sustainability, Nuclear resources and Legal Regulation of Hazardous Substances, Sustainable Development: Programme and Policies, Sustainability assessment and Indicators		
<b>UNIT IV</b>	<b>NGO'S FOR SUSTAINABILITY</b>	<b>9</b>
Civil Society Initiatives in Environment Management, Civil Society Initiatives for Sustainable Development, Global Initiatives in Protecting Global Environment, World Summit on Sustainable Development (Johannesburg Summit 2002), Ecological economics, Environmental sustainability, Social inclusion, Health for all, education for all, Food security and Water security, NGOs and Sustainable Development strategies		
<b>UNIT V</b>	<b>LEGAL FRAMEWORKS</b>	<b>9</b>
Need for a Legal framework and its enforcement, Legal measures to control pollution, Environmental Legislations in India, Mechanism to implement Environmental Laws in India, Legal Protection of Forests Act 1927, Legal Protection of Wild Life, Role of NGO's in implementing environmental laws, Challenges in the implementation of environmental legislation		

**TOTAL 45 : PERIODS**

### **OUTCOMES**

Upon completion of this course, the student will :

- CO1 Have a thorough grounding on the issues and challenges being faced in attaining sustainable development
- CO2 Have a knowledge on the role of NGOs towards sustainable development
- CO 3 Present strategies for NGOs in attaining sustainable development
- CO 4 recognize the importance of providing energy, food security and health equity to all members of the society without damaging the environment
- CO 5 understand the environmental legislations

### **REFERENCE BOOKS**

1. Kulsange, S and Kamble, R. (2019). Environmental NGO's: Sustainability Stewardship, Lap Lambert Academic Publishing, India, ISBN-13: 978-6200442444.
2. Dodds, F. (2007). NGO diplomacy: The influence of nongovernmental organizations in international environmental negotiations. Mit Press, Cambridge, ISBN-13: 978-0262524766.
3. Ghosh, S. (Ed.). (2019). Indian environmental law: Key concepts and principles. Orient BlackSwan, India, ISBN-13: 978-9352875795.
4. Alan Fowler and Chiku Malunga (2010) NGO Management: The Earthscan Companion, Routledge, ISBN-13 : 978-1849711197.

**OMG353**

**DEMOCRACY AND GOOD GOVERNANCE**

**L T P C**  
**3 0 0 3**

**UNIT-I**

**(9)**

Structure and Process of Governance: Indian Model of Democracy, Parliament, Party Politics and Electoral Behaviour, Federalism, the Supreme Court and Judicial Activism, Units of Local Governance

**UNIT-II**

**(9)**

Regulatory Institutions – SEBI, TRAI, Competition Commission of India,

**UNIT-III**

**(9)**

Lobbying Institutions: Chambers of Commerce and Industries, Trade Unions, Farmers Associations, etc.

**UNIT- IV**

**(9)**

Contemporary Political Economy of Development in India: Policy Debates over Models of Development in India, Recent trends of Liberalisation of Indian Economy in different sectors, E-governance

**UNIT-V**

**(9)**

Dynamics of Civil Society: New Social Movements, Role of NGO's, Understanding the political significance of Media and Popular Culture.

**TOTAL 45 : PERIODS**

**REFERENCES:**

1. Atul Kohli (ed.): The Success of India's Democracy, Cambridge University Press, 2001.
2. Corbridge, Stuart and John Harris: Reinventing India: Liberalisation, Hindu Nationalism and Popular Democracy, Oxford University Press, 2000.
3. J.Dreze and A.Sen, India: Economic Development and Social Opportunity, Clarendon, 1995.
4. Saima Saeed: Screening the Public Sphere: Media and Democracy in India, 2013
5. Himat Singh: Green Revolution Reconsidered: The Rural World of Punjab, OUP, 2001.
6. Jagdish Bhagwati: India in Transition: Freeing The Economy, 1993.
7. Smitu Kothari: Social Movements and the Redefinition of Democracy, Boulder, Westview, 1993.

UNIVERSITY  
PROGRESS THROUGH KNOWLEDGE

**OME354**

**APPLIED DESIGN THINKING**

**L T P C**  
**3 0 0 3**

**OBJECTIVES:**

The course aims to

- Introduce tools & techniques of design thinking for innovative product development
- Illustrate customer-centric product innovation using on simple use cases
- Demonstrate development of Minimum usable Prototypes
- Outline principles of solution concepts & their evaluation
- Describe system thinking principles as applied to complex systems

**UNIT I**

**DESIGN THINKING PRINCIPLES**

**9**

Exploring Human-centered Design - Understanding the Innovation process, discovering areas of opportunity, Interviewing & empathy-building techniques, Mitigate validation risk with FIR [Forge Innovation rubric] - Case studies

**UNIT II**

**ENDUSER-CENTRIC INNOVATION**

**9**

Importance of customer-centric innovation - Problem Validation and Customer Discovery - Understanding problem significance and problem incidence - Customer Validation. Target user, User persona & user stories. Activity: Customer development process - Customer interviews and field visit

**UNIT III APPLIED DESIGN THINKING TOOLS 9**

Concept of Minimum Usable Prototype [MUP] - MUP challenge brief - Designing & Crafting the value proposition - Designing and Testing Value Proposition; Design a compelling value proposition; Process, tools and techniques of Value Proposition Design

**UNIT IV CONCEPT GENERATION 9**

Solution Exploration, Concepts Generation and MUP design- Conceptualize the solution concept; explore, iterate and learn; build the right prototype; Assess capability, usability and feasibility. Systematic concept generation; evaluation of technology alternatives and the solution concepts

**UNIT V SYSTEM THINKING 9**

System Thinking, Understanding Systems, Examples and Understandings, Complex Systems

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

**At the end of the course, learners will be able to:**

- Define & test various hypotheses to mitigate the inherent risks in product innovations.
- Design the solution concept based on the proposed value by exploring alternate solutions to achieve value-price fit.
- Develop skills in empathizing, critical thinking, analyzing, storytelling & pitching
- Apply system thinking in a real-world scenario

**TEXT BOOKS**

1. Steve Blank, (2013), The four steps to epiphany: Successful strategies for products that win, Wiley.
2. Alexander Osterwalder, Yves Pigneur, Gregory Bernarda, Alan Smith, Trish Papadacos, (2014), Value
3. Proposition Design: How to Create Products and Services Customers Want, Wiley
4. Donella H. Meadows, (2015), "Thinking in Systems -A Primer", Sustainability Institute.
5. Tim Brown,(2012) "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation", Harper Business.

**REFERENCES**

1. <https://www.ideo.com/pages/design-thinking#process>
2. <https://blog.forgeforward.in/valuation-risk-versus-validation-risk-in-product-innovations-49f253ca8624>
3. <https://blog.forgeforward.in/product-innovation-rubric-adf5ebdfd356>
4. <https://blog.forgeforward.in/evaluating-product-innovations-e8178e58b86e>
5. <https://blog.forgeforward.in/user-guide-for-product-innovation-rubric-857181b253dd>
6. <https://blog.forgeforward.in/star-tup-failure-is-like-true-lie-7812cdf9b85>

**MF3003**

**REVERSE ENGINEERING**

**LT P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- The main learning objective of this course is to prepare students for:
- Applying the fundamental concepts and principles of reverse engineering in product design and development.
- Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- Applying the concept and principles of material identification and process verification in reverse engineering of product design and development.
- Analysing the various legal aspect and applications of reverse engineering in product design and development.
- Understand about 3D scanning hardware & software operations and procedure to generate 3D model

**UNIT I INTRODUCTION & GEOMETRIC FORM****9 Hours**

Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering – Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

**UNIT II MATERIAL CHARACTERISTICS AND PROCESS IDENTIFICATION****9 Hours**

.Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness – Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification.

**UNIT III DATA PROCESSING****9 Hours**

Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility.

**UNIT IV 3D SCANNING AND MODELLING****9 Hours**

Introduction, working principle and operations of 3D scanners: Laser, White Light, Blue Light - Applications- Software for scanning and modelling: Types- Applications- Preparation techniques for Scanning objects- Scanning and Measuring strategies - Calibration of 3D Scanner- Step by step procedure: 3D scanning - Geometric modelling – 3D inspection- Case studies.

**UNIT V INDUSTRIAL APPLICATIONS****9 Hours**

Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry. Case studies and Solving Industrial projects in Reverse Engineering. Legality: Patent – Copyrights – Trade Secret – Third-Party Materials.

**TOTAL : 45 PERIODS****COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Apply the fundamental concepts and principles of reverse engineering in product design and development.
- Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.
- Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
- Analyze the various legal aspect
- Applications of reverse engineering in product design and development.

**TEXT BOOKS:**

1. Robert W. Messler, Reverse Engineering: Mechanisms, Structures, Systems & Materials, 1st Edition, McGraw-Hill Education, 2014
2. Wego Wang, Reverse Engineering Technology of Reinvention, CRC Press, 2011

**REFERENCES:**

1. Scott J. Lawrence , Principles of Reverse Engineering, Kindle Edition, 2022
2. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Prentice Hall, 2001
3. Kathryn, A. Ingle, "Reverse Engineering", McGraw-Hill, 1994.
4. Linda Wills, "Reverse Engineering", Kluwer Academic Publishers, 1996
5. Vinesh Raj and Kiran Fernandes, "Reverse Engineering: An Industrial Perspective", Springer-Verlag London Limited 2008.

**COURSE OBJECTIVES:**

- To be acquainted with sustainability in manufacturing and its evaluation.
- To provide knowledge in environment and social sustainability.
- To provide the student with the knowledge of strategy to achieve sustainability.
- To familiarize with trends in sustainable operations.
- To create awareness in current sustainable practices in manufacturing industry.

**UNIT – I ECONOMIC SUSTAINABILITY 9**

Industrial Revolution-Economic sustainability: globalization and international issues Sustainability status - Emerging issues- Innovative products- Reconfiguration manufacturing enterprises - Competitive manufacturing strategies - Performance evaluation- Management for sustainability - Assessments of economic sustainability

**UNIT – II SOCIAL AND ENVIRONMENTAL SUSTAINABILITY 9**

Social sustainability – Introduction-Work management -Human rights - Societal commitment - Customers -Business practices -Modelling and assessing social sustainability. Environmental issues pertaining to the manufacturing sector: Pollution - Use of resources -Pressure to reduce costs - Environmental management: Processes that minimize negative environmental impacts - environmental legislation and energy costs - need to reduce the carbon footprint of manufacturing Operations-Modelling and assessing environmental sustainability

**UNIT – III SUSTAINABILITY PRACTICES 9**

Sustainability awareness - Measuring Industry Awareness-Drivers and barriers -Availability of sustainability indicators -Analysis of sustainability practicing -Modeling and assessment of sustainable practicing -Sustainability awareness -Sustainability drivers and barriers - Availability of sustainability indicators- Designing questionnaires- Optimizing Sustainability Indexes-Elements – Cost and time model.

**UNIT – IV MANUFACTURING STRATEGY FOR SUSTAINABILITY 9**

Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.

**UNIT – V TRENDS IN SUSTAINABLE OPERATIONS 9**

Principles of sustainable operations - Life cycle assessment manufacturing and service activities - influence of product design on operations - Process analysis – Capacity management - Quality management -Inventory management - Just-In-Time systems - Resource efficient design - Consumerism and sustainable well-being.

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

- CO1: Discuss the importance of economic sustainability.  
 CO2: Describe the importance of sustainable practices.  
 CO3: Identify drivers and barriers for the given conditions.  
 CO4: Formulate strategy in sustainable manufacturing.  
 CO5: Plan for sustainable operation of industry with environmental, cost consciousness.

**TEXT BOOKS:**

1. Ibrahim Garbie, "Sustainability in Manufacturing Enterprises Concepts, Analyses and Assessments for Industry 4.0", Springer International Publishing., United States, 2016, ISBN-13: 978-3319293042.

2. Davim J.P., "Sustainable Manufacturing", John Wiley & Sons., United States, 2010, ISBN: 978-1-848-21212-1.

#### REFERENCES:

1. Jovane F, Emper, W.E. and Williams, D.J., "The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing", Springer, 2009, United States, ISBN 978-3-540-77011-4.
2. Kutz M., "Environmentally Conscious Mechanical Design", John Wiley & Sons., United States, 2007, ISBN: 978-0-471-72636-4.
3. Seliger G., "Sustainable Manufacturing: Shaping Global Value Creation", Springer, United States, 2012, ISBN 978-3-642-27289-9.

Mapping of COs with POs and PSOs															
COs/Pos & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	-	2	-	-	-	2	2	-	1	1	2	2	2	1
CO2	3	-	-	-	-	-	2	-	-	1	1	2	1	2	2
CO3	3	-	-	-	-	-	2	3	-	1	1	2	1	2	2
CO4	3	-	3	-	-	-	2	-	-	1	1	2	2	2	1
CO5	3	-	3	-	-	-	2	2	-	1	1	2	2	2	1
CO/PO & PSO Average	3	-	3	-	-	-	2	2	-	1	1	2	2	2	1
1 – Slight, 2 – Moderate, 3 – Substantial															

AU3791

**ELECTRIC AND HYBRID VEHICLES**

**L T P C**  
**3 0 0 3**

#### COURSE OBJECTIVES:

The objective of this course is to prepare the students to know about the general aspects of Electric and Hybrid Vehicles (EHV), including architectures, modelling, sizing, and sub system design and hybrid vehicle control.

#### UNIT I DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES

**9**

Need for Electric vehicle- Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. - Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refuelling Systems.

#### UNIT II ENERGY SOURCES

**9**

Battery Parameters- - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion-Sodium based- Metal Air. Battery Modelling - Equivalent circuits, Battery charging- Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System.

#### UNIT III MOTORS AND DRIVES

**9**

Types of Motors- DC motors- AC motors, PMSM motors, BLDC motors, Switched reluctance motors working principle, construction and characteristics.

#### UNIT IV POWER CONVERTERS AND CONTROLLERS

**9**

Solid state Switching elements and characteristics – BJT, MOSFET, IGBT, SCR and TRIAC - Power Converters – rectifiers, inverters and converters - Motor Drives - DC, AC motor, PMSM motors, BLDC motors, Switched reluctance motors – four quadrant operations –operating modes



**UNIT V HYBRID AND ELECTRIC VEHICLES****9**

Main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

At the end of this course, the student will be able to

1. Understand the operation and architecture of electric and hybrid vehicles
2. Identify various energy source options like battery and fuel cell
3. Select suitable electric motor for applications in hybrid and electric vehicles.
4. Explain the role of power electronics in hybrid and electric vehicles
5. Analyze the energy and design requirement for hybrid and electric vehicles.

**TEXT BOOKS:**

1. Iqbal Husain, " Electric and Hybrid Vehicles-Design Fundamentals", CRC Press,2003
2. Mehrdad Ehsani, " Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRC Press,2005.

**REFERENCES:**

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained " John Wiley & Sons,2003
2. Lino Guzzella, " Vehicle Propulsion System" Springer Publications,2005
3. Ron HodKinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	2	1		3	2					2		1	3
2	1	1	2	1		3	2					2		1	3
3	1	1	2	1		3	2					2		1	3
4	1	1	2	1		3	2					2		1	3
5	1	1	2	1		3	2					2		1	3
<b>Avg.</b>	1	1	2	1		3	2					2		1	3

**OAS352****SPACE ENGINEERING****L T P C  
3 0 0 3****OBJECTIVES:**

- Use the standard atmosphere tables and equations.
- Find lift and drag coefficient data from NACA plots.
- Apply the concept of static stability to flight vehicles.
- Describe the concepts of stress, strain, Young's modulus, Poisson's ratio, yield strength.
- Demonstrate a basic knowledge of dynamics relevant to orbital mechanics.

**UNIT I STANDARD ATMOSPHERE****6**

History of aviation – standard atmosphere - pressure, temperature and density altitude.

**UNIT II AERODYNAMICS****10**

Aerodynamic forces – Lift generation Viscosity and its implications - Shear stress in a velocity profile - Lagrangian and Eulerian flow field - Concept of a streamline – Aircraft terminology and geometry - Aircraft types - Lift and drag coefficients using NACA data.

**UNIT III PERFORMANCE AND PROPULSION****9**

Viscous and pressure drag - flow separation - aerodynamic drag - thrust calculations -thrust/power available and thrust/power required.

**UNIT IV AIRCRAFT STABILITY AND STRUCTURAL THEORY 10**  
Degrees of freedom of aircraft motions - stable, unstable and neutral stability - concept of static stability - Hooke's Law- brittle and ductile materials - moment of inertia - section modulus.

**UNIT V SPACE APPLICATIONS 10**  
History of space research - spacecraft trajectories and basic orbital manoeuvres - six orbital elements - Kepler's laws of orbits - Newton's law of gravitation.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Illustrate the history of aviation & developments over the years
- Ability to identify the types & classifications of components and control systems
- Explain the basic concepts of flight & Physical properties of Atmosphere
- Identify the types of fuselage and constructions.
- Distinguish the types of Engines and explain the principles of Rocket

**TEXT BOOKS:**

1. John D. Anderson, Introduction to Flight, 8 th Ed., McGraw-Hill Education, New York,2015.
2. E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021.
3. Stephen. A. Brandt, "Introduction to Aeronautics: A design perspective &quot; American Institute of Aeronautics & Astronautics,1997.

**REFERENCE:**

1. Kermode, A.C., "Mechanics of Flight", Himalayan Book, 1997.

**OIM351**

**INDUSTRIAL MANAGEMENT**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce fundamental concepts of industrial management
- To understand the approaches to the study of Management
- To learn about Decision Making, Organizing and leadership
- To analyze the Managerial Role and functions
- To know about the Supply Chain Management'

**UNIT 1 INTRODUCTION 9**

Technology Management - Definition - Functions - Evolution of Modern Management - Scientific Management Development of Management Thought. Approaches to the study of Management, Forms of Organization -Individual Ownership - Partnership - Joint Stock Companies - Co-operative Enterprises - Public Sector Undertakings, Corporate Frame Work- Share Holders - Board of Directors - Committees - Chief Executive Line and Functional Managers,-Financial-Legal-Trade Union

**UNIT 2 FUNCTIONS OF MANAGEMENT 9**

Planning - Nature and Purpose - Objectives - Strategies – Policies and Planning Premises - Decision Making - Organizing - Nature and Process - Premises - Departmentalization - Line and staff - Decentralization -Organizational culture, Staffing - selection and training .Placement - Performance appraisal - Career Strategy – Organizational Development. Leading - Managing human factor - Leadership .Communication, Controlling - Process of Controlling - Controlling techniques, productivity and operations management - Preventive control, Industrial Safety.

**UNIT 3 ORGANIZATIONAL BEHAVIOUR 9**

Definition - Organization - Managerial Role and functions -Organizational approaches, Individual behaviour - causes - Environmental Effect - Behaviour and Performance, Perception - Organizational Implications. Personality - Contributing factors - Dimension – Need Theories - Process Theories - Job Satisfaction, Learning and Behaviour-Learning Curves, Work Design and approaches.

**UNIT 4 GROUPDYNAMICS****9**

Group Behaviour - Groups - Contributing factors - Group Norms, Communication - Process - Barriers to communication - Effective communication, leadership - formal and informal characteristics – Managerial Grid - Leadership styles - Group Decision Making - Leadership Role in Group Decision, Group Conflicts - Types -Causes - Conflict Resolution -Inter group relations and conflict, Organization centralization and decentralization - Formal and informal - Organizational Structures Organizational Change and Development -Change Process – Resistance to Change - Culture and Ethics.

**UNIT 5 MODERN CONCEPTS****9**

Management by Objectives (MBO) - Management by Exception (MBE),Strategic Management - Planning for Future direction - SWOT Analysis -Evolving development strategies, information technology in management Decisions support system-Management Games Business Process Re-engineering(BPR) –Enterprises Resource Planning (ERP) - Supply Chain Management (SCM) - Activity Based Management (AM) - Global Perspective - Principles and Steps Advantages and disadvantage

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

CO1: Understand the basic concepts of industrial management

CO2: Identify the group conflicts and its causes.

CO3: Perform swot analysis

CO4 : Analyze the learning curves

CO5 : Understand the placement and performance appraisal

**REFERENCES:**

Maynard H.B, "Industrial Engineering Hand book", McGraw-Hill, sixth 2008

**CO's – PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1											2	1	
2		3	2	3											2
3	2	3	2	3									1	2	3
4	2	2	3	3										3	3
5	2	2											2		
AVg.	2	2.2	2.3	3									1.8	2	2.6

**OIE354****QUALITY ENGINEERING****L T P C  
3 0 0 3****COURSE OBJECTIVES**

- Developing a clear knowledge in the basics of various quality concepts.
- Facilitating the students in understanding the application of control charts and its techniques.
- Developing the special control procedures for service and processor oriented industries.
- Analyzing and understanding the process capability study.
- Developing the acceptance sampling procedures for incoming raw material.

**UNIT I INTRODUCTION****9**

Quality Dimensions–Quality definitions–Inspection–Quality control–Quality Assurance–Quality planning–Quality costs–Economics of quality– Quality loss function

**UNIT II CONTROLCHARTS 9**

Chance and assignable causes of process variation, statistical basis of the control chart, control charts for variables- X , R and S charts, attribute control charts - p, np, c and u- Construction and application.

**UNIT III SPECIAL CONTROL PROCEDURES 9**

Warning and modified control limits, control chart for individual measurements, multi-vari chart, Xchart with a linear trend, chart for moving averages and ranges, cumulative-sum and exponentially weighted moving average control charts.

**UNIT IV STATISTICALPROCESSCONTROL 9**

Process stability, process capability analysis using a Histogram or probability plots and control chart.Gauge capability studies,setting specification limits.

**UNITV ACCEPTANCE SAMPLING 9**

The acceptance sampling fundamental, OC curve, sampling plans for attributes, simple, double, multiple and sequential, sampling plans for variables,MIL-STD-105DandMIL-STD-414E&IS2500 standards.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Students will be able to:

**CO1:** Control the quality of processes using control charts for variables in manufacturing industries.

**CO2:** Control the occurrence of defective product and the defects in manufacturing companies.

**CO3:** Control the occurrence of defects in services.

**CO4:** Analyzing and understanding the process capability study.

**CO5:** Developing the acceptance sampling procedures for incoming raw material.

**CO's – PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	3		3			1	2			2	1		
2		3	3		3	3			3			3		2	
3	3	3	3		3				3			3	1		
4	3		2		3						1		1		
5		2			3				3			3			1
AVg.	2.6	2.7	2.7		3	3		1	2.7		1	2.7	1	2	1

**OSF351**

**FIRE SAFETY ENGINEERING**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES**

- 1: To enable the students to acquire knowledge of Fire and Safety Studies
- 2: To learn about the effect of fire on materials used for construction, the method of test for non-combustibility & fire resistance
- 3: To learn about fire area, fire stopped areas and different types of fire-resistant doors
- 4: To learn about the method of fire protection of structural members and their repair due to fire damage.
- 5: To develop safety professionals for both technical and management through systematic and quality-based study programmes

**UNIT I INHERENT SAFETY CONCEPTS 9**

Compartment fire-factors controlling fire severity, ventilation controlled and fuel controlled fires; Spread of fire in rooms, within building and between buildings. Effect of temperature on the properties of structural materials- concrete, steel, masonry and wood; Behavior of non-structural materials on fire- plastics, glass, textile fibres and other house hold materials.

<b>UNIT II</b>	<b>PLANT LOCATIONS</b>	<b>9</b>
Compartment temperature-time response at pre-flashover and post flashover periods; Equivalence of fire severity of compartment fire and furnace fire; Fire resistance test on structural elements-standard heating condition, Indian standard test method, performance criteria.		
<b>UNIT III</b>	<b>WORKING CONDITIONS</b>	<b>9</b>
Fire separation between building- principle of calculation of safe distance. Design principles of fire resistant walls and ceilings; Fire resistant screens- solid screens and water curtains; Local barriers; Fire stopped areas-in roof, in fire areas and in connecting structures; Fire doors- Low combustible, Non-combustible and Spark-proof doors; method of suspension of fire doors; Air-tight sealing of doors;		
<b>UNIT IV</b>	<b>FIRE SEVERITY AND REPAIR TECHNIQUES</b>	<b>9</b>
Fabricated fire proof boards-calcium silicate, Gypsum, Vermiculite, and Perlite boards; Fire protection of structural elements - Wooden, Steel and RCC.. Reparability of fire damaged structures-Assessment of damage to concrete, steel, masonry and timber structures, Repair techniques- repair methods to reinforced concrete Columns, beams and slabs, Repair to steel structural members, Repair to masonry structures.		
<b>UNIT V</b>	<b>WORKING AT HEIGHTS</b>	<b>9</b>
Safe Access - Requirement for Safe Work Platforms- Stairways - Gangways and Ramps-Fall Prevention & Fall Protection - Safety Belts - Safety nets - Fall Arrestors- Working on Fragile Roofs - Work Permit Systems-Accident Case Studies.		
		<b>TOTAL : 45 PERIODS</b>

### **COURSE OUTCOMES**

On completion of the course the student will be able to

**CO1:** Understand the effect of fire on materials used for construction

**CO2:** Understand the method of test for non-combustibility and fire resistance; and will be able to select different structural elements and their dimensions for a particular fire resistance rating of a building.

**CO3:** To understand the design concept of fire walls, fire screens, local barriers and fire doors and able to select them appropriately to prevent fire spread.

**CO4:** To decide the method of fire protection to RCC, steel, and wooden structural elements and their repair methods if damaged due to fire.

**CO5:** Describe the safety techniques and improve the analytical and intelligence to take the right decision at right time.

### **TEXT BOOKS**

1. Roytman, M. Y, "Principles of fire safety standards for building construction". Amerind Publishing Co. Pvt. Ltd., New Delhi, 1975
2. John A. Purkiss, "Fire safety engineering design of structures" (2nd edn.), Butterworth Heinemann, Oxford, UK, 2009.

### **REFERENCES:**

1. Smith, E.E. and Harmathy, T.Z. (Editors), "Design of buildings for fire safety". ASTM Special Publication 685, American Society for Testing and Materials, Boston, U.S.A, 1979.
2. Butcher, E. G. and Parnell, A. C, "Designing of fire safety". JohnWiley and Sons Ltd., New York, U.S.A. 1983.
3. Jain, V.K, "Fire safety in buildings" (2nd edn.). New Age International(P) Ltd., New Delhi, 2010.
4. Hazop&Hazan, "Identifying and Assessing Process Industry Hazards", Fourth Edition , 1999
4. Frank R. Spellman, Nancy E. Whiting, "The Handbook of Safety Engineering: Principles and Applications", 2009

## CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	-	1	-	-	1	-	-	-	-	-	-	-	-	-
2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
3	1	-	2	-	-	-	3	-	-	1	-	-	-	-	-
4	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
5	2	-	1	-	-	1	1	1	-	1	-	1	-	-	-
AVg.	1.3	-	1.75	-	-	1	1.3	1		1	-	1	-	-	-

OAE352

FUNDAMENTALS OF AERONAUTICAL ENGINEERING

L T P C  
3 0 0 3

### OBJECTIVES:

- To acquire the knowledge on the Historical evaluation of Airplanes
- To learn the different component systems and functions
- To know the concepts of basic properties and principles behind the flight
- To learn the basics of different structures & construction
- To learn the various types of power plants used in aircrafts

### UNIT I HISTORY OF FLIGHT

8

Balloon flight-ornithopter-Early Airplanes by Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

### UNIT II AIRCRAFT CONFIGURATIONS AND ITS CONTROLS

10

Different types of flight vehicles, classifications-Components of an airplane and their functions- Conventional control, powered control- Basic instruments for flying-Typical systems for control actuation.

### UNIT III BASICS OF AERODYNAMICS

9

Physical Properties and structures of the Atmosphere, Temperature, pressure and altitude relationships, Newton's Law of Motions applied to Aeronautics-Evolution of lift, drag and moment. Aerofoils, Mach number, Maneuvers.

### UNIT IV BASICS OF AIRCRAFT STRUCTURES

9

General types of construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Metallic and non-metallic materials. Use of Aluminium alloy, titanium, stainless steel and composite materials. Stresses and strains-Hooke's law- stress-strain diagrams-elastic constants-Factor of Safety.

### UNIT V BASICS OF PROPULSION

9

Basic ideas about piston, turboprop and jet engines – use of propeller and jets for thrust production- Comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space.

**TOTAL : 45 PERIODS**

### OUTCOMES:

- Illustrate the history of aircraft & developments over the years
- Ability to identify the types & classifications of components and control systems
- Explain the basic concepts of flight & Physical properties of Atmosphere
- Identify the types of fuselage and constructions.
- Distinguish the types of Engines and explain the principles of Rocket

## TEXT BOOKS

1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition , 2015
2. E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021
3. Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.

## REFERENCES

1. Sadhu Singh, "Internal Combustion Engines and Gas Turbine"-, SS Kataria & Sons, 2015
2. Kermode , "Flight without Formulae", -, Pitman; 4th revised edition 1989

**OML351**

## **INTRODUCTION TO NON-DESTRUCTIVE TESTING**

**L T P C**  
**3 0 0 3**

### **COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basic importance of NDT in quality assurance.
- Imbibing the basic principles of various NDT techniques, its applications, limitations, codes and standards.
- Equipping themselves to locate a flaw in various materials, products.
- Applying apply the testing methods for inspecting materials in accordance with industry specifications and standards.
- Acquiring the knowledge on the selection of the suitable NDT technique for a given application

### **UNIT I INTRODUCTION TO NDT & VISUAL TESTING**

**9**

Concepts of Non-destructive testing-relative merits and limitations-NDT Versus mechanical testing, Fundamentals of Visual Testing – vision, lighting, material attributes, environmental factors, visual perception, direct and indirect methods – mirrors, magnifiers, boroscopes and fibroscopes – light sources and special lighting.

### **UNIT II LIQUID PENETRANT & MAGNETIC PARTICLE TESTING**

**9**

Liquid Penetrant Inspection: principle, applications, advantages and limitations, dyes, developers and cleaners, Methods & Interpretation.

Magnetic Particle Inspection: Principles, applications, magnetization methods, magnetic particles, Testing Procedure, demagnetization, advantages and limitations, – Interpretation and evaluation of test indications.

### **UNIT III EDDY CURRENT TESTING & THERMOGRAPHY**

**9**

Eddy Current Testing: Generation of eddy currents– properties– eddy current sensing elements, probes, Instrumentation, Types of arrangement, applications, advantages, limitations – Factors affecting sensing elements and coil impedance, calibration, Interpretation/Evaluation.

Thermography- Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal – Concept, example, advantages & limitations. Electromagnetic spectrum, infrared thermography- approaches, IR detectors, Instrumentation and methods, applications.

### **UNIT IV ULTRASONIC TESTING & AET**

**9**

Ultrasonic Testing: Types of ultrasonic waves, characteristics, attenuation, couplants, probes, EMAT. Inspection methods-pulse echo, transmission and phased array techniques, types of scanning and displays, angle beam inspection of welds, time of flight diffraction (TOFD) technique, Thickness determination by ultrasonic method, Study of A, B and C scan presentations, calibration. Acoustic Emission Technique – Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages & Limitations, Interpretation of Results, Applications.

**UNIT V RADIOGRAPHY TESTING****9**

Sources-X-rays and Gamma rays and their characteristics-absorption, scattering. Filters and screens, Imaging modalities-film radiography and digital radiography (Computed, Direct, Real Time, CT scan). Problems in shadow formation, exposure factors, inverse square law, exposure charts, Penetrameters, safety in radiography.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

After completion of this course, the students will be able to

1. Realize the importance of NDT in various engineering fields.
2. Have a basic knowledge of surface NDE techniques which enables to carry out various inspection in accordance with the established procedures.
3. Calibrate the instrument and inspect for in-service damage in the components by means of Eddy current testing as well as Thermography testing.
4. Differentiate various techniques of UT and AET and select appropriate NDT methods for better evaluation.
5. Interpret the results of Radiography testing and also have the ability to analyse the influence of various parameters on the testing.

**TEXT BOOKS:**

1. Baldev Raj, T. Jayakumar and M. Thavasimuthu, Practical Non Destructive Testing, Alpha Science International Limited, 3rd edition, 2002.
2. J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition, 2011.
3. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010.

**REFERENCES:**

1. ASM Metals Handbook, V-17, "Nondestructive Evaluation and Quality Control", American Society of Metals, USA, 2001.
2. Barry Hull and Vernon John, "Nondestructive Testing", Macmillan, 1989.
3. Chuck Hellier, "Handbook of Nondestructive Evaluation", Mc Graw Hill, 2012.
4. Louis Cartz, "Nondestructive Testing", ASM International, USA, 1995.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
<b>C01</b>	2	2	2	3			2	2				2	1	2	
<b>C02</b>	3	1	2	2			2	2				2	2	2	1
<b>C03</b>	3	2	1	2			2	2				2	2	2	
<b>CO4</b>	3	1	2	2			2	2				2	2	2	2
<b>CO5</b>	3	2	2	2			2	2				2	2	2	1
<b>Avg</b>	2.8	1.6	1.8	2.2			2	2				2	1.8	2	1.3



**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

1. Selecting sensors to develop mechatronics systems.
2. Explaining the architecture and timing diagram of microprocessor, and also interpret and develop programs.
3. Designing appropriate interfacing circuits to connect I/O devices with microprocessor.
4. Applying PLC as a controller in mechatronics system.
5. Designing and develop the apt mechatronics system for an application.

**UNIT – I INTRODUCTION AND SENSORS 9**

Introduction to Mechatronics – Systems – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and Dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance Sensors – Strain Gauges – Eddy Current Sensor – Hall Effect Sensor – Temperature Sensors – Light Sensors.

**UNIT – II 8085 MICROPROCESSOR 9**

Introduction – Pin Configuration - Architecture of 8085 – Addressing Modes – Instruction set, Timing diagram of 8085.

**UNIT – III PROGRAMMABLE PERIPHERAL INTERFACE 9**

Introduction – Architecture of 8255, Keyboard Interfacing, LED display – Interfacing, ADC and DAC Interface, Temperature Control – Stepper Motor Control – Traffic Control Interface.

**UNIT – IV PROGRAMMABLE LOGIC CONTROLLER 9**

Introduction – Architecture – Input / Output Processing – Programming with Timers, Counters and Internal relays – Data Handling – Selection of PLC.

**UNIT – V ACTUATORS AND MECHATRONICS SYSTEM DESIGN 9**

Types of Stepper and Servo motors – Construction – Working Principle – Characteristics, Stages of Mechatronics Design Process – Comparison of Traditional and Mechatronics Design Concepts with Examples – Case studies of Mechatronics Systems – Pick and Place Robot – Engine Management system – Automatic Car Park Barrier.

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

CO1: Select sensors to develop mechatronics systems.

CO2: Explain the architecture and timing diagram of microprocessor, and also interpret and develop programs.

CO3: Design appropriate interfacing circuits to connect I/O devices with microprocessor.

CO 4: Apply PLC as a controller in mechatronics system.

CO 5: Design and develop the apt mechatronics system for an application.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	3		2						2	3	2	3
CO2	3	2	1	3		2						2	3	2	3
CO3	3	2	1	3		2						2	3	2	3
CO4	3	2	1	3		2						2	3	2	3
CO5	3	2	1	3		2						2	3	2	3
CO/PO & PSO Average	3	2	1	3		2						2	3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

**TEXT BOOKS:**

1. Bolton W., "Mechatronics", Pearson Education, 6th Edition, 2015.
2. Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Penram International Publishing Private Limited, 6th Edition, 2013.

**REFERENCES:**

1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., "Mechatronics", Chapman and Hall, 1993.
2. Davis G. Alciatore and Michael B. Hstand, "Introduction to Mechatronics and Measurement systems", McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, "Mechatronics Principles, Concepts and Applications", McGraw Hill Education, 2015.
5. Smaili. A and Mrad. F, "Mechatronics Integrated Technologies for Intelligent Machines", Oxford University Press, 2007.

**ORA351****FOUNDATION OF ROBOTICS**

L	T	P	C
3	0	0	3

**COURSE OBJECTIVES:**

1. To study the kinematics, drive systems and programming of robots.
2. To study the basics of robot laws and transmission systems.
3. To familiarize students with the concepts and techniques of robot manipulator, its kinematics.
4. To familiarize students with the various Programming and Machine Vision application in robots.
5. To build confidence among students to evaluate, choose and incorporate robots in engineering systems.

**UNIT – I FUNDAMENTALS OF ROBOT****9**

Robot – Definition – Robot Anatomy – Co-ordinate systems, Work Envelope, types and classification – specifications – Pitch, yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and their functions – Need for Robots – Different Applications.

**UNIT – II ROBOT KINEMATICS****9**

Forward kinematics, inverse kinematics and the difference: forward kinematics and inverse Kinematics of Manipulators with two, three degrees of freedom (in 2 dimensional), four degrees of freedom (in 3 dimensional) – derivations and problems. Homogeneous transformation matrices, translation and rotation matrices.

**UNIT – III ROBOT DRIVE SYSTEMS AND END EFFECTORS****9**

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of All These Drives. End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic grippers, vacuum grippers, internal grippers and external grippers, selection and design considerations of a gripper

**UNIT – IV      SENSORS IN ROBOTICS****9**

Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors, safety considerations in robotic cell, proximity sensors, fail safe hazard sensor systems, and compliance mechanism. Machine vision system - camera, frame grabber, sensing and digitizing image data – signal conversion, image storage, lighting techniques, image processing and analysis – data reduction, segmentation, feature extraction, object recognition, other algorithms, applications – Inspection, identification, visual serving and navigation.

**UNIT – V      PROGRAMMING AND APPLICATIONS OF ROBOT****9**

Teach pendant programming, lead through programming, robot programming languages – VAL programming – Motion Commands, Sensors commands, End-Effector Commands, and simple programs - Role of robots in inspection, assembly, material handling, underwater, space and medical fields.

**TOTAL : 45 PERIODS****COURSE OUTCOMES**

At the end of the course, students will be able to:

CO1: Interpret the features of robots and technology involved in the control.

CO2: Apply the basic engineering knowledge and laws for the design of robotics.

CO3: Explain the basic concepts like various configurations, classification and parts of end effectors compare various end effectors and grippers and tools and sensors used in robots.

CO4: Explain the concept of kinematics, degeneracy, dexterity and trajectory planning.

CO5: Demonstrate the image processing and image analysis techniques by machine vision system.

Mapping of COs with POs and PSOs															
COs/POs& PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	1								1			3
CO2	3	2	1	1								1			3
CO3	3	2	1	1								1			3
CO4	3	2	1	1								1			3
CO5	3	2	1	1								1			3
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

**TEXT BOOKS:**

1. Ganesh.S.Hedge, "A textbook of Industrial Robotics", Lakshmi Publications, 2006.
2. Mikell.P.Groover , "Industrial Robotics – Technology, Programming and applications" McGraw Hill 2<sup>ND</sup> edition 2012.

**REFERENCES:**

1. Fu K.S. Gonalz R.C. and ice C.S.G."Robotics Control, Sensing, Vision and Intelligence", McGraw Hill book co. 2007.
2. YoramKoren, "Robotics for Engineers", McGraw Hill Book, Co., 2002.
3. Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill 2005.
4. John. J.Craig, "Introduction to Robotics: Mechanics and Control" 2nd Edition, 2002.
5. Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer India reprint, 2010.

**OBJECTIVES:**

- To introduce the concepts of remote sensing processes and its components.
- To expose the various remote sensing platforms and sensors and to introduce the elements of data interpretation

**UNIT I REMOTE SENSING AND ELECTROMAGNETIC RADIATION 9**

Definition – components of RS – History of Remote Sensing – Merits and demerits of data collation between conventional and remote sensing methods - Electromagnetic Spectrum – Radiation principles - Wave theory, Planck's law, Wien's Displacement Law, Stefan's Boltzmann law, Kirchoff's law – Radiation sources: active & passive - Radiation Quantities

**UNIT II EMR INTERACTION WITH ATMOSPHERE AND EARTH MATERIAL 9**

Standard atmospheric profile – main atmospheric regions and its characteristics – interaction of radiation with atmosphere – Scattering, absorption and refraction – Atmospheric windows - Energy balance equation – Specular and diffuse reflectors – Spectral reflectance & emittance – Spectroradiometer – Spectral Signature concepts – Typical spectral reflectance curves for vegetation, soil and water – solid surface scattering in microwave region.

**UNIT III ORBITS AND PLATFORMS 9**

Motions of planets and satellites – Newton's law of gravitation - Gravitational field and potential - Escape velocity - Kepler's law of planetary motion - Orbit elements and types – Orbital perturbations and maneuvers – Types of remote sensing platforms - Ground based, Airborne platforms and Space borne platforms – Classification of satellites – Sun synchronous and Geosynchronous satellites – Lagrange Orbit.

**UNIT IV SENSING TECHNIQUES 9**

Classification of remote sensors – Resolution concept : spatial, spectral, radiometric and temporal resolutions - Scanners - Along and across track scanners – Optical-infrared sensors – Thermal sensors – microwave sensors – Calibration of sensors - High Resolution Sensors - LIDAR , UAV – Orbital and sensor characteristics of live Indian earth observation satellites

**UNIT V DATA PRODUCTS AND INTERPRETATION 9**

Photographic and digital products – Types, levels and open source satellite data products – selection and procurement of data– Visual interpretation: basic elements and interpretation keys - Digital interpretation – Concepts of Image rectification, Image enhancement and Image classification

**TOTAL:45 PERIODS****COURSE OUTCOMES:**

On completion of the course, the student is expected to

- CO 1** Understand the concepts and laws related to remote sensing
- CO 2** Understand the interaction of electromagnetic radiation with atmosphere and earth material
- CO 3** Acquire knowledge about satellite orbits and different types of satellites
- CO 4** Understand the different types of remote sensors
- CO 5** Gain knowledge about the concepts of interpretation of satellite imagery

**TEXTBOOKS:**

1. Thomas M.Lillesand, Ralph W. Kiefer and Jonathan W. Chipman, Remote Sensing and Image interpretation, John Wiley and Sons, Inc, New York,2015.
2. George Joseph and C Jeganathan, Fundamentals of Remote Sensing,Third Edition Universities Press (India) Private limited, Hyderabad, 2018

**REFERENCES:**

1. Janza, F.Z., Blue H.M. and Johnson,J.E. Manual of Remote Sensing. Vol.1, American Society of Photogrametry, Virginia, USA, 2002.
2. Verbyla, David, Satellite Remote Sensing of Natural Resources. CRC Press, 1995
3. Paul Curran P.J. Principles of Remote Sensing. Longman, RLBS, 1988.

4. Introduction to Physics and Techniques of Remote Sensing , Charles Elachi and Jacob Van Zyl, 2006 Edition II, Wiley Publication.
5. Basudeb Bhatta, Remote Sensing and GIS, Oxford University Press, 2011

### CO-PO MAPPING

PO	Graduate Attribute	Course Outcome					Average
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering Knowledge	3	3	3	3	3	3
PO2	Problem Analysis				3	3	3
PO3	Design/Development of Solutions				3	3	3
PO4	Conduct Investigations of Complex Problems				3	3	3
PO5	Modern Tool Usage				3	3	3
PO6	The Engineer and Society						
PO 7	Environment and Sustainability						
PO 8	Ethics						
PO 9	Individual and Team Work						
PO 10	Communication						
PO 11	Project Management and Finance						
PO 12	Life-long Learning	3		3	3	3	3
PSO 1	Knowledge of Geoinformatics discipline	3	3	3	3	3	3
PSO 2	Critical analysis of Geoinformatics Engineering problems and innovations	3	3	3	3	3	3
PSO 3	Conceptualization and evaluation of Design solutions	3	3	3	3	3	3

**OAI351**

**URBAN AGRICULTURE**

**L T P C**

**3 0 0 3**

#### OBJECTIVES:

- To introduce the students the principles of agricultural crop production and the production practices of crops in modern ways.
- To delineate the role of agricultural engineers in relation to various crop production practices.

#### UNIT I INTRODUCTION

**9**

Benefits of urban agriculture- economic benefits, environmental benefits, social and cultural benefits, educational, skill-building and job training benefits, health, nutrition and food accessibility benefits.

#### UNIT II VERTICAL FARMING

**9**

Vertical farming- types, green facade, living/green wall-modular green wall , vegetated mat wall-Structures and components for green wall system: plant selection, growing media, irrigation and plant nutrition: Design, light, benefits of vertical gardening. Roof garden and its types. Kitchen garden, hanging baskets: The house plants/ indoor plants

#### UNIT III SOIL LESS CULTIVATION

**9**

Hydroponics, aeroponics, aquaponics: merits and limitations, costs and Challenges, backyard gardens- tactical gardens- street landscaping- forest gardening, greenhouses, urban beekeeping

#### UNIT IV MODERN CONCEPTS

**9**

Growth of plants in vertical pipes in terraces and inside buildings, micro irrigation concepts suitable for roof top gardening, rain hose system, Green house, polyhouse and shade net system of crop production on roof tops

#### UNIT V WASTE MANAGEMENT

**9**

Concept, scope and maintenance of waste management- recycle of organic waste, garden wastes- solid waste management-scope, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, waste utilization.

**COURSE OUTCOMES**

1. Demonstrate the principles behind crop production and various parameters that influences the crop growth on roof tops
2. Explain different methods of crop production on roof tops
3. Explain nutrient and pest management for crop production on roof tops
4. Illustrate crop water requirement and irrigation water management on roof tops
5. Explain the concept of waste management on roof tops

**TEXT BOOKS:**

1. Martellozzo F and J S Landry. 2020. Urban Agriculture. Scitus Academics Llc.
2. Rob Roggema. 2016. Sustainable Urban Agriculture and Food Planning. Routledge Taylor and Francis Group.
3. Akrong M O. 2012. Urban Agriculture. LAP Lambert Academic Publishing.

**REFERENCES:**

1. Agha Rokh A. 2008. Evaluation of ornamental flowers and fishes breeding in Bushehr urban wastewater using a pilot-scale aquaponic system. Water and Wastewater, 19 (65): 47–53.
2. Agrawal M, Singh B, Rajput M, Marshall F and Bell J. N. B. 2003. Effect of air pollution on peri-urban agriculture: A case study. Environmental Pollution, 126 (3): 323–329. <https://www.sciencedirect.com/science/article/pii/S0269749103002458#aep-section-id24>.
3. Jac Smit and Joe Nasr. 1992. Urban agriculture for sustainable cities: using wastes and idle land and water bodies as resources. Environment and Urbanization, 4 (2):141-152.

**CO-PO MAPPING**

PO/PSO		CO1	CO2	CO3	CO4	CO5	Overall correlation of COs with POs
PO1	Engineering Knowledge	1	2	1	1	2	1
PO2	Problem Analysis	1	1	1	1	1	2
PO3	Design/ Development of Solutions	1	2	1	1	3	2
PO4	Conduct Investigations of Complex Problems	1	1	2	2	1	1
PO5	Modern Tool Usage	1	2	1	1	1	2
PO6	The Engineer and Society	1	2	1	2	1	1
PO7	Environment and sustainability	1	2	1	1	2	1
PO8	Ethics	2	1	1	1	2	1
PO9	Individual and team work:	1	1	2	1	1	1
PO10	Communication	1	2	1	1	2	1
PO11	Project management and finance	1	1	1	1	1	2
PO12	Life-long learning:	1	2	1	1	3	2
PSO1	To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	1	2	1	1	2	1
PSO2	To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.	2	1	2	1	1	1
PSO3	To inculcate entrepreneurial skills through strong Industry-Institution linkage.	1	2	1	2	1	2

**OBJECTIVE:**

- To equip the students with the principles and design of water treatment units and distribution system.

**UNIT I SOURCES OF WATER****9**

Public water supply system – Planning, Objectives, Design period, Population forecasting; Water demand – Sources of water and their characteristics, Surface and Groundwater – Impounding Reservoir – Development and selection of source – Source Water quality – Characterization – Significance – Drinking Water quality standards.

**UNIT II CONVEYANCE FROM THE SOURCE****9**

Water supply – intake structures – Functions; Pipes and conduits for water – Pipe materials – Hydraulics of flow in pipes – Transmission main design – Laying, jointing and testing of pipes – appurtenances – Types and capacity of pumps – Selection of pumps and pipe materials.

**UNIT III WATER TREATMENT****9**

Objectives – Unit operations and processes – Principles, functions, and design of water treatment plant units, aerators of flash mixers, Coagulation and flocculation – sand filters - Disinfection – Construction, Operation and Maintenance aspects.

**UNIT IV ADVANCED WATER TREATMENT****9**

Water softening – Desalination- R.O. Plant – demineralization – Adsorption - Ion exchange– Membrane Systems - Iron and Manganese removal - Defluoridation - Construction and Operation and Maintenance aspects

**UNIT V WATER DISTRIBUTION AND SUPPLY****9**

Requirements of water distribution – Components – Selection of pipe material – Service reservoirs - Functions – Network design – Economics - Computer applications – Appurtenances – Leak detection - Principles of design of water supply in buildings – House service connection – Fixtures and fittings, systems of plumbing and types of plumbing.

**TOTAL: 45 PERIODS****OUTCOMES**

CO1: An understanding of water quality criteria and standards, and their relation to public health

CO2: The ability to design the water conveyance system

CO3: The knowledge in various unit operations and processes in water treatment

CO4: An ability to understand the various systems for advanced water treatment

CO5: An insight into the structure of drinking water distribution system

**TEXT BOOKS :**

- Garg. S.K., "Water Supply Engineering", Khanna Publishers, Delhi, September 2008.
- Punmia B.C, Arun K.Jain, Ashok K.Jain, " Water supply Engineering" Lakshmi publication private limited, New Delhi, 2016.
- Rangwala "Water Supply and Sanitary Engineering", February 2022
- Birdie.G.S., "Water Supply and Sanitary Engineering", Dhanpat Rai and sons, 2018.

**REFERENCES :**

- Fair. G.M., Geyer.J.C., "Water Supply and Wastewater Disposal", John Wiley and Sons, 1954.

2. Babbit.H.E, and Donald.J.J, "Water Supply Engineering" , McGraw Hill book Co, 1984.
3. Steel. E.W.et al., "Water Supply Engineering" , Mc Graw Hill International book Co, 1984.
4. Duggal. K.N., "Elememts of public Health Engineering", S.Chand and Company Ltd, New Delhi, 1998.

### CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		3						3		3			3		
2		3		2		2				3			3		
3				2		2				3			3		
4			3	2				3	2	3			3		
5			3	2			1		2	3		1			
Avg.		3	3	2		2	1	3	2	3		1	3		

1.low, 2-medium, 3-high, '-'- no correlation

**Note: The average value of this course to be used for program articulation matrix.**

OEE352

**ELECTRIC VEHICLE TECHNOLOGY**

**L T P C**  
**3 0 0 3**

#### COURSE OBJECTIVES

- To provide knowledge about electric machines and special machine
- To understand the basics of power converters
- To know the concepts of controlling DC and AC drive systems
- To understand the architecture and power train components.
- To impart knowledge on vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs)

#### UNIT I ROTATING POWER CONVERTERS 9

Magnetic circuits- DC machine and AC machine –Working principle of Generator and Motor-DC and AC - Voltage and torque equations – Characteristics and applications. Working principle of special machines like: Brushless DC motor, Switched reluctance motor and PMSM.

#### UNIT II STATIC POWER CONVERTERS 9

Working and Characteristics of Power Diodes, MOSFET and IGBT. Working of uncontrolled rectifiers, controlled rectifiers (Single phase and Three phase), DC choppers, single and three phase inverters, Multilevel inverters and Matrix Converters.

#### UNIT III CONTROL OF DC AND AC MOTOR DRIVES 9

Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and braking) of induction motor drives, Transformation theory, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives

#### UNIT IV HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENTS 9

History of evolution of Electric Vehicles - Comparison of Electric Vehicles with Internal Combustion Engines - Architecture of Electric Vehicles (EV) and Hybrid Electric Vehicles (HEV) – Plug-in Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes.



**UNIT V MECHANICS OF HYBRID ELECTRIC VEHICLES AND CONTROL OF VEHICLES**

**9**

Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of HEV's - motor torque and power rating and battery capacity. HEV supervisory control - Selection of modes - power spilt mode - parallel mode - engine brake mode - regeneration mode - series parallel mode

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- CO1: Able to understand the principles of conventional and special electrical machines.
- CO2: Acquired the concepts of power devices and power converters
- CO3: Able to understand the control for DC and AC drive systems.
- CO4: Learned the electric vehicle architecture and power train components.
- CO5: Acquired the knowledge of mechanics of electric vehicles and control of electric vehicles.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	3	2			3								3	3	3
<b>CO2</b>	3	2	2			3			3				3	3	3
<b>CO3</b>	3			3		2	2						3	3	3
<b>CO4</b>	3	2	2		3								3	3	3
<b>CO5</b>	3		2								2		3	3	3
<b>Avg</b>	3	2	2	3	3	1	2		3		2		3	3	3

**REFERENCES:**

- 1 Stephen D. Umans, "Fitzgerald & Kingsley's Electric Machinery", Tata McGraw Hill, 7<sup>th</sup> Edition, 2020.
- 2 Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011
- 3 Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek "Analysis of Electric Machinery and Drive Systems", 3<sup>rd</sup> Edition, Wiley-IEEE Press, 2013.
- 4 Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Pearson, fourth Edition, 10<sup>th</sup> Impression 2021.
- 5 Iqbal Husain, 'Electric and Hybrid Electric Vehicles', CRC Press, 2021.
- 6 Wei Liu, 'Hybrid Electric Vehicle System Modeling and Control', Second Edition, WILEY, 2017
- 7 James Larminie and John Lowry, 'Electric Vehicle Technology Explained', Second Edition, Wiley, 2012

**OEI353**

**INTRODUCTION TO PLC PROGRAMMING**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

1. Understand basic PLC terminologies digital principles, PLC architecture and operation.
2. Familiarize different programming language of PLC.
3. Develop PLC logic for simple applications using ladder logic.
4. Understand the hardware and software behind PLC and SCADA.
5. Exposures about communication architecture of PLC/SCADA.

**UNIT I INTRODUCTION TO PLC**

**9**

Introduction to PLC: Microprocessor, I/O Ports, Isolation, Filters, Drivers, Microcontrollers/DSP, PLC/DDC- PLC Construction: What is a PLC, PLC Memories, PLC I/O, , PLC Special I/O, PLC Types.

**UNIT II PLC INSTRUCTIONS 9**

PLC Basic Instructions: PLC Ladder Language- Function block Programming- Ladder/Function Block functions- PLC Basic Instructions, Basic Examples (Start Stop Rung, Entry/Reset Rung)- Configuration of Sensors, Switches, Solid State Relays-Interlock examples- Timers, Counters, Examples.

**UNIT III PLC PROGRAMMING 9**

Different types of PLC program, Basic Ladder logic, logic functions, PLC module addressing, registers basics, basic relay instructions, Latching Relays, arithmetic functions, comparison functions, data handling, data move functions, timer-counter instructions, input-output instructions, sequencer instructions

**UNIT IV COMMUNICATION OF PLC AND SCADA 9**

Communication Protocol – Modbus, HART, Profibus- Communication facilities SCADA: - Hardware and software, Remote terminal units, Master Station and Communication architectures

**UNIT V CASE STUDIES 9**

Stepper Motor Control- Elevator Control-CNC Machine Control- conveyor control-Interlocking Problems

**TOTAL:45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content**

**Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)**

**5**

1. Market survey of the recent PLCs and comparison of their features.
2. Summarize the PLC standards
3. Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)
4. Market survey of Communication Network Used for PLC/SCADA.

**COURSE OUTCOMES:**

- CO1** Know the basic requirement of a PLC input/output devices and architecture. (L1)  
**CO2** Ability to apply Basics Instruction Sets used for ladder Logic and Function Block Programming.(L2)  
**CO3** Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.(L3)  
**CO4** Able to develop a PLC logic for a specific application on real world problem. (L5)  
**CO5** Ability to Understand the Concepts of Communication used for PLC/SCADA.(L1)

**TEXT BOOKS:**

1. Frank Petruzzola, Programmable Logic Controllers, Tata Mc-Graw Hill Edition
2. John W. Webb, Ronald A. Reis, Programmable Logic Controllers Principles and Applications, PHI publication

**REFERENCES:**

1. MadhuchandMitra and SamerjitSengupta, Programmable Logic Controllers Industrial Automation an Introduction, Penram International Publishing Pvt. Ltd.
2. J. R. Hackworth and F. D. Hackworth, Programmable Logic Controllers Principles andApplications, Pearson publication

**List of Open Source Software/ Learning website:**

1. <https://nptel.ac.in/courses/108105063>
2. <https://www.electrical4u.com/industrial-automation/>
3. <https://www.etf.ues.rs.ba/~slubura/Procesni%20racunari/Programmable%20Logic%20Controllers%20Programming%20Methods.pdf>
4. <https://www.electrical4u.com/industrial-automation/>

## MAPPING COURSE OUTCOMES WITH PROGRAMME OUTCOMES

PO, PSO CO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1					1		1					
CO2	3	3	2					1		1	2				2
CO3	3	3	3	3	1			1		1					
CO4	3	3		3	3			1		1			3	3	
CO5	3	3	3	2	1			1		1			3	3	3
Avg	3	2.9	2.25	2.6	1.6			1		1			3	3	2.9

OCH351

NANO TECHNOLOGY

L T P C  
3 0 0 3

### UNIT I INTRODUCTION

8

General definition and size effects—important nano structured materials and nano particles- importance of nano materials- Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials- surface area - band gap energy and applications. Photochemistry and Electrochemistry of nanomaterials –Ionic properties of nanomaterials- Nano catalysis.

### UNIT II SYNTHESIS OF NANOMATERIALS

8

Bottom up and Top-down approach for obtaining nano materials - Precipitation methods – sol gel technique – high energy ball milling, CVD and PVD methods, gas phase condensation, magnetron sputtering and laser deposition methods – laser ablation, sputtering.

### UNIT III NANO COMPOSITES

10

Definition- importance of nanocomposites- nano composite materials-classification of composites- metal/metal oxides, metal-polymer- thermoplastic based, thermoset based and elastomer based- influence of size, shape and role of interface in composites applications.

### UNIT IV NANO STRUCTURES AND CHARACTERIZATION TECHNIQUES

10

Classifications of nanomaterials - Zero dimensional, one-dimensional and two-dimensional nanostructures- Kinetics in nanostructured materials- multilayer thin films and superlattice- clusters of metals, semiconductors and nanocomposites. Spectroscopic techniques, Diffraction methods, thermal analysis method, BET analysis method.

### UNIT V APPLICATIONS OF NANO MATERIALS

9

Overview of nanomaterials properties and their applications, nano painting, nano coating, nanomaterials for renewable energy, Molecular Electronics and Nanoelectronics – Nanobots- Biological Applications. Emerging technologies for environmental applications- Practice of nanoparticles for environmental remediation and water treatment.

**TOTAL : 45 PERIODS**

### OUTCOMES:

CO1 Understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications.

CO2 Able to acquire knowledge about the different types of nano material synthesis

CO3 Describes about the shape, size, structure of composite nano materials and their interference

CO4 Understand the different characterization techniques for nanomaterials

CO5 Develop a deeper knowledge in the application of nanomaterials in different fields.

## TEXT BOOKS

1. Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmom, Burkhard Raguse, " Nano Technology: Basic Science & Engineering Technology", 2005, Overseas Press
2. G. Cao, "Nanostructures & Nanomaterials: Synthesis, Properties & Applications" Imperial College Press, 2004
3. William A Goddard "Handbook of Nanoscience, Engineering and Technology", 3<sup>rd</sup> Edition, CRC Taylor and Francis group 2012.

## REFERENCES

1. R.H.J.Hannink & A.J.Hill, Nanostructure Control, Wood Head Publishing Ltd.,Cambridge, 2006.
2. C.N.R.Rao, A.Muller, A.K.Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications Vol. I & II, 2nd edition, 2005, Wiley VCH Verlag Gbtl & Co
3. Ivor Brodie and Julius J.Muray,'The physics of Micro/Nano – Fabrication',Springer International Edition,2010

## COURSE ARTICULATION MATRIX

Course Outcomes	Statement	Program Outcome														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications	2	3	2	3	3	-	-	-	1	1	-	3	1	1	3
CO2	acquire knowledge about the different types of nano material synthesis	2	3	1	3	3	-	-	-	1	1	-	3	2	1	3
CO3	describes about the shape, size,structure of composite nano materials and their interference	2	2	2	3	3	1	1	-	1	1	-	3	2	1	3
CO4	understand the different characterization techniques for nanomaterials	2	2	1	3	3	1	1	1	1	-	1	3	1	1	3
CO5	develop a deeper knowledge in the application of nanomaterials in different fields	2	2	1	3	3	1	1	1	1	-	1	3	2	1	3
Overall CO		3	2	2	1	3	3	1	1	1	1	1	1	3	2	1

OCH352

**FUNCTIONAL MATERIALS**

**L T P C**  
**3 0 0 3**

**OBJECTIVE:**

- The course emphasis on the molecular self assembly and materials for polymer electronics

**UNIT I INTRODUCTION**

**9**

Historical Perspectives, Lessons from the Nature, Engineering the Functions, Tuning the functions, Multiscale Modeling and Computation, Classification of Functional Materials, Functional Diversity of Materials, Hybrid Materials, Technological Relevance, Societal Impact.

**UNIT II MOLECULAR SELF ASSEMBLY**

**9**

Molecular Organization, Self-Assembly in Biology, Energetics of Self-Organization, A Few Case Studies, Synthetic Protocols and Challenges, Solvent-assisted Self-Assembly, Directed Assembly-Langmuir-Blodgett and Langmuir-Schaefer techniques, Technological Applications of SAMs.

**UNIT III BIO-INSPIRED MATERIALS**

**9**

Bio-inspired materials, Classification, Biomimicry, Spider Silk, Lotus Leaf, Gecko feet, Synovial fluid, 'Bionics'-Bio-inspired Information Technologies, Artificial Sensory Organs, Biomineralization- En route to Nanotechnology.

**UNIT IV SMART OR INTELLIGENT MATERIALS**

**9**

Criteria for Smartness, Significance of Smart Materials, Representative Examples like Smart Gels and Polymers, Electro/Magneto Rheological Fluids, Smart Electroceramics, Technical Limitations and Challenges, Functional Nanocomposites, Polymer-carbon nanotube composites.

**UNIT V MATERIALS FOR POLYMER ELECTRONICS**

**9**

Polymers for Electronics, Organic Light Emitting Diodes, Working Principle of OLEDs, Illustrated Examples, Organic Field-Effect Transistors Operating Principle, Design Considerations, Polymer FETs vs Inorganic FETs, Liquid Crystal Displays, Engineering Aspects of Flat Panel Displays, Intelligent Polymers for Data Storage, Polymer-based Data Storage-Principle, Magnetic Vs. Polymer-based Data Storage.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- Students will be able to differentiate among various functional properties and select appropriate material for certain functional applications, analyze the nature and potential of functional material.

**TEXT BOOK:**

1. Vijayamohan K. Pillai and MeeraParthasarathy, "Functional Materials: A chemist's perspective", Universities Press Hyderabad (2012).

**REFERENCE:**

1. Stephen Manne "Biomimetic Materials Chemistry" Wiley-VCH Newyork, 1966.

OFD352

**TRADITIONAL INDIAN FOODS**

**L T P C**  
**3 0 0 3**

**OBJECTIVE:**

- To help students acquire a sound knowledge on diversities of foods, food habits and patterns in India with focus on traditional foods.

**UNIT I HISTORICAL AND CULTURAL PERSPECTIVES**

**9**

Food production and accessibility - subsistence foraging, horticulture, agriculture and pastoralization, origin of agriculture, earliest crops grown. Food as source of physical sustenance, food as religious and cultural symbols; importance of food in understanding human culture -

variability, diversity, from basic ingredients to food preparation; impact of customs and traditions on food habits, heterogeneity within cultures (social groups) and specific social contexts - festive occasions, specific religious festivals, mourning etc. Kosher, Halal foods; foods for religious and other fasts.

**UNIT II TRADITIONAL METHODS OF FOOD PROCESSING 9**

Traditional methods of milling grains – rice, wheat and corn – equipments and processes as compared to modern methods. Equipments and processes for edible oil extraction, paneer, butter and ghee manufacture – comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation – sundrying, osmotic drying, brining, pickling and smoking.

**UNIT III TRADITIONAL FOOD PATTERNS 9**

Typical breakfast, meal and snack foods of different regions of India. Regional foods that have gone Pan Indian / Global. Popular regional foods; Traditional fermented foods, pickles and preserves, beverages, snacks, desserts and sweets, street foods; IPR issues in traditional foods

**UNIT IV COMMERCIAL PRODUCTION OF TRADITIONAL FOODS 9**

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods – types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods – ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters.

**UNIT V HEALTH ASPECTS OF TRADITIONAL FOODS 9**

Comparison of traditional foods with typical fast foods / junk foods – cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments / illnesses.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

CO1 To understand the historical and traditional perspective of foods and food habits

CO2 To understand the wide diversity and common features of traditional Indian foods and meal patterns.

**TEXT BOOKS:**

1. Sen, Colleen Taylor "Food Culture in India" Greenwood Press, 2005.
2. Davidar, Ruth N. "Indian Food Science: A Health and Nutrition Guide to Traditional Recipes: East West Books, 2001.

**OFD353**

**INTRODUCTION TO FOOD PROCESSING**

**L T P C**

**3 0 0 3**

**OBJECTIVE:**

- The course aims to introduce the students to the area of Food Processing. This is necessary for effective understanding of a detailed study of food processing and technology subjects. This course will enable students to appreciate the importance of food processing with respect to the producer, manufacturer and consumer.

**UNIT I PROCESSING OF FOOD AND ITS IMPORTANCE 9**

Source of food - plant, animal and microbial origin; different foods and groups of foods as raw materials for processing – cereals, pulses, grains, vegetables and fruits, milk and animal foods, sea weeds, algae, oil seeds & fats, sugars, tea, coffee, cocoa, spices and condiments, additives; need and significance of processing these foods.

**UNIT II METHODS OF FOOD HANDLING AND STORAGE 9**

Nature of harvested crop, plant and animal; storage of raw materials and products using low temperature, refrigerated gas storage of foods, gas packed refrigerated foods, sub atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; freezing of raw and processed foods.

**UNIT III LARGE-SCALE FOOD PROCESSING 12**

Milling of grains and pulses; edible oil extraction; Pasteurisation of milk and yoghurt; canning and bottling of foods; drying – Traditional and modern methods of drying, Dehydration of fruits, vegetables, milk, animal products etc; preservation by use of acid, sugar and salt; Pickling and curing with microorganisms, use of salt, and microbial fermentation; frying, baking, extrusion cooking, snack foods.

**UNIT IV FOOD WASTES IN VARIOUS PROCESSES 6**

Waste disposal-solid and liquid waste; rodent and insect control; use of pesticides; ETP; selecting and installing necessary equipment.

**UNIT V FOOD HYGIENE 9**

Food related hazards – Biological hazards – physical hazards – microbiological considerations in foods. Food adulteration – definition, common food adulterants, contamination with toxic metals, pesticides and insecticides; Safety in food procurement, storage handling and preparation; Relationship of microbes to sanitation, Public health hazards due to contaminated water and food; Personnel hygiene; Training & Education for safe methods of handling and processing food; sterilization and disinfection of manufacturing plant; use of sanitizers, detergents, heat, chemicals, Cleaning of equipment and premises.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course the students are expected to

CO1 Be aware of the different methods applied to processing foods.

CO2 Be able to understand the significance of food processing and the role of food and beverage industries in the supply of foods.

**TEXT BOOKS/REFERENCES:**

1. Karnal, Marcus and D.B. Lund "Physical Principles of Food Preservation". Rutledge, 2003.
2. VanGarde, S.J. and Woodburn. M "Food Preservation and Safety Principles and Practice". Surbhi Publications, 2001.
3. Sivasankar, B. "Food Processing & Preservation", Prentice Hall of India, 2002.
4. Khetarpaul, Neelam, "Food Processing and Preservation", Daya Publications, 2005.

**OPY352**

**IPR FOR PHARMA INDUSTRY**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- To provide the basic fundamental knowledge of different forms of Intellectual Property Rights in national and international level.
- To provide the significance of the Intellectual Property Rights about the patents, copyrights, industrial design, plant and geographical indications.
- This paper is to study significance of the amended patent act on pharma industry.

**UNIT I INTRODUCTION- INTELLECTUAL PROPERTY RIGHTS 9**

Introduction, Types of Intellectual Property Rights -patents, plant varieties protection, geographical indicators, copyright, trademark, trade secrets.

**UNIT II PATENTS 9**

Patents-Objective, Introduction, Requirement for patenting- Novelty, Inventive step (Non-obviousness) and industrial application (utility), Non-patentable inventions, rights of patent owner, assignment of patent rights, patent specification (provisional and complete), parts of complete specification, claims, procedure for obtaining patents, compulsory license.

**UNIT III PLANT VARIETY-TRADITIONAL KNOWLEDGE –GEOGRAPHICAL INDICATIONS 9**

Plant variety- Justification, criteria for protection of plant variety and protection in India. Traditional knowledge- Concept of traditional knowledge, protection of traditional knowledge under Intellectual Property frame works in national level and Traditional knowledge digital library (TKDL). Geographical Indications – Justification for protection, National and International position.

**UNIT IV ENFORCEMENT AND PRACTICAL ASPECTS OF IPR 9**

Introduction – civil remedies – injunction, damage, account of profit – criminal remedies – patent, trademark. Practical aspects – Introduction, benefits of licensing, licensing of basic types of IPR, licensing clauses of IPR. Case studies of patent infringement, compulsory licensing, simple patent license agreements.

**UNIT V INTERNATIONAL BACKGROUND OF INTELLECTUAL PROPERTY 9**

International Background of Intellectual Property- Paris Convention, Berne convention, World Trade Organization (WTO), World Intellectual Property Organization (WIPO), Trade Related Aspects of Intellectual Property Rights (TRIPS) and Patent Co-operation Treaty (PCT).

**TOTAL:45 PERIODS**

**TEXT BOOKS:**

1. N. Nagpal, M. Arora, M.R.D. Usman, S. Rahar, "Intellectual Property Rights" Edu creation Publishing, New Delhi, 2017.
2. The Patents Act, 1970 (Bare Act with Short Notes) (New Delhi: Universal Law Publishing Company Pvt. Ltd. 2012.
3. B.S. Rao, P.V. Appaji, "Intellectual Property Rights in Pharmaceutical Industry: Theory and Practice", 2015.

**REFERENCES:**

1. Patents for Chemicals, Pharmaceuticals, & Biotechnology-Fundamentals of Global Law, Practice and Strategy. Philip W. Grubb, Oxford University Press, 2004.
2. Basic Principles of patent law – Basics principles and acquisition of IPR. Ramakrishna T. CIPRA, NLSIU, Bangalore, 2005
3. S. Lakshmana Prabu, TNK. Suriyaprakash, "Intellectual Property Rights", 1st ed., In Tech open access, Croatia, 2017.

**COURSE OUTCOMES**

The student will be able to

- C1** Understand and differentiate the categories of intellectual property rights.
- C2** Describe about patents and procedure for obtaining patents.
- C3** Distinguish plant variety, traditional knowledge and geographical indications under IPR.
- C4** Provide the information about the different enforcements and practical aspects involved in protection of IPR.
- C5** Provide different organizations role and responsibilities in the protection of IPR in the international level.
- C6** Understand the interrelationships between different Intellectual Property Rights on International Society



CO – PO MAPPING												
IPR FOR PHARMA INDUSTRY												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C1	3	3		2					2	2		
C2		3	3				2	2				
C3	3	3					2	2				1
C4					2		3	3		2	2	
C5		3					3			2		1
C6	3	2				2	2					2

OTT351

**BASICS OF TEXTILE FINISHING**

**L T P C**

**3 0 0 3**

**OBJECTIVE:**

- To enable the students to understand the basics and different types of finishes required for textile materials and machines used for finishing.

**UNIT I RESIN FINISHING**

**9**

Importance of finishing and its classification. Resin finishing: Mechanism of creasing, Types of Resins .Anti crease, wash and wear, durable press resin finishing. Study about eco friendly method of anti crease finishing.

**UNIT II FLAME PROOF & WATERPROOF**

**9**

Concept of Flame proof & flame retardancy. Flame retardant finishes for cotton, Concept of waterproof and water repellent Finishes, Durable & Semi durable and Temporary finishes, Concept of Antimicrobial finish.

**UNIT III SOIL RELEASE AND ANTISTATIC FINISHES**

**9**

Soil Release Finishing: Mechanism of soil retention & soil release. Anti pilling Finishing: chemical and mechanical methods to produce anti pilling. Concept of UV Protection finishes- Concept of antistatic finishes.

**UNIT IV MECHANICAL FINISHES**

**9**

Mechanical finishing of textile materials - calendaring, compacting, Sanforising, Peach finishing. Object of Heat setting. Various methods of heat setting and mechanism of heat setting.

**UNIT V STIFFENING AND SOFTENING**

**9**

Concept of stiffening and softening of textile materials. Mechanism in the weight reduction of PET .Concept of Micro encapsulation techniques in finishing process, Nano finish, Plasma Treatment and Bio finishing.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

**Upon completion of the course, the students will be able to Understand the**

CO: 1 Basics of Resin Finishing Process.

CO:2 Concept of Flame proof & flame retardancy, waterproof and water repellent, Antimicrobial finishes.

CO: 3 Concept of Soil Release, Anti Pilling, UV Protection and Antistatic finishes.

CO: 4 Concept of Mechanical finishing.

CO: 5 Basics of Micro encapsulation techniques, Nano finish, Plasma Treatment.

**TEXT BOOKS:**

- V.A.Shennai, "Technology of Finishing", Vol X, Sevak Publications, Mumbai
- Perkins, W.S., "Textile colouration and finishing", Carolina Academic Press., U.K, ISBN: 0890898855.2004.

## REFERENCES:

1. Microencapsulation in finishing, Review of progress of Colouration, SDC, 2001 62
2. Chakraborty, J.N, Fundamentals and Practices in colouration of Textiles, Woodhead Publishing India, 2009, ISBN-13:978-81-908001-4-3
3. W. D. Schindler and P. J. Hauser "Chemical finishing of textiles", Woodhead Publishing Cambridge England,2004.

## OTT352 INDUSTRIAL ENGINEERING FOR GARMENT INDUSTRY

L T P C  
3 0 0 3

### OBJECTIVES:

- To enable the students to learn about basics of industrial engineering and different tools of industrial engineering and its application in apparel industry

### UNIT I INTRODUCTION

9

Scope of industrial engineering in apparel Industry, role of industrial engineers.

**Productivity:** Definition - Productivity, Productivity measures .Reduction of work content due to the product and process, Reduction of ineffective time due to the management, due to the worker. Causes for low productivity in apparel industry and measures for improvement.

### UNIT II WORK STUDY

9

Definition, Purpose, Basic procedure and techniques of work-study.

**Work environment** – Lighting, Ventilation, Climatic condition on productivity. Temperature control, humidity control, noise control measures. Safety and ergonomics on work station and work environment

**Material Handling** – Objectives, Classification and characteristics of material handling equipments, Specialized material handling equipments.

### UNIT III METHOD STUDY

9

Definition, Objectives, Procedure, Process charts and symbols. Various charts – Charts indicating process sequence: Outline process chart, flow process chart (man type, material type and equipment type); Charts using time scale – multiple activity chart. Diagrams indicating movement – flow diagram, string diagram, cycle graph, chrono cycle graph, travel chart

**MOTION STUDY:** Principle of motion economy, Two handed process chart, micro motion analysis – therbligs, SIMO chart.

### UNIT IV WORK MEASUREMENT

9

Definition, purpose, procedure, equipments, techniques. Time study - Definition, basics of time study- equipments. Time study forms, Stop watch procedure. Predetermined motion time standards (PMTS). Time Study rating, calculation of standard time, Performance rating – relaxation and other allowances. Calculation of SAM for different garments, GSD.

### UNIT V WORK STUDY APPLICATION

9

Application of work study techniques in cutting, stitching and packing in garment industry. Workaids in sewing, Pitch diagram, Line balancing, Capacity planning, scientific method of training.

**TOTAL: 45 PERIODS**

### OUTCOMES:

Upon the completion of the course the student shall be able to understand

CO1: Fundamental concepts of industrial Engineering and productivity

CO2: Method study

CO3: Motion analysis

CO4: Work measurement and SAM

CO5: Ergonomics and its application to garment industry

**TEXT BOOKS:**

1. George Kanwaty, "Introduction to Work Study ", ILO, Geneva, 1996, ISBN: 9221071081 | ISBN-13: 9789221071082
2. Enrick N. L., "Time study manual for Textile industry", Wiley Eastern (P) Ltd., 1989, ISBN: 0898740444 | ISBN-13: 9780898740448
3. Khanna O. P., and Sarup A., "Industrial Engineering and Management", Dhanpat Rai Publications, New Delhi, 2010, ISBN: 818992835X / ISBN: 978-8189928353

**REFERENCES**

1. Norberd Lloyd Enrick., "Industrial Engineering Manual for Textile Industry", Wiley Eastern (P) Ltd., New Delhi, 1988, ISBN: 0882756311 | ISBN-13: 9780882756318
2. Chuter A. J., "Introduction to Clothing Production Management", Wiley-Black well Science, U.S. A., 1995, ISBN: 0632039396 | ISBN-13: 9780632039395
3. GordanaColovic., "Ergonomics in the garment industry", Wood publishing India Pvt. Ltd., India, 2014, ISBN: 0857098225 | ISBN-13: 9780857098221
4. Rajesh Bheda, "Managing Productivity in Apparel Industry "CBS Publishers & Distributors, 2008

**Course Articulation Matrix:**

Course Outcomes	Statement	Program Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Fundamental concepts of industrial Engineering and productivity	2	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO2	Method study	1	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO3	Motion analysis	1	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO4	Work measurement and SAM	1	2	3	3	2	1	1	2	2	1	3	2	1	1	-
CO5	Ergonomics and its application to garment industry	1	2	3	3	2	1	2	2	2	1	3	2	1	1	-
<b>Overall CO</b>		1.2	2	3	3	2	1	1.2	2	2	1	2.4	2	1	1	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OTT353****BASICS OF TEXTILE MANUFACTURE****L T P C  
3 0 0 3****OBJECTIVES:**

To enable the students to learn about the basics of fibre forming, yarn production, fabric formation, coloration of fabrics and garment manufacturing

**UNIT I NATURAL FIBRES****9**

Introduction: Definition of staple fibre, filament; Classification of natural and man-made fibres, essential and desirable properties of fibres. Production and cultivation of Natural Fibers: Cultivation of cotton, production of silk (sericulture), wool and jute – physical and chemical structure of these fibres..

**UNIT II REGENERATED AND SYNTHETIC FIBRES 9**

Production sequence of regenerated and modified cellulosic fibres: viscose rayon, Acetate Rayon, high wet modulus and high tenacity fibres; synthetic fibres – chemical structure, fibre forming polymers, production principles.

**UNIT III BASICS OF SPINNING 9**

Spinning – principle of yarn formation, sequence of machines for yarn production with short staple fibres and blends, principles of opening and cleaning machines; yarn numbering - calculations

**UNIT IV BASICS OF WEAVING 9**

Woven fabric – warp, weft, weaving, path of warp; looms – classification, handloom and its parts, powerloom, automatic looms, shuttleless looms, special type of looms; preparatory machines for weaving process and their objectives; basic weaving mechanism - primary, secondary and auxiliary mechanisms,

**UNIT V BASICS OF KNITTING AND NONWOVEN 9**

Knitting – classification, principle, types of fabrics; nonwoven process –classification, principle, types of fabrics.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

On completion of this course, the students shall have the basic knowledge on

CO1: Classification of fibres and production of natural fibres

CO2: Regenerated and synthetic fibres

CO3: Yarn spinning

CO4: Weaving

CO5: Knitting and nonwoven

**TEXT BOOKS**

1. Mishra S. P. , “A Text Book of Fibre Science and Technology”, New Age Publishers, 2000, ISBN: 8122412505
2. Marks R., and Robinson. T.C., “Principles of Weaving”, The Textile Institute, Manchester, 1989, ISBN: 0 900739 258.
3. Spencer D.J., “Knitting Technology”, III Ed., Textile Institute, Manchester, 2001, ISBN: 185573 333 1.

**REFERENCES:**

1. Hornberer M., Eberle H., Kilgus R., Ring W. and Hermeling H., “Clothing Technology: From Fibre to Fabric”, Europa LehrmittelVerlag, 2008, ISBN: 3808562250 / ISBN: 978-3808562253.
2. Wynne A., “Motivate Series-Textiles”, Maxmillan Publications, London, 1997.
3. Carr H. and Latham B., “The Technology of Clothing Manufacture” Backwell Science, U.K., 1994, ISBN: 0632037482 / ISBN:13: 9780632037483.Klein W., “The Rieter Manual of Spinning, Vol.1”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-1-4 / ISBN 13 978-3-9523173-1-0.
4. Klein W., “The Rieter Manual of Spinning, Vol.2”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-2-2 / ISBN 13 978-3-9523173-2-7.
5. Klein W., “The Rieter Manual of Spinning, Vol.1-3”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-3-0 / ISBN 13 978-3-9523173-3-4.
6. Talukdar. M.K., Sriramulu. P.K., and Ajgaonkar. D.B., “Weaving: Machines, Mechanisms, Management”, Mahajan Publishers, Ahmedabad, 1998, ISBN: 81-85401-16-0.
7. Morton W. E., and Hearle J. W. S., “Physical Properties of Textile Fibres”, The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95
8. Gohl E. P. G., “Textile Science”, CBS Publishers and distributors, 1987, ISBN 0582685958

**OPE351 INTRODUCTION TO PETROLEUM REFINING AND  
PETROCHEMICALS**

**L T P C  
3 0 0 3**

**OBJECTIVE:**

The course is aimed to  
Gain knowledge about petroleum refining process and production of petrochemical products.

**UNIT I ORIGIN, FORMATION AND REFINING OF CRUDE OIL 9**

Origin, Formation and Evaluation of Crude Oil. Testing of Petroleum Products. Refining of Petroleum - Atmospheric and Vacuum Distillation.

**UNIT II CRACKING 9**

Cracking, Thermal Cracking, Vis-breaking, Catalytic Cracking (FCC), Hydro Cracking, Coking and Air Blowing of Bitumen

**UNIT III REFORMING AND HYDROTREATING 9**

Catalytic Reforming of Petroleum Feed Stocks. Lube oil processing- Solvent Treatment Processes, Dewaxing, Clay Treatment and Hydrofining. Treatment Techniques: Removal of Sulphur Compounds in all Petroleum Fractions to improve performance.

**UNIT IV INTRODUCTION TO PETROCHEMICALS 9**

Petrochemicals - Cracking of Naphtha and Feed stock gas for the production of Ethylene, Propylene, Isobutylene and Butadiene. Production of Acetylene from Methane, and Extraction of Aromatics.

**UNIT V PRODUCTION OF PETROCHEMICALS 9**

Production of Petrochemicals like Dimethyl Terephthalate(DMT), Ethylene Glycol, Synthetic glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate (MMA), Vinyl Acetate Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol, Acetone, Methanol, Formaldehyde, Acetaldehyde, Pentaerythritol and production of Carbon Black.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On the completion of the course students are expected to

**CO1:** Understand the classification, composition and testing methods of crude petroleum and its products.  
Learn the mechanism of refining process.

**CO2:** Understand the insights of primary treatment processes to produce the precursors.

**CO3:** Study the secondary treatment processes cracking, vis-breaking and coking to produce more petroleum products.

**CO4:** Appreciate the need of treatment techniques for the removal of sulphur and other impurities from petroleum products.

**CO5:** Understand the societal impact of petrochemicals and learn their manufacturing processes.

**CO6:** Learn the importance of optimization of process parameters for the high yield of petroleum products.

**TEXT BOOKS:**

- 1.Nelson, W. L., "Petroleum Refinery Engineering", 4th Edition. McGraw Hill, New York,1985.
2. Wiseman. P., "Petrochemicals", UMIST Series in Science and Technology, John Wiley & Sons,1986.

**REFERENCES:**

1. Bhaskara Rao, B. K., "Modern Petroleum Refining Processes", 2nd Edition, Oxford and IBH Publishing Company, New Delhi, 1990.
2. Bhaskara Rao, B. K. "A Text on Petrochemicals", 1st Edition, Khanna Publishers

**OBJECTIVES:**

At the end of the course, the student is expected to

- understand and analyse the energy data of industries
- carryout energy accounting and balancing
- conduct energy audit and suggest methodologies for energy savings and
- utilise the available resources in optimal ways

**UNIT I INTRODUCTION****9**

Energy - Power – Past & Present scenario of World; National Energy consumption Data –Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

**UNIT II ELECTRICAL SYSTEMS****9**

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

**UNIT III THERMAL SYSTEMS****9**

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution & U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

**UNIT IV ENERGY CONSERVATION IN MAJOR UTILITIES****9**

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems –Cooling Towers – D.G. sets

**UNIT V ECONOMICS****9**

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept

**TOTAL: 45 PERIODS****OUTCOMES:**

Upon completion of this course, the students can able to analyze the energy data of industries.

CO1: Remember the knowledge for Basic combustion and furnace design and selection of thermal and mechanical energy equipment.

CO2: Study the Importance of Stoichiometry relations, Theoretical air required for complete combustion.

CO3: Skills on combustion thermodynamics and kinetics.

CO4: Apply calculation and design tube still heaters.

CO5: Studied different heat treatment furnace.

CO6: Practical and theoretical knowledge burner design.

**TEXT BOOKS:**

1. Energy Manager Training Manual (4 Volumes) available at [www.energymanagertraining.com](http://www.energymanagertraining.com). a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.

**REFERENCES:**

1. Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988.
2. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford, 1981.
3. Dryden. I.G.C., "The Efficient Use of Energy" Butterworths, London, 1982
4. Turner. W.C., "Energy Management Hand book", Wiley, New York, 1982.
5. Murphy. W.R. and G. Mc KAY, "Energy Management", Butterworths, London 1987

**COURSE OBJECTIVES**

- Understand the fundamentals of plastics processing, such as the relationships between material structural properties and required processing parameters, and so on
- To gain practical knowledge on the polymer selection and its processing
- Understanding the major plastic material processing techniques (Extrusion, Injection molding, Compression and Transfer molding, Blow molding, Thermoforming and casting)
- To understand suitable additives for plastics compounding
- To Propose troubleshooting mechanisms for defects found in plastics products manufactured by various processing techniques

**UNIT I INTRODUCTION TO PLASTICS PROCESSING****9**

Introduction to plastic processing – Principles of plastic processing: processing of plastics vs. metals and ceramics. Factors influencing the efficiency of plastics processing: molecular weight, viscosity and rheology. Difference in approach for thermoplastic and thermoset processing. Additives for plastics compounding and processing: antioxidants, light stabilizers, UV stabilizers, lubricants, impact modifiers, flame retardants, antistatic agents, stabilizers and plasticizers. Compounding: plastic compounding techniques, plasticization, pelletization.

**UNIT II EXTRUSION****9**

Extrusion – Principles of extrusion. Features of extruder: barrel, screw, types of screws, drive mechanism, specifications, heating & cooling systems, types of extruders. Flow mechanism: process variables, die entry effects and exit instabilities. Die swell, Defects: melt fracture, shark skin, bambooning. Factors determining efficiency of an extruder. Extrusion of films: blown and cast films. Tube/pipe extrusion. Extrusion coating: wire & cable. Twin screw extruder and its applications. Applications of extrusion and new developments.

**UNIT III INJECTION MOLDING****9**

Injection molding – Principles and processing outline, machinery, accessories and functions, specifications, process variables, mould cycle. Types of clamping: hydraulic and toggle mechanisms. Start-up and shut down procedures-Cylinder nozzles- Press capacity projected area -Shot weight Basic theoretical concepts and their relationship to processing - Interaction of moulding process aspect effects in quoted variables. Basic mould types. Reciprocating vs. plunger type injection moulding. Thermoplastic vs. thermosetting injection moulding. Injection moulding vs. other plastic processing techniques. State-of-the art injection moulding techniques - Introduction to trouble shooting

**UNIT IV COMPRESSION AND TRANSFER MOLDING****9**

Compression moulding – Basic principles of compression and transfer moulding-Meaning of terms-Bulk factor and flow properties, moulding materials, process variables and process cycle, Inter relation between flow properties-Curing time-Mould temperature and Pressure requirements. Preforms and preheating- Techniques of preheating. Machines used-Types of compression mould- positive, semi-positive and flash. Common moulding faults and their correction- Finishing of mouldings. Transfer moulding: working principle, equipment, Press capacity-Integral moulds and auxiliary ram moulds, moulding cycle, moulding tolerances, pot transfer, plunger transfer and screw transfer moulding techniques, advantages over compression moulding

**UNIT V BLOW MOLDING, THERMOFORMING AND CASTING****9**

Blow moulding: principles and terminologies. Injection blow moulding. Extrusion blow moulding. Design guidelines for optimum product performance and appearance. Thermoforming: principle, vacuum forming, pressure forming mechanical forming. Casting: working principle, types and applications.

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES

- Ability to find out the correlation between various processing techniques with product properties.
- Understand the major plastics processing techniques used in moulding (injection, blow, compression, and transfer), extrusion, thermoforming, and casting.
- Acquire knowledge on additives for plastic compounding and methods employed for the same
- Familiarize with the machinery and ancillary equipment associated with various plastic processing techniques.
- Select an appropriate processing technique for the production of a plastic product

## REFERENCES:

1. S. S. Schwart, S. H. Goodman, Plastics Materials and Processes, Van Nostrad Reinhold Company Inc. (1982).
2. F. Hensen (Ed.), Plastic Extrusion Technology, Hanser Gardner (1997).
3. W. S. Allen and P. N. Baker, Hand Book of Plastic Technology, Volume-1, Plastic Processing Operations [Injection, Compression, Transfer, Blow Molding], CBS Publishers and Distributors (2004).
4. M. Chanda, S. K. Roy, Plastic Technology handbook, 4th Edn., CRC Press (2007).
5. I. I. Rubin, Injection Molding Theory & Practice, Society of Plastic Engineers, Wiley (1973).
6. D.V. Rosato, M. G. Rosato, Injection Molding Hand Book, Springer (2012).
7. M. L. Berins (Ed.), SPI Plastic Engineering Hand Book of Society of Plastic Industry Inc., Springer (2012).
8. B. Strong, Plastics: Material & Processing, A, Pearson Prentice hall (2005).
9. D.V Rosato, Blow Molding Hand Book, Carl HanserVerlag GmbH & Co (2003).

OEC351

**SIGNALS AND SYSTEMS**

**L T P C**  
**3 0 0 3**

## COURSE OBJECTIVES :

- To understand the basic properties of signal & systems
- To know the methods of characterization of LTI systems in time domain
- To analyze continuous time signals and system in the Fourier and Laplace domain
- To analyze discrete time signals and system in the Fourier and Z transform domain

### **UNIT I CLASSIFICATION OF SIGNALS AND SYSTEMS 9**

Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids\_Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals -Classification of systems- CT systems and DT systems- – Linear & Nonlinear, Time-variant& Time-invariant,Causal & Non-causal, Stable & Unstable.

### **UNIT II ANALYSIS OF CONTINUOUS TIME SIGNALS 9**

Fourier series for periodic signals - Fourier Transform – properties- Laplace Transforms and Properties

### **UNIT III LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS 9**

Impulse response - convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems - Systems connected in series / parallel.

### **UNIT IV ANALYSIS OF DISCRETE TIME SIGNALS 9**

Baseband signal Sampling–Fourier Transform of discrete time signals (DTFT)– Properties of DTFT - Z Transform & Properties



**UNIT V LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS****9**

Impulse response–Difference equations–Convolution sum- Discrete Fourier Transform and Z Transform  
 Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:****At the end of the course, the student will be able to:**

CO1:Determine if a given system is linear/causal/stable

CO2: Determine the frequency components present in a deterministic signal

CO3:Characterize continuous LTI systems in the time domain and frequency domain

CO4:Characterize discrete LTI systems in the time domain and frequency domain

CO5:Compute the output of an LTI system in the time and frequency domains

**TEXT BOOKS:**

1. Oppenheim, Willsky and Hamid, "Signals and Systems", 2nd Edition, Pearson Education, New Delhi, 2015.(Units I - V)
2. Simon Haykin, Barry Van Veen, "Signals and Systems", 2nd Edition, Wiley, 2002

**REFERENCES:**

1. B. P. Lathi, "Principles of Linear Systems and Signals", 2<sup>nd</sup> Edition, Oxford, 2009.
2. M. J. Roberts, "Signals and Systems Analysis using Transform methods and MATLAB", McGraw-Hill Education, 2018.
3. John Alan Stuller, "An Introduction to Signals and Systems", Thomson, 2007.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	3	-	3	2	-	-	-	-		3	-	-	1
2	3	-	3	-	-	2	-	-	-	-		3	-	3	-
3	3	3	-	-	3	2	-	-	-	-		3	2	-	-
4	3	3	-	-	3	2	-	-	-	-		3	-	3	1
5	3	3	-	3	3	2	-	-	-	-		3	-	3	1
<b>CO</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>1</b>

**OEC352 FUNDAMENTALS Of ELECTRONIC DEVICES AND CIRCUITS****L T P C  
3 0 0 3****COURSE OBJECTIVES :**

- To give a comprehensive exposure to all types of devices and circuits constructed with discrete components. This helps to develop a strong basis for building linear and digital integrated circuits
- To analyze the frequency response of small signal amplifiers
- To design and analyze single stage and multistage amplifier circuits
- To study about feedback amplifiers and oscillators principles
- To understand the analysis and design of multi vibrators

**UNIT I SEMICONDUCTOR DEVICES****9**

PN junction diode, Zener diode, BJT, MOSFET, UJT –structure, operation and V-I characteristics, Rectifiers – Half Wave and Full Wave Rectifier, Zener as regulator

**UNIT II AMPLIFIERS****9**

Load line, operating point, biasing methods for BJT and MOSFET, BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response –Analysis of CS and Source follower – Gain and frequency response- High frequency analysis.

**UNIT III MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER****9**

Cascode amplifier, Differential amplifier – Common mode and Difference mode analysis – Tuned amplifiers – Gain and frequency response – Neutralization methods.

**UNIT IV FEEDBACK AMPLIFIERS AND OSCILLATORS****9**

Advantages of negative feedback – Analysis of Voltage / Current, Series, Shunt feedback Amplifiers – positive feedback–Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.

**UNIT V POWER AMPLIFIERS AND DC/DC CONVERTERS****9**

Power amplifiers- class A-Class B-Class AB-Class C-Temperature Effect- Class AB Power amplifier using MOSFET –DC/DC convertors – Buck, Boost, Buck-Boost analysis and design.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

At the end of the course the students will be able to

CO1: Explain the structure and working operation of basic electronic devices.

CO2: Design and analyze amplifiers.

CO3: Analyze frequency response of BJT and MOSFET amplifiers

CO4: Design and analyze feedback amplifiers and oscillator principles.

CO5: Design and analyze power amplifiers and supply circuits

**TEXT BOOKS:**

1. David A. Bell, "Electronic Devices and Circuits", Oxford Higher Education press, 5 th Edition, 2010.
2. Robert L. Boylestad and Louis Nasheresky, "Electronic Devices and Circuit Theory", 10th Edition, Pearson Education / PHI, 2008.
3. Adel .S. Sedra, Kenneth C. Smith, "Micro Electronic Circuits", Oxford University Press, 7 th Edition, 2014.

**REFERENCES:**

1. Donald.A. Neamen, "Electronic Circuit Analysis and Design", Tata McGraw Hill, 3 rd Edition, 2010.
2. D.Schilling and C.Belove, "Electronic Circuits", McGraw Hill, 3 rd Edition, 1989
3. Muhammad H.Rashid, "Power Electronics", Pearson Education / PHI , 2004.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	2	1	-	-	-	-	-	1	2	1	1
2	3	2	2	3	2	2	-	-	-	-	-	1	2	1	1
3	3	3	3	2	1	2	-	-	-	-	-	1	2	1	1
4	3	3	2	3	2	2	-	-	-	-	-	1	2	1	1
5	3	2	3	2	2	1	-	-	-	-	-	1	2	1	1
CO	3	3	3	3	2	2	-	-	-	-	-	1	2	1	1

**OBJECTIVES:**

- To understand the global trends and development methodologies of various types of products and services
- To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
- To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification
- To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
- To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

**UNIT I BASICS OF PRODUCT DEVELOPMENT 9**

Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies - Product Life Cycle – Product Development Planning and Management.

**UNIT II REQUIREMENTS AND SYSTEM DESIGN 9**

Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - System Design & Modeling - Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.

**UNIT III DESIGN AND TESTING 9**

Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines - Concept Screening & Evaluation - Detailed Design - Component Design and Verification – Mechanical, Electronics and Software Subsystems - High Level Design/Low Level Design of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping - Introduction to Rapid Prototyping and Rapid Manufacturing - System Integration, Testing, Certification and Documentation

**UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT 9**

Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - Sustenance -Maintenance and Repair – Enhancements - Product EoL - Obsolescence Management – Configuration Management - EoL Disposal

**UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY 9**

The Industry - Engineering Services Industry - Product Development in Industry versus Academia –The IPD Essentials - Introduction to Vertical Specific Product Development processes -Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.

**TOTAL: 45 PERIODS****OUTCOMES:**

Upon completion of the course, the students will be able to:

- Define, formulate, and analyze a problem
- Solve specific problems independently or as part of a team
- Gain knowledge of the Innovation & Product Development process in the Business Context
- Work independently as well as in teams
- Manage a project from start to finish

**TEXT BOOKS:**

1. Book specially prepared by NASSCOM as per the MoU.
2. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011.
3. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.

**REFERENCES:**

1. Hiriappa B, "Corporate Strategy – Managing the Business", Author House, 2013.
2. Peter F Drucker, "People and Performance", Butterworth – Heinemann [Elsevier], Oxford, 2004.
3. Vinod Kumar Garg and Venkita Krishnan N K, "Enterprise Resource Planning – Concepts", Second Edition, Prentice Hall, 2003.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1	3	2	3	1						1		1				
2	3	2	3	1						1		1				
3	3	2	3	1	1			1	1	1		1				
4	3	2	3	1	1			1	1	1		1				
5	3	2	3	1	1			1	1	1		1				
AVg.																

**OBM333****ASSISTIVE TECHNOLOGY**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVES:****The student should be made to:**

- To know the hardware requirement various assistive devices
- To understand the prosthetic and orthotic devices
- To know the developments in assistive technology

**UNIT I CARDIAC ASSIST DEVICES****9**

Cardiac functions and parameters, principle of External counter pulsation techniques, intra aortic balloon pump, Auxillary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves, cardiac pacemaker.

**UNIT II HEMODIALYSERS****9**

Physiology of kidney, Artificial kidney, Dialysis action, hemodialyser unit, membrane dialysis, portable dialyser monitoring and functional parameters.

**UNIT III HEARING AIDS****9**

Anatomy of ear, Common tests – audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids – principles, drawbacks in the conventional unit, DSP based hearing aids.

**UNIT IV PROSTHETIC AND ORTHODIC DEVICES****9**

Hand and arm replacement – different types of models, externally powered limb prosthesis, feedback in orthotic system, functional electrical stimulation, sensory assist devices.

**UNIT V RECENT TRENDS****9**

Transcutaneous electrical nerve stimulator, bio-feedback, assistive devices in drug delivery

**TOTAL:45 PERIODS****OUTCOMES:**

**On successful completion of this course, the student will be able to**

CO1: Interpret the various mechanical techniques that will help in assisting the heart functions.

CO2: Describe the underlying principles of hemodialyzer machine.

CO3: Indicate the methodologies to assess the hearing loss.

CO4: Evaluate the types of assistive devices for mobilization.

CO5: Explain about TENS and biofeedback system.

**TEXT BOOKS:**

1. Joseph D. Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press,2006
2. Marion. A. Hersh, Michael A. Johnson,Assistive Technology for visually impaired and blind,Springer Science & Business Media, 1st edition, 12-May-2010
3. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, CRC Press, 1st edition,2010.

**REFERENCES:**

1. Kenneth J. Turner Advances in Home Care Technologies: Results of the match Project, Springer, 1stedition, 2011.
2. Gerr M. Craddock Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003.
3. 3D Printing in Orthopaedic Surgery, Matthew Dipaola , Elsevier 2019 ISBN 978 -0-323-662116
4. Cardiac Assist Devices, Daniel Goldstein (Editor), Mehmet Oz (Editor), Wiley-Blackwell April 2000 ISBN: 978-0-879-93449-1

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1	3	1	1	1	1											
2	3	1	1	1	1											
3	3	1	1	1	1											
4	3	1	1	1	1											
5	3	1	1	1	1											
AVg.																

**OMA352****OPERATIONS RESEARCH**

**L T P C**  
**3 0 0 3**

**OBJECTIVES:**

This course will help the students to

- Determine the optimum solution for Linear programming problems.
- Study the Transportation and assignment models and various techniques to solve them.

- Acquire the knowledge of optimality, formulation and computation of integer programming problems.
- Acquire the knowledge of optimality, formulation and computation of dynamic programming problems.
- Determine the optimum solution for non-linear programming problems.

**UNIT I LINEAR PROGRAMMING**

**9**

Formulation of linear programming models – Graphical solution – Simplex method - Big M Method – Two phase simplex method - Duality - Dual simplex method.

**UNIT II TRANSPORTATION AND ASSIGNMENT PROBLEMS**

**9**

Matrix form of Transportation problems – Loops in T.P – Initial basic feasible solution – Transportation algorithm – Assignment problem – Unbalanced assignment problems .

**UNIT III INTEGER PROGRAMMING**

**9**

Introduction – All and mixed I.P.P – Gomory's method – Cutting plane algorithm – Branch and bound algorithm – Zero – one programming.

**UNIT IV DYNAMIC PROGRAMMING PROBLEMS**

**9**

Recursive nature of computation – Forward and backward recursion – Resource Allocation model – Cargo – loading model – Work – force size model - Investment model – Solution of L.P.P by dynamic programming .

**UNIT V NON - LINEAR PROGRAMMING PROBLEMS**

**9**

Lagrange multipliers – Equality constraints – Inequality constraints – Kuhn – Tucker Conditions – Quadratic programming.

**TOTAL:45 PERIODS**

**OUTCOMES:**

At the end of the course, students will be able to

- Could develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems.
- Analyze the concept of developing, formulating, modeling and solving transportation and assignment problems.
- Solve the integer programming problems using various methods.
- Conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming.
- Determine the optimum solution for non linear programming problems.

**TEXT BOOKS:**

1. Kanti Swarup, P.K.Gupta and Man Mohan, " Operations Research " , Sultan Chand & Sons, New Delhi, Fifth Edition , 1990.
2. Taha. H.A, " Operations Research – An Introduction , Pearson Education, Ninth Edition , New Delhi, 2012.

**REFERENCES :**

1. J.K.Sharma , " Operations Research - Theory and Applications " Mac Millan India Ltd , Second Edition , New Delhi , 2003.
2. Richard Bronson & Govindasami Naadimuthu , " Operations Research " ( Schaum's Outlines – TMH Edition) Tata McGraw Hill, Second Edition, New Delhi, 2004.
3. Pradeep Prabhakar Pai , " Operations Research and Practice", Oxford University Press, New Delhi , 2012.

4. J.P.Singh and N.P.Singh , " Operations Research , Ane Books Pvt.Ltd, New Delhi , 2014.
5. F.S.Hillier and G.J. Lieberman, " Introduction to Operations Research " , Tata McGraw Hill, Eighth Edition , New Delhi, 2005.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS 01	PS 02	PS 03
CO1	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO2	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
CO3	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO4	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO5	3	3	2	2	0	0	0	0	2	0	0	2	-	-	-
Avg	3	3	1	0.8	0	0	0	0	2	0	0	2	-	-	-

**OMA353**

**ALGEBRA AND NUMBER THEORY**

**L T P C**  
**3 0 0 3**

**OBJECTIVES:**

- To introduce the basic notions of groups, rings, fields which will then be used to solve related problems.
- To examine the key questions in the Theory of Numbers.
- To give an integrated approach to number theory and abstract algebra, and provide a firm basis for further reading and study in the subject.

**UNIT I GROUPS AND RINGS**

**9**

Groups: Definition - Properties - Homomorphism - Isomorphism - Cyclic groups - Cosets - Lagrange's theorem.

Rings: Definition - Sub rings - Integral domain - Field - Integer modulo n - Ring homomorphism.

**UNIT II FINITE FIELDS AND POLYNOMIALS**

**9**

Rings - Polynomial rings - Irreducible polynomials over finite fields - Factorization of polynomials over finite fields.

**UNIT III DIVISIBILITY THEORY AND CANONICAL DECOMPOSITIONS**

**9**

Division algorithm- Base-b representations – Number patterns – Prime and composite numbers – GCD – Euclidean algorithm – Fundamental theorem of arithmetic – LCM.

**UNIT IV DIOPHANTINE EQUATIONS AND CONGRUENCES**

**9**

Linear Diophantine equations – Congruence's – Linear Congruence's - Applications : Divisibility tests - Modular exponentiation - Chinese remainder theorem – 2x2 linear systems.

**UNIT V CLASSICAL THEOREMS AND MULTIPLICATIVE FUNCTIONS**

**9**

Wilson's theorem – Fermat's Little theorem – Euler's theorem – Euler's Phi functions – Tau and Sigma functions.

**TOTAL: 45 PERIODS**

**OUTCOMES :**

- Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.
- Demonstrate accurate and efficient use of advanced algebraic techniques.
- The students should be able to demonstrate their mastery by solving non-trivial problems related to the concepts, and by proving simple theorems about the, statements proven by the text

**TEXT BOOKS :**

1. Grimaldi, R.P and Ramana, B.V., "Discrete and Combinatorial Mathematics", Pearson Education, 5<sup>th</sup> Edition, New Delhi, 2007.
2. Thomas Koshy, "Elementary Number Theory with Applications", Elsevier Publications , New Delhi , 2002.

**REFERENCES:**

1. San Ling and Chaoping Xing, "Coding Theory – A first Course", Cambridge Publications, Cambridge, 2004.
2. Niven.I, Zuckerman.H.S., and Montgomery, H.L., "An Introduction to Theory of Numbers" , John Wiley and Sons , Singapore, 2004.
3. Lidl.R., and Pitz. G, "Applied Abstract Algebra", Springer Verlag, New Delhi, 2<sup>nd</sup> Edition , 2006.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	3	1	2	-	-	-	2	1	-	1	2	2	-	-	-
<b>CO2</b>	3	3	1	1	3	1	2	1	1	1	2	2	-	-	-
<b>CO3</b>	3	3	2	1	3	1	3	1	1	1	2	3	-	-	-
<b>CO4</b>	3	3	2	2	3	2	2	1	1	1	2	3	-	-	-
<b>CO5</b>	2	2	1	-	3	1	2	1	1	1	3	3	-	-	-
<b>Avg</b>	2.8	2.4	1.6	0.8	2.4	1	2.2	1	0.8	1	2.2	2.6	-	-	-

**OMA354****LINEAR ALGEBRA****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- To test the consistency and solve system of linear equations.
- To find the basis and dimension of vector space.
- To obtain the matrix of linear transformation and its eigenvalues and eigenvectors.
- To find orthonormal basis of inner product space and find least square approximation.
- To find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.

**UNIT I MATRICES AND SYSTEM OF LINEAR EQUATIONS****9**

Matrices - Row echelon form - Rank - System of linear equations - Consistency - Gauss elimination method - Gauss Jordan method.

**UNIT II VECTOR SPACES****9**

Vector spaces over Real and Complex fields - Subspace – Linear space - Linear independence and dependence - Basis and dimension.

**UNIT III LINEAR TRANSFORMATION****9**

Linear transformation - Rank space and null space - Rank and nullity - Dimension theorem– Matrix representation of linear transformation - Eigenvalues and eigenvectors of linear transformation – Diagonalization.

**UNIT IV INNER PRODUCT SPACES****9**

Inner product and norms - Properties - Orthogonal, Orthonormal vectors - Gram Schmidt orthonormalization process - Least square approximation.

**UNIT V EIGEN VALUE PROBLEMS AND MATRIX DECOMPOSITION****9**



Eigen value Problems : Power method, Jacobi rotation method - Singular value decomposition – QR decomposition.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

After the completion of the course the student will be able to

1. Test the consistency and solve system of linear equations.
2. Find the basis and dimension of vector space.
3. Obtain the matrix of linear transformation and its eigenvalues and eigenvectors.
4. Find orthonormal basis of inner product space and find least square approximation.
5. Find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.

**TEXT BOOKS**

1. Faires J.D. and Burden R., Numerical Methods, Brooks/Cole (Thomson Publications), New Delhi, 2002.
2. Friedberg A.H, Insel A.J. and Spence L, Linear Algebra, Pearson Education, 5<sup>th</sup> Edition, 2019.

**REFERENCES**

1. Bernard Kolman, David R. Hill, Introductory Linear Algebra, Pearson Educations, New Delhi, 8<sup>th</sup> Edition, 2009.
2. Gerald C.F. and Wheatley P.O, Applied Numerical Analysis, Pearson Educations, New Delhi, 7<sup>th</sup> Edition, 2007.
3. Kumaresan S, Linear Algebra - A geometric approach, Prentice Hall of India, New Delhi, Reprint, 2010.
4. Richard Branson, Matrix Operations, Schaum's outline series, 1989.
5. Strang G, Linear Algebra and its applications, Thomson (Brooks / Cole) New Delhi, 4<sup>th</sup> Edition, 2005.
6. Sundarapandian V, Numerical Linear Algebra, Prentice Hall of India, New Delhi, 2014.

**CO's- PO's & PSO's MAPPING**

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	3	2	2	2	1	1	1	1	3	-	-	-
CO2	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO3	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO4	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO5	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
Avg	3	3	3	3	2.8	2	2	1	1	1	1	3	-	-	-

**OBT352**

**BASICS OF MICROBIAL TECHNOLOGY**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVE:**

- Enable the Non-biological student's to understand about the basics of life science and their pro and cons for living organisms.

**UNIT I BASICS OF MICROBES AND ITS TYPES**

**9**

Introduction to microbes, existence of microbes, inventions of great scientist and history, types of microorganisms – Bacteria, Virus, Fungi.

**UNIT II MICROBIAL TECHNIQUES**

**9**

Sterilization – types – physical and chemical sterilization, Decontamination, Preservation methods, fermentation, Cultivation and growth of microbes, Diagnostic methods.

**UNIT III PATHOGENIC MICROBES**

**9**

Infectious Disease – Awareness, Causative agent, Prevention and control - Cholera, Dengu, Malaria, Diarrhea, Tuberculosis, Typhoid, Covid, HIV.

**UNIT IV BENEFICIAL MICROBES**

**9**

Applications of microbes – Clinical microbiology, agricultural microbiology, Food Microbiology, Environmental Microbiology, Animal Microbiology, Marine Microbiology.

**UNIT V PRODUCTS FROM MICROBES**

**9**

Fermented products – Fermented Beverages, Curd, Cheese, Mushroom, Agricultural products – Biopesticide, Biofertilizers, Vermi compost, Pharmaceutical products - Antibiotics, Vaccines

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course the students will be able to

1. Microbes and their types
2. Cultivation of microbes
3. Pathogens and control measures for safety
4. Microbes in different industry for economy.

**TEXT BOOKS**

1. Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993.
2. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.
3. Prescott L.M., Harley J.P., Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 1996.

**OBT353**

**BASICS OF BIOMOLECULES**

**L T P C**

**3 0 0 3**

**OBJECTIVES:**

- The objective is to offer basic concepts of biochemistry to students with diverse background in life sciences including but not limited to the structure and function of various biomolecules and their metabolism.

**UNIT I CARBOHYDRATES**

**9**

Introduction to carbohydrate, classification, properties of monosaccharide, structural aspects of monosaccharides. Introduction to disaccharide (lactose, maltose, sucrose) and polysaccharide (Heparin, starch, and glycogen) biological function of carbohydrate.

**UNIT II LIPID AND FATTY ACIDS**

**9**

Introduction to lipid, occurrence, properties, classification of lipid. Importance of phospholipids, sphingolipid and glycerolipid. Biological function of lipid. Fatty acid, Introduction, Nomenclature and classification of fatty acid Essential and non essential fatty acids.

**UNIT III AMINO ACIDS AND PROTEIN.**

**9**

Introduction to amino acid, structure, classification of protein based on polarity. Introduction to protein, classification of protein based on solubility, shape, composition and Function. Peptide bond– Structure of peptide bond. Denaturation – renaturation of protein, properties of protein. Introduction to lipoprotein, glycoprotein and nucleoprotein. Biological function of protein.

#### **UNIT IV NUCLEIC ACIDS**

**9**

Introduction to nucleic acid, Difference between nucleotide and nucleoside, composition of DNA & RNA; RNA Structure of Nitrogen bases in DNA and RNA along with the nomenclature- DNA double helix (Watson and crick) model, types of DNA, RNA.

#### **UNIT V VITAMINS AND HORMONES**

**9**

Different types of vitamins, their diverse biochemical functions and deficiency related diseases. Overview of hormones. Hormone mediated signaling. Mechanism of action of steroid hormones, epinephrine, glucagons and insulin. Role of vitamins and hormones in metabolism; Hormonal disorders; Therapeutic uses of vitamins and hormones.

#### **OUTCOMES:**

- Students will learn about various kinds of biomolecules and their physiological role.
- Students will gain knowledge about various metabolic disorders and will help them to know the importance of various biomolecules in terms of disease correlation.

**TOTAL: 45 PERIODS**

#### **TEXT BOOKS**

1. Lehninger Principles of Biochemistry 6th Edition by David L. Nelson, Michael M. Cox W.H. Freeman and Company 2017
2. Satyanarayana, U. and U. Chakerapani, "Biochemistry" 3rd Rev. Edition, Books & Allied (P) Ltd., 2006.
3. Rastogi, S.C. "Biochemistry" 2nd Edition, Tata McGraw-Hill, 2003.
4. Conn, E.E., et al., "Outlines of Biochemistry" 5th Edition, John Wiley & Sons, 1987.
5. Outlines of Biochemistry, 5th Edition: By E E Conn, P K Stumpf, G Bruening and R Y Doi. pp 693. John Wiley and Sons, New York. 1987.

#### **REFERENCES**

1. Berg, Jeremy M. et al. "Biochemistry", 6th Edition, W.H. Freeman & Co., 2006.
2. Murray, R.K., et al. "Harper's Illustrated Biochemistry", 31st Edition, McGraw-Hill, 2018.
3. Voet, D. and Voet, J.G., "Biochemistry", 4th Edition, John Wiley & Sons Inc., 2010.

#### **OBT354 FUNDAMENTALS OF CELL AND MOLECULAR BIOLOGY**

**L T P C  
3 0 0 3**

#### **OBJECTIVES:**

- To provide knowledge on the fundamentals of cell biology.
- To understand the signalling mechanisms.
- Understand basic principles of molecular biology at intracellular level to regulate growth, division and development.

#### **UNIT I INTRODUCTION TO CELL**

**9**

Cell, cell wall and Extracellular Matrix (ECM), composition, cellular dimensions, Evolution, Organisation, differentiation of prokaryotic and Eukaryotic cells, Virus, bacteria, cyanobacteria,

mycoplasma and prions.

**UNIT II CELL ORGANELLES 9**

Molecular organisation, biogenesis and function Mitochondria, endoplasmic reticulum, golgi apparatus, plastids, chloroplast, leucoplast, centrosome, lysosome, ribosome, peroxisome, Nucleus and nucleolus. Endo membrane system, concept of compartmentalisation.

**UNIT III BIO-MEMBRANE TRANSPORT 9**

Physicochemical properties of cell membranes. Molecular constitute of membranes, asymmetrical organisation of lipids and proteins. Solute transport across membrane's-fick's law, simple diffusion, passive-facilitated diffusion, active transport- primary and secondary, group translocation, transport ATPases, membrane transport in bacteria and animals. Transportmechanism- mobile carriers and pores mechanisms. Transport by vesicle formation, endocytosis, exocytosis, cell respiration.

**UNIT IV CELL CYCLE 9**

Cell cycle- Cell division by mitosis and meiosis, Comparison of meiosis and mitosis, regulation of cell cycle, cell lysis, Cytokinesis, Cell signaling, Cell communication, Cell adhesion and Cell junction, cell cycle checkpoints.

**UNIT V CENTRAL DOGMA 9**

Overview of Central dogma DNA replication: Meselson & Stahl experiment, bi-directional DNA replication, Okazaki fragments. Structure and function of mRNA, rRNA and tRNA. RNA synthesis: Initiation, elongation and termination of RNA synthesis Introduction to Genetic code- Steps in translation: Initiation, Elongation and termination of protein synthesis.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Understanding of cell at structural and functional level.
- Understand the central dogma of life and its significance.
- Comprehend the basic mechanisms of cell division.

**TEXTBOOKS:**

1. Cooper, G.M. and R.E. Hansman "The Cell: A Molecular Approach", 8th Edition, Oxford University Press, 2018
2. Friefelder, David. "Molecular Biology." Narosa Publications, 1999
3. Weaver, Robert F. "Molecular Biology" 11nd Edition, Tata McGraw-Hill, 2003.

**REFERENCES:**

1. Lodish H, Berk A, Matsudaira P, Kaiser CA, Krieger M, Schot MP, Zipursky L, Darnell J. Molecular Cell Biology, 6th Edition, 2007.
2. Becker, W.M. et al., "The World of the Cell", 9th Edition, Pearson Education, 2003.
3. Campbell, N.A., J.B. Reece and E.J. Simon "Essential Biology", VIIrd Edition, Pearson International, 2007.
4. Alberts, Bruce et al., "Essential Cell Biology", 4th Edition, W.W. Norton, 2013.

**OBJECTIVE:**

- To impart knowledge about the basics of lean principles, tools and techniques, and implementation in the construction industry.

**UNIT I INTRODUCTION****9**

Introduction and overview of the construction project management - Review of Project Management & Productivity Measurement Systems - Productivity in Construction - Daily Progress Report-The state of the industry with respect to its management practices -construction project phases - The problems with current construction management techniques.

**UNIT II LEAN MANAGEMENT****9**

Introduction to lean management - Toyota's management principle-Evolution of lean in construction industry - Production theories in construction –Lean construction value - Value in construction - Target value design - Lean project delivery system- Forms of waste in construction industry - Waste Elimination.

**UNIT III CORE CONCEPTS IN LEAN****9**

Concepts in lean thinking – Principles of lean construction – Variability and its impact – Traditional construction and lean construction – Traditional project delivery - Lean construction and workflow reliability – Work structuring – Production control.

**UNIT IV LEAN TOOLS AND TECHNIQUES****9**

Value Stream Mapping – Work sampling – Last planner system – Flow and pull based production – Last Planner System – Look ahead schedule – constraint analysis – weekly planning meeting- Daily Huddles – Root cause analysis – Continuous improvement – Just in time.

**UNIT V LEAN IMPLEMENTATION IN CONSTRUCTION INDUSTRY****9**

Lean construction implementation- Enabling lean through information technology - Lean in design - Design Structure - BIM (Building Information Modelling) - IPD (Integrated Project Delivery) – Sustainability through lean construction approach.

**TOTAL : 45 PERIODS****OUTCOMES:**

On completion of this course, the student is expected to be able to

- CO1** Explains the contemporary management techniques and the issues in present scenario.
- CO2** Apply the basics of lean management principles and their evolution from manufacturing industry to construction industry.
- CO3** Develops a better understanding of core concepts of lean construction tools and techniques and their importance in achieving better productivity.
- CO4** Apply lean techniques to achieve sustainability in construction projects.
- CO5** Apply lean construction techniques in design and modeling.

**REFERENCES:**

- Corfe, C. and Clip, B., Implementing lean in construction: Lean and the sustainability agenda, CIRIA, 2013.
- Shang Gao and Sui Pheng Low, Lean Construction Management: The Toyota Way, Springer, 2014.
- Dave, B., Koskela, L., Kiviniemi, A., Owen, R., and Tzortzopoulos, P., Implementing lean in construction: Lean construction and BIM, CIRIA, 2013.
- Ballard, G., Tommelein, I., Koskela, L. and Howell, G., Lean construction tools and techniques, 2002.
- Salem, O., Solomon, J., Genaidy, A. and Luegring, M., Site implementation and Assessment of Lean Construction Techniques, Lean Construction Journal, 2005.

## OPEN ELECTIVE IV

**OHS352**

**PROJECT REPORT WRITING**

**L T P C**  
**3 0 0 3**

### **COURSE OBJECTIVES**

The Course will enable Learners to,

- Understand the essentials of project writing.
- Perceive the difference between general writing and technical writing
- Assimilate the fundamental features of report writing.
- Understand the essential differences that exist between general and technical writing.
- Learn the structure of a technical and project report.

#### **UNIT I**

**9**

Writing Skills – Essential Grammar and Vocabulary – Passive Voice, Reported Speech, Concord, Signpost words, Cohesive Devices – Paragraph writing - Technical Writing vs. General Writing.

#### **UNIT II**

**9**

Project Report – Definition, Structure, Types of Reports, Purpose – Intended Audience – Plagiarism – Report Writing in STEM fields – Experiment – Statistical Analysis.

#### **UNIT III**

**9**

Structure of the Project Report: (Part 1) Framing a Title – Content – Acknowledgement – Funding Details - Abstract – Introduction – Aim of the Study – Background - Writing the research question - Need of the Study/Project Significance, Relevance – Determining the feasibility – Theoretical Framework.

#### **UNIT IV**

**9**

Structure of the Project Report: (Part 2) – Literature Review, Research Design, Methods of Data Collection - Tools and Procedures - Data Analysis - Interpretation - Findings –Limitations -Recommendations – Conclusion – Bibliography.

#### **UNIT V**

**9**

Proof reading a report – Avoiding Typographical Errors – Bibliography in required Format – Font – Spacing – Checking Tables and Illustrations – Presenting a Report Orally – Techniques.

**TOTAL:45 PERIODS**

### **OUTCOMES**

By the end of the course, learners will be able to

- Write effective project reports.
- Use statistical tools with confidence.
- Explain the purpose and intension of the proposed project coherently and with clarity.
- Create writing texts to suit achieve the intended purpose.
- Master the art of writing winning proposals and projects.

### **CO-PO & PSO MAPPING**

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	1	1	1	3	2	2	3	3	3	3	-	-	-
2	2	2	2	1	1	1	2	1	2	3	2	3	-	-	-
3	2	2	3	3	2	3	2	2	2	3	2	3	-	-	-
4	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
5	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
<b>AVg.</b>	2.4	2.2	2.4	2.2	2	2.6	2.4	2.2	2.6	3	2.6	3	-	-	-

- 1-low, 2-medium, 3-high, ‘-‘- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.

#### REFERENCES:

1. Gerson and Gerson - Technical Communication: Process and Product, 7th Edition, Prentice Hall(2012)
2. Virendra K. Pamecha - Guide to Project Reports, Project Appraisals and Project Finance (2012)
3. Daniel Riordan - Technical Report Writing Today (1998)  
Darla-Jean Weatherford - Technical Writing for Engineering Professionals (2016) Penwell Publishers.

**OMA355**

**ADVANCED NUMERICAL METHODS**

**L T P C**

**3 0 0 3**

#### OBJECTIVE:

- To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in engineering and technology. This will also serve as a precursor for future research.

#### **UNIT I ALGEBRAIC EQUATIONS AND EIGENVALUE PROBLEM 9**

System of nonlinear equations : Fixed point iteration method - Newton's method; System of linear equations: Thomas algorithm for tri diagonal system - SOR iteration methods ; Eigen value problems: Given's method - Householder's method.

#### **UNIT II INTERPOLATION 9**

Central difference: Stirling and Bessel's interpolation formulae ; Piecewise spline interpolation: Piecewise linear, piecewise quadratic and cubic spline ; Least square approximation for continuous data (upto 3rd degree).

#### **UNIT III NUMERICAL METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS 9**

Explicit Adams - Bashforth Techniques - Implicit Adams - Moulton Techniques, Predictor -Corrector Techniques - Finite difference methods for solving two - point linear boundary value problems - Orthogonal Collocation method.

#### **UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS 9**

Laplace and Poisson's equations in a rectangular region : Five point finite difference schemes - Leibmann's iterative methods - Dirichlet's and Neumann conditions – Laplace equation in polar coordinates : Finite difference schemes .

#### **UNIT V FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATIONS 9**

Parabolic equations : Explicit and implicit finite difference methods – Weighted average approximation - Dirichlet's and Neumann conditions – First order hyperbolic equations - Method of characteristics - Different explicit and implicit methods; Wave equation : Explicit scheme – Stability of above schemes.

**TOTAL : 45 PERIODS**

#### OUTCOMES:

Upon completion of this course, the students will be able to:

- CO1: demonstrate the understandings of common numerical methods for nonlinear equations, system of linear equations and eigenvalue problems;
- CO2: understand the interpolation theory;
- CO3: understand the concepts of numerical methods for ordinary differential equations;
- CO4: demonstrate the understandings of common numerical methods for elliptic equations;
- CO5: understand the concepts of numerical methods for time dependent partial differential equations

**TEXT BOOKS:**

1. Grewal, B.S., "Numerical Methods in Engineering & Science ", Khanna Publications, Delhi, 2013.
2. Gupta, S.K., "Numerical Methods for Engineers", (Third Edition), New Age Publishers, 2015.
3. Jain, M.K., Iyengar, S.R.K. and Jain, R.K., "Computational Methods for Partial Differential Equations", New Age Publishers, 1994.

**REFERENCES:**

1. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
2. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", 9 th Edition, Cengage Learning, New Delhi, 2016.
3. Gupta S.K., "Numerical Methods for Engineers", 4th Edition, New Age Publishers, 2019.
4. Sastry, S.S., "Introductory Methods of Numerical Analysis", 5th Edition, PHI Learning, 2015.
5. Morton, K.W. and Mayers D.F., "Numerical solution of Partial Differential equations", Cambridge University press, Cambridge, 2002.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	3	2	2	2	1	1	1	1	3	-	-	-
CO2	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO3	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO4	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO5	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
Avg	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-

**OMA356****RANDOM PROCESSES****L T P C**  
**3 0 0 3****OBJECTIVES:**

- To introduce the basic concepts of probability, one and two dimensional random variables with applications to engineering which can describe real life phenomenon.
- To understand the basic concepts of random processes which are widely used in communication networks.
- To acquaint with specialized random processes which are apt for modelling the real time scenario.
- To understand the concept of correlation and spectral densities.
- To understand the significance of linear systems with random inputs.

**UNIT I RANDOM VARIABLES****9**

Discrete and continuous random variables – Moments – Moment generating functions – Joint Distribution- Covariance and Correlation – Transformation of a random variable.

**UNIT II RANDOM PROCESSES****9**

Classification – Characterization – Cross correlation and Cross covariance functions - Stationary Random Processes – Markov process - Markov chain.

**UNIT III SPECIAL RANDOM PROCESSES****9**

Bernoulli Process – Gaussian Process - Poisson process – Random telegraph process.

**UNIT IV CORRELATION AND SPECTRAL DENSITIES****9**



Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties.

**UNIT V LINEAR SYSTEMS WITH RANDOM INPUTS**

**9**

Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and cross correlation functions of input and output.

**TOTAL: 45 PERIODS**

**OUTCOMES**

Upon successful completion of the course, students should be able to:

- Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
- Apply the concept random processes in engineering disciplines.
- Understand and apply the concept of correlation and spectral densities.
- Get an exposure of various distribution functions and help in acquiring skills in handling situations involving more than one variable.
- Analyze the response of random inputs to linear time invariant systems.

**TEXT BOOKS**

1. Ibe, O.C., "Fundamentals of Applied Probability and Random Processes ", 1<sup>st</sup> Indian Reprint, Elsevier, 2007.
2. Peebles, P.Z., "Probability, Random Variables and Random Signal Principles ", Tata McGraw Hill, 4<sup>th</sup> Edition, New Delhi, 2002.

**REFERENCES**

1. Cooper. G.R., McGillem. C.D., "Probabilistic Methods of Signal and System Analysis", Oxford University Press, New Delhi, 3<sup>rd</sup> Indian Edition, 2012.
2. Hwei Hsu, "Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes ", Tata McGraw Hill Edition, New Delhi, 2004.
3. Miller. S.L. and Childers. D.G., "Probability and Random Processes with Applications to Signal Processing and Communications ", Academic Press, 2004.
4. Stark. H. and Woods. J.W., "Probability and Random Processes with Applications to Signal Processing ", Pearson Education, Asia, 3<sup>rd</sup> Edition, 2002.
5. Yates. R.D. and Goodman. D.J., "Probability and Stochastic Processes", Wiley India Pvt. Ltd., Bangalore, 2<sup>nd</sup> Edition, 2012.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
<b>CO2</b>	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
<b>CO3</b>	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
<b>CO4</b>	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
<b>CO5</b>	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
<b>Avg</b>	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-

**OMA357**

**QUEUEING AND RELIABILITY MODELLING**

**L T P C  
3 0 0 3**

**OBJECTIVES:**

- To provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems in communication engineering.
- To understand the concept of queueing models and apply in engineering.
- To provide the required mathematical support in real life problems and develop probabilistic models which can be used in several areas of science and engineering.



<b>Avg</b>	3	3	1.4	0.8	0	0	0	0	2	0	0	2	-	-	-
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## OMG354 PRODUCTION AND OPERATIONS MANAGEMENT FOR ENTREPRENEURS

**L T P C**  
**3 0 0 3**

### OBJECTIVES:

- To know the basic concept and function of Production and Operation Management for entrepreneurship.
- To understand the Production process and planning.
- To understand the Production and Operations Management Control for business owners.

### UNIT I INTRODUCTION TO PRODUCTION AND OPERATIONS MANGEMENT 9

Functions of Production Management - Relationship between production and other functions – Production management and operations management, Characteristics of modern production and operation management, organisation of production function, recent trends in production /operations management - production as an organisational function, decision making in production Operations research

### UNIT II PRODUCTION & OPERATION SYSTEMS 9

Production Systems- principles – Models - CAD and CAM- Automation in Production - Functions and significance- Capacity and Facility Planning: Importance of capacity planning- Capacity measurement – Capacity Requirement Planning (CRP) process for manufacturing and service industry

### UNIT III PRODUCTION & OPERATIONS PLANNING 9

Facility Planning – Location of facilities – Location flexibility – Facility design process and techniques – Location break even analysis-Production Process Planning: Characteristic of production process systems – Steps for production process- Production Planning Control Functions – Planning phase- Action phase- Control phase - Aggregate production planning

### UNIT IV PRODUCTION & OPERATIONS MANAGEMENT PROCESS 9

Process selection with PLC phases- Process simulation tools- Work Study – Significance – Methods, evolution of normal/ standard time – Job design and rating - Value Analysis - Plant Layout: meaning – characters – Plant location techniques - Types- MRP and Layout Design - Optimisation and Theory of Constraints (TOC)– Critical Chain Project Management (CCPM)- REL (Relationship) Chart – Assembly line balancing- – Plant design optimisation -Forecasting methods.

### UNIT V CONTROLLING PRODUCTION & OPERATIONS MANAGEMENT 9

Material requirement planning (MRP)- Concept- Process and control - Inventory control systems and techniques – JIT and Lean manufacturing - Network techniques - Quality Management: Preventive Vs Breakdown maintenance for Quality – Techniques for measuring quality - Control Chart (X , R , p , np and C chart ) - Cost of Quality, Continuous improvement (Kaizen) - Quality awards - Supply Chain Management - Total Quality Management - 6 Sigma approach and Zero Defect Manufacturing.

**TOTAL 45 : PERIODS**

### COURSE OUTCOMES

**Upon completion of this course the learners will be able:**

- CO1: To understand the basics and functions of Production and Operation Management for business owners.
- CO2: To learn about the Production & Operation Systems.
- CO3: To acquaint on the Production & Operations Planning Techniques followed by entrepreneurs in Industries.
- CO4: To known about the Production & Operations Management Processes in organisations.
- CO5: To comprehend the techniques of controlling, Production and Operations in industries.



## TEXT BOOKS

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2. Mollinga P. *et al.* "Integrated Water Resources Management", Water in South Asia Volume I, Sage Publications, 2006.

## REFERENCES

1. Technical Advisory Committee, Background Papers No: 1, 4 and 7, Stockholm, Sweden. 2002.
2. IWRM Guidelines at River Basin Level (UNESCO, 2008).
3. Tutorial on Basic Principles of Integrated Water Resources Management ,CAP-NET.  
[http://www.pacificwater.org/userfiles/file/IWRM/Toolboxes/introduction%20to%20iwrms/Tutorial\\_text.pdf](http://www.pacificwater.org/userfiles/file/IWRM/Toolboxes/introduction%20to%20iwrms/Tutorial_text.pdf)
4. Pramod R. Bhawe, 2011, Water Resources Systems, Narosa Publishers.
5. The 17 Goals, United Nations, <https://sdgs.un.org/goals>.

**OMG355**

## MULTIVARIATE DATA ANALYSIS

**L T P C**  
**3 0 0 3**

### OBJECTIVE:

- To know various multivariate data analysis techniques for business research.

### UNIT I INTRODUCTION

**9**

Uni-variate, Bi-variate and Multi-variate techniques – Classification of multivariate techniques – Guidelines for multivariate analysis and interpretation.

### UNIT II PREPARING FOR MULTIVARIATE ANALYSIS

**9**

Conceptualization of research model with variables, collection of data --Approaches for dealing with missing data – Testing the assumptions of multivariate analysis.

### UNIT III MULTIPLE LINEAR REGRESSION ANALYSIS, FACTOR ANALYSIS

**9**

Multiple Linear Regression Analysis – Inferences from the estimated regression function – Validation of the model. -Approaches to factor analysis – interpretation of results.

### UNIT IV LATENT VARIABLE TECHNIQUES

**9**

Confirmatory Factor Analysis, Structural equation modelling, Mediation models, Moderation models, Longitudinal studies.

### UNIT V ADVANCED MULTIVARIATE TECHNIQUES

**9**

Multiple Discriminant Analysis, Logistic Regression, Cluster Analysis, Conjoint Analysis, multidimensional scaling.

**TOTAL: 45 PERIODS**

### OUTCOMES:

- Demonstrate a sophisticated understanding of the concepts and methods; know the exact scopes and possible limitations of each method; and show capability of using multivariate techniques to provide constructive guidance in decision making.
- Use advanced techniques to conduct thorough and insightful analysis, and interpret the results correctly with detailed and useful information.
- Show substantial understanding of the real problems; conduct deep analysis using correct methods; and draw reasonable conclusions with sufficient explanation and elaboration.
- Write an insightful and well-organized report for a real-world case study, including thoughtful and convincing details.
- Make better business decisions by using advanced techniques in data analytics. ‘

**REFERENCES :**

1. Joseph F Hair, Rolph E Anderson, Ronald L. Tatham & William C. Black, Multivariate Data Analysis, Pearson Education, New Delhi, 2005.
2. Barbara G. Tabachnick, Linda S.Fidell, Using Multivariate Statistics, 6th Edition, Pearson, 2012.
3. Richard A Johnson and Dean W.Wichern, Applied Multivariate Statistical Analysis, Prentice Hall, New Delhi, 2005.
4. David R Anderson, Dennis J Seveency, and Thomas A Williams, Statistics for Business and Economics, Thompson, Singapore, 2002



**OBJECTIVES:**

The course aims to

- Outline Fundamental concepts in UI & UX
- Introduce the principles of Design and Building an mobile app
- Illustrate the use of CAD in product design
- Outline the choice and use of prototyping tools
- Understanding design of electronic circuits and fabrication of electronic devices

**UNIT I UI/UX 9**

Fundamental concepts in UI & UX - Tools - Fundamentals of design principles - Psychology and Human Factors for User Interface Design - Layout and composition for Web, Mobile and Devices - Typography - Information architecture - Color theory - Design process flow, wireframes, best practices in the industry -User engagement ethics - Design alternatives

**UNIT II APP DEVELOPMENT 9**

SDLC - Introduction to App Development - Types of Apps - web Development - understanding Stack - Frontend - backend - Working with Databases - Introduction to API - Introduction to Cloud services - Cloud environment Setup- Reading and writing data to cloud - Embedding ML models to Apps - Deploying application.

**UNIT III INDUSTRIAL DESIGN 9**

Introduction to Industrial Design - Points, lines, and planes - Sketching and concept generation - Sketch to CAD - Introduction to CAD tools - Types of 3D modeling - Basic 3D Modeling Tools - Part creation – Assembly - Product design and rendering basics - Dimensioning & Tolerancing

**UNIT IV MECHANICAL RAPID PROTOTYPING 9**

Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - Mechanical Prototyping; 3D Printing and classification - Laser Cutting and engraving - RD Works - Additive manufacturing

**UNIT V ELECTRONIC RAPID PROTOTYPING 9**

Basics of electronic circuit design - lumped circuits - Electronic Prototyping - Working with simulation tool - simple PCB design with EDA

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

**At the end of the course, learners will be able to:**

- Create quick UI/UX prototypes for customer needs
- Develop web application to test product traction / product feature
- Develop 3D models for prototyping various product ideas
- Built prototypes using Tools and Techniques in a quick iterative methodology

**TEXT BOOKS**

1. Peter Fiell, Charlotte Fiell, Industrial Design A-Z, TASCHEN America Llc(2003)
2. Samar Malik, Autodesk Fusion 360 - The Master Guide.
3. Steve Krug, Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability, Pearson,3rd edition(2014)

## REFERENCES

1. <https://www.adobe.com/products/xd/learn/get-started.html>
2. <https://developer.android.com/guide>
3. <https://help.autodesk.com/view/fusion360/ENU/courses/>
4. [https://help.prusa3d.com/en/category/prusaslicer\\_204](https://help.prusa3d.com/en/category/prusaslicer_204)

**MF3010**

**MICRO AND PRECISION ENGINEERING**

**L T P C**  
**3 0 0 3**

### COURSE OBJECTIVES:

At the end of this course the student should be able to

- Learn about the precision machine tools
- Learn about the macro and micro components.
- Understand handling and operating of the precision machine tools.
- Learn to work with miniature models of existing machine tools/robots and other instruments.
- Learn metrology for micro system

### UNIT I INTRODUCTION TO MICROSYSTEMS

**9**

Design, and material selection, micro-actuators: hydraulic, pneumatic, electrostatic/ magnetic etc. for medical to general purpose applications. Micro-sensors based on Thermal, mechanical, electrical properties; micro-sensors for measurement of pressure, flow, temperature, inertia, force, acceleration, torque, vibration, and monitoring of manufacturing systems.

### UNIT II FABRICATION PROCESSES FOR MICRO-SYSTEMS

**9**

Additive, subtractive, forming process, microsystems-Micro-pumps, micro- turbines, micro engines, micro-robot, and miniature biomedical devices

### UNIT III INTRODUCTION TO PRECISION ENGINEERING

**9**

Machine tools, holding and handling devices, positioning fixtures for fabrication/ assembly of microsystems. Precision drives: inch worm motors, ultrasonic motors, stick- slip mechanism and other piezo-based devices.

### UNIT IV PRECISION MACHINING PROCESSES

**9**

Precision machining processes for macro components - Diamond turning, fixed and free abrasive processes, finishing processes.

### UNIT V METROLOGY FOR MICRO SYSTEMS

**9**

Metrology for micro systems - Surface integrity and its characterization.

**TOTAL : 45 PERIODS**

### COURSE OUTCOMES:

Upon the completion of this course the students will be able to

- Select suitable precision machine tools and operate
- Apply the macro and micro components for fabrication of micro systems.
- Apply suitable machining process
- Able to work with miniature models of existing machine tools/robots and other instruments.
- Apply metrology for micro system



**TEXT BOOKS:**

1. Davim, J. Paulo, ed. Microfabrication and Precision Engineering: Research and Development. Woodhead Publishing, 2017
2. Gupta K, editor. Micro and Precision Manufacturing. Springer; 2017

**REFERENCES:**

1. Dornfeld, D., and Lee, D. E., Precision Manufacturing, 2008, Springer.
2. H. Nakazawa, Principles of Precision Engineering, 1994, Oxford University Press.
3. Whitehouse, D. J., Handbook of Surface Metrology, Institute of Physics Publishing, Philadelphia PA, 1994.
4. Murthy.R.L, —Precision Engineering in ManufacturingII, New Age International, New Delhi, 2005

**OMF354****COST MANAGEMENT OF ENGINEERING PROJECTS****LT P C****3 0 0 3****COURSE OBJECTIVES:**

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

**UNIT – I INTRODUCTION TO COSTING CONCEPTS****9**

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.'

**UNIT – II INTRODUCTION TO PROJECT MANAGEMENT****9**

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts

**UNIT – III PROJECT EXECUTION AND COSTING CONCEPTS****9**

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing

**UNIT – IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL****9**

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

**UNIT – V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT****9**

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Understand the costing concepts and their role in decision making.

CO2: Understand the project management concepts and their various aspects in selection.

CO3: Interpret costing concepts with project execution.

CO4: Gain knowledge of costing techniques in service sector and various budgetary control techniques.

CO5: Become familiar with quantitative techniques in cost management.

## TEXT BOOKS:

1. John M. Nicholas, Herman Steyn Project Management for Engineering, Business and Technology, Taylor & Francis, 2 August 2020, ISBN: 9781000092561.
2. Albert Lester, Project Management, Planning and Control, Elsevier/Butterworth-Heinemann, 2007, ISBN: 9780750669566, 075066956X.

## REFERENCES:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991.
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988.
3. Charles T. Horngren et al Cost Accounting a Managerial Emphasis, Prentice Hall of India, New Delhi, 2011.
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003.
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007.

**AU3002**

**BATTERIES AND MANAGEMENT SYSTEM**

**L T P C**

**3 0 0 3**

## COURSE OBJECTIVES:

The objective of this course is to make the students to understand the working and characteristics of different types of batteries and their management .

### UNIT I            **ADVANCED BATTERIES**

**9**

Li-ion Batteries-different formats, chemistry, safe operating area, efficiency, aging. Characteristics-SOC,DOD, SOH. Balancing-Passive Balancing Vs Active Balancing. Other Batteries-NCM and NCA Batteries. *NCR18650B* specifications.

### UNIT II            **BATTERY PACK**

**9**

Battery Pack- design, sizing, calculations, flow chart, real and simulation Model. Peak power – definition, testing methods-relationships with Power, Temperature and ohmic Internal Resistance. Cloud based and Local Smart charging.

### UNIT III            **BATTERY MODELLING**

**9**

Battery Modelling Methods-Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model, PNGV model. State space Models- Introduction. Battery Modelling software/simulation frameworks

### UNIT IV            **BATTERY STATE ESTIMATION**

**9**

SOC Estimation- Definition, importance, single cell Vs series batteries SOC. Estimation Methods- Load voltage, Electromotive force, AC impedance, Ah counting, Neural networks, Neuro-fuzzy forecast method, Kalman filter. Estimation Algorithms.

## UNIT V BMS ARCHITECTURE AND REAL TIME COMPONENTS

9

Battery Management System- need, operation, classification. BMS ASIC-bq76PL536A-Q1 Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex Ray-CANedge1 package.ARBIN Battery Tester. BMS Development with Modeling software and Model-Based Design.

TOTAL =45 PERIODS

### COURSE OUTCOMES:

At the end of this course, students will be able to

1. Acquire knowledge of different Li-ion Batteries performance.
2. Design a Battery Pack and make related calculations.
3. Demonstrate a BatteryModel or Simulation.
4. Estimate State-of-Charges in a Battery Pack.
5. Approach different BMS architectures during real world usage.

### TEXT BOOKS

1. Jiuchun Jiang and Caiping Zhang, "Fundamentals and applications of Lithium-Ion batteriesin Electric Drive Vehicles", Wiley, 2015.
2. Davide Andrea , "Battery Management Systems for Large Lithium-Ion Battery Packs" ARTECH House, 2010.

### REFERENCE BOOKS

1. Developing Battery Management Systems with Simulink and Model-Based Design-whitepaper
2. Panasonic *NCR18650B- DataSheet*
3. bq76PL536A-Q1- IC DataSheet
4. CC2662R-Q1- IC DataSheet

AU3008

SENSORS AND ACTUATORS

L T P C  
3 0 0 3

### COURSE OBJECTIVES:

- The objective of this course is to make the students to list common types of sensor and actuators used in automotive vehicles.

## UNIT I INTRODUCTION TO MEASUREMENTS AND SENSORS

9

Sensors: Functions- Classifications- Main technical requirement and trends Units and standards- Calibration methods- Classification of errors- Error analysis- Limiting error- Probable error-Propagation of error- Odds and uncertainty- principle of transduction-Classification. Static characteristics-mathematical model of transducers- Zero, First and Second order transducers-Dynamic characteristics of first and second order transducers for standard test inputs.

## UNIT II VARIABLE RESISTANCE AND INDUTANCE SENSORS

9

Principle of operation- Construction details- Characteristics and applications of resistive potentiometer- Strain gauges- Resistive thermometers- Thermistors- Piezoresistive sensors Inductive potentiometer- Variable reluctance transducers:- EI pick up and LVDT

## UNIT III VARIABLE AND OTHER SPECIAL SENSORS

9

Variable air gap type, variable area type and variable permittivity type- capacitor microphone Piezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor- digital transducers-Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor.

**UNIT IV AUTOMOTIVE ACTUATORS****9**

Electromechanical actuators- Fluid-mechanical actuators- Electrical machines- Direct-current machines- Three-phase machines- Single-phase alternating-current Machines - Duty-type ratings for electrical machines. Working principles, construction and location of actuators viz. Solenoid, relay, stepper motor etc.

**UNIT V AUTOMATIC TEMPERATURE CONTROL ACTUATORS****9**

Different types of actuators used in automatic temperature control- Fixed and variable displacement temperature control- Semi Automatic- Controller design for Fixed and variable displacement type air conditioning system.

**TOTAL :45 PERIODS****COURSE OUTCOMES:**

At the end of the course, the student will be able to

1. List common types of sensor and actuators used in vehicles.
2. Design measuring equipment's for the measurement of pressure force, temperature and flow.
3. Generate new ideas in designing the sensors and actuators for automotive application
4. Understand the operation of these sensors, actuators and electronic control.
5. Design temperature control actuators for vehicles.

**TEXT BOOKS:**

1. Doebelin's Measurement Systems: 7th Edition (SIE), Ernest O. Doebelin Dhanesh N. Manik McGraw Hill Publishers, 2019.
2. Robert Brandy, "Automotive Electronics and Computer System", Prentice Hall, 2001
3. William Kimberley, "Bosch Automotive Handbook", 6th Edition, Robert Bosch GmbH, 2004.
4. Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th Edition, 2007, ISBN No: 978-3-658-01783-5.

**REFERENCES:**

1. James D Halderman, "Automotive Electrical and Electronics", Prentice Hall, USA, 2013
2. Tom Denton, "Automotive Electrical and Electronics Systems," Third Edition, 2004, SAE International.
3. Patranabis.D, "Sensors and Transducers", 2nd Edition, Prentice Hall India Ltd, 2003
4. William Ribbens, "Understanding Automotive Electronics -An Engineering Perspective," 7th Edition, Elsevier Butterworth-Heinemann Publishers, 2012.

**OAS353****SPACE VEHICLES**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVES:**

- To interpret the missile space stations, space vs earth environment.
- To explain the life support systems, mission logistics and planning.
- To deploy the skills effectively in the understanding of space vehicle configuration design.
- To explain Engine system and support of space vehicle
- To interpret nose cone configuration of space vehicle

**UNIT I FUNDAMENTAL ASPECTS****9**

Energy and Efficiencies of power plants for space vehicles – Typical Performance Values – Mission design – Structural design aspects during launch - role of launch environment on launch vehicle integrity.

**UNIT II SELECTION OF ROCKET PROPULSION SYSTEMS 9**

Ascent flight mechanics – Launch vehicle selection process – Criteria for Selection for different missions – selection of subsystems – types of staging – Interfaces – selection and criteria for stages and their role in launch vehicle configuration design.

**UNIT III ENGINE SYSTEMS, CONTROLS, AND INTEGRATION 9**

Propellant Budget – Performance of Complete or Multiple Rocket Propulsion Systems – Engine Design – Engine Controls – Engine System Calibration – System Integration and Engine Optimization.

**UNIT IV THRUST VECTOR CONTROL 9**

TVC Mechanisms with a Single Nozzle – TVC with Multiple Thrust Chambers or Nozzles – Testing – Integration with Vehicle – SITVC method – other jet control methods - exhaust plume problems in space environment

**UNIT V NOSE CONE CONFIGURATION 9**

Aerodynamic aspects on the selection of nose shape of a launch vehicle - design factors in the finalization of nose configuration with respect to payload - nose cone thermal protection system - separation of fairings - payload injection mechanism

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On successful completion of this course, the student will be able to

- Explain exotic space propulsion concepts, such as nuclear, solar sail, and antimatter.
- Apply knowledge in selecting the appropriate rocket propulsion systems.
- interpret the air-breathing propulsion suitable for initial stages and fly-back boosters.
- Analyze aerodynamics aspect, including boost-phase lift and drag, hypersonic, and re-entry.
- Adapt from aircraft engineers moving into launch vehicle, spacecraft, and hypersonic vehicle design.

**OIM352**

**MANAGEMENT SCIENCE**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

Of this course are

1. To introduce fundamental concepts of management and organization to students.
2. To impart knowledge to students on various aspects of marketing, quality control and marketing strategies.
3. To make students familiarize with the concepts of human resources management.
4. To acquaint students with the concepts of project management and cost analysis.
5. To make students familiarize with the concepts of planning process and business strategies.

**UNIT I INTRODUCTION TO MANAGEMENT AND ORGANISATION 9**

Concepts of Management and organization- nature, importance and Functions of Management, Systems Approach to Management - Taylor's Scientific Management Theory- Fayal's Principles of Management- Maslow's theory of Hierarchy of Human Needs- Douglas McGregor's Theory X and Theory Y-Hertzberg Two Factor Theory of Motivation-Leadership Styles, Social responsibilities of Management, Designing Organisational Structures: Basic concepts related to Organisation - Departmentation and Decentralisation.

**UNIT II OPERATIONS AND MARKETING MANAGEMENT 9**

Principles and Types of Plant Layout-Methods of Production(Job, batch and Mass Production), Work Study - Basic procedure involved in Method Study and Work Measurement – Business Process Reengineering (BPR)-Statistical Quality Control: control charts for Variables and Attributes (simple Problems) and Acceptance Sampling, Objectives of Inventory control, EOQ, ABC Analysis, Purchase Procedure, Stores Management and Store Records - JIT System, Supply Chain Management, Functions of Marketing, Marketing Mix, and Marketing Strategies based on Product Life Cycle.

**UNIT III HUMAN RESOURCES MANAGEMENT****9**

Concepts of HRM, HRD and Personnel Management and Industrial Relations (PMIR), HRM vs PMIR, Basic functions of HR Manager: Manpower planning, Recruitment, Selection, Training and Development, Wage and Salary Administration, Promotion, Transfer, Performance Appraisal, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating –Capability Maturity Model (CMM) Levels.

**UNIT IV PROJECT MANAGEMENT****9**

Network Analysis, Programme Evaluation and Review Technique (PERT), Critical Path Method(CPM), identifying critical path, Probability of Completing the project within given time, Project Cost Analysis, Project Crashing (simple problems).

**UNIT V STRATEGIC MANAGEMENT AND CONTEMPORARY STRATEGIC ISSUES****9**

Mission, Goals, Objectives, Policy, Strategy, Programmes, Elements of Corporate Planning Process, Environmental Scanning, Value Chain Analysis, SWOT Analysis, Steps in Strategy Formulation and Implementation, Generic Strategy alternatives. Bench Marking and Balanced Score Cards Contemporary Business Strategies.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

Upon completion of the course, Students will be able to

CO1: Plan an organizational structure for a given context in the organization to carry out production operations through Work-study.

CO2: Survey the markets, customers and competition better and price the given products appropriately

CO3: Ensure quality for a given product or service.

CO4: Plan, schedule and control projects through PERT and CPM.

CO5: Evaluate strategy for a business or service organisation.

**TEXTBOOKS:**

1. Kanishka Bedi, Production and Operations Management, Oxford University Press, 2007.
2. Stoner, Freeman, Gilbert, Management, 6<sup>th</sup> Ed, Pearson Education, New Delhi, 2004.
3. Thomas N. Duening & John M. Ivancevich Management Principles and Guidelines, Biztantra, 2007.
4. P. Vijay Kumar, N. Appa Rao and Ashnab, Chnalill, Cengage Learning India, 2012.

**REFERECES:**

1. Kotler Philip and Keller Kevin Lane: Marketing Management, Pearson, 2012.
2. Koontz and Weihrich: Essentials of Management, McGraw Hill, 2012.
3. Lawrence R Jauch, R. Gupta and William F. Glueck: Business Policy and Strategic Management Science, McGraw Hill, 2012.
4. Samuel C. Certo: Modern Management, 2012.

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3			3	3	3		3	3	2			2	3	
2	3			2	3	3		2	3	2				2	
3	3			3	2	2		3	2	2					2
4	3			3	3	2		3	2	3					3
5	3			2	3	3		2	3	3			2	1	
<b>AVg.</b>	3			2.6	2.8	2.6		2.6	2.6	2.4			2	2	2.5

**COURSE OBJECTIVES:**

- To understand the concept of production planning and control act work study,
- To apply the concept of product planning,
- To analyze the production scheduling,
- To apply the Inventory Control concepts.
- To prepare the manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

**UNIT I INTRODUCTION****9**

Objectives and benefits of planning and control-Functions of production control-Types of production-job- batch and continuous-Product development and design-Marketing aspect - Functional aspects-Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration-Standardization, Simplification & specialization- Break even analysis-Economics of a new design.

**UNITII WORK STUDY****9**

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

**UNITIII PRODUCT PLANNING AND PROCESS PLANNING****9**

Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning- Steps in process planning-Quantity determination in batch production-Machine capacity, balancing- Analysis of process capabilities in a multi product system.

**UNITIV PRODUCTION SCHEDULING****9**

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance – Flow production scheduling-Batch production scheduling-Product sequencing – Production Control systems- Periodic batch control-Material requirement planning kanban – Dispatching-Progress reporting and expediting- Manufacturing lead time-Techniques for aligning completion times and due dates.

**UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC****9**

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size-ABC analysis - Recorder procedure-Introduction to computer integrated production planning systems-elements of JUST IN TIME SYSTEMS-Fundamentals of MRP II and ERP.

**TOTAL : 45 PERIODS****COURSE OUTCOMES:**

Upon completion of this course,

CO1:The students can able to prepare production planning and control act work study,

CO2:The students can able to prepare product planning,

CO3:The students can able to prepare production scheduling,

CO4:The students can able to prepare Inventory Control.

CO5:They can plan manufacturing requirements manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

**TEXT BOOKS:**

1. James. B. Dilworth, "Operations management – Design, Planning and Control for manufacturing and services" Mcgraw Hill International edition 1992.

2. Martand Telsang, "Industrial Engineering and Production Management", First edition, S. Chand and Company, 2000.

**REFERENCES**

1. Chary. S.N., "Theory and Problems in Production & Operations Management", Tata McGraw Hill, 1995.
2. Elwood S.Buffa, and Rakesh K.Sarin, "Modern Production / Operations Management", 8th Edition John Wiley and Sons, 2000
3. Jain. K.C. & Aggarwal. L.N., "Production Planning Control and Industrial Management", Khanna Publishers, 1990
4. Kanishka Bedi, "Production and Operations management", 2nd Edition, Oxford university press, 2007.
5. Melynck, Denzler, " Operations management – A value driven approach" Irwin Mcgraw hill.
6. Norman Gaither, G. Frazier, "Operations Management" 9th Edition, Thomson learning IE, 2007
7. Samson Eilon, "Elements of Production Planning and Control", Universal Book Corpn.1984
8. Upendra Kachru, " Production and Operations Management – Text and cases" 1st Edition, Excel books 2007

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1	3	3			3		1					1		3		
2	3	2			3										2	
3		2			3										2	
4		2	2													
5	3	3	2												1	
AVg.	3	2.6	2		3		1					1		3	1.8	

**OIE353**

**OPERATIONS MANAGEMENT**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVE:**

- Recognize and appreciate the concept of Production and Operations Management in creating and enhancing a firm's competitive advantages.
- Describe the concept and contribution of various constituents of Production and Operations Management (both manufacturing and service).
- Relate the interdependence of the operations function with the other key functional areas of a firm.
- Teach analytical skills and problem-solving tools to the analysis of the operations problems.
- Apply scheduling and Lean Concepts for improving System Performance.

**UNIT I INTRODUCTION TO OPERATIONS MANAGEMENT**

**9**

Operations Management – Nature, Importance, historical development, transformation processes, differences between services and goods, a system perspective, functions, challenges, current priorities, recent trends; Operations Strategy - Strategic fit , framework; Supply Chain Management

**UNIT II FORECASTING, CAPACITY AND FACILITY DESIGN**

**9**

Demand Forecasting - Need, Types, COURSE OBJECTIVES and Steps. Overview of Qualitative and Quantitative methods. Capacity Planning - Long range, Types, Developing capacity alternatives. Overview of sales and operations planning. Overview of MRP, MRP II and ERP. Facility Location – Theories, Steps in Selection, Location Models. Facility Layout – Principles, Types, Planning tools and techniques.



**UNIT III DESIGN OF PRODUCT, PROCESS AND WORK SYSTEMS 9**  
 Product Design – Influencing factors, Approaches, Legal, Ethical and Environmental issues.  
 Process – Planning, Selection, Strategy, Major Decisions. Work Study – COURSE OBJECTIVES,  
 Procedure. Method Study and Motion Study. Work Measurement and Productivity – Measuring  
 Productivity and Methods to improve productivity.

**UNIT IV MATERIALS MANAGEMENT 9**  
 Materials Management – COURSE OBJECTIVES, Planning, Budgeting and Control. Purchasing –  
 COURSE OBJECTIVES, Functions, Policies, Vendor rating and Value Analysis. Stores  
 Management – Nature, Layout, Classification and Coding. Inventory – COURSE OBJECTIVES, Costs  
 and control techniques. Overview of JIT.

**UNIT V SCHEDULING AND PROJECT MANAGEMENT 9**  
 Project Management – Scheduling Techniques, PERT, CPM; Scheduling - work centers – nature,  
 importance; Priority rules and techniques, shopfloor control; Flow shop scheduling – Johnson's  
 Algorithm – Gantt charts; personnel scheduling in services.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- CO1:** The students will appreciate the role of Production and Operations management in enabling and enhancing a firm's competitive advantages in the dynamic business environment.
- CO2:** The students will obtain sufficient knowledge and skills to forecast demand for Production and Service Systems.
- CO3:** The students will be able to Formulate and Assess Aggregate Planning strategies and Material Requirement Plan.
- CO4:** The students will be able to develop analytical skills to calculate capacity requirements and developing capacity alternatives.
- CO5:** The students will be able to apply scheduling and Lean Concepts for improving System Performance.

**TEXT BOOKS**

1. Richard B. Chase, Ravi Shankar, F. Robert Jacobs, Nicholas J. Aquilano, Operations and Supply Management, Tata McGraw Hill, 12<sup>th</sup> Edition, 2010.
2. Norman Gaither and Gregory Frazier, Operations Management, South Western Cengage Learning, 2002.

**REFERENCES**

1. William J Stevenson, Operations Management, Tata McGraw Hill, 9<sup>th</sup> Edition, 2009.
2. Russel and Taylor, Operations Management, Wiley, Fifth Edition, 2006.
3. Kanishka Bedi, Production and Operations Management, Oxford University Press, 2004.
4. Chary S. N, Production and Operations Management, Tata McGraw Hill, Third Edition, 2008.
5. Aswathappa K and Shridhara Bhat K, Production and Operations Management, Himalaya Publishing House, Revised Second Edition, 2008.
6. Mahadevan B, Operations Management Theory and practice, Pearson Education, 2007.
7. Pannerselvam R, Production and Operations Management, Prentice Hall India, Second Edition, 2008.

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3											2			
2		3	3											3	3
3		2	3	3									2	3	
4		3	3	3									2	3	
5			3	2											
<b>AVg.</b>	3	2.6	3	2.6								2	2	3	3

**COURSE OBJECTIVES:**

1. Demonstrate an understanding of how occupational hygiene standards are set and used in work health and safety.
2. Compare and contrast the roles of environmental and biological monitoring in work health and safety
3. Outline strategies for identifying, assessing and controlling risks associated with airborne gases, vapours and particulates
4. Discuss how personal protective equipment can be used to reduce risks associated with workplace exposures
5. Provide high-level advice on managing and controlling noise and noise-related hazards

**UNIT I INTRODUCTION AND SCOPE****9**

Occupational Health and Environmental Safety Management - Principles practices. Comm on Occupational diseases: Occupational Health Management Services at the work place. Pre-employment, periodic medical examination of workers, medical surveillance for control of occupational diseases and health records.

**UNIT II MONITORING FOR SAFETY, HEALTH & ENVIRONMENT****9**

Occupational Health and Environment Safety Management System, ILO and EPA Standards Industrial Hygiene: Definition of Industrial Hygiene, Industrial Hygiene: Control Methods, Substitution, Changing the process, Local Exhaust Ventilation, Isolation, Wet method, Personal hygiene, housekeeping and maintenance, waste disposal, special control measures.

**UNIT III OCCUPATIONAL HEALTH AND ENVIRONMENTAL SAFETY EDUCATION****9**

Element of training cycle, Assessment of needs. Techniques of training, design and development of training programs. Training methods and strategies types of training. Evaluation and review of training programs. Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety, Exposure Limit .

**UNIT IV OCCUPATIONAL SAFETY, HEALTH AND ENVIRONMENT MANAGEMENT****9**

Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000, OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards, Performance measurements to determine effectiveness of PSM. Importance of Industrial safety, role of safety department,

**UNIT V INDUSTRIAL HAZARDS****9**

Radiation: Types and effects of radiation on human body, Measurement and detection of radiation intensity. Effects of radiation on human body, Measurement – disposal of radioactive waste, Control of radiation ii. Noise and Vibration: Sources, and its control, Effects of noise on the auditory system and health, Measurement of noise , Different air pollutants in industries, Effect of different gases and particulate matter ,acid fumes ,smoke, fog on human health, Vibration: effects.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

Students able to

- CO1: Explain and apply human factors engineering concepts in both evaluation of existing systems and design of new systems
- CO2: Specify designs that avoid occupation related injuries
- CO3: Define and apply the principles of work design, motion economy, and work environment design.
- CO4: Identify the basic human sensory, cognitive, and physical capabilities and limitations with respect to human-machine system performance.
- CO5: Acknowledge the impact of workplace design and environment on productivity

**TEXT BOOKS:**

1. R. K. Jain and Sunil S. Rao , Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006)
2. Slote. L, Handbook of Occupational Safety and Health, John Willey and Sons, New York .

**REFERENCES:**

1. Jeanne MagerStellman, Encyclopedia of Occupational Health and Safety (ILO) Ms. Irma Jourdan publication
2. Frank P Lees - Loss of prevention in Process Industries, Vol. 1 and 2,
3. ButterworthHeinemann Ltd., London (1991). 2. Industrial Safety - National Safety Council of India
4. Frank P Lees – Loss of prevention in Process Industries , Vol. 1 and 2, Butterworth- Heinemann Ltd., London
5. R. K. Jain and Sunil S. Rao, Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006).

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2		2		2	-	-	-	-	-	2	-	-	-	-
2	-		2		-	-	1	-	-	-	1	-	-	-	-
3	-		-		2	-	-	-	-	-	2	-	-	-	-
4	-		-		-	-	-	-	2	-	3	-	-	-	-
5	-		-		-	-	-	1	-	-	-	-	-	-	-
AVg.	2	-	2	-	-	-	1	1	2	-	2	-	-	-	-

**OSF353****CHEMICAL PROCESS SAFETY****L T P C  
3 0 0 3****COURSE OBJECTIVES**

- Teach the principles of safety applicable to the design, and operation of chemical process plants.
- Ensure that potential hazards are identified and mitigation measures are in place to prevent unwanted release of energy.
- Learn about the hazardous chemicals into locations that could expose employees and others to serious harm.
- Focuses on preventing incidents and accidents during large scale manufacturing of chemicals and pharmaceuticals.
- Ensure that the general design of the plant is capable of complying with the dose limits in force and with the radioactive releases.

**UNIT I SAFETY IN THE STORAGE AND HANDLING OF CHEMICALS AND GASES 9**

Types of storage-general considerations for storage layouts- atmospheric venting, pressure and temperature relief - relief valve sizing calculations - storage and handling of hazardous chemicals and industrial gases, safe disposal methods, reaction with other chemicals, hazards during transportation - pipe line transport - safety in chemical laboratories.

**UNIT II CHEMICAL REACTION HAZARDS 9**

Hazardous inorganic and organic reactions and processes, Reactivity as a process hazard, Detonations, Deflagrations, and Runaways, Assessment and Testing strategies, Self - heating hazards of solids, Explosive potential of chemicals, Structural groups and instability of chemicals, Thermochemical screening,

**UNIT III SAFETY IN THE DESIGN OF CHEMICAL PROCESS PLANTS 9**

Design principles -Process design development -types of designs, feasibility survey, preliminary design, Flow diagrams, piping and instrumentation diagram, batch versus continuous operation, factors in equipment scale up and design, equipment specifications - reliability and safety in designing - inherent safety - engineered safety - safety during startup and shutdown - non destructive testing methods - pressure and leak testing - emergency safety devices - scrubbers and flares- new concepts in safety design and operation- Pressure vessel testing standards- Inspection techniques for boilers and reaction vessels.

**UNIT IV SAFETY IN THE OPERATION OF CHEMICAL PROCESS PLANTS 9**

Properties of chemicals - Material Safety Data Sheets - the various properties and formats used - methods available for property determination. Operational activities and hazards -standards operating procedures - safe operation of pumps, compressors, heaters, column, reactors, pressure vessels, storage vessels, piping systems - effects of pressure, temperature, Flow rate and humidity on operations - corrosion and control measures- condition monitoring - control valves - safety valves - pressure reducing valves, drains, bypass valves, inert gases. Chemical splashes, eye irrigation and automatic showers.

**UNIT V SAFETY AND ANALYSIS 9**

Safety vs reliability- quantification of basic events, system safety quantification, Human error analysis, Accident investigation and analysis, OSHAS 18001 and OSHMS.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:****Students able to**

- CO1** Differentiate between inherent safety and engineered safety and recognize the importance of safety in the design of chemical process plants.  
**CO2** Develop thorough knowledge about safety in the operation of chemical plants.  
**CO3** Apply the principles of safety in the storage and handling of gases.  
**CO4** Identify the conditions that lead to reaction hazards and adopt measures to prevent them.  
**CO5** Develop thorough knowledge about

**TEXT BOOK**

- 1 David A Crowl & Joseph F Louvar, "Chemical Process safety", Pearson publication, 3<sup>rd</sup> Edition, 2014
- 2 Maurice Jones .A, "Fire Protection Systems, 2<sup>nd</sup> edition, Jones & Bartlett Publishers, 2015

**REFERENCES:**

1. Ralph King and Ron Hirst, "King's safety in the process industries", Arnold, London, 1998.
2. Industrial Environment and its Evolution and Control, NIOSH Publication, 1973.
3. National Safety Council, "Accident prevention manual for industrial operations". Chicago, 1982.
4. Lewis, Richard. J., Sr, "Sax's dangerous properties of materials". (Ninth edition). Van Nostrand Reinhold, New York, 1996.
5. Roy E Sanders, "Chemical Process Safety", 3<sup>rd</sup> Edition, Gulf professional publishing, 2006

**CO's- PO's & PSO's MAPPING**

CO	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	-	-	-	1	-	-	1	-	-	-	2	-	-
2	-			2	-	-	-	-	1	-		-	-	2	-
3	-	3		1	-	-	-	2	-	-	1	-	-	-	-
4	-	2	-		-	1	-	-	1	-		-	-	-	2
5	-	2	3		-	-	-	1	-	-	1	-	-	-	-
<b>AVg.</b>	<b>2</b>	<b>2.5</b>	<b>3</b>	<b>1.5</b>	<b>-</b>	<b>1</b>	<b>-</b>	<b>1.5</b>	<b>1</b>	<b>-</b>	<b>1</b>	<b>-</b>	<b>2</b>	<b>2</b>	<b>2</b>

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the importance of various materials used in electrical, electronics and magnetic applications
- Acquiring knowledge on the properties of electrical, electronics and magnetic materials.
- Gaining knowledge on the selection of suitable materials for the given application
- Knowing the fundamental concepts in Semiconducting materials
- Getting equipped with the materials used in optical and optoelectronic applications.

**UNIT I DIELECTRIC MATERIALS****9**

Dielectric as Electric Field Medium, leakage currents, dielectric loss, dielectric strength, breakdown voltage, breakdown in solid dielectrics, flashover, liquid dielectrics, electric conductivity in solid, liquid and gaseous dielectrics, Ferromagnetic materials, properties of ferromagnetic materials in static fields, spontaneous, polarization, curie point, anti-ferromagnetic materials, piezoelectric materials, pyroelectric materials.

**UNIT II MAGNETIC MATERIALS****9**

Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials, magnetic Anisotropy, Magnetostriction, diamagnetism, magnetically soft and hard materials, special purpose materials, feebly magnetic materials, Ferrites, cast and cermet permanent magnets, ageing of magnets. Factors effecting permeability and Hysteresis

**UNIT III SEMICONDUCTOR MATERIALS****9**

Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale Integration techniques. Concept of superconductivity; theories and examples for high temperature superconductivity; discussion on specific superconducting materials; comments on fabrication and engineering applications.

**UNIT IV MATERIALS FOR ELECTRICAL APPLICATIONS****9**

Materials used for Resistors, rheostats, heaters, transmission line structures, stranded conductors, bimetals fuses, soft and hard solders, electric contact materials, electric carbon materials, thermocouple materials. Solid, Liquid and Gaseous insulating materials, Effect of moisture on insulation.

**UNIT V OPTICAL AND OPTOELECTRONIC MATERIALS****9**

Principles of photoconductivity - effect of impurities - principles of luminescence-laser principles - He-Ne, injection lasers, LED materials - binary, ternary photoelectronic materials - LCD materials - photo detectors - applications of optoelectronic materials - optical fibres and materials - electro optic modulators - Kerr effect - Pockels effect.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

After completion of this course, the students will be able to

- Understand various types of dielectric materials, their properties in various conditions.
- Evaluate magnetic materials and their behavior.
- Evaluate semiconductor materials and technologies.

- Select suitable materials for electrical engineering applications.
- Identify right material for optical and optoelectronic applications

#### TEXT BOOKS:

1. Pradeep Fulay, "Electronic, Magnetic and Optical materials", CRC Press, Taylor and Francis, 2nd illustrated edition, 2017.
2. "R K Rajput", "A course in Electrical Engineering Materials", Laxmi Publications, 2009.

#### REFERENCE BOOKS:

1. T K Basak, "A course in Electrical Engineering Materials", New Age Science Publications, 2009
2. TTTI Madras, "Electrical Engineering Materials", McGraw Hill Education, 2004.
3. Adrianus J. Dekker, "Electrical Engineering Materials", PHI Publication, 2006.
4. S. P. Seth, P. V. Gupta "A course in Electrical Engineering Materials", Dhanpat Rai & Sons, 2011.
5. C. Kittel, "Introduction to Solid State Physics", 7th Edition, John Wiley & Sons, Singapore, (2006).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
<b>C01</b>	3	2	2	3								2	2	2	1
<b>C02</b>	3	1	2	2								2	2	2	1
<b>C03</b>	3	2	1	2								2	2	2	1
<b>CO4</b>	3	2	1	2								2	2	2	2
<b>CO5</b>	3	2	2	2								2	2	2	1
<b>Avg</b>	3	1.8	1.6	2.2								2	2	2	1.2

**OML353**

**NANOMATERIALS AND APPLICATIONS**

**L T P C**  
**3 0 0 3**

#### COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Understanding the evolution of nanomaterials in the scientific era and make them to understand different types of nanomaterials for the future engineering applications
2. Gaining knowledge on dimensionality effects on different properties of nanomaterials
3. Getting acquainted with the different processing techniques employed for fabricating nanomaterials
4. Having knowledge on the different characterisation techniques employed to characterise the nanomaterials
5. Acquiring knowledge on different applications of nanomaterials in different disciplines of engineering.

#### UNIT I NANOMATERIALS

**9**

Introduction, Classification: 0D, 1D, 2D, 3D nanomaterials and nano-composites, their mechanical, electrical, optical, magnetic properties; Nanomaterials versus bulk materials.

#### UNIT II THERMODYNAMICS & KINETICS OF NANOSTRUCTURED MATERIALS

**9**

Size and interface/interphase effects, interfacial thermodynamics, phase diagrams, diffusivity, grain growth, and thermal stability of nanomaterials.

#### UNIT III PROCESSING

**9**

Bottom-up and top-down approaches for the synthesis of nanomaterials, mechanical alloying, chemical routes, severe plastic deformation, and electrical wire explosion technique.

**UNIT IV STRUCTURAL CHARACTERISTICS****9**

Principles of emerging nanoscale X-ray techniques such as small angle X-ray scattering and X-ray absorption fine structure (XAFS), electron and neutron diffraction techniques and their application to nanomaterials; SPM, Nanoindentation, Grain size, phase formation, texture, stress analysis

**UNIT V APPLICATIONS****9**

Applications of nanoparticles, quantum dots, nanotubes, nanowires, nanocoatings; applications in electronic, electrical and medical industries

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

After completion of this course, the students will be able to

1. Evaluate nanomaterials and understand the different types of nanomaterials
2. Recognise the effects of dimensionality of materials on the properties
3. Process different nanomaterials and use them in engineering applications
4. Use appropriate techniques for characterising nanomaterials
5. Identify and use different nanomaterials for applications in different engineering fields.

**TEXT BOOKS:**

1. Bhusan, Bharat (Ed), "Springer Handbook of Nanotechnology", 2nd edition, 2007.
2. Carl C. Koch (ed.), NANOSTRUCTURED MATERIALS, Processing, Properties and Potential Applications, NOYES PUBLICATIONS, Norwich, New York, U.S.A.

**REFERENCES:**

1. Poole C.P, and Owens F.J., Introduction to Nanotechnology, John Wiley 2003
2. Nalwa H.S., Encyclopedia of Nanoscience and Nanotechnology, American Scientific Publishers 2004
3. Zehetbauer M.J. and Zhu Y.T., Bulk Nanostructured Materials, Wiley 2008
4. Wang Z.L., Characterization of Nanophase Materials, Wiley 2000
5. Gutkin Y., Ovid'ko I.A. and Gutkin M., Plastic Deformation in Nanocrystalline Materials, Springer 2004

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	3								2	1	2	
CO2	3	1	2	2								2	2	2	1
CO3	3	2	1	2								2	2	2	
CO4	3	1		2								2	2	2	2
CO5	3	2	2	2								2	2	2	1
Avg	2.8	1.6	1.7	2.2								2	1.8	2	1.3

**COURSE OBJECTIVES:**

1. To learn the various types of sensors, transducers, sensor output signal types, calibration techniques, formulation of system equation and its characteristics.
2. To understand basic working principle, construction, Application and characteristics of displacement, speed and ranging sensors.
3. To understand and analyze the working principle, construction, application and characteristics of force, magnetic and heading sensors.
4. To learn and analyze the working principle, construction, application and characteristics of optical, pressure, temperature and other sensors.
5. To familiarize students with different signal conditioning circuits design and data acquisition system.

**UNIT I            SENSOR CLASSIFICATION, CHARACTERISTICS AND SIGNAL TYPES            9**

Basics of Measurement – Classification of Errors – Error Analysis – Static and Dynamic Characteristics of Transducers – Performance Measures of Sensors – Classification of Sensors – Sensor Calibration Techniques – Sensor Outputs - Signal Types - Analog and Digital Signals, PWM and PPM.

**UNIT II            DISPLACEMENT, PROXIMITY AND RANGING SENSORS            9**

Displacement Sensors – Brush Encoders - Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – Range Sensors - Ultrasonic Ranging - Reflective Beacons - Laser Range Sensor (LIDAR) – GPS - RF Beacons.

**UNIT III            FORCE, MAGNETIC AND HEADING SENSORS            9**

Strain Gage – Types, Working, Advantage, Limitation, and Applications: Load Measurement – Force and Torque Measurement - Magnetic Sensors – Types, Principle, Advantage, Limitation, and Applications - Magneto Resistive – Hall Effect, Eddy Current Sensor - Heading Sensors – Compass, Gyroscope and Inclinometers.

**UNIT IV            OPTICAL, PRESSURE, TEMPERATURE AND OTHER SENSORS            9**

Photo Conductive Cell, Photo Voltaic, Photo Resistive, LDR – Fiber Optic Sensors – Pressure – Diaphragm – Bellows - Piezoelectric - Piezo-resistive - Acoustic, Temperature – IC, Thermistor, RTD, Thermocouple – Non Contact Sensor - Chemical Sensors - MEMS Sensors - Smart Sensors.

**UNIT V            SIGNAL CONDITIONING            9**

Need for Signal Conditioning – Resistive, Inductive and Capacitive Bridges for Measurement - DC and AC Signal Conditioning - Voltage, Current, Power and Instrumentation Amplifiers – Filter and Isolation Circuits – Fundamentals of Data Acquisition System

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

- CO1: Understand various sensor effects, sensor characteristics, signal types, calibration methods and obtain transfer function and empirical relation of sensors. They can also analyze the sensor response.
- CO2: Analyze and select suitable sensor for displacement, proximity and range measurement.
- CO3: Analyze and select suitable sensor for force, magnetic field, speed, position and direction measurement.
- CO4: Analyze and Select suitable sensor for light detection, pressure and temperature measurement and also familiar with other miniaturized smart sensors.
- CO5: Select and design suitable signal conditioning circuit with proper compensation and linearizing element based on sensor output signal.



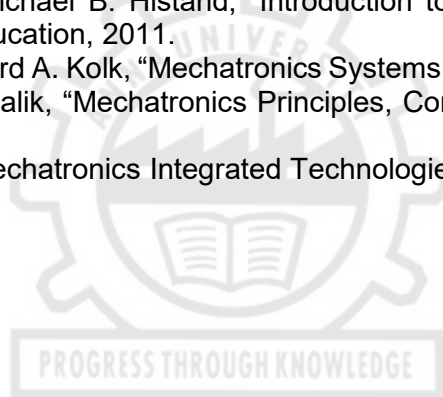
Mapping of COs with POs and PSOs															
COs/POs & PSOs	POs											PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2								1	2	3	2	1
CO2	3	3	2	1	1	1					1	2	3	2	1
CO3	3	3	2	1	1	1					1	2	3	2	1
CO4	3	3	2	1	1	1					1	2	3	2	1
CO5	3	3	2	1	1	1					1	2	3	2	1
CO/PO & PSO Av	3	3	2	0.8	0.8	0.8					0.8	2	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial															

### TEXT BOOKS

1. Bolton W., "Mechatronics", Pearson Education, 6th Edition, 2015.
2. Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Penram International Publishing Private Limited, 6th Edition, 2013.

### REFERENCES:

1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., "Mechatronics", Chapman and Hall, 1993.
2. Davis G. Alciatore and Michael B. Hstand, "Introduction to Mechatronics and Measurement systems", McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, "Mechatronics Principles, Concepts and Applications", McGraw Hill Education, 2015.
5. Smaili. A and Mrad. F, "Mechatronics Integrated Technologies for Intelligent Machines", Oxford University Press, 2007.



**ORA352**

**CONCEPTS IN MOBILE ROBOTS**

**L T P C**  
**3 0 0 3**

### COURSE OBJECTIVES

1. To introduce mobile robotic technology and its types in detail.
2. To learn the kinematics of wheeled and legged robot.
3. To familiarize the intelligence into the mobile robots using various sensors.
4. To acquaint the localization strategies and mapping technique for mobile robot.
5. To aware the collaborative mobile robotics in task planning, navigation and intelligence.

**UNIT – I INTRODUCTION TO MOBILE ROBOTICS 9**

Introduction – Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Robots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles

**UNIT – II KINEMATICS 9**

Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints – Degree of Mobility and Steerability – **Manoeuvrability** – Workspace – Degrees of Freedom – Path and Trajectory Considerations – Motion Controls - Holonomic Robots

**UNIT – III PERCEPTION 9**

Sensor for Mobile Robots – Classification and Performance Characterization – Wheel/Motor Sensors – Heading Sensors - Ground-Based Beacons - Active Ranging - Motion/Speed Sensors – Camera - Visual Appearance based Feature Extraction.

**UNIT – IV LOCALIZATION 9**

Localization Based Navigation Versus Programmed Solutions - Map Representation - Continuous Representations - Decomposition Strategies - Probabilistic Map-Based Localization - Landmark-Based Navigation - Globally Unique Localization - Positioning Beacon Systems - Route-Based Localization - Autonomous Map Building - Simultaneous Localization and Mapping (SLAM).

**UNIT – V PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS 9**

Introduction - Competences for Navigation: Planning and Reacting - Path Planning - Obstacle Avoidance - Navigation Architectures - Control Localization - Techniques for Decomposition - Case Studies – Collaborative Robots – Swarm Robots.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

**CO1:** Evaluate the appropriate mobile robots for the desired application.

**CO2:** Create the kinematics for given wheeled and legged robot.

**CO3:** Analyse the sensors for the intelligence of mobile robotics.

**CO4:** Create the localization strategies and mapping technique for mobile robot.

**CO5:** Create the collaborative mobile robotics for planning, navigation and intelligence for desired applications.

**TEXT BOOKS**

1. Roland Siegwart and IllahR.Nourbakish, "Introduction to Autonomous Mobile Robots" MIT Cambridge, 2004.

**REFERENCES:**

1. Dragomir N. Nenchev, Atsushi Konno, TeppeiTsujiita, "Humanoid Robots: Modelling and C Butterworth-Heinemann, 2018
2. MohantaJagadish Chandra, "Introduction to Mobile Robots Navigation", LAP Lambert Ac Publishing, 2015.
3. Peter Corke, "Robotics, Vision and Control", Springer, 2017.
4. Ulrich Nehmzow, "Mobile Robotics: A Practical Introduction", Springer, 2003.
5. Xiao Qi Chen, Y.Q. Chen and J.G. Chase, "Mobile Robots - State of the Art in Land, Sea, Collaborative Missions", Intec Press, 2009.
6. Alonzo Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Pres ISBN: 978-1107031159.

**COURSE OBJECTIVES:**

1. To impart knowledge on basics of propulsion system and ship dynamic movements
2. To educate them on basic layout and propulsion equipment's
3. To impart basic knowledge on performance of the ship
4. To impart basic knowledge on Ship propeller and its types
5. To impart knowledge on ship rudder and its types

**UNIT I BASICS SHIP PROPULSION SYSTEM AND EQUIPMENTS 9**

law of floatation - Basics principle of propulsion- Earlier methods of propulsion- ship propulsion machinery- boiler, Marine steam engine, diesel engine, ship power transmission system, ship dynamic structure, Marine propulsion equipment - shaft tunnel, Intermediate shaft and bearing, stern tube, stern tube sealing etc. degree of freedom, Modern propelling methods- water jet propulsion , screw propulsion.

**UNIT II SHIPS MOVEMENTS AND SHIP STABILIZATION 9**

Thrust augmented devices, Ship hull, modern ship propulsion design, bow thruster – Advantages, various methods to stabilize the ship- passive and active stabilizer, fin stabilizer, bilge keel - stabilizing and securing ship in port- effect of tides on ship – effect of river water and sea water sailing vessel, Load line and load line of marking- draught markings.

**UNIT III SHIPS SPEED AND ITS PERFORMANCE 9**

Ship propulsion factors, factors affecting ships speed, various velocities of ship, hull drag, effects of fouling on ships hull, ship wake, relation between powers, Fuel consumption of ship, cavitations - effects of cavitation's, ship turning radius.

**UNIT IV BASICS OF PROPELLER 9**

Propeller dimension, Propeller and its types – fixed propeller, control pitch propeller, kort nozzle, ducted propeller, voith schneider, Parts of propeller, 3 blade - 5 blade - 6 blade propellers and its advantages, propeller boss hub, crown nut, propeller skew, pitch of propeller - Thrust creation by propeller. Propeller Material – Propeller balancing- static and dynamic.

**UNIT V BASICS OF RUDDER 9**

Rudder dimension, Area of rudder and its design, Rudder arrangements, Rudder fittings- Rudder pintle - Rudder types- Balanced rudder, semi balanced rudder, Spade rudder, merits and demerits of various types of rudders, Propeller and rudder interaction, Rudder stopper, movement of rudders, Basic construction of Rudder

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to:

- CO1: Explain the basics of propulsion system and ship dynamic movements
- CO2: Familiarize with various components assisting ship stabilization.
- CO3: Demonstrate the performance of the ship.
- CO4: Classify the Propeller and its types, Materials etc.
- CO5: Categories the Rudder and its types, design criteria of rudder.

**TEXT BOOKS:**

1. GP. Ghose, "Basic Ship propulsion",2015
2. E.A. Stokoe "Reeds Ship construction for marine engineers", Vol. 5,2010

3. E.A. Stokoe, "Reeds Naval architecture for the marine engineers", 4<sup>th</sup> Edition, 2009

**REFERENCES:**

1. DJ Eyers and GJ Bruse, "Ship Construction", 7<sup>th</sup> Edition, 2006.
2. KJ Rawson and EC Tupper, "Basic Ship theory I" Vol. 1, 5<sup>th</sup> Edition, 2001.

**MAPPING OF COS AND POS:**

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	1	1	1	1	1						1	1		1		1
2	1	1	1											1		1
3	1			1	1				1	1	1		1	1		1
4	1		1	1										1		1
5	1		1	1										1		1
<b>Avg</b>	5/5=1	2/2=1	4/4=1	4/4=1	2/2=1				1/1=1	1/1=1	2/2=1	1/1=1	1/1=1	5/5=1		5/5=1

**OMV351**

**MARINE MERCHANT VESSELS**

**L T P C**  
**3 0 0 3**

**OBJECTIVES:**

At the end of the course, students are expected to acquire

1. Knowledge on basics of Hydrostatics
2. Familiarization on types of merchant ships
3. Knowledge on Shipbuilding Materials
4. Knowledge on marine propeller and rudder
5. Awareness on governing bodies in shipping industry

**UNIT I INTRODUCTION TO HYDROSTATICS**

**9**

Archimedes Principle- Laws of floatation– Meta centre – stability of floating and submerged bodies- Density, relative density - Displacement –Pressure –centre of pressure.

**UNIT II TYPES OF SHIP**

**10**

General cargo ship - Refrigerated cargo ships - Container ships - Roll-on Roll-off ships – Oil tankers- Bulk carriers - Liquefied Natural Gas carriers - Liquefied Petroleum Gas carriers - Chemical tankers - Passenger ships

**UNIT III SHIPBUILDING MATERIALS**

**9**

Types of Steels used in Shipbuilding - High tensile steels, Corrosion resistant steels, Steel sandwich panels, Steel castings, Steel forgings - Other shipbuilding materials, Aluminium alloys, Aluminium alloy sandwich panels, Fire protection especially for Aluminium Alloys, Fiber Reinforced Composites

**UNIT IV MARINE PROPELLER AND RUDDER**

**8**

Types of rudder, construction of Rudder-Types of Propeller, Propeller material-Cavitations and its effects on propeller

**UNIT V GOVERNING BODIES FOR SHIPPING INDUSTRY**

**9**

Role of IMO (International Maritime Organization), SOLAS (International Convention for the Safety of Life at Sea), MARPOL (International Convention for the Prevention of Pollution from Ships), MLC (Maritime Labour Convention), STCW 2010 (International Convention on Standards of Training, Certification and Watch keeping for Seafarers), Classification societies Administration authorities

**OUTCOMES:**

Upon completion of this course, students would

1. Acquire Knowledge on floatation of ships
2. Acquire Knowledge on features of various ships
3. Acquire Knowledge of Shipbuilding Materials
4. Acquire Knowledge to identify the different types of marine propeller and rudder
5. Understand the Roles and responsibilities of governing bodies

**TEXT BOOKS:**

1. D.J.Eyres, “Ship Constructions”, Seventh Edition, Butter Worth Heinemann Publishing, USA,2015
2. Dr.DA Taylor, “Merchant Ship Naval Architecture” I. Mar EST publications, 2006
3. EA Stokoe, E.A, “Naval Architecture for Marine Engineers”, Vol.4, Reeds Publications,2000

**REFERENCES:**

1. Kemp & Young “Ship Construction Sketches & Notes”, Butter Worth Heinemann Publishing,USA, 2011
2. MARPOL Consolidated Edition , Bhandakar Publications, 2018
3. SOLAS Consolidated Edition , Bhandakar Publications, 2016

**OMV352**

**ELEMENTS OF MARINE ENGINEERING**

**L T P C**  
**3 0 0 3**

**OBJECTIVES:**

**At the end of the course, students are expected to**

1. Understand the role of Marine machinery systems
2. Be familiar with Marine propulsion machinery system
3. Acquaint with Marine Auxiliary machinery system
4. Have acquired basics of Marine Auxiliary boiler system
5. Be aware of ship propellers and steering system

**UNIT I            ELEMENTARY KNOWLEDGE ON MARINE MACHINERY SYSTEMS            9**

Marine Engineering Terminologies, Parts of Ship, Introduction to Machinery systems on board ships – Propulsion Machinery system, Electricity Generator system, Steering gear system, Air compressors & Air reservoirs, Fuel oil and Lubricating Oil Purifiers, Marine Boiler systems

**UNIT II            MARINE PROPULSION MACHINERY SYSTEM            9**

Two stroke Large Marine slow speed Diesel Engine – General Construction, Basic knowledge of Air starting and reversing mechanism, Cylinder lubrication oil system, Main lubricating oil system and cooling water system

**UNIT III            MARINE AUXILIARY MACHINERY SYSTEM            9**

Four stroke medium speed Diesel engine – General Construction, Inline, V-type arrangement of engine, Difference between slow speed and medium speed engines – advantages, limitations and applications

**UNIT IV            MARINE BOILER SYSTEM            9**

Types of Boiler – Difference between Water tube boiler and Fire tube boiler, Need for boiler on board ships, Uses of steam, Advantages of using steam as working medium, Boiler mountings and accessories – importance of mountings, need for accessories

## UNIT V SHIP PROPELLERS AND STEERING MECHANISM

9

Importance of Propellor and Steering gear, Types of propellers - Fixed pitch propellers, Controllable pitch propellers, Water jet propellers, Steering gear systems - 2-Ram and 4 Ram steering gear, Electric steering gear

**TOTAL: 45 PERIODS**

### OUTCOMES:

**At the end of the course, students should able to,**

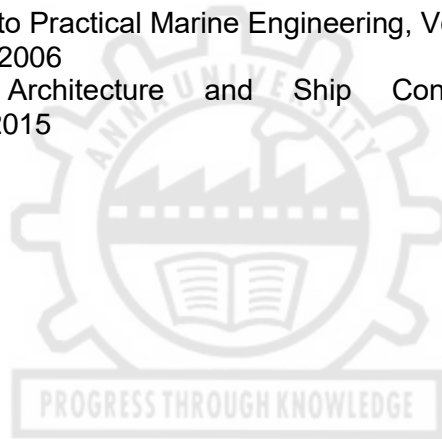
1. Distinguish the role of various marine machinery systems
2. Relate the components of marine propulsion machinery system
3. Explain the importance of marine auxiliary machinery system
4. Acquire knowledge of marine boiler system
5. Understand the importance of ship propellers and steering system

### TEXT BOOKS:

1. Taylor, "Introduction to Marine engineering", Revised Second Edition, Butterworth Heinemann, London, 2011
2. J.K.Dhar, "Basic Marine Engineering", Tenth Edition, G-Maritime Publications, Mumbai, 2011
3. K.Ramaraj, "Text book on Marine Engineering", Eswar Press, Chennai, 2018

### REFERENCES:

1. Alan L.Rowen, "Introduction to Practical Marine Engineering, Volume 1&2, The Institute of Marine Engineers (India), Mumbai, 2006
2. A.S.Tambwekar, "Naval Architecture and Ship Construction", The Institute of Marine Engineers (India), Mumbai, 2015



**CRA332**

**DRONE TECHNOLOGIES**

L	T	P	C
3	0	0	3

### COURSE OBJECTIVES:

1. To understand the basics of drone concepts
2. To learn and understand the fundamentals of design, fabrication and programming of drone
3. To impart the knowledge of an flying and operation of drone
4. To know about the various applications of drone
5. To understand the safety risks and guidelines of fly safely



**TEXT BOOKS**

1. Daniel Tal and John Altschuld, "Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation", 2021 John Wiley & Sons, Inc.
2. Terry Kilby and Belinda Kilby, "Make: Getting Started with Drones", Maker Media, Inc, 2016

**REFERENCES**

1. John Baichtal, "Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs", Que Publishing, 2016
2. Završnik, "Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance", Springer, 2018.

**OGI352****GEOGRAPHICAL INFORMATION SYSTEM****L T P C**  
**3 0 0 3****OBJECTIVE:**

To impart the knowledge on basic components, data preparation and implementation of Geographical Information System.

**UNIT I FUNDAMENTALS OF GIS****9**

Introduction to GIS - Basic spatial concepts - Coordinate Systems - GIS and Information Systems – Definitions – History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Proprietary and open source Software - Types of data – Spatial, Attribute data- types of attributes – scales/ levels of measurements.

**UNIT II SPATIAL DATA MODELS****9**

Database Structures – Relational, Object Oriented – Entities – ER diagram - data models - conceptual, logical and physical models - spatial data models – Raster Data Structures – Raster Data Compression - Vector Data Structures - Raster vs Vector Models- TIN and GRID data models.

**UNIT III DATA INPUT AND TOPOLOGY****9**

Scanner - Raster Data Input – Raster Data File Formats – Georeferencing – Vector Data Input – Digitizer – Datum Projection and reprojection -Coordinate Transformation – Topology - Adjacency, connectivity and containment – Topological Consistency – Non topological file formats - Attribute Data linking – Linking External Databases – GPS Data Integration

**UNIT IV DATA QUALITY AND STANDARDS****9**

Data quality - Basic aspects - completeness, logical consistency, positional accuracy, temporal accuracy, thematic accuracy and lineage – Metadata – GIS Standards – Interoperability - OGC - Spatial Data Infrastructure

**UNIT V DATA MANAGEMENT AND OUTPUT****9**

Import/Export – Data Management functions- Raster to Vector and Vector to Raster Conversion - Data Output - Map Compilation – Chart/Graphs – Multimedia – Enterprise Vs. Desktop GIS- distributed GIS.

**TOTAL:45 PERIODS****COURSE OUTCOMES:**

On completion of the course, the student is expected to



- CO1** Have basic idea about the fundamentals of GIS.  
**CO2** Understand the types of data models.  
**CO3** Get knowledge about data input and topology  
**CO4** Gain knowledge on data quality and standards  
**CO5** Understand data management functions and data output

**TEXT BOOKS:**

1. Kang - Tsung Chang, Introduction to Geographic Information Systems, McGraw Hill Publishing, 2nd Edition, 2011.
2. Ian Heywood, Sarah Cornelius, Steve Carver, Srinivasa Raju, "An Introduction Geographical Information Systems, Pearson Education, 2nd Edition,2007.

**REFERENCE:**

1. Lo. C. P., Albert K.W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice-Hall India Publishers, 2006.

**CO – PO – PSO MAPPING: GEOGRAPHIC INFORMATION SYSTEM**

PO	Graduate Attribute	Course Outcome					Average
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering Knowledge	3	3	3	3	3	3
PO2	Problem Analysis				3	3	3
PO3	Design/Development of Solutions			3	3	3	3
PO4	Conduct Investigations of Complex Pro			3	3	3	3
PO5	Modern Tool Usage		3		3	3	3
PO6	The Engineer and Society						
PO 7	Environment and Sustainability						
PO 8	Ethics						
PO 9	Individual and Team Work						
PO 10	Communication						
PO 11	Project Management and Finance						
PO 12	Life-long Learning						
PSO 1	Knowledge of Geoinformatics disciplin	3	3	3	3	3	3
PSO 2	Critical analysis of Geoinformatics Engineering problems and innovations	3	3	3	3	3	3
PSO 3	Conceptualization and evaluation of D solutions	3	3	3	3	3	3

**OAI352**

**AGRICULTURE ENTREPRENEURSHIP DEVELOPMENT**

**L T P C**

**3 0 0 3**

**OBJECTIVES**

- To introduce the importance of Agri-business management, its characteristics and principles
- To impart knowledge on the functional areas of Agri-business like Marketing management, Product pricing methods and Market potential assessment.

**UNIT I ENTREPRENEURIAL ENVIRONMENT IN INDIAN CONTEXT**

**9**

Entrepreneur Development(ED): Concept of entrepreneur and entrepreneurship assessing overall



**REFERENCES:**

1. Harih S B, Conner U J and Schwab G D, 1981, Management of the Farm Business, Prentice Hall Inc, New Jersey
2. Omri Ralins, N.1980, Introduction to Agricultural: Prentice Hall Inc, New Jersey
3. Gittenger Price, 1989, Economic Analysis of Agricultural project, John Hopkins University, Press, London.
4. Thomas W Zimmer and Norman M Scarborough, 1996, Entrepreneurship, Prentice Hall, New Jersey.
5. Mar J Dollinger, 1999, Entrepreneurship strategies and resources, Prentice –Hall, Upper Saddal Rover, New Jersey.

**CO-PO MAPPING**

PO/PSO		CO1	CO2	CO3	CO4	CO5	Overall correlation COs with POs
PO1	Engineering Knowledge	1	2	1	1	1	2
PO2	Problem Analysis	2	1	1	1	2	1
PO3	Design/ Development of Solutions	1	1	1	2	1	2
PO4	Conduct Investigations of Complex Problems	1	1	2	1	1	1
PO5	Modern Tool Usage	2	1	1	1	1	2
PO6	The Engineer and Society	1	2	1	2	1	1
PO7	Environment and sustainability	1	1	2	1	1	1
PO8	Ethics	1	2	1	1	1	1
PO9	Individual and team work:	1	1	1	2	1	1
PO10	Communication	1	1	1	1	2	1
PO11	Project management and finance	1	1	2	1	1	1
PO12	Life-long learning:	1	2	1	1	1	2
PSO1	To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	1	2	1	1	1	1
PSO2	To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.	1	1	2	1	1	1
PSO3	To inculcate entrepreneurial skills through strong Industry-Institution linkage.	1	2	1	1	2	1

**OBJECTIVE:**

The identification of different aspects of biological diversity and conservation techniques.

**UNIT I INTRODUCTION****9**

Concept of Species, Variation; Introduction to Major Plant Groups; Evolutionary relationships between Plant Groups; Nomenclature and History of plant taxonomy; Systems of Classification and their Application; Study of Plant Groups; Study of Identification Characters; Study of important families of Angiosperms; Plant Diversity Application.

**UNIT II INTRODUCTION TO ANIMAL DIVERSITY AND TAXONOMY****9**

Principles and Rules of Taxonomy; ICZN Rules, Animal Study Techniques; Concepts of Taxon, Categories, Holotype, Paratype, Topotype etc; Classification of Animal kingdom, Invertebrates, Vertebrates, Evolutionary relationships between Animal Groups.

**UNIT III MICROBIAL DIVERSITY****9**

Microbes and Earth History, Magnitude, Occurrence and Distribution. Concept of Species, Criteria for Classification, Outline Classification of Microorganisms (Bacteria, Viruses and Protozoa); Criteria for Classification and Identification of Fungi; Chemical and Biochemical Methods of Microbial Diversity Analysis

**UNIT IV MEGA DIVERSITY****9**

Biodiversity Hot-spots, Floristic and Faunal Regions in India and World; IUCN Red List; Factors affecting Diversity, Impact of Exotic Species and Human Disturbance on Diversity, Dispersal, Diversity-Stability Relationship; Socio- economic Issues of Biodiversity; Sustainable Utilization of Bioresources; National Movements and International Convention/Treaties on Biodiversity.

**UNIT V CONSERVATIONS OF BIODIVERSITY****9**

In-Situ Conservation- National parks, Wildlife sanctuaries, Biosphere reserves; Ex-situ conservation- Gene bank, Cryopreservation, Tissue culture bank; Long term captive breeding, Botanical gardens, Animal Translocation, Zoological Gardens; Concept of Keystone Species, Endangered Species, Threatened Species, Rare Species, Extinct Species

**TOTAL: 45 PERIODS****TEXT BOOKS:**

1. A textbook of Botany: Angiosperms- Taxonomy, Anatomy, Economic Botany & Embryology. S. Chand, Limited, Pandey, B. P. January 2001
2. Principles of Systematic Zoology, Mcgraw-Hill College, Ashlock, P.D., Latest Edition.
3. Microbiology, MacGraw Hill Companies Inc, Prescott, L.M., Harley, J.P., and Klein D.A. (2022).
4. Microbiology, Pearson Publisher, Gerard J. Tortora, Berdell R. Funke, Christine L. Case, 13<sup>th</sup> Edition 2019.

**REFERENCES:**

1. Ecological Census Technique: A Handbook, Cambridge University Press, Sutherland, W.
2. Encyclopedia of Biodiversity, Academic Press, Simonson Asher Levin.

**OUTCOMES:**

Upon successful completion of this course, students will:

CO1: An insight into the structure and function of diversity for ecosystem stability.

CO2: Understand the concept of animal diversity and taxonomy

CO3: Understand socio-economic issues pertaining to biodiversity

CO4: An understanding of biodiversity in community resource management.

CO5: Student can apply fundamental knowledge of biodiversity conservation to solve problems associated with infrastructure development.

**CO's- PO's & PSO's MAPPING**

CO\PO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		2						2		2			2	2	
2		2		2	2	2							3	2	
3				2		2							3	2	3
4	3	2			2			2	2	2	2		3	2	3
5		2	3	2			1					1		2	
<b>Avg.</b>	3	2	3	2	2	2	1	2	2	2	2	1	3	2	3

1-low, 2-medium, 3-high, '-'- no correlation

Note: The average value of this course to be used for program articulation matrix.

OEE353

INTRODUCTION TO CONTROL SYSTEMS

L T P C  
3 0 0 3

### OBJECTIVES

- To impart knowledge on various representations of systems.
- To familiarize time response analysis of LTI systems and steady state error.
- To analyze the frequency responses and stability of the systems
- To analyze the stability of linear systems in frequency domain and time domain
- To develop linear models mainly state variable model and transfer function model

### UNIT I MATHEMATICAL MODELS OF PHYSICAL SYSTEMS

9

Definition & classification of system – terminology & structure of feedback control theory –Analogous systems - Physical system representation by Differential equations – Block diagram reduction–Signal flow graphs.

### UNIT II TIME RESPONSE ANALYSIS & ROOTLOCUS TECHNIQUE

9

Standard test signals – Steady state error & error constants – Time Response of I and II order system– Root locus–Rules for sketching root loci.

### UNIT III FREQUENCY RESPONSE ANALYSIS

9

Correlation between Time & Frequency response – Polar plots – Bode Plots – Determination of Transfer Function from Bode plot.

### UNIT IV STABILITY CONCEPTS & ANALYSIS

9

Concept of stability – Necessary condition – RH criterion – Relative stability – Nyquist stability criterion – Stability from Bode plot – Relative stability from Nyquist & Bode – Closed loop frequency response.

### UNIT V STATE VARIABLE ANALYSIS

9

Concept of state – State Variable & State Model – State models for linear & continuous time systems– Solution of state & output equation–controllability & observability.

**TOTAL: 45 PERIODS**

### OUTCOMES:

Ability to

CO1: Design the basic mathematical model of physical System.

CO2: Analyze the time response analysis and techniques.

CO3: Analyze the transfer function from different plots.

CO4: Apply the stability concept in various criterion.

CO5: Assess the state models for linear and continuous Systems.

**TEXTBOOKS:**

1. Farid Golnarghi , Benjamin C. Kuo, Automatic Control Systems Paper back McGraw Hill Education, 2018.
2. Katsuhiko Ogata, 'Modern Control Engineering', Pearson, 5<sup>th</sup> Edition 2015.
3. J. Nagrath and M. Gopal, Control Systems Engineering (Multi Colour Edition), New Age International, 2018.

**REFERENCES:**

1. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, Pearson Education, 2010.
2. Control System Dynamics" by Robert Clark, Cambridge University Press, 1996 USA.
3. John J. D'Azzo, Constantine H. Houpis and Stuart N. Sheldon, Linear Control System Analysis and Design, 5<sup>th</sup> Edition, CRC PRESS, 2003.
4. S. Palani, Control System Engineering, McGraw-Hill Education Private Limited, 2009.
5. Yaduvir Singh and S. Janardhanan, Modern Control, Cengage Learning, First Impression 2010.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2							2	3	3	3
CO2	3	3	2	3	1								3	3	3
CO3	3	3	3	2	2								3	3	3
CO4	3	3	3	2	2							2	3	3	3
CO5	3	3	3	1	1							1	3	3	3
													3	3	3

**OEI354****INTRODUCTION TO INDUSTRIAL AUTOMATION SYSTEMS****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

1. To educate on design of signal conditioning circuits for various applications.
2. To Introduce signal transmission techniques and their design.
3. Study of components used in data acquisition systems interface techniques
4. To educate on the components used in distributed control systems
5. To introduce the communication buses used in automation industries.

**UNIT I INTRODUCTION****9**

Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems : Modbus & Profibus

**UNIT II AUTOMATION COMPONENTS****9**

Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.

**UNIT III COMPUTER AIDED MEASUREMENT AND CONTROL SYSTEMS****9**

Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer aided process control software, Computer based data acquisition system, Internet of things (IoT) for plant automation.

**UNIT IV PROGRAMMABLE LOGIC CONTROLLERS****9**

Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.

**UNIT V DISTRIBUTED CONTROL SYSTEM**

**9**

Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.

**TOTAL:45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)**

**5**

1. Market survey of the recent PLCs and comparison of their features.
2. Summarize the PLC standards
3. Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)
4. Market survey of Industrial Data Networks.

**COURSE OUTCOMES:**

**Students able to**

- CO1** Design a signal conditioning circuits for various application (L3).
- CO2** Acquire a detail knowledge on data acquisition system interface and DCS system (L2).
- CO3** Understand the basics and Importance of communication buses in applied automation Engineering (L2).
- CO4** Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.(L3)
- CO5** Able to develop a PLC logic for a specific application on real world problem. (L5)

**TEXT BOOKS:**

1. S.K.Singh, "Industrial Instrumentation", Tata Mcgraw Hill, 2nd edition companies,2003.
2. C D Johnson, "Process Control Instrumentation Technology", Prentice Hall India,8th Edition, 2006.
3. E.A.Parr, Newnes ,NewDelhi,"Industrial Control Handbook",3rd Edition, 2000.

**REFERENCES:**

1. John W. Webb and Ronald A. Reis, "Programmable Logic Controllers: Principles and Applications", 5th Edition, Prentice Hall Inc., New Jersey, 2003.
2. Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, McGraw- Hill, New York, 2016.
3. Krishna Kant, "Computer - Based Industrial Control", 2nd Edition, Prentice Hall, New Delhi, 2011.
4. Gary Dunning, Thomson Delmar,"Programmable Logic Controller", CeneageLearning, 3 rd Edition,2005.

**List of Open Source Software/ Learning website:**

1. <https://archive.nptel.ac.in/courses/108/105/108105062/>
2. <https://nptel.ac.in/courses/108105063>
3. <https://www.electrical4u.com/industrial-automation/>
4. <https://realpars.com/what-is-industrial-automation/>
5. <https://automationforum.co/what-is-industrial-automation-2/>

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
<b>CO1</b>	3	2	2	2	1	1	-	1	-	1	-	1	1	-	1
<b>CO2</b>	3	1	1	-	1	-	-	1	-	1	-	-	1	-	1
<b>CO3</b>	3	-	1	-	1	-	-	1	-	1	-	-	1	-	1
<b>CO4</b>	3	3	3	3	1			1		1			1		1

<b>CO5</b>	3	3	3	3	1	1		1		1			1		1
<b>AVg.</b>	3	2.25	2	2.6	1	1	-	1	-	1	-	-	1	-	1

**OCH353**

**ENERGY TECHNOLOGY**

**L T P C**  
**3 0 0 3**

**UNIT I INTRODUCTION**

**8**

Units of energy, conversion factors, general classification of energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, Renewable and non-renewable energy sources and their availability. Prospects of Renewable energy sources

**UNIT II CONVENTIONAL ENERGY**

**8**

Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.

**UNIT III NON-CONVENTIONAL ENERGY**

**10**

Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.

**UNIT IV BIOMASS ENERGY**

**10**

Biomass energy resources, thermo-chemical and biochemical methods of biomass conversion, combustion, gasification, pyrolysis, biogas production, ethanol, fuel cells, alkaline fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, solid polymer electrolyte fuel cell, magneto hydrodynamic power generation, energy storage routes like thermal energy storage, chemical, mechanical storage and electrical storage.

**UNIT V ENERGY CONSERVATION**

**9**

Energy conservation in chemical process plants, energy audit, energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, steam economy in chemical plants, energy conservation.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to

CO1: Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.

CO2: Students will excel as professionals in the various fields of energy engineering

CO3: Compare different renewable energy technologies and choose the most appropriate based on local conditions.

CO4: Explain the technological basis for harnessing renewable energy sources.

CO5: Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level.

**TEXT BOOKS:**



1. Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005.
2. Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi, 1984.
3. Bansal, N.K., Kleeman, M. and Meliss, M., Renewable Energy Sources and Conversion Technology, Tata McGraw Hill, 1990.
4. Nagpal, G.R., Power Plant Engineering, Khanna Publishers, 2008.

## REFERENCES

1. Nejat Vezirog, Alternate Energy Sources, IT, McGraw Hill, New York.
2. El. Wakil, Power Plant Technology, Tata McGraw Hill, New York, 2002.
3. Sukhatme. S.P., Solar Energy - Thermal Collection and Storage, Tata McGraw hill, New Delhi, 1981.

## Course articulation matrix

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PS O2	PS O3
CO1	Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.	2	3	2	3	3	-	-	-	1	1	-	3	1	1	3
CO2	Students will excel as professionals in the various fields of energy engineering	2	3	1	3	3	-	-	-	1	1	-	3	2	1	3
CO3	Compare different renewable energy technologies and choose the most appropriate based on local conditions.	2	2	2	3	3	1	1	-	1	1	-	3	2	1	3
CO4	Explain the technological basis for harnessing renewable energy sources.	2	2	1	3	3	1	1	1	1	-	1	3	1	1	3
CO5	Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level	2	2	1	3	3	1	1	1	1	-	1	3	2	1	3
<b>OVERALL CO</b>		<b>2</b>	<b>2</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>3</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OBJECTIVE:**

- To enable the students to analyze properties of a surfaces and correlate them to structure, chemistry, and physics and surface modification technique.

**UNIT I SURFACE STRUCTURE AND EXPERIMENTAL PROBES 9**

Relevance of surface science to Chemical and Electrochemical Engineering, Heterogeneous Catalysis and Nanoscience; Surface structure and reconstructions, adsorbate structure, Band and Vibrational structure, Importance of UHV techniques, Electronic probes and molecular beams, Scanning probes and diffraction, Qualitative introduction to electronic and vibrational spectroscopy

**UNIT II ADSORPTION, DYNAMICS, THERMODYNAMICS AND KINETICS AT SURFACES 9**

Interactions at the surface, Physisorption, Chemisorption, Diffusion, dynamics and reactions of atoms/molecules on surfaces, Generic reaction mechanism on surfaces, Adsorption isotherms, Kinetics of adsorption, Use of temperature desorption methods

**UNIT III LIQUID INTERFACES 9**

Structure and Thermodynamics of liquid-solid interface, Self-assembled monolayers, Electrified interfaces, Charge transfer at the liquid-solid interfaces, Photoelectrochemical processes, Gratzel cells

**UNIT IV HETEROGENEOUS CATALYSIS 9**

Characterization of heterogeneous catalytic processes, Microscopic kinetics to catalysis, Overview of important heterogeneous catalytic processes: Haber-Bosch, Fischer-Tropsch and Automotive catalysis, Role of promoters and poisons, Bimetallic surfaces, surface functionalization and clusters in catalysis, Role of Sabatier principle in catalyst design, Rate oscillations and spatiotemporal pattern formation

**UNIT V EPITAXIAL GROWTH AND NANO SURFACE-STRUCTURES 9**

Origin of surface forces, Role of stress and strain in epitaxial growth, Energetic and growth modes, Nucleation theory, Nonequilibrium growth modes, MBE, CVD and ablation techniques, Catalytic growth of nanotubes, Etching of surfaces, Formation of nanopillars and nanorods and its application in photoelectrochemical processes, Polymer surfaces and biointerfaces.

**TOTAL: 45 PERIODS****OUTCOME:**

- Upon completion of this course, the students can understand, predict and design surface properties based on surface structure. Students would understand the physics and chemistry behind surface phenomena

**TEXT BOOK:**

- K. W. Kolasinski, "Surface Science: Foundations of catalysis and nanoscience" II Edition, John Wiley & Sons, New York, 2008.

**REFERENCE:**

- Gabor A. Somorjai and Yimin Li "Introduction to Surface Chemistry and catalysis", II Edition John Wiley & Sons, New York, 2010.

**OBJECTIVES:**

The course aims to

- Acquaint and equip the students with different techniques of measurement of engineering properties.
- Make the students understand the nature of food constituents in the design of processing equipment

**UNIT I****9**

Engineering properties of food materials: physical, thermal, aerodynamic, mechanical, optical and electromagnetic properties.

**UNIT II****9**

Drying and dehydration: Basic drying theory, heat and mass transfer in drying, drying rate curves, calculation of drying times, dryer efficiencies; classification and selection of dryers; tray, vacuum, osmotic, fluidized bed, pneumatic, rotary, tunnel, trough, bin, belt, microwave, IR, heat pump and freeze dryers; dryers for liquid: Drum or roller dryer, spray dryer and foammat dryers

**UNIT III****9**

Size reduction: Benefits, classification, determination and designation of the fineness of ground material, sieve/screen analysis, principle and mechanisms of comminution of food, Rittinger's, Kick's and Bond's equations, work index, energy utilization; Size reduction equipment: Principal types, crushers (jaw crushers, gyratory, smooth roll), hammer mills and impactors, attrition mills, buhr mill, tumbling mills, tumbling mills, ultra fine grinders, fluid jet pulverizer, colloid mill, cutting machines (slicing, dicing, shredding, pulping)

**UNIT IV****9**

Mixing: theory of solids mixing, criteria of mixer effectiveness and mixing indices, rate of mixing, theory of liquid mixing, power requirement for liquids mixing; Mixing equipment: Mixers for lo.w- or medium-viscosity liquids (paddle agitators, impeller agitators, powder-liquid contacting devices, other mixers), mixers for high viscosity liquids and pastes, mixers for dry powders and particulate solids.

**UNIT V****9**

Mechanical Separations: Theory, centrifugation, liquid-liquid centrifugation, liquid-solid centrifugation, clarifiers, desludging and decanting machine, Filtration: Theory of filtration, rate of filtration, pressure drop during filtration, applications, constant-rate filtration and constant-pressure filtration, derivation of equation; Filtration equipment; plate and frame filter press, rotary filters, centrifugal filters and air filters, filter aids, Membrane separation: General considerations, materials for membrane construction, ultra-filtration, microfiltration, concentration, polarization, processing variables, membrane fouling, applications of ultra-filtration in food processing, reverse osmosis, mode of operation, and applications; Membrane separation methods, demineralization by electro-dialysis, gel filtration, ion exchange, per-evaporation and osmotic dehydration.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

At the end of the course the students will be able to

CO1 understand the importance of food polymers

CO2 understand the effect of various methods of processing on the structure and texture of food materials

CO3 understand the interaction of food constituents with respect to thermal, electrical properties to develop new technologies for processing and preservation.

**TEXT BOOKS:**

1. R.L. Earle. 2004. Unit Operations in Food Processing. The New Zealand Institute of Food Science & Technology, Nz. Warren L. McCabe, Julian Smith, Peter Harriott. 2004.
2. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA. Christie John Geankoplis. 2003.
3. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed. Prentice-Hall, NY, USA.
4. George D. Saravacos and Athanasios E. Kostaropoulos. 2002. Handbook of Food Processing Equipment. Springer Science+Business Media, New York, USA.
5. J. F. Richardson, J. H. Harker and J. R. Backhurst. 2002. Coulson & Richardson's Chemical Engineering, Vol. 2, Particle Technology and Separation Processes, 5th Ed.

**OFD355****FOOD SAFETY AND QUALITY REGULATIONS****L T P C**  
**3 0 0 3****OBJECTIVES:**

- To characterize different type of food hazards, physical, chemical and biological in the industry and food service establishments
- To help become skilled in systems for food safety surveillance
- To be aware of the regulatory and statutory bodies in India and the world
- To ensure processed food meets global standards

**UNIT I****10**

Introduction to food safety and security: Hygienic design of food plants and equipments, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labeling. Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials. Control of rats, rodents, mice, birds, insects and microbes. Cleaning and Disinfection, ISO 22000 – Importance and Implementation

**UNIT II****8**

Food quality: Various Quality attributes of food, Instrumental, chemical and microbial Quality control. Sensory evaluation of food and statistical analysis. Water quality and other utilities.

**UNIT III****9**

Critical Quality control point in different stages of production including raw materials and processing materials. Food Quality and Quality control including the HACCP system. Food inspection and Food Law, Risk assessment – microbial risk assessment, dose response and exposure response modelling, risk management, implementation of food surveillance system to monitor food safety, risk communication

**UNIT IV****9**

Indian and global regulations: FAO in India, Technical Cooperation programmes, Bio-security in Food and Agriculture, World Health Organization (WHO), World Animal Health Organization (OIE), International Plant Protection Convention (IPPC)

**UNIT V****9**

Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

CO1 Thorough Knowledge of food hazards, physical, chemical and biological in the industry and food service establishments

CO2 Awareness on regulatory and statutory bodies in India and the world

## REFERENCES:

1. Handbook of food toxicology by S. S. Deshpande, 2002
2. The food safety information handbook by Cynthia A. Robert, 2009
3. Nutritional and safety aspects of food processing by Tannenbaum SR, Marcel Dekker Inc., New York 1979
4. Microbiological safety of Food by Hobbs BC, 1973
5. Food Safety Handbook by Ronald H. Schmidt, Gary E. Rodrick, A John Wiley & Sons Publication, 2003

**OPY353**

**NUTRACEUTICALS**

**L T P C**  
**3 0 0 3**

## OBJECTIVES:

- To understand the basic concepts of Nutraceuticals and functional food, their chemical nature and methods of extraction.
- To understand the role of Nutraceuticals and functional food in health and disease.

### **UNIT I INTRODUCTION AND SIGNIFICANCE**

**6**

Introduction to Nutraceuticals and functional foods; importance, history, definition, classification, list of functional foods and their benefits, Phytochemicals, zoochemicals and microbes in food, plants, animals and microbes.

### **UNIT II PHYTOCHEMICALS AS NUTRACEUTICALS**

**11**

Phytoestrogens in plants; isoflavones; flavonols, polyphenols, tannins, saponins, lignans, lycopene, chitin, carotenoids. Manufacturing practice of selected nutraceuticals such as lycopene, isoflavonoids, glucosamine, phytosterols. Formulation of functional foods containing nutraceuticals - stability, analytical and labelling issues.

### **UNIT III ASSESSMENT OF ANTIOXIDANT ACTIVITY**

**11**

In vitro and in vivo methods for the assessment of antioxidant activity, Comparison of different *in vitro* methods to evaluate the antioxidant, antioxidant mechanism, Prediction of the antioxidant activity of natural phenolics from electrotopological state indices, Optimising phytochemical release by process technology; Variation of Antioxidant Activity during technological treatments, new food grade peptidases from plant sources.

### **UNIT IV ROLE IN HEALTH AND DISEASE**

**11**

The health benefit of - Soy protein, Spirulina, Tea, Olive oil, plant sterols, Broccoli, omega3 fatty acid and eicosanoids. Nutraceuticals and Functional foods in Gastrointestinal disorder, Cancer, CVD, Diabetic Mellitus, HIV and Dental disease; Importance and function of probiotic, prebiotic and synbiotic and their applications, Functional foods and immune competence; role and use in obesity and nervous system disorders.

### **UNIT V SAFETY ISSUES**

**6**

Health Claims, Adverse effects and toxicity of nutraceuticals, regulations and safety issues International and national.

**TOTAL: 45 PERIODS**

## TEXT BOOKS:

1. Bisset, Normal Grainger and Max Wich H "Herbal Drugs and Phytopharmaceuticals", 2nd Edition, CRC, 2001.
2. Handbook of Nutraceuticals and Functional Foods: Robert Wildman, CRC, Publications. 2006
3. WEBB, PP, Dietary Supplements and Functional Foods Blackwell Publishing Ltd (United Kingdom), 2006

4. Ikan, Raphael “Natural Products: A Laboratory Guide”, 2nd Edition, Academic Press / Elsevier, 2005.

**REFERENCES:**

1. Asian Functional Foods (Nutraceutical Science and Technology) by John Shi (Editor), Fereidoon Shahidi (Editor), Chi-Tang Ho (Editor), CRC Publications, Taylor & Francis, 2007
2. Functional Foods and Nutraceuticals in Cancer Prevention by Ronald Ross Watson (Author), Blackwell Publishing, 2007
3. Marketing Nutrition: Soy, Functional Foods, Biotechnology, and Obesity by Brian Wansink.
4. Functional foods: Concept to Product: Edited by G R Gibson and C M Williams, Wood head Publ., 2000
5. Hanson, James R. “Natural Products: The Secondary Metabolites”, Royal Society of Chemistry, 2003.

**COURSE OUTCOME - NUTRACEUTICALS**

- CO 1** Acquire knowledge about the nutraceuticals and functional foods, their classification and benefits.
- CO 2** Acquire knowledge of phytochemicals, zoochemicals and microbes in food, plants, animals and microbes
- CO 3** Attain the knowledge of the manufacturing practices of selected nutraceutical components and formulation considerations of functional foods.
- CO 4** Distinguish the various *in vitro* and *in vivo* assessment of antioxidant activity of compounds from plant sources.
- CO 5** Gain information about the health benefits of various functional foods and nutraceuticals in the prevention and treatment of various lifestyle diseases.
- CO 6** Attain the knowledge of the regulatory and safety issues of nutraceuticals at national and international level.

CO – PO MAPPING												
NUTRACEUTICALS												
COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3											1
CO 2	3											1
CO 3	3					2						
CO 4	3											
CO 5	3					2						1
CO 6	3							2				1

**OTT354**

**BASICS OF DYEING AND PRINTING**

**L T P C  
3 0 0 3**

**OBJECTIVE:**

- To enable the students to learn about the basics of Pretreatment, dyeing, printing and machinery in textile processing.

**UNIT I INTRODUCTION**

**9**

Impurities present in different fibres, Inspection of grey goods and lot preparation. Shearing,

**UNIT II PRE TREATMENT**

**9**

Desizing-Objective of Desizing- types of Desizing- Objective of Scouring- Mechanism of Scouring– Degumming of Silk, Scouring of wool - Bio Scouring. Bleaching -Objective of Bleaching: Bleaching mechanism of Hydrogen Peroxide, Hypo chlorites. Objective of Mercerizing - Physical and Chemical changes of Mercerizing.

**UNIT III DYEING 9**

Dye - Affinity, Substantively, Reactivity, Exhaustion and Fixation. Classification of dyes. Direct dyes: General properties, principles and method of application on cellulosic materials. Reactive dyes – principles and method of application on cellulosic materials hot brand, cold brand.

**UNIT IV PRINTING 9**

Definition of printing – Difference between printing and dying- Classification thickeners – Requirements to be good thickener, printing paste Preparation - different styles of printing.

**UNIT V MACHINERIES 9**

Fabric Processing - winch, jigger and soft flow machines. Beam dyeing machines: Printing -flat bed screen - Rotary screen. Thermo transfer printing machinery. Garment dyeing machines.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of the course, the students will be able to Understand the

- CO1: Basics of grey fabric
- CO2: Basics of pre treatment
- CO3: Concept of Dyeing
- CO4: Concept of Printing
- CO5: Machinery in processing industry

**TEXT BOOKS:**

1. Trotman, E.R., Textile Scouring and Bleaching, Charless Griffins, Com. Ltd., London 1990.
2. Shenai V.A. "Technology of Textile Processing Vol. IV" 1998, Sevak Publications, Mumbai.

**REFERENCES:**

1. Trotman E. R., "Dyeing and Chemical Technology of Textile Fibres", Charles Griffin & Co. Ltd., U.K., 1984, ISBN : 0 85264 165 6.
2. Dr. N N Mahapatra., "Textile dyeing", Wood head publishing India, 2018
3. Mathews Kolanjikombil., "Dyeing of Textile substrates III –Fibres, Yarns and Knitted fabrics", Wood head publishing India , 2021
4. Bleaching & Mercerizing – BTRA Silver Jubilee Monograph series
5. Chakraborty, J.N, "Fundamentals and Practices in colouration of Textiles", Wood head Publishing India, 2009, ISBN-13:978-81-908001-4-3.

**COURSE ARTICULATION MATRIX:**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Course Out	Statement	Program Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Classification of fibres and production of natural fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO2	Regenerated and synthetic fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO3	Yarn spinning	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO4	Weaving	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-

CO5	Knitting and nonwoven	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
Overall		-	-	-	-	-	-	-	2	1	-	1	1	-	1	-

FT 3201

FIBRE SCIENCE

L T P C  
3 0 0 3

### COURSE OBJECTIVES

- To enable the students to learn about the types of fibre and its properties

#### UNIT I INTRODUCTION TO TEXTILE FIBRES

9

Definition of various forms of textile fibres - staple fibre, filament, bicomponent fibres. Classification of Natural and Man-made fibres, essential and desirable properties of Fibres. Production and cultivation of Natural Fibers: Cotton, Silk, Wool -Physical and chemical structure of the above fibres.

#### UNIT II REGENERATED FIBRES

9

Production Sequence of Regenerated Cellulosic fibres: Viscose Rayon, Acetate rayon – High wet modulus fibres: Modal and Lyocel ,Tencel

#### UNIT III SYNTHETIC FIBRES

9

Production Sequence of Synthetic Fibers: polymer-Polyester, Nylon, Acrylic and polypropylene. Mineral fibres: fibre glass ,carbon .Introduction to spin finishes and texturization

#### UNIT IV SPECIALITY FIBRES

9

Properties and end uses of high tenacity and high modulus fibres, high temperature and flame retardant fibres, Chemical resistant fibres

#### UNIT V FUNCTIONAL SPECIALITY FIBRES

9

**Properties and end uses :** Fibres for medical application – Biodegradable fibres based on PLA ,Super absorbent fibres elastomeric fibres, ultra-fine fibres, electrospun nano fibres, metallic fibres – Gold and Silver coated.

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES

Upon completion of this course, the student would be able to

- Understand the process sequence of various fibres
- Understand the properties of various fibres

### TEXT BOOKS:

- Morton W. E., and Hearle J. W. S., “Physical Properties of Textile Fibres”, The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95
- Meredith R., and Hearle J. W. S., “Physical Methods of Investigation of Textiles”, Wiley Publication, New York, 1989, ISBN: B00JCV6ZWU | ISBN-13:
- Mukhopadhyay S. K., “Advances in Fibre Science”, The Textile Institute,1992, ISBN: 1870812379

### REFERENCES:

- Meredith R., “Mechanical Properties of Textile Fibres”, North Holland, Amsterdam, 1986, ISBN: 1114790699, ISBN-13: 9781114790698



- Hearle J. W. S., Lomas B., and Cooke W. D., "Atlas of Fibre Fracture and Damage to Textiles", The Textile Institute, 2<sup>nd</sup> Edition, 1998, ISBN: 1855733196.
- Raheel M. (ed.), "Modern Textile Characterization Methods", Marcel Dekker, 1995, ISBN:0824794737
- Mukhopadhyay. S. K., "The Structure and Properties of Typical Melt Spun Fibres", Textile Progress, Vol. 18, No. 4, Textile Institute, 1989, ISBN: 1870812115
- Hearle J.W.S., "Polymers and Their Properties: Fundamentals of Structures and Mechanics Vol 1", Ellis Horwood, England, 1982, ISBN: 047027302X | ISBN-13: 9780470273029 36

**OTT355**

**GARMENT MANUFACTURING TECHNOLOGY**

**L T P C**  
**3 0 0 3**

**OBJECTIVE:**

- To enable the students to understand the basics of pattern making, cutting and sewing.
- To expose the students to various problems & remedies during garment manufacturing

**UNIT I PATTERN MAKING, MARKER PLANNING, CUTTING 9**

Anthropometry, specification sheet, pattern making – principles, basic pattern set drafting, grading, marker planning, spreading & cutting

**UNIT II TYPES OF SEAMS, STITCHES AND FUNCTIONS OF NEEDLES 9**

Different types of seams and stitches; single needle lock stitch machine – mechanism and accessories; needle – functions, special needles, needlepoint

**UNIT III COMPONENTS AND TRIMS USED IN GARMENT 9**

Sewing thread-construction, material, thread size, packages, accessories – labels, linings, interlinings, wadding, lace, braid, elastic, hook and loop fastening, shoulder pads, eyelets and laces, zip fasteners, buttons

**UNIT IV GARMENT INSPECTION AND DIMENSIONAL CHANGES 9**

Raw material, in process and final inspection; needle cutting; sewability of fabrics; strength properties of apparel; dimensional changes in apparel due to laundering, dry-cleaning, steaming and pressing.

**UNIT V GARMENT PRESSING, PACKING AND CARE LABELING 9**

Garment pressing – categories and equipment, packing; care labelling of apparels

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of the course, the students will be able to Understand

- CO1: Pattern making, marker planning, cutting  
 CO2: Types of seams, stitches and functions of needles  
 CO3: Components and trims used in garment  
 CO4: Garment inspection and dimensional changes  
 CO5: Garment pressing, packing and care labelling

**TEXT BOOKS:**

- Carr H., and Latham B., "The Technology of Clothing Manufacture", Blackwell Science Ltd., Oxford, 1994.
- Gerry Cooklin, "Introduction to Clothing Manufacture" Blackwell Science Ltd., 1995. 64
- Harrison.P.W Garment Dyeing, The Textile Institute Publication, Textile Progress, Vol .19 No.2,1988.

**REFERENCES:**

- Winifred Aldrich., "Metric Pattern Cutting", Blackwell Science Ltd., Oxford, 1994
- Peggall H., "The Complete Dress Maker", Marshall Caverdish, London, 1985

3. Jai Prakash and Gaur R.K., "Sewing Thread", NITRA, 1994
4. Ruth Glock, Grace I. Kunz, "Apparel Manufacturing", Dorling Kindersley Publishing Inc., New Jersey, 1995.
5. Pradip V.Mehta, "An Introduction to Quality Control for the Apparel Industry", J.S.N. Internationals, 1992.

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	1	1	1	-	2	-	1	1	-	2	3	1	2	3	1	3
2	2	2	1	1	1	-	1	1	-	2	2	1	2	2	1	2
3	1	1	1	1	1	1	1	1	-	1	2	1	1	3	1	3
4	2	1	1	1	2	2	2	1	1	2	3	1	2	3	1	3
5	2	2	1	1	1	1	2	1	-	2	2	1	2	2	1	2
<b>Avg</b>	1.6	1.2	1	0.8	1.4	0.8	1.4	1	0.2	1.8	2.4	1	1.8	2.6	1	2.6

OPE353

INDUSTRIAL SAFETY

L T P C  
3 0 0 3

**OBJECTIVES:**

- To educate about the health hazards and the safety measures to be followed in the industrial environment.
- Describe industrial legislations (Factories Acts, Workmen's Compensation and other laws) enacted for the protection of employees health at work settings
- Describe methods of prevention and control of Occupational Health diseases, accidents / emergencies and other hazards

**UNIT I INTRODUCTION**

9

Need for developing Environment, Health and Safety systems in work places - Accident Case Studies - Status and relationship of Acts - Regulations and Codes of Practice - Role of trade union safety representatives. International initiatives - Ergonomics and work place.

**UNIT II OCCUPATIONAL HEALTH AND HYGIENE**

9

Definition of the term occupational health and hygiene - Categories of health hazards - Exposure pathways and human responses to hazardous and toxic substances - Advantages and limitations of environmental monitoring and occupational exposure limits - Hierarchy of control measures for occupational health risks - Role of personal protective equipment and the selection criteria - Effects on humans - control methods and reduction strategies for noise, radiation and excessive stress.

**UNIT III WORKPLACE SAFETY AND SAFETY SYSTEMS**

9

Features of Satisfactory and Safe design of work premises – good housekeeping - lighting and colour, Ventilation and Heat Control – Electrical Safety – Fire Safety – Safe Systems of work for manual handling operations – Machine guarding – Working at different levels – Process and System Safety.

**UNIT IV HAZARDS AND RISK MANAGEMENT**

9

Safety appraisal - analysis and control techniques – plant safety inspection – Accident investigation - Analysis and Reporting – Hazard and Risk Management Techniques – major accident hazard control – Onsite and Offsite emergency Plans.

**UNIT V ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT****9**

Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and methods of its effective implementation and review – Elements of Management Principles – Education and Training – Employee Participation.

**TOTAL: 45 PERIODS****OUTCOMES:**

After completion of this course, the student is expected to be able to:

- Describe, with example, the common work-related diseases and accidents in occupational setting
- Name essential members of the Occupational Health team
- What roles can a community health practitioners play in an Occupational setting to ensure the protection, promotion and maintenance of the health of the employee

**OPE354 UNIT OPERATIONS IN PETRO CHEMICAL INDUSTRIES****L T P C  
3 0 0 3****OBJECTIVES:**

- To impart to the student basic knowledge on fluid mechanics, mechanical operations, heat transfer operations and mass transfer operations.

**UNIT I FLUID MECHANICS CONCEPTS**

Fluid definition and classification of fluids, types of fluids, Rheological behaviour of fluids & Newton's Law of viscosity. Fluid statics-Pascal's law, Hydrostatic equilibrium, Barometric equation and pressure measurement(problems),Basic equations of fluid flow - Continuity equation, Euler's equation and Bernoulli equation; Types of flow - laminar and turbulent; Reynolds experiment; Flow through circular and non-circular conduits - Hagen Poiseuille equation (no derivation). Flow through stagnant fluids – theory of Settling and Sedimentation – Equipment (cyclones, thickeners) Conceptual numericals.

**UNIT II FLOW MEASUREMENTS & MECHANICAL OPERATIONS**

Different types of flow measuring devices (Orifice meter, Venturimeter, Rotameter) with derivations, flow measurements –. Pumps – types of pumps (Centrifugal & Reciprocating pumps), Energy calculations and characteristics of pumps. Size reduction–characteristics of comminute products, sieve analysis, Properties and handling of particulate solids – characterization of solid particles, average particle size, screen analysis- Conceptual numerical of differential and cumulative analysis. Size reduction, crushing laws, working principle of ball mill. Filtration & types, filtration equipments (plate and frame, rotary drum). Conceptual numericals.

**UNIT III CONDUCTIVE & CONVECTIVE HEAT TRANSFER**

Modes of heat transfer; Conduction – steady state heat conduction through unilayer and multilayer walls, cylinders; Insulation, critical thickness of insulation. Convection- Forced and Natural convection, principles of heat transfer co-efficient, log mean temperature difference, individual and overall heat transfer co-efficient, fouling factor; Condensation – film wise and drop wise (no derivation). Heat transfer equipments – double pipe heat exchanger, shell and tube heat exchanger (with working principle and construction with applications).

**UNIT IV BASICS OF MASS TRANSFER**

Diffusion-Fick's law of diffusion. Types of diffusion. Steady state molecular diffusion in fluids at rest and laminar flow (stagnant / unidirection and bi direction). Measurement of diffusivity, Mass transfer coefficients and their correlations. Conceptual numerical.

## UNIT V MASS TRANSFER OPERATIONS

Basic concepts of Liquid-liquid extraction – equilibrium, stage type extractors (belt extraction and basket extraction). Distillation – Methods of distillation, distillation of binary mixtures using McCabe Thiele method. Drying- drying operations, batch and continuous drying. Conceptual numerical.

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:

At the end of the course the student will be able to:

- State and describe the nature and properties of the fluids.
- Study the different flow measuring instruments, the principles of various size reductions, conveying equipment's, sedimentation and mixing tanks.
- Comprehend the laws governing the heat and mass transfer operations to solve the problems.
- Design the heat transfer equipment suitable for specific requirement.

### TEXTBOOKS:

1. Unit operations in Chemical Engineering Warren L. McCabe, Julian C. Smith & Peter Harriot McGraw-Hill Education (India) Edition 2014
2. Fluid Mechanics K L Kumar S Chand & Company Ltd 2008
3. Introduction to Chemical Engineering Badger W.I. and Banchemo, J.T., Tata McGraw Hill New York 1997

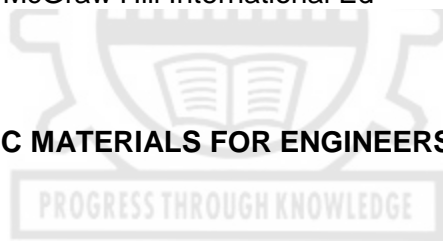
### REFERENCE BOOKS

1. Principles of Unit Operations Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B. Anderson John Wiley & Sons 2nd edition 2008
2. Unit Operations of Chemical Engineering, Vol I & II Chattopadhyaya Khanna Publishers, Delhi-6 1996
3. Heat Transfer J P Holman McGraw Hill International Ed

OPT352

**PLASTIC MATERIALS FOR ENGINEERS**

**L T P C**  
**3 0 0 3**



### COURSE OBJECTIVES

- Understand the advantages, disadvantages and general classification of plastic materials
- To know the manufacturing, sources, and applications of engineering thermoplastics
- Understand the basics as well as the advanced applications of various plastic materials in the industry
- To understand the preparation methods of thermosetting materials
- Select suitable specialty plastics for different end applications

## UNIT I INTRODUCTION TO PLASTIC MATERIALS

**9**

Introduction to Plastics – Brief history of plastics, advantages and disadvantages, thermoplastic and thermosetting behavior, amorphous polymers, crystalline polymers and cross-linked structures. General purpose thermoplastics/ Commodity plastics: manufacture, structure, properties and applications of polyethylene (PE), cross-linked PE, chlorinated PE, polypropylene, polyvinyl chloride-compounding, formulation, polypropylene (PP)

## UNIT II ENGINEERING THERMOPLASTICS AND APPLICATIONS

**9**

Engineering thermoplastics – Aliphatic polyamides: structure, properties, manufacture and applications of Nylon 6, Nylon 66. Polyesters: manufacture, structure, properties and uses of PET, PBT. Manufacture, structure, properties and uses of Polycarbonates, acetal resins, polyimides, PMMA, polyphenylene oxide, thermoplastic polyurethane (PU)

**UNIT III THERMOSETTING PLASTICS****9**

Thermosetting Plastics – Manufacture, curing, moulding powder, laminates, properties and uses of phenol formaldehyde resins, urea formaldehyde, melamine formaldehyde, unsaturated polyester resin, epoxy resin, silicone resins, polyurethane resins.

**UNIT IV MISCELLANEOUS PLASTICS FOR END APPLICATIONS****9**

Miscellaneous plastics- Manufacture, properties and uses of polystyrene, HIPS, ABS, SAN, poly(tetrafluoroethylene) (PTFE), TFE and copolymers, PVDF, PVA, poly (vinyl acetate), poly (vinyl carbazole), cellulose acetate, PEEK, High energy absorbing polymers, super absorbent polymers- their synthesis, properties and applications

**UNIT V PLASTICS MATERIALS FOR BIOMEDICAL APPLICATIONS****9**

Sources, raw materials, methods of manufacturing, properties and applications of bio-based polymers- poly lactic acid (PLA), poly hydroxy alkanooates (PHA), PBAT, bioplastics- bio-PE, bio-PP, bio-PET, polymers for biomedical applications

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

- To study the importance, advantages and classification of plastic materials
- Summarize the raw materials, sources, production, properties and applications of various engineering thermoplastics
- To understand the application of polyamides, polyesters and other engineering thermoplastics, thermosetting resins
- Know the manufacture, properties and uses of thermosetting resins based on polyester, epoxy, silicone and PU
- To understand the engineering applications of various polymers in miscellaneous areas and applications of different biopolymers

**REFERENCES**

1. Marianne Gilbert (Ed.), Brydson's Plastics Materials, 8<sup>th</sup> Edn., Elsevier (2017).
2. J.A.Brydson, Plastics Materials, 7<sup>th</sup> Edn., Butterworth Heinemann (1999).
3. Manas Chanda, Salil K. Roy, Plastics Technology Handbook, 4<sup>th</sup> Edn., CRC press (2006).
4. A. Brent Strong, Plastics: Materials and Processing, 3<sup>rd</sup> Edn., Pearson Prentice Hall (2006).
5. Olagoke Olabisi, Kolapo Adewale (Eds.), Handbook of Thermoplastics 2<sup>nd</sup> Edn., CRC press(2016).
6. Charles A. Harper, Modern Plastics Handbook, McGraw-Hill, New York, 1999.
7. H. Dominighaus, Plastics for Engineers, Hanser Publishers, Munich, 1988.

**OPT353****PROPERTIES AND TESTING OF PLASTICS****L T P C  
3 0 0 3****COURSE OBJECTIVES**

- To understand the relevance of standards and specifications as well as the specimen preparation for polymer testing.
- To study the mechanical properties and testing of polymer materials and their structural property relationships.
- To understand the thermal properties of polymers and their testing methods.
- To gain knowledge on the electrical and optical properties of polymers and their testing methods.
- To study about the environmental effects and prevent polymer degradation.

**UNIT I INTRODUCTION TO CHARACTERIZATION AND TESTING OF POLYMERS 9**

Introduction- Standard organizations: BIS, ASTM, ISO, BS, DIN etc. Standards and specifications. Importance of standards in the quality control of polymers and polymer products. Preparation of test pieces, conditioning and test atmospheres. Tests on elastomers: processability parameters of rubbers – plasticity, Mooney viscosity, scorch time, cure time, cure rate index, Processability tests carried out on thermoplastics and thermosets: MFI, cup flow index, gel time, bulk density, bulk factor.

**UNIT II MECHANICAL PROPERTIES 9**

Mechanical properties: Tensile, compression, flexural, shear, tear strength, hardness, impact strength, resilience, abrasion resistance, creep and stress relaxation, compression set, dynamic fatigue, ageing properties, Basic concepts of stress and strain, short term tests: Viscoelastic behavior (simple models: Kelvin model for creep and stress relaxation, Maxwell-Voigt model, strain recovery and dynamic response), Effect of structure and composition on mechanical properties, Behavior of reinforced polymers

**UNIT III THERMAL RHEOLOGICAL PROPERTIES 9**

Thermal properties: Transition temperatures, specific heat, thermal conductivity, co-efficient of thermal expansion, heat deflection temperature, Vicat softening point, shrinkage, brittleness temperature, thermal stability and flammability. Product testing: Plastic films, sheeting, pipes, laminates, foams, containers, cables and tubes.

**UNIT IV ELECTRICAL AND OPTICAL PROPERTIES 9**

Electrical properties: volume and surface resistivity, dielectric strength, dielectric constant and power factor, arc resistance, tracking resistance, dielectric behavior of polymers (dielectric co-efficient, dielectric polarization), dissipation factor and its importance. Optical properties: transparency, refractive index, haze, gloss, clarity, birefringence.

**UNIT V ENVIRONMENTAL AND CHEMICAL RESISTANCE 9**

Environmental stress crack resistance (ESCR), water absorption, weathering, aging, ozone resistance, permeability and adhesion. Tests for chemical resistance. Acids, alkalies, Flammability tests- oxygen index test.

**TOTAL : 45 PERIODS****COURSE OUTCOMES**

- Understand the relevance of standards and specifications.
- Summarize the various test methods for evaluating the mechanical properties of the polymers.
- To know the thermal, electrical & optical properties of polymers.
- Identify various techniques used for characterizing polymers.
- Distinguish the processability tests used for thermoplastics, thermosets and elastomers.

**REFERENCES:**

1. F.Majewska, H.Zowall, Handbook of analysis of synthetic polymers and plastics, Ellis Horwood Limited Publisher 1977.
2. J.F.Rabek, Experimental Methods in Polymer Chemistry, John Wiley and Sons 1980.
3. R.P.Brown, Plastic test methods, 2<sup>nd</sup> Edn., Harlond, Longman Scientific, 1981.
4. A. B. Mathur, I. S. Bharadwaj, Testing and Evaluation of Plastics, Allied Publishers Pvt. Ltd., New Delhi, 2003.
5. Vishu Shah, Handbook of Plastic Testing Technology, 3<sup>rd</sup> Edn., John Wiley & Sons 2007.
6. S. K. Nayak, S. N. Yadav, S. Mohanty, Fundamentals of Plastic Testing, Springer, 2010.

**OBJECTIVES:**

- Understand the fundamentals of IC technology components and their characteristics.
- Understand combinational logic circuits and design principles.
- Understand sequential logic circuits and clocking strategies.
- Understand Interconnects and Memory Architecture.
- Understand the design of arithmetic building blocks

**UNIT I MOS TRANSISTOR PRINCIPLES****9**

MOS logic families (NMOS and CMOS), Ideal and Non Ideal IV Characteristics, CMOS devices. MOS(FET) Transistor DC transfer Characteristics ,small signal analysis of MOSFET.

**UNIT II COMBINATIONAL LOGIC CIRCUITS****9**

Propagation Delays, stick diagram, Layout diagrams, Examples of combinational logic design, Elmore's constant, Static Logic Gates, Dynamic Logic Gates, Pass Transistor Logic, Power Dissipation.

**UNIT III SEQUENTIAL LOGIC CIRCUITS AND CLOCKING STRATEGIES****9**

Static Latches and Registers, Dynamic Latches and Registers, Pipelines, Timing classification of Digital Systems, Synchronous Design, Self-Timed Circuit Design .

**UNIT IV INTERCONNECT, MEMORY ARCHITECTURE****9**

Interconnect Parameters – Capacitance, Resistance, and Inductance, Logic Implementation using Programmable Devices (ROM, PLA, FPGA), Memory Architecture and Building Blocks.

**UNIT V DESIGN OF ARITHMETIC BUILDING BLOCKS****9**

Arithmetic Building Blocks: Data Paths, Adders-Ripple Carry Adder, Carry-Bypass Adder, Carry Select Adder, Carry-Look Ahead Adder, Multipliers, Barrel Shifter, power and speed tradeoffs.

**TOTAL: 45 PERIODS****OUTCOMES:**

**Upon successful completion of the course the student will be able to**

**CO1:** Understand the working principle and characteristics of MOSFET

**CO2:** Design Combinational Logic Circuits

**CO3:** Design Sequential Logic Circuits and Clocking systems

**CO4:** Understand Memory architecture and interconnects

**CO5:** Design of arithmetic building blocks.

**TEXT BOOKS:**

1. Jan D Rabaey, Anantha Chandrakasan, "Digital Integrated Circuits: A Design Perspective", PHI, 2016.(Units II, III IV and V).
2. Neil H E Weste, Kamran Eshranghian, "Principles of CMOS VLSI Design: A System Perspective," Addison Wesley, 2009.( Units - I).

**REFERENCES:**

1. D.A. Hodges and H.G. Jackson, Analysis and Design of Digital Integrated Circuits, International Student Edition, McGraw Hill 1983
2. P. Rashinkar, Paterson and L. Singh, "System-on-a-Chip Verification-Methodology and Techniques", Kluwer Academic Publishers,2001
3. Samiha Mourad and Yervant Zorian, "Principles of Testing Electronic Systems", Wiley 2000
4. M. Bushnell and V. D. Agarwal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers,2000

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	2	1	3	-	-	-	-	2	3	3	3	3
2	3	3	2	2	1	-	-	-	-	-	-	2	3	3	3
3	3	-	3	2	1	2	-	-	-	-	3	2	3	2	3
4	3	3	2	2	2	-	-	-	-	-	-	1	3	3	2
5	2	-	3	2	2	1	-	-	-	-	1	1	3	2	2
CO	3	3	2	2	1	2	-	-	-	-	2	2	3	3	3

**CBM370**

**WEARABLE DEVICES**

**L T P C**  
**3 0 0 3**

**OBJECTIVES:**

**The student should be made to:**

- To know the hardware requirement of wearable systems
- To understand the communication and security aspects in the wearable devices
- To know the applications of wearable devices in the field of medicine

**UNIT I INTRODUCTION TO WEARABLE SYSTEMS AND SENSORS 9**

Wearable Systems- Introduction, Need for Wearable Systems, Drawbacks of Conventional Systems for Wearable Monitoring, Applications of Wearable Systems, Types of Wearable Systems, Components of wearable Systems. Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Impedance plethysmography, Wearable ground reaction force sensor.

**UNIT II SIGNAL PROCESSING AND ENERGY HARVESTING FOR WEARABLE DEVICES 9**

Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, sampling frequency for reduced energy consumption, Rejection of irrelevant information. Power Requirements- Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.

**UNIT III WIRELESS HEALTH SYSTEMS 9**

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication Techniques.

**UNIT IV SMART TEXTILE 9**

Introduction to smart textile- Passive smart textile, active smart textile. Fabrication Techniques- Conductive Fibres, Treated Conductive Fibres, Conductive Fabrics, Conductive Inks. Case study- smart fabric for monitoring biological parameters - ECG, respiration.

**UNIT V APPLICATIONS OF WEARABLE SYSTEMS 9**

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, neural recording, Gait analysis, Sports Medicine.

**OUTCOMES:**

On successful completion of this course, the student will be able to

CO1: Describe the concepts of wearable system.

CO2: Explain the energy harvestings in wearable device.

CO3: Use the concepts of BAN in health care.

CO4: Illustrate the concept of smart textile

CO5: Compare the various wearable devices in healthcare system

**TOTAL: 45 PERIODS**

**TEXT BOOKS**

1. Annalisa Bonfiglio and Danilo De Rossi, Wearable Monitoring Systems, Springer, 2011



2. Zhang and Yuan-Ting, Wearable Medical Sensors and Systems, Springer, 2013
3. Edward Sazonov and Micheal R Neuman, Wearable Sensors: Fundamentals, Implementation and Applications, Elsevier, 2014
4. Mehmet R. Yuce and JamilY.Khan, Wireless Body Area Networks Technology, Implementation applications, Pan Stanford Publishing Pte.Ltd, Singapore, 2012

**REFERENCES:**

1. Sandeep K.S, Gupta, Tridib Mukherjee and Krishna Kumar Venkatasubramanian, Body Area Networks Safety, Security, and Sustainability, Cambridge University Press, 2013.
2. Guang-Zhong Yang, Body Sensor Networks, Springer, 2006.

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	2			1					1		1
2	3	2	1	1	2			1					1		1
3	3	2	1	1	2			1					1		1
4	3	2	1	1	2			1					1		1
5	3	2	1	1	2			1					1		1
AVg.															

**CBM356**

**MEDICAL INFORMATICS**

**L T P C  
3 0 0 3**

**PREAMBLE:**

1. To study the applications of information technology in health care management.
2. This course provides knowledge on resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine.

**UNIT I INTRODUCTION TO MEDICAL INFORMATICS 9**

Introduction - Structure of Medical Informatics –Internet and Medicine -Security issues, Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, Health Informatics – Medical Informatics, Bioinformatics

**UNIT II COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING 9**

Automated clinical laboratories-Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System - Computer assisted medical imaging- nuclear medicine, ultrasound imaging, computed X-ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance.

**UNIT III COMPUTERISED PATIENT RECORD 9**

Introduction - conventional patient record, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for patients.

**UNIT IV COMPUTER ASSISTED MEDICAL DECISION-MAKING 9**

Neuro computers and Artificial Neural Networks application, Expert system-General model of CMD, Computer–assisted decision support system-production rule system cognitive model, semantic networks, decisions analysis in clinical medicine-computers in the care of critically ill patients, Computer aids for the handicapped.

**UNIT V RECENT TRENDS IN MEDICAL INFORMATICS 9**

Virtual reality applications in medicine, Virtual endoscopy, Computer assisted surgery, Surgical simulation, Telemedicine - Tele surgery, Computer assisted patient education and health- Medical education and healthcare information, computer assisted instruction in medicine.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

**Upon completion of the course, students will be able to:**

1. Explain the structure and functional capabilities of Hospital Information System.
2. Describe the need of computers in medical imaging and automated clinical laboratory.
3. Articulate the functioning of information storage and retrieval in computerized patient record system.
4. Apply the suitable decision support system for automated clinical diagnosis.
5. Discuss the application of virtual reality and telehealth technology in medical industry.

**TEXT BOOKS:**

1. Mohan Bansal, "Medical informatics", Tata McGraw Hill Publishing Ltd, 2003.
2. R.D.Lele, "Computers in medicine progress in medical informatics", Tata Mcgraw Hill,2005

**REFERENCES:**

1. Kathryn J. Hannah, Marion J Ball, "Health Informatics", 3<sup>rd</sup> Edition, Springer, 2006.

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	2			1					1	1	1
2	3	2	1	1	2			1					1	1	1
3	3	2	1	1	2			1					1	1	1
4	3	2	1	1	2			1					1	1	1
5	3	2	1	1	2			1					1	1	1
AVg.															

**OBT355**

**BIOTECHNOLOGY FOR WASTE MANAGEMENT**

**L T P C  
3 0 0 3**

**UNIT I BIOLOGICAL TREATMENT PROCESS**

**9**

Fundamentals of biological process - Anaerobic process – Pretreatment methods in anaerobic process – Aerobic process, Anoxic process, Aerobic and anaerobic digestion of organic wastes - Factors affecting process efficiency - Solid state fermentation – Submerged fermentation – Batch and continuous fermentation

**UNIT II WASTE BIOMASS AND ITS VALUE ADDITION**

**9**

Types of waste biomass – Solid waste management - Nature of biomass feedstock – Biobased economy/process – Value addition of waste biomass – Biotransformation of biomass – Biotransformation of marine processing wastes – Direct extraction of biochemicals from biomass – Plant biomass for industrial application

**UNIT III BIOCONVERSION OF WASTES TO ENERGY**

**9**

Perspective of biofuels from wastes - Bioethanol production – Biohydrogen Production – dark and photofermentative process - Biobutanol production – Biogas and Biomethane production - Single stage

anaerobic digestion, Two stage anaerobic digestion - Biodiesel production - Enzymatic hydrolysis technologies

**UNIT IV CHEMICALS AND ENZYME PRODUCTION FROM WASTES**

**9**

Production of lactic acid, succinic acid, citric acid – Biopolymer synthesis – Production of Amylases - Lignocellulolytic enzymes - Pectinolytic enzymes - Proteases – Lipases

**UNIT V BIOCUMPOSTING OF ORGANIC WASTES**

**9**

Overview of composting process - Benefits of composting, Role of microorganisms in composting - Factors affecting the composting process - Waste Materials for Composting, Fundamentals of composting process - Composting technologies, Composting systems – Nonreactor Composting, Reactor composting - Compost Quality

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

After completion of this course, the students should be able

1. To learn the various methods biological treatment
2. To know the details of waste biomass and its value addition
3. To develop the bioconversion processes to convert wastes to energy
4. To synthesize the chemicals and enzyme from wastes
5. To produce the biocompost from wastes
6. To apply the theoretical knowledge for the development of value added products

**TEXT BOOKS**

1. Antoine P. T., (2017) "Biofuels from Food Waste Applications of Saccharification Using Fungal Solid State Fermentation", CRC press
2. Joseph C A., (2019)"Anaerobic Waste-Wastewater Treatment and Biogas Plants-A Practical Handbook", CRC Press,

**REFERENCE BOOKS**

1. Palmiro P. and Oscar F.D'Urso, (2016) 'Biotransformation of Agricultural Waste and By-Products', The Food, Feed, Fibre, Fuel (4F) Economy, Elsevier
2. Kaur Brar S., Gurpreet Singh D. and Carlos R.S., (Eds), (2014)'Biotransformation of Waste Biomass into High Value Biochemicals', Springer.
3. Keikhosro K, Editor, (2015) 'Lignocellulose-Based Bioproducts', Springer.
4. John P, (2014) 'Waste Management Practices-Municipal, Hazardous, and Industrial', Second Edition, CRC Press, 2014

<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>9</b>
Lifestyle diseases – Definition ; Risk factors – Eating, smoking, drinking, stress, physical activity, illicit drug use ; Obesity, diabetes, cardiovascular diseases, respiratory diseases, cancer; Prevention – Diet and exercise.		
<b>UNIT II</b>	<b>CANCER</b>	<b>9</b>
Types - Lung cancer, Mouth cancer, Skin cancer, Cervical cancer, Carcinoma oesophagus; Causes Tobacco usage, Diagnosis – Biomarkers, Treatment		
<b>UNIT III</b>	<b>CARDIOVASCULAR DISEASES</b>	<b>9</b>
Coronary atherosclerosis – Coronary artery disease; Causes -Fat and lipids, Alcohol abuse -- Diagnosis - Electrocardiograph, echocardiograph, Treatment, Exercise and Cardiac rehabilitation		
<b>UNIT IV</b>	<b>DIABETES AND OBESITY</b>	<b>9</b>
Types of Diabetes mellitus; Blood glucose regulation; Complications of diabetes – Paediatric and adolescent obesity – Weight control and BMI		
<b>UNIT V</b>	<b>RESPIRATORY DISEASES</b>	<b>9</b>
Chronic lung disease, Asthma, COPD; Causes - Breathing pattern (Nasal vs mouth), Smoking – Diagnosis - Pulmonary function testing		

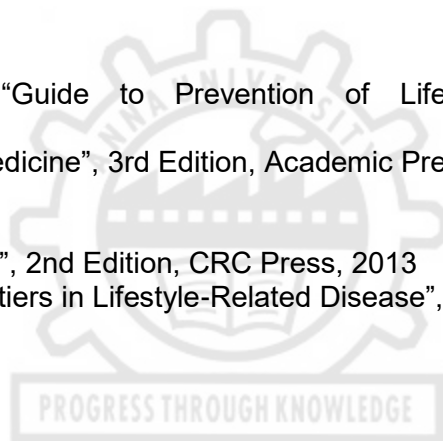
**TOTAL: 45 PERIODS**

**TEXT BOOKS:**

1. R.Kumar&Meenal Kumar, “Guide to Prevention of Lifestyle Diseases”, Deep & Deep Publications, 2003
2. Gary Eggar et al, “Lifestyle Medicine”, 3rd Edition, Academic Press, 2017

**REFERENCES:**

1. James M.R, “Lifestyle Medicine”, 2nd Edition, CRC Press, 2013
2. Akira Miyazaki et al, “New Frontiers in Lifestyle-Related Disease”, Springer, 2008



<b>OBT357</b>	<b>BIOTECHNOLOGY IN HEALTH CARE</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

**COURSE OBJECTIVES**

The aim of this course is to

1. Create higher standard of knowledge on healthcare system and services
2. Prioritize advanced technologies for the diagnosis and treatment of various diseases

<b>UNIT I</b>	<b>PUBLIC HEALTH</b>	<b>9</b>
Definition and Concept of Public Health, Historical aspects of Public Health, Changing Concepts of Public Health, Public Health versus Medical Care, Unique Features of Public Health, Determinants of Health (Social, Economic, Cultural, Environmental, Education, Genetics, Food and Nutrition). Indicators of health, Burden of disease, Role of different disciplines in Public Health.		

<b>UNIT II</b>	<b>CLINICAL DISEASES</b>	<b>9</b>
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Communicable diseases: Chickenpox / Shingles, COVID-19, Tuberculosis, Hepatitis B, Hepatitis C, HIV / AIDS, Influenza, Swine flu. Non Communicable diseases: Diabetes mellitus, atherosclerosis, fatty liver, Obesity, Cancer

### **UNIT III VACCINOLOGY**

**9**

History of Vaccinology, conventional approaches to vaccine development, live attenuated and killed vaccines, adjuvants, quality control, preservation and monitoring of microorganisms in seed lot systems. Instruments related to monitoring of temperature, sterilization, environment.

### **UNIT IV OUTPATIENT & IN PATIENT SERVICES**

**9**

Radiotherapy, Nuclear medicine, surgical units, OT Medical units, G & Obs. units Pediatric, neonatal units, Critical care units, Physical medicine & Rehabilitation, Neurology, Gastroenterology, Endoscopy, Pulmonology, Cardiology.

### **UNIT V BASICS OF IMAGING MODALITIES**

**9**

Diagnostic X-rays - Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography – Different types of biotelemetry systems.

**TOTAL: 45 PERIODS**

#### **TEXT BOOKS:**

1. Joseph J.carr and John M. Brown, Introduction to Biomedical Equipment Technology, John Wiley and sons, New York, 4th Edition, 2012.
2. Thomas M. Devlin.Textbook of Biochemistry with clinical correlations. Wiley Liss Publishers
3. The Vaccine Book (2nd Ed.), Rafi Ahmed, Roy M. Anderson et. al.Editor(s): Barry R. Bloom, PaulHenri Lambert, Academic Press, 2016, Pages xxi-xxiv.

#### **REFERENCE BOOKS:**

1. Suh, Sang, Gurupur, Varadraj P., Tanik, Murat M., Health Care Systems, Technology and Techniques, Springer, 1st Edition, 2011
2. Burtis & Ashwood W.B. Tietz Textbook of Clinical chemistry. Saunders Company
3. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker

## **VERTICAL 1: FINTECH AND BLOCK CHAIN**

**CMG331**

**FINANCIAL MANAGEMENT**

**L T P C**

**3 0 0 3**

#### **LEARNING OBJECTIVES**

- 1.To acquire the knowledge of the decision areas in finance.
2. To learn the various sources of Finance
3. To describe about capital budgeting and cost of capital.
4. To discuss on how to construct a robust capital structure and dividend policy
5. To develop an understanding of tools on Working Capital Management.

### **UNIT I INTRODUCTION TO FINANCIAL MANGEMENT**

**9**

Definition and Scope of Finance Functions - Objectives of Financial Management - Profit Maximization and Wealth Maximization- Time Value of money- Risk and return concepts.

**UNIT II . SOURCES OF FINANCE****9**

Long term sources of Finance -Equity Shares – Debentures - Preferred Stock – Features – Merits and Demerits. Short term sources - Bank Sources, Trade Credit, Overdrafts, Commercial Papers, Certificate of Deposits, Money market mutual funds etc

**UNIT III INVESTMENT DECISIONS****9**

Investment Decisions: capital budgeting – Need and Importance – Techniques of Capital Budgeting -- Payback -ARR – NPV – IRR –Profitability Index.

Cost of Capital - Cost of Specific Sources of Capital - Equity -Preferred Stock- Debt - Reserves - Concept and measurement of cost of capital - Weighted Average Cost of Capital.

**UNIT IV FINANCING AND DIVIDEND DECISION****9**

Operating Leverage and Financial Leverage- EBIT-EPS analysis. Capital Structure – determinants of Capital structure- Designing an Optimum capital structure. Dividend policy - Aspects of dividend policy - practical consideration - forms of dividend policy - - Determinants of Dividend Policy

**UNIT V WORKING CAPITAL DECISION****9**

Working Capital Management: Working Capital Management - concepts - importance -Determinants of Working capital. Cash Management: Motives for holding cash – Objectives and Strategies of Cash Management. Receivables Management: Objectives - Credit policies.

**TOTAL : 45 PERIODS****TEXT BOOKS**

1. M.Y. Khan and P.K.Jain Financial management, Text, Tata McGraw Hill
2. M. Pandey Financial Management, Vikas Publishing House Pvt. Ltd

**REFERENCES .**

1. James C. Vanhorne –Fundamentals of Financial Management– PHI Learning,.
2. Prasanna Chandra, Financial Management,
3. Srivatsava, Mishra, Financial Management, Oxford University Press, 2011

**CMG332****FUNDAMENTALS OF INVESTMENT****L T P C  
3 0 0 3****OBJECTIVES:**

1. Describe the investment environment in which investment decisions are taken.
2. Explain how to Value bonds and equities
3. Explain the various approaches to value securities
4. Describe how to create efficient portfolios through diversification
5. Discuss the mechanism of investor protection in India.

**UNIT I THE INVESTMENT ENVIRONMENT**

The investment decision process, Types of Investments – Commodities, Real Estate and Financial Assets, the Indian securities market, the market participants and trading of securities, security market indices, sources of financial information, Concept of return and risk, Impact of Taxes and Inflation on return.

## **UNIT II FIXED INCOME SECURITIES**

Bond features, types of bonds, estimating bond yields, Bond Valuation types of bond risks, default risk and credit rating.

## **UNIT III APPROACHES TO EQUITY ANALYSIS**

Introduction to Fundamental Analysis, Technical Analysis and Efficient Market Hypothesis, dividend capitalisation models, and price-earnings multiple approach to equity valuation.

## **UNIT IV PORTFOLIO ANALYSIS AND FINANCIAL DERIVATIVES**

Portfolio and Diversification, Portfolio Risk and Return; Mutual Funds; Introduction to Financial Derivatives; Financial Derivatives Markets in India

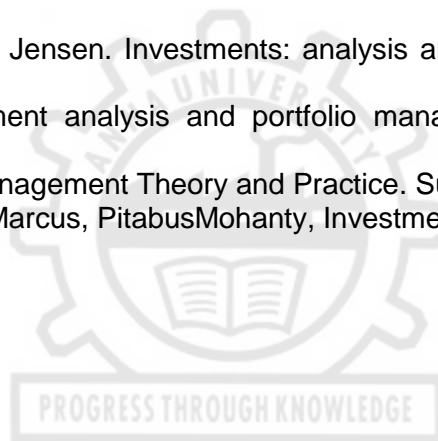
## **UNIT V INVESTOR PROTECTION**

Role of SEBI and stock exchanges in investor protection; Investor grievances and their redressal system, insider trading, investors' awareness and activism

**TOTAL: 45 PERIODS**

### **REFERENCES:**

1. Charles P. Jones, Gerald R. Jensen. Investments: analysis and management. Wiley, 14<sup>TH</sup> Edition, 2019.
2. Chandra, Prasanna. Investment analysis and portfolio management. McGraw-hill education, 5<sup>th</sup>, Edition, 2017.
3. Rustagi, R. P. Investment Management Theory and Practice. Sultan Chand & Sons, 2021.
4. Zvi Bodie, Alex Kane, Alan J Marcus, Pitabhus Mohanty, Investments, McGraw Hill Education (India), 11 Edition (SIE), 2019



**CMG333**

**BANKING, FINANCIAL SERVICES AND INSURANCE**

**L T P C  
3 0 0 3**

### **OBJECTIVES**

- Understand the Banking system in India
- Grasp how banks raise their sources and how they deploy it
- Understand the development in banking technology
- Understand the financial services in India
- Understand the insurance Industry in India

### **UNIT I INTRODUCTION TO INDIAN BANKING SYSTEM**

**9**

Overview of Banking system – Structure – Functions – Banking system in India - Key Regulations in Indian Banking sector – RBI. Relationship between Banker and Customer - Retail & Wholesale Banking – types of Accounts - Opening and operation of Accounts.

### **UNIT II MANAGING BANK FUNDS/ PRODUCTS**

**9**

Liquid Assets - Investment in securities - Advances - Loans. Negotiable Instruments – Cheques, Bills of Exchange & Promissory Notes. Designing deposit schemes – Asset and Liability Management – NPA's – Current issues on NPA's – M&A's of banks into securities market

**UNIT III DEVELOPMENT IN BANKING TECHNOLOGY 9**  
 Payment system in India – paper based – e payment –electronic banking –plastic money – e-money – forecasting of cash demand at ATM's –The Information Technology Act, 2000 in India – RBI's Financial Sector Technology vision document – security threats in e-banking & RBI's Initiative.

**UNIT IV FINANCIAL SERVICES 9**  
 Introduction – Need for Financial Services – Financial Services Market in India – NBFC — Leasing and Hire Purchase — mutual funds. Venture Capital Financing –Bill discounting –factoring – Merchant Banking

**UNIT V INSURANCE 9**  
 Insurance –Concept - Need - History of Insurance industry in India. Insurance Act, 1938 –IRDA – Regulations – Life Insurance - Annuities and Unit Linked Policies - Lapse of the Policy – revival – settlement of claim

**TOTAL : 45 PERIODS**

**REFERENCES :**

1. Padmalatha Suresh and Justin Paul, "Management of Banking and Financial Services, Pearson, Delhi, 2017.
2. Meera Sharma, "Management of Financial Institutions – with emphasis on Bank and Risk Management", PHI Learning Pvt. Ltd., New Delhi 2010
3. Peter S. Rose and Sylvia C. and Hudgins, "Bank Management and Financial Services", Tata McGraw Hill, New Delhi, 2017

**CMG334 INTRODUCTION TO BLOCKCHAIN AND ITS APPLICATIONS L T P C**  
**3 0 0 3**

**UNIT I INTRODUCTION TO BLOCKCHAIN 9**  
 Blockchain: The growth of blockchain technology - Distributed systems - The history of blockchain and Bitcoin - Features of a blockchain - Types of blockchain, Consensus: Consensus mechanism - Types of consensus mechanisms - Consensus in blockchain. Decentralization: Decentralization using blockchain - Methods of decentralization - Routes to decentralization- Blockchain and full ecosystem decentralization - Smart contracts - Decentralized Organizations- Platforms for decentralization.

**UNIT II INTRODUCTION TO CRYPTOCURRENCY 9**  
 Bitcoin – Digital Keys and Addresses – Transactions – Mining – Bitcoin Networks and Payments – Wallets – Alternative Coins – Theoretical Limitations – Bitcoin limitations – Name coin – Prime coin – Zcash – Smart Contracts – Ricardian Contracts- Deploying smart contracts on a blockchain

**UNIT III ETHEREUM 9**  
 Introduction - The Ethereum network - Components of the Ethereum ecosystem - Transactions and messages - Ether cryptocurrency / tokens (ETC and ETH) - The Ethereum Virtual Machine (EVM), Ethereum Development Environment: Test networks - Setting up a private net - Starting up the private network

**UNIT IV WEB3 AND HYPERLEDGE ` 9**  
 Introduction to Web3 – Contract Deployment – POST Requests – Development Frameworks – Hyperledger as a Protocol – The Reference Architecture – Hyperledger Fabric – Distributed Ledger – Corda.

**UNIT V EMERGING TRENDS 9**  
 Kadena – Ripple – Rootstock – Quorum – Tendermint – Scalability – Privacy – Other Challenges – Blockchain Research – Notable Projects – Miscellaneous Tools.

**TOTAL: 45 PERIODS**



## REFERENCE

1. Imran. Bashir. Mastering block chain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained. Packt Publishing, 2<sup>nd</sup> Edition, 2018
2. Peter Borovykh , Blockchain Application in Finance, Blockchain Driven, 2nd Edition, 2018
3. ArshdeepBahga, Vijay Madiseti, "Blockchain Applications: A Hands On Approach", VPT, 2017.

**CMG335**

### **FINTECH PERSONAL FINANCE AND PAYMENTS**

**L T P C**  
**3 0 0 3**

#### **UNIT I CURRENCY EXCHANGE AND PAYMENT**

**9**

Understand the concept of Crypto currency- Bitcoin and Applications -Cryptocurrencies and Digital Crypto Wallets -Types of Cryptocurrencies - Cryptocurrencies and Applications, block chain, Artificial Intelligence, machine learning. Fintech users, Individual Payments, RTGS Systems, Immediate Page 54 of 90 Payment Service (IMPS), Unified Payments Interface (UPI).Legal and Regulatory Implications of Crypto currencies, Payment systems and their regulations.Digital Payments Smart Cards, Stored-Value Cards, EC Micropayments, Payment Gateways, Mobile Payments, Digital and Virtual Currencies, Security, Ethical, Legal, Privacy, and Technology Issues

#### **UNIT II DIGITAL FINANCE AND ALTERNATIVE FINANCE**

**9**

A Brief History of Financial Innovation, Digitization of Financial Services, Crowd funding, Charity and Equity,. Introduction to the concept of Initial Coin Offering

#### **UNIT III INSURETECH**

**9**

InsurTech Introduction , Business model disruption AI/ML in InsurTech IoT and InsurTech ,Risk Modeling ,Fraud Detection Processing claims and Underwriting Innovations in Insurance Services

#### **UNIT IV PEER TO PEER LENDING**

**9**

P2P and Marketplace Lending, New Models and New Products in market place lending P2P Infrastructure and technologies, Concept of Crowdfunding Crowdfunding Architecture and Technology ,P2P and Crowdfunding unicorns and business models , SME/MSME Lending: Unique opportunities and Challenges, Solutions and Innovations

#### **UNIT V REGULATORY ISSUES**

**9**

FinTech Regulations: Global Regulations and Domestic Regulations, Evolution of RegTech, RegTech Ecosystem: Financial Institutions, RegTech Ecosystem: StartupsRegTech, Startups: Challenges, RegTech Ecosystem: Regulators, Use of AI in regulation and Fraud detection

**TOTAL : 45 PERIODS**

#### **REFERENCES:**

1. Swanson Seth, Fintech for Beginners: Understanding and Utilizing the power of technology, Createspace Independent Publishing Platform,2016.
2. Models AuTanda, Fintech Bigtech And Banks Digitalization and Its Impact On Banking Business, Springer, 2019
3. Henning Diedrich, Ethereum: Blockchains, Digital Assets, Smart Contracts, Decentralized Autonomous Organizations, Wildfire Publishing, 2016
4. Jacob William, FinTech:TheBeginner's Guide to Financial Technology, Createspace Independent Publishing Platform, 2016
5. IIBF, Digital Banking, Taxmann Publication, 2016
6. Jacob William, Financial Technology, Create space Independent Pub, 2016
7. Luke Sutton, Financial Technology: Bitcoin & Blockchain, Createspace Independent Pub, 2016

**CMG336**

### **INTRODUCTION TO FINTECH**

**L T P C**  
**3 0 0 3**

#### **OBJECTIVES:**

1. To learn about history, importance and evolution of Fintech
2. To acquire the knowledge of Fintech in payment industry
3. To acquire the knowledge of Fintech in insurance industry
4. To learn the Fintech developments around the world
5. To know about the future of Fintech

#### **UNIT I INTRODUCTION**

**9**

Fintech - Definition, History, concept, meaning, architecture, significance, Goals, key areas in Fintech, Importance of Fintech, role of Fintech in economic development, opportunities and challenges in Fintech, Evolution of Fintech in different sectors of the industry - Infrastructure, Banking Industry, Startups and Emerging Markets, recent developments in FinTech, future prospects and potential issues with Fintech.

#### **UNIT II PAYMENT INDUSTRY**

**9**

FinTech in Payment Industry-Multichannel digital wallets, applications supporting wallets, onboarding and KYC application, FinTech in Lending Industry- Formal lending, Informal lending, P2P lending, POS lending, Online lending, Payday lending, Microfinance, Crowdfunding.

#### **UNIT III INSURANCE INDUSTRY**

**9**

FinTech in Wealth Management Industry-Financial Advice, Automated investing, Socially responsible investing, Fractional Investing, Social Investing. FinTech in Insurance Industry- P2P insurance, On-Demand Insurance, On-Demand Consultation, Customer engagement through Quote to sell, policy servicing, Claims Management, Investment linked health insurance.

#### **UNIT IV FINTECH AROUND THE GLOBE**

**9**

FinTech developments - US, Europe and UK, Germany, Sweden, France, China, India, Africa, Australia, New Zealand, Brazil and Middle East, Regulatory and Policy Assessment for Growth of FinTech. FinTech as disruptors, Financial institutions collaborating with FinTech companies, The new financial world.

#### **UNIT V FUTURE OF FINTECH**

**9**

How emerging technologies will change financial services, the future of financial services, banking on innovation through data, why FinTech banks will rule the world, The FinTech Supermarket, Banks partnering with FinTech start-ups, The rise of BankTech, Fintech impact on Retail Banking, A future without money, Ethics in Fintech.

**TOTAL:45 PERIODS**

#### **REFERENCES**

1. Arner D., Barbers J., Buckley R, The evolution of FinTech: a new post crisis paradigm, University of New South Wales Research Series, 2015
2. Susanne Chishti, Janos Barberis, The FINTECH Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries, Wiley Publications, 2016
3. Richard Hayen, FinTech: The Impact and Influence of Financial Technology on Banking and the Finance Industry, 2016
4. Parag Y Arjunwadkar, FinTech: The Technology Driving Disruption in the financial service industry CRC Press, 2018
5. Sanjay Phadke, Fintech Future : The Digital DNA of Finance Paperback .Sage Publications, 2020
6. Pranay Gupta, T. Mandy Tham, Fintech: The New DNA of Financial Services Paperback, 2018

**COURSE OBJECTIVES:**

- To develop and strengthen the entrepreneurial quality and motivation of learners.
- To impart the entrepreneurial skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of entrepreneurship and management in Technology oriented businesses.
- To empower the learners to run a Technology driven business efficiently and effectively

**UNIT I INTRODUCTION TO ENTREPRENEURSHIP****9**

Entrepreneurship- Definition, Need, Scope - Entrepreneurial Skill & Traits - Entrepreneur vs. Intrapreneur; Classification of entrepreneurs, Types of entrepreneurs -Factors affecting entrepreneurial development – Achievement Motivation – Contributions of Entrepreneurship to Economic Development.

**UNIT II BUSINESS OWNERSHIP & ENVIRONMENT****9**

Types of Business Ownership – Business Environmental Factors – Political-Economic-Sociological-Technological-Environmental-Legal aspects – Human Resources Mobilisation-Basics of Managing Finance-Essentials of Marketing Management - Production and Operations Planning – Systems Management and Administration

**UNIT III FUNDAMENTALS OF TECHNOENTREPRENEURSHIP****9**

Introduction to Technopreneurship - Definition, Need, Scope- Emerging Concepts- Principles - Characteristics of a technopreneur - Impacts of Technopreneurship on Society – Economy- Job Opportunities in Technopreneurship - Recent trends

**UNIT IV APPLICATIONS OF TECHNOENTREPRENEURSHIP****9**

Technology Entrepreneurship - Local, National and Global practices - Intrapreneurship and Technology interactions, Networking of entrepreneurial activities – Launching - Managing Technology based Product / Service entrepreneurship – Success Stories of Technopreneurs - Case Studies

**UNIT V EMERGING TRENDS IN ENTREPRENEURSHIP****9**

Effective Business Management Strategies For Franchising - Sub-Contracting- Leasing- Technopreneurs – Agripreneurs - Netpreneurs- Portfolio entrepreneurship - NGO Entrepreneurship – Recent Entrepreneurial Developments - Local – National – Global perspectives.

**TOTAL45 : PERIODS****OUTCOMES:**

Upon completion of this course, the student should be able to:

CO 1 Learn the basics of Entrepreneurship

CO 2 Understand the business ownership patterns and environment

CO 3 Understand the Job opportunities in Industries relating to Technopreneurship

CO 4 Learn about applications of technopreneurship and successful technopreneurs

CO 5 Acquaint with the recent and emerging trends in entrepreneurship

**TEXT BOOKS:**

- 1) S.S.Khanka, "Entrepreneurial Development" S.Chand & Co. Ltd. Ram Nagar New Delhi, 2021.
- 2) Donal F Kuratko Entrepreneurship (11th Edition) Theory, Process, Practice by Published 2019 by Cengage Learning.

**REFERENCES :**

- 1) Daniel Mankani. 2003. Technopreneurship: The successful Entrepreneur in the new Economy. Prentice Hall
- 2) Edward Elgar. 2007. Entrepreneurship, Cooperation and the Firm: The Emergence and Survival of High-Technology Ventures in Europe. Edi: Jan Ulijn, Dominique Drillon, and Frank Lasch. Wiley Pub.
- 3) Lang, J. 2002, The High Tech Entrepreneur's Handbook, Ft.com.
- 4) David Sheff 2002, China Dawn: The Story of a Technology and Business Revolution,
- 5) HarperBusiness, <https://fanny.staff.uns.ac.id/files/2013/12/Technopreneur-BASED-EDUCATION-REVOLUTION.pdf>
- 6) JumpStart: A Technopreneurship Fable, Dennis Posadas, (Singapore: Pearson Prentice Hall, 2009
- 7) Basics of Technopreneurship: Module 1.1-1.2, Frederico Gonzales, President-PESO Inc; M. Barcelon, UP
- 8) Journal articles pertaining to Entrepreneurship

**CMG338 TEAM BUILDING AND LEADERSHIP MANAGEMENT FOR BUSINESS L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To develop and strengthen the Leadership qualities and motivation of learners.
- To impart the Leadership skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of Team Building in managing Technology oriented businesses.
- To empower the learners to build robust teams for running and leading a business efficiently and effectively

**NIT I INTRODUCTION TO MANAGING TEAMS 9**

Introduction to Team - Team Dynamics - Team Formation – Stages of Team Development - Enhancing teamwork within a group - Team Coaching - Team Decision Making - Virtual Teams - Self Directed Work Teams (SDWTs) -Multicultural Teams.

**UNIT II MANAGING AND DEVELOPING EFFECTIVE TEAMS 9**

Team-based Organisations- Leadership roles in team-based organisations - Offsite training and team development - Experiential Learning - Coaching and Mentoring in team building - Building High-Performance Teams - Building Credibility and Trust - Skills for Developing Others - Team Building at the Top - Leadership in Teamwork Effectiveness.

**UNIT III INTRODUCTION TO LEADERSHIP 9**

Introduction to Leadership - Leadership Myths – Characteristics of Leader, Follower and Situation - Leadership Attributes - Personality Traits and Leadership- Intelligence Types and Leadership - Power and Leadership - Delegation and Empowerment .

**UNIT IV LEADERSHIP IN ORGANISATIONS 9**

Leadership Styles – LMX Theory- Leadership Theory and Normative Decision Model - Situational Leadership Model - Contingency Model and Path Goal Theory – Transactional and Transformational Leadership - Charismatic Leadership - Role of Ethics and Values in Organisational Leadership.

**UNIT V LEADERSHIP EFFECTIVENESS 9**

Leadership Behaviour - Assessment of Leadership Behaviors - Destructive Leadership - Motivation and Leadership - Managerial Incompetence and Derailment Conflict Management - Negotiation and Leadership - Culture and Leadership - Global Leadership – Recent Trends in Leadership.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the student should be able to:

- CO 1 Learn the basics of managing teams for business.
- CO 2 Understand developing effective teams for business management.
- CO 3 Understand the fundamentals of leadership for running a business.
- CO 4 Learn about the importance of leadership for business development.
- CO 5 Acquaint with emerging trends in leadership effectiveness for entrepreneurs.”

**REFERENCES :**

1. Hughes, R.L., Ginnett, R.C., & Curphy, G.J., Leadership: Enhancing the lessons of experience, 9th Ed, McGraw Hill Education, Chennai, India. (2019).
2. Katzenback, J.R., Smith, D.K., The Wisdom of Teams: Creating the High Performance Organisations, Harvard Business Review Press, (2015).
3. Haldar, U.K., Leadership and Team Building, Oxford University Press, (2010).
4. Daft, R.L., The Leadership Experience, Cengage, (2015).
5. Daniel Levi, Group Dynamics for Teams ,4th Ed, (2014), Sage Publications.
6. Dyer, W. G., Dyer, W. G., Jr., & Dyer, J. H..Team building: Proven strategies for improving team performance, 5thed, Jossey-Bass, (2013).

**CMG339**

**CREATIVITY & INNOVATION IN ENTREPRENEURSHIP**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES**

- To develop the creativity skills among the learners
- To impart the knowledge of creative intelligence essential for entrepreneurs
- To know the applications of innovation in entrepreneurship.
- To develop innovative business models for business.

**UNIT I CREATIVITY**

**9**

Creativity: Definition- Forms of Creativity-Essence, Elaborative and Expressive Creativities- Quality of Creativity-Existential, Entrepreneurial and Empowerment Creativities – Creative Environment- Creative Technology- - Creative Personality and Motivation.

**UNIT II CREATIVE INTELLIGENCE**

**9**

Creative Intelligence: Convergent thinking ability – Traits Congenial to creativity – Creativity Training-- Criteria for evaluating Creativity-Credible Evaluation- Improving the quality of our creativity – Creative Tools and Techniques - Blocks to creativity- fears and Disabilities- Strategies for Unblocking- Designing Creativity Enabling Environment.

**UNIT III INNOVATION**

**9**

Innovation: Definition- Levels of Innovation- Incremental Vs Radical Innovation-Product Innovation and Process- Technological, Organizational Innovation – Indicators- Characteristics of Innovation in Different Sectors. Theories in Innovation and Creativity- Design Thinking and Innovation- Innovation as Collective Change-Innovation as a system

**UNIT IV INNOVATION AND ENTREPRENEURSHIP****9**

Innovation and Entrepreneurship: Entrepreneurial Mindset , Motivations and Behaviours- Opportunity Analysis and Decision Making- Industry Understanding - Entrepreneurial Opportunities- Entrepreneurial Strategies – Technology Pull/Market Push – Product -Market fit

**UNIT V INNOVATIVE BUSINESS MODELS****9**

Innovative Business Models: Customer Discovery-Customer Segments-Prospect Theory and Developing Value Propositions- Developing Business Models: Elements of Business Models – Innovative Business Models: Elements, Designing Innovative Business Models- Responsible Innovation and Creativity.

**TOTAL 45 : PERIODS****COURSE OUTCOMES:**

Upon completion of this course, the student should be able to:

CO 1 Learn the basics of creativity for developing Entrepreneurship

CO 2 Understand the importance of creative intelligence for business growth

CO 3 Understand the advances through Innovation in Industries

CO 4 Learn about applications of innovation in building successful ventures

CO 5 Acquaint with developing innovative business models to run the business effeciently and effectively

**SUGGESTED READINGS:**

1 Creativity and Inovation in Entrepreneurship, Kankha, Sultan Chand

2 Pradip N Khandwalla, Lifelong Creativity, An Unending Quest, Tata Mc Graw Hill, 2004.

3 Paul Trott, Innovation Management and New Product Development, 4e, Pearson, 2018.

4 Vinnie Jauhari, Sudanshu Bhushan, Innovation Management, Oxford Higher Education, 2014.

5 Innovation Management, C.S.G. Krishnamacharyulu, R. Lalitha, Himalaya Publishing House, 2010.

6 Dale Timpe, Creativity, Jaico Publishing House, 2003.

7 Brian Clegg, Paul Birch, Creativity, Kogan Page, 2009.

8 Strategic Innovation: Building and Sustaining Innovative Organizations- Course Era, Raj Echambadi.

**CMG340****PRINCIPLES OF MARKETING MANAGEMENT FOR BUSINESS****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- To provide basic knowledge of concepts, principles, tools and techniques of marketing for entrepreneurs
- To provide an exposure to the students pertaining to the nature and Scope of marketing, which they are expected to possess when they enter the industry as practitioners.
- To give them an understanding of fundamental premise underlying market driven strategies and the basic philosophies and tools of marketing management for business owners.

**UNIT I INTRODUCTION TO MARKETING MANAGEMENT****9**

Introduction - Market and Marketing – Concepts- Functions of Marketing - Importance of Marketing - Marketing Orientations - Marketing Mix-The Traditional 4Ps - The Modern Components of the Mix - The Additional 3Ps - Developing an Effective Marketing Mix.

**UNIT II MARKETING ENVIRONMENT****9**

Introduction - Environmental Scanning - Analysing the Organisation's Micro Environment and Macro Environment - Differences between Micro and Macro Environment – Techniques of Environment Scanning - Marketing organization - Marketing Research and the Marketing Information System, Types and Components.

**UNIT III PRODUCT AND PRICING MANAGEMENT****9**

Product- Meaning, Classification, Levels of Products – Product Life Cycle (PLC) - Product Strategies - Product Mix - Packaging and Labelling - New Product Development - Brand and Branding - Advantages and disadvantages of branding Pricing - Factors Affecting Price Decisions - Cost Based Pricing - Value Based and Competition Based Pricing - Pricing Strategies - National and Global Pricing.

#### **UNIT IV PROMOTION AND DISTRIBUTION MANAGEMENT**

**9**

Introduction to Promotion – Marketing Channels- Integrated Marketing Communications (IMC) - Introduction to Advertising and Sales Promotion – Basics of Public Relations and Publicity - Personal Selling - Process - Direct Marketing - Segmentation, Targeting and Positioning (STP)-Logistics Management- Introduction to Retailing and Wholesaling.

#### **UNIT V CONTEMPORARY ISSUES IN MARKETING MANAGEMENT**

**9**

Introduction - Relationship Marketing Vs. Relationship Management - Customer Relationship Management (CRM) - Forms of Relationship Management - CRM practices - Managing Customer Loyalty and Development – Buyer-Seller Relationships- Buying Situations in Industrial / Business Market - Buying Roles in Industrial Marketing - Factors that Influence Business - Services Marketing - E-Marketing or Online Marketing.

**TOTAL: 45 PERIODS**

#### **COURSE OUTCOMES:**

**After completion of this course, the students will be able to:**

CO1 Have the awareness of marketing management process

CO 2 Understand the marketing environment

CO 3 Acquaint about product and pricing strategies

CO 4 Knowledge of promotion and distribution in marketing management.

CO 5 Comprehend the contemporary marketing scenarios and offer solutions to marketing issues.

#### **REFERENCES:**

1. Marketing Management, Sherlekar S.A, Himalaya Publishing House, 2016.
2. Marketing Management, Philip Kotler and Kevin Lane Keller, PHI 15th Ed, 2015.
- 3 Marketing Management- An Indian perspective, Vijay Prakash Anand, Biztantra, Second edition, 2016.
4. Marketing Management Global Perspective, Indian Context, V.S.Ramaswamy &S.Namakumari, Macmillan Publishers India,5th edition, 2015.
5. Marketing Management, S.H.H. Kazmi, 2013, Excel Books India.
6. Marketing Management- text and Cases, Dr. C.B.Gupta & Dr. N.Rajan Nair, 17th edition, 2016.

#### **CMG341 HUMAN RESOURCE MANAGEMENT FOR ENTREPRENEURS**

**L T P C**  
**3 0 0 3**

#### **OBJECTIVES:**

- 1) To introduce the basic concepts, structure and functions of human resource management for entrepreneurs.
- 2) To create an awareness of the roles, functions and functioning of human resource department.
- 3) To understand the methods and techniques followed by Human Resource Management practitioners.

#### **UNIT I INTRODUCTION TO HRM**

**9**

Concept, Definition, Objectives- Nature and Scope of HRM - Evolution of HRM - HR Manager Roles-Skills - Personnel Management Vs. HRM - Human Resource Policies - HR Accounting - HR Audit - Challenges in HRM.

#### **UNIT II HUMAN RESOURCE PLANNING**

**9**

HR Planning - Definition - Factors- Tools - Methods and Techniques - Job analysis- Job rotation- Job Description - Career Planning - Succession Planning - HRIS - Computer Applications in HR - Recent Trends

**UNIT III RECRUITMENT AND SELECTION 9**

Sources of recruitment- Internal Vs. External - Domestic Vs. Global Sources -eRecruitment - Selection Process- Selection techniques -eSelection- Interview Types- Employee Engagement.

**UNIT IV TRAINING AND EMPLOYEE DEVELOPMENT 9**

Types of Training - On-The-Job, Off-The-Job - Training Needs Analysis – Induction and Socialisation Process - Employee Compensation - Wages and Salary Administration – Health and Social Security Measures- Green HRM Practices

**UNIT V CONTROLLING HUMAN RESOURCES 9**

Performance Appraisal – Types - Methods - Collective Bargaining - Grievances Redressal Methods – Employee Discipline – Promotion – Demotion - Transfer – Dismissal - Retrenchment - Union Management Relationship - Recent Trends

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course the learners will be able:

CO 1 To understand the Evolution of HRM and Challenges faced by HR Managers

CO 2 To learn about the HR Planning Methods and practices.

CO 3 To acquaint about the Recruitment and Selection Techniques followed in Industries.

CO 4 To known about the methods of Training and Employee Development.

CO 5 To comprehend the techniques of controlling human resources in organisations.

**REFERENCES:**

- 1) Gary Dessler and Biju Varkkey, Human Resource Management, 14e , Pearson, 2015.
- 2) Mathis and Jackson, Human Resource Management, Cengage Learning 15e, 2017.
- 3) David A. Decenzo, Stephen.P.Robbins, and Susan L. Verhulst, Human Resource Management, Wiley, International Student Edition, 11th Edition, 2014
- 4) R. Wayne Mondy, Human Resource Management, Pearson , 2015.
- 5) Luis R.Gomez-Mejia, David B.Balkin, Robert L Cardy. Managing Human Resource. PHI Learning. 2012
- 6) John M. Ivancevich, Human Resource Management,12e, McGraw Hill Irwin,2013.
- 7) K. Aswathappa, Sadhna Dash , Human Resource Management - Text and Cases , 9th Edition, McGraw Hill, 2021.
- 8) Uday Kumar Haldar, Juthika Sarkar. Human Resource management. Oxford. 2012

**CMG342 FINANCING NEW BUSINESS VENTURES**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- To develop the basics of business venture financing.
- To impart the knowledge essential for entrepreneurs for financing new ventures.
- To acquaint the learners with the sources of debt and equity financing.
- To empower the learners towards fund raising for new ventures effectively.



<b>UNIT I</b>	<b>ESSENTIALS OF NEW BUSINESS VENTURE</b>	<b>9</b>
Setting up new Business Ventures – Need - Scope - Franchising - Location Strategy, Registration Process - State Directorate of Industries- Financing for New Ventures - Central and State Government Agencies - Types of loans – Financial Institutions - SFC, IDBI, NSIC and SIDCO.		
<b>UNIT II</b>	<b>INTRODUCTION TO VENTURE FINANCING</b>	<b>9</b>
Venture Finance – Definition – Historic Background - Funding New Ventures- Need – Scope – Types - Cost of Project - Means of Financing - Estimation of Working Capital - Requirement of funds – Mix of Debt and Equity - Challenges and Opportunities.		
<b>UNIT III</b>	<b>SOURCES OF DEBT FINANCING</b>	<b>9</b>
Fund for Capital Assets - Term Loans - Leasing and Hire-Purchase - Money Market instruments – Bonds, Corporate Papers – Preference Capital- Working Capital Management- Fund based Credit Facilities - Cash Credit - Over Draft.		
<b>UNIT IV</b>	<b>SOURCES OF EQUITY FINANCING</b>	<b>9</b>
Own Capital, Unsecured Loan - Government Subsidies , Margin Money- Equity Funding - Private Equity Fund- Schemes of Commercial banks - Angel Funding – Crowdfunding- Venture Capital.		
<b>UNIT V</b>	<b>METHODS OF FUND RAISING FOR NEW VENTURES</b>	<b>9</b>
Investor Decision Process - Identifying the appropriate investors- Targeting investors- Developing Relationships with investors - Investor Selection Criteria- Company Creation- Raising Funds - Seed Funding- VC Selection Criteria – Process- Methods- Recent Trends		

**TOTAL: 45 PERIODS**

#### **OUTCOMES:**

Upon completion of this course, the students should be able to:

- CO 1 Learn the basics of starting a new business venture.
- CO 2 Understand the basics of venture financing.
- CO 3 Understand the sources of debt financing.
- CO 4 Understand the sources of equity financing.
- CO 5 Acquaint with the methods of fund raising for new business ventures.

#### **REFERENCES :**

- 1) Principles of Corporate Finance by Brealey and Myers et al., 12<sup>TH</sup> ed, McGraw Hill Education (India) Private Limited, 2018
- 2) Prasanna Chandra, Projects : Planning ,Analysis, Selection ,Financing, Implementation and Review, McGraw Hill Education India Pvt Ltd ,New Delhi , 2019.
- 3) Introduction to Project Finance. Andrew Fight, Butterworth-Heinemann, 2006.
- 4) Metrick, Andrew; Yasuda, Ayako. Venture Capital And The Finance Of Innovation. Venture Capital And The Finance Of Innovation, 2nd Edition, Andrew Metrick And Ayako Yasuda, Eds., John Wiley And Sons, Inc, 2010.
- 5) Feld, Brad; Mendelson, Jason. Venture Deals. Wiley, 2011.
- 6) May, John; Simons, Cal. Every Business Needs An Angel: Getting The Money You Need To Make Your Business Grow. Crown Business, 2001.
- 7) Gompers, Paul Alan; Lerner, Joshua. The Money Of Invention: How Venture Capital Creates New Wealth. Harvard Business Press, 2001.
- 8) Camp, Justin J. Venture Capital Due Diligence: A Guide To Making Smart Investment Choices And Increasing Your Portfolio Returns. John Wiley & Sons, 2002.
- 9) Byers, Thomas. Technology Ventures: From Idea To Enterprise. McGraw-Hill Higher Education, 2014.
- 10) Lerner, Josh; Leamon, Ann; Hardyman, Felda. Venture Capital, Private Equity, And The Financing Of Entrepreneurship. 2012.

## VERTICAL 3: PUBLIC ADMINISTRATION

CMG343

PRINCIPLES OF PUBLIC ADMINISTRATION

L T P C  
3 0 0 3

### UNIT-I

1. Meaning, Nature and Scope of Public Administration
2. Importance of Public Administration
3. Evolution of Public Administration

(9)

### UNIT-II

1. New Public Administration
2. New Public Management
3. Public and Private Administration

(9)

### UNIT-III

1. Relationships with Political Science, History and Sociology
2. Classical Approach
3. Scientific Management Approach

(9)

### UNIT-IV

1. Bureaucratic Approach: Max Weber
2. Human Relations Approach : Elton Mayo
3. Ecological Approach : Riggs

(9)

### UNIT-V

1. Leadership: Leadership - Styles - Approaches
2. Communication: Communication Types - Process - Barriers
3. Decision Making: Decision Making - Types, Techniques and Processes.

(9)

**TOTAL: 45 PERIODS**

### REFERENCES:

1. Avasthi and Maheswari: Public Administration in India, Agra:Lakshmi Narain Agarwal,2013.
2. Ramesh K Arora: Indian Public Administration, New Delhi: Wishwa Prakashan, 2012.
3. R.B. Jain: Public Administration in India,21st Century Challenges for Good Governance, New Delhi: Deep and Deep, 2002.
4. Rumki Basu: Public Administration:Concept and Theories, New Delhi: Sterling, 2013.
5. R. Tyagi, Public Administration, Atma Ram & Sons, New Delhi, 1983.

**CMG344**

**CONSTITUTION OF INDIA**

**L T P C  
3 0 0 3**

**UNIT- I**

**(9)**

1. Constitutional Development Since 1909 to 1947
2. Making of the Constitution.
3. Constituent Assembly

**UNIT-II**

**(9)**

1. Fundamental Rights
2. Fundamental Duties
3. Directive Principles of State Policy

**UNIT-III**

**(9)**

1. President
2. Parliament
3. Supreme Court

**UNIT-IV**

**(9)**

1. Governor
2. State Legislature
3. High Court

**UNIT-V**

**(9)**

1. Secularism
2. Social Justice
3. Minority Safeguards

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Basu. D.D.: Introduction to Indian Constitution ; Prentice Hall; New Delhi.
2. Kapur. A.C: Indian Government and Political System; S.Chand and Company Ltd., New Delhi.
3. Johari J.C.: Indian Politics, Vishal Publications Ltd, New Delhi
4. Agarwal R.C: Indian Political System; S.Chand & Co., New Delhi

**CMG345**

**PUBLIC PERSONNEL ADMINISTRATION**

**L T P C  
3 0 0 3**

**UNIT-I**

**(9)**

1. Meaning, Scope and Importance of Personnel Administration
2. Types of Personnel Systems: Bureaucratic, Democratic and Representative systems

**UNIT-II**

**(9)**

1. Generalist Vs Specialist
2. Civil Servants' Relationship with Political Executive
3. Integrity in Administration.

**UNIT-III**

**(9)**

1. Recruitment: Direct Recruitment and Recruitment from Within

2. Training: Kinds of Training

3. Promotion

**UNIT-IV**

(9)

1. All India Services

2. Service Conditions

3. State Public Service Commission

**UNIT-V**

(9)

1. Employer Employee Relations

2. Wage and Salary Administration

3. Allowances and Benefits

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Stahl Glean O: Public Personnel Administration

2. Parnandikar Pai V.A: Personnel System for Development Administration.

3. Bhambhiru . P: Bureaucracy and Policy in India.

4. Dwivedi O.P and Jain R.B: India's Administrative state.

5. Muttalis M.A: Union Public Service Commission.

6. Bhakara Rao .V: Employer Employee Relations in India.

7. Davar R.S. Personnel Management & Industrial Relations

**CMG346**

**ADMINISTRATIVE THEORIES**

**L T P C**

**3 0 0 3**

**UNIT I**

(9)

Meaning, Scope and significance of Public Administration, Evolution of Public Administration as a discipline and Identity of Public Administration

**UNIT II**

(9)

Theories of Organization: Scientific Management Theory, Classical Model, Human Relations Theory

**UNIT III**

(9)

Organization goals and Behaviour, Groups in organization and group dynamics, Organizational Design.

**UNIT IV**

(9)

Motivation Theories, content, process and contemporary; Theories of Leadership: Traditional and Modern: Process and techniques of decision-making

**UNIT V**

(9)

Administrative thinkers: Kautilya, Woodrow Willson, C.I. Barnard . Peter Drucker

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Crozier M : The Bureaucratic phenomenon (Chand)

2. Blau. P.M and Scott. W : Formal Organizations (RKP)

3. Presthus. R : The Organizational Society (MAC)

4. Alvi, Shum Sun Nisa : Eminent Administrative Thinkers.
5. Keith Davis : Organization Theory (MAC)

**CMG347**

**INDIAN ADMINISTRATIVE SYSTEM**

**L T P C**  
**3 0 0 3**

**UNIT I**

**(9)**

Evolution and Constitutional Context of Indian Administration, Constitutional Authorities: Finance Commission, Union Public Services Commission, Election Commission, Comptroller and Auditor General of India, Attorney General of India

**UNIT II**

**(9)**

Role & Functions of the District Collector, Relationship between the District Collector and Superintendent of Police, Role of Block Development Officer in development programmes, Local Government

**UNIT III**

**(9)**

Main Features of 73rd Constitutional Amendment Act 1992, Salient Features of 74th Constitutional Amendment Act 1992

**UNIT IV**

**(9)**

Coalition politics in India, Integrity and Vigilance in Indian Administration

**UNIT V**

**(9)**

Corruption – Ombudsman, Lok Pal & Lok Ayuktha

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. S.R. Maheswari : Indian Administration
2. Khera. S.S : Administration in India
3. Ramesh K. Arora : Indian Public Administration
4. T.N. Chaturvedi : State administration in India
5. Basu, D.D : Introduction to the Constitution of India

**CMG348**

**PUBLIC POLICY ADMINISTRATION**

**L T P C**  
**3 0 0 3**

**UNIT-I**

**(9)**

Meaning and Definition of Public Policy - Nature, Scope and Importance of public policy – Public policy relationship with social sciences especially with political science and Public Administration.

**UNIT-II**

**(9)**

Approaches in Policy Analysis - Institutional Approach – Incremental Approach and System's Approach – Dror's Optimal Model

**UNIT-III**

**(9)**

Major stages involved in Policy making Process – Policy Formulation – Policy Implementation – Policy Evaluation.

**UNIT-IV****(9)**

Institutional Framework of Policy making – Role of Bureaucracy – Role of Interest Groups and Role of Political Parties.

**UNIT-V****(9)**

Introduction to the following Public Policies – New Economic Policy – Population Policy – Agriculture policy - Information Technology Policy.

**TOTAL: 45 PERIODS****REFERENCES:**

1. Rajesh Chakrabarti & Kaushik Sanyal : Public Policy in India, Oxford University Press, 2016.
2. Kuldeep Mathur : Public Policy and Politics in India, Oxford University Press, 2016.
3. Bidyutv Chakrabarty: Public Policy: Concept, Theory and Practice, 2015.
4. Pradeep Saxena : Public Policy Administration and Development
5. Sapru R.K. : Public Policy: Formulation, Implementation and Evaluation, Sterling Publishers, 2016.

**VERTICAL 4: BUSINESS DATA ANALYTICS****CMG349****STATISTICS FOR MANAGEMENT****L T P C  
3 0 0 3****OBJECTIVE:**

- To learn the applications of statistics in business decision making.

**UNIT I INTRODUCTION****9**

Basic definitions and rules for probability, Baye's theorem and random variables, Probability distributions: Binomial, Poisson, Uniform and Normal distributions.

**UNIT II SAMPLING DISTRIBUTION AND ESTIMATION****9**

Introduction to sampling distributions, Central limit theorem and applications, sampling techniques, Point and Interval estimates of population parameters.

**UNIT III TESTING OF HYPOTHESIS - PARAMETRIC TESTS****9**

Hypothesis testing: one sample and two sample tests for means of large samples (z-test), one sample and two sample tests for means of small samples (t-test), ANOVA one way.

**UNIT IV NON-PARAMETRIC TESTS****9**

Chi-square tests for independence of attributes and goodness of fit, Kolmogorov-Smirnov – test for goodness of fit, Mann – Whitney U test and Kruskal Wallis test.

**UNIT V CORRELATION AND REGRESSION****9**

Correlation –Rank Correlation – Regression – Estimation of Regression line – Method of Least Squares – Standard Error of estimate.

**TOTAL:45 PERIODS****OUTCOMES:**

- To facilitate objective solutions in business decision making.
- To understand and solve business problems
- To apply statistical techniques to data sets, and correctly interpret the results.
- To develop skill-set that is in demand in both the research and business environments
- To enable the students to apply the statistical techniques in a work setting.

## REFERENCES:

1. Richard I. Levin, David S. Rubin, Masood H.Siddiqui, Sanjay Rastogi, Statistics for Management, Pearson Education, 8th Edition, 2017.
2. Prem. S. Mann, Introductory Statistics, Wiley Publications, 9th Edition, 2015.
3. T N Srivastava and Shailaja Rego, Statistics for Management, Tata McGraw Hill, 3rd Edition 2017.
4. Ken Black, Applied Business Statistics, 7th Edition, Wiley India Edition, 2012.
5. David R. Anderson, Dennis J. Sweeney, Thomas A.Williams, Jeffrey D.Camm, James
6. Cochran, Statistics for business and economics, 13th edition, Thomson (South – Western) Asia, Singapore, 2016.
7. N. D. Vohra, Business Statistics, Tata McGraw Hill, 2017.

**CMG350**

**DATAMINING FOR BUSINESS INTELLIGENCE**

**L T P C**  
**3 0 0 3**

## OBJECTIVES:

- To know how to derive meaning form huge volume of data and information.
- To understand how knowledge discovering process is used in business decision making.

### UNIT I INTRODUCTION

9

Data mining, Text mining, Web mining, Data ware house.

### UNIT II DATA MINING PROCESS

9

Datamining process – KDD, CRISP-DM, SEMMA  
Prediction performance measures

### UNIT III PREDICTION TECHNIQUES

9

Data visualization, Time series – ARIMA, Winter Holts,

### UNIT IV CLASSIFICATION AND CLUSTERING TECHNIQUES

9

Classification, Association, Clustering.

### UNIT V MACHINE LEARNING AND AI

9

Genetic algorithms, Neural network, Fuzzy logic, Ant Colony optimization, Particle Swarm optimization

**TOTAL: 45 PERIODS**

## OUTCOMES:

1. Learn to apply various data mining techniques into various areas of different domains.
2. Be able to interact competently on the topic of data mining for business intelligence.
3. Apply various prediction techniques.
4. Learn about supervised and unsupervised learning technique.
5. Develop and implement machine learning algorithms

## REFERENCES:

1. Jaiwei Ham and Micheline Kamber, Data Mining concepts and techniques, Kauffmann Publishers 2006
2. Efraim Turban, Ramesh Sharda, Jay E. Aronson and David King, Business Intelligence, Prentice Hall, 2008.
3. W.H.Inmon, Building the Data Warehouse, fourth edition Wiley India pvt. Ltd. 2005.
4. Ralph Kimball and Richard Merz, The data warehouse toolkit, John Wiley, 3rd edition,2013.
5. Michel Berry and Gordon Linoff, Mastering Data mining, John Wiley and Sons Inc, 2nd Edition, 2011
6. Michel Berry and Gordon Linoff, Data mining techniques for Marketing, Sales and Customer support, John Wiley, 2011

7. G. K. Gupta, Introduction to Data mining with Case Studies, Prentice hall of India, 2011
8. Giudici, Applied Data mining – Statistical Methods for Business and Industry, John Wiley. 2009
9. Elizabeth Vitt, Michael Luckevich Stacia Misner, Business Intelligence, Microsoft, 2011
10. Michalewicz Z., Schmidt M. Michalewicz M and Chiriac C, Adaptive Business Intelligence, Springer – Verlag, 2007
11. GalitShmueli, Nitin R. Patel and Peter C. Bruce, Data Mining for Business Intelligence – Concepts, Techniques and Applications Wiley, India, 2010.

**CMG351**

**HUMAN RESOURCE ANALYTICS**

**L T P C  
3 0 0 3**

**OBJECTIVES:**

- To develop the ability of the learners to define and implement HR metrics that are aligned with the overall business strategy.
- To know the different types of HR metrics and understand their respective impact and application.
- To understand the impact and use of HR metrics and their connection with HR analytics.
- To understand common workforce issues and resolving them using people analytics.

**UNIT I INTRODUCTION TO HR ANALYTICS 9**

People Analytics - stages of maturity - Human Capital in the Value Chain : impact on business – HR metrics and KPIs.

**UNIT II HR ANALYTICS I: RECRUITMENT 9**

Recruitment Metrics : Fill-up ratio - Time to hire - Cost per hire - Early turnover - Employee referral hires - Agency hires - Lateral hires - Fulfillment ratio- Quality of hire.

**UNIT III HR ANALYTICS - TRAINING AND DEVELOPMENT 9**

Training & Development Metrics : Percentage of employees trained- Internally and externally trained -Training hours and cost per employee - ROI.

**UNIT IV HR ANALYTICS EMPLOYEE ENGAGEMENT AND CAREER PROGRESSION 9**

Employee Engagement Metrics :Talent Retention index - Voluntary and involuntary turnover- grades, performance, and service tenure - Internal hired index Career Progression Metrics: Promotion index - Rotation index - Career path index.

**UNIT V - HR ANALYTICS IV: WORKFORCE DIVERSITY AND DEVELOPMENT 9**

Workforce Diversity and Development Metrics : Employees per manager – Workforce age profiling - Workforce service profiling - Churnover index - Workforce diversity index - Gender mix

**TOTAL: 45 PERIODS**

**OUTCOME:**

- The learners will be conversant about HR metrics and ready to apply at work settings.
- The learners will be able to resolve HR issues using people analytics.





4. Avinash Kaushik, Web Analytics - An Hour a Day, Wiley Publishing, 2007
5. Ric T. Peterson, Web Analytics Demystified, Celilo Group Media and CafePress 2004
6. Takeshi Moriguchi, Web Analytics Consultant Official Textbook, 7th Edition, 2016

**CMG353**

**OPERATION AND SUPPLY CHAIN ANALYTICS**

**L T P C**  
**3 0 0 3**

**OBJECTIVE:**

To treat the subject in depth by emphasizing on the advanced quantitative models and methods in operations and supply chain management and its practical aspects and the latest developments in the field.

**UNIT I INTRODUCTION**

**9**

Descriptive, predictive and prescriptive analytics, Data Driven Supply Chains – Basics, transforming supply chains.

**UNIT II WAREHOUSING DECISIONS**

**9**

P-Median Methods - Guided LP Approach, Greedy Drop Heuristics, Dynamic Location Models, Space Determination and Layout Methods.

**UNIT III INVENTORY MANAGEMENT**

**9**

Dynamic Lot sizing Methods, Multi-Echelon Inventory models, Aggregate Inventory system and LIMIT, Risk Analysis in Supply Chain, Risk pooling strategies.

**UNIT IV TRANSPORTATION NETWORK MODELS**

**9**

Minimal Spanning Tree, Shortest Path Algorithms, Maximal Flow Problems, Transportation Problems, Set covering and Set Partitioning Problems, Travelling Salesman Problem, Scheduling Algorithms.

**UNIT V MCDM MODELS**

**9**

Analytic Hierarchy Process(AHP), Data Envelopment Analysis (DEA), Fuzzy Logic an Techniques, the analytical network process (ANP), TOPSIS.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- To enable quantitative solutions in business decision making under conditions of certainty, risk and uncertainty.

**REFERENCES:**

1. Nada R. Sanders, Big data driven supply chain management: A framework for implementing analytics and turning information into intelligence, Pearson Education, 2014.
2. Michael Watson, Sara Lewis, Peter Cacioppi, Jay Jayaraman, Supply Chain Network Design: Applying Optimization and Analytics to the Global Supply Chain, Pearson Education, 2013.
3. Anna Nagurney, Min Yu, Amir H. Masoumi, Ladimer S. Nagurney, Networks Against Time: Supply Chain Analytics for Perishable Products, Springer, 2013.
4. Muthu Mathirajan, Chandrasekharan Rajendran, Sowmyanarayanan Sadagopan, Arunachalam Ravindran, Parasuram Balasubramanian, Analytics in Operations/Supply Chain Management , I.K. International Publishing House Pvt. Ltd., 2016.
5. Gerhard J. Plenert, Supply Chain Optimization through Segmentation and Analytics, CRC Press, Taylor & Francis Group, 2014.

**CMG354**

**FINANCIAL ANALYTICS**

**L T P C**  
**3 0 0 3**

**OBJECTIVE:**

- This course introduces a core set of modern analytical tools that specifically target finance applications.

**UNIT I CORPORATE FINANCE ANALYSIS 9**

Basic corporate financial predictive modelling- Project analysis- cash flow analysis- cost of capital, Financial Break even modelling, Capital Budget model-Payback, NPV, IRR.

**UNIT II FINANCIAL MARKET ANALYSIS 9**

Estimation and prediction of risk and return ( bond investment and stock investment) –Time series-examining nature of data, Value at risk, ARMA, ARCH and GARCH.

**UNIT III PORTFOLIO ANALYSIS 9**

Portfolio Analysis – capital asset pricing model, Sharpe ratio, Option pricing models- binomial model for options, Black Scholes model and Option implied volatility.

**UNIT IV TECHNICAL ANALYSIS 9**

Prediction using charts and fundamentals – RSI, ROC, MACD, moving average and candle charts, simulating trading strategies. Prediction of share prices.

**UNIT V CREDIT RISK ANALYSIS 9**

Credit Risk analysis- Data processing, Decision trees, logistic regression and evaluating credit risk model.

**TOTAL: 45 PERIODS**

**OUTCOME**

- The learners should be able to perform financial analysis for decision making using excel, Python and R.

**REFERENCES:**

1. Financial analytics with R by Mark J. Bennett, Dirk L. Hugen, Cambridge university press.
2. Haskell Financial Data Modeling and Predictive Analytics Paperback – Import, 25 Oct 2013 by Pavel Ryzhov.
3. Quantitative Financial Analytics: The Path To Investment Profits Paperback – Import, 11 Sep 2017 by Edward E Williams (Author), John A Dobelman.
4. Python for Finance - Paperback – Import, 30 Jun 2017 by Yuxing Yan (Author).
5. Mastering Python for Finance Paperback – Import, 29 Apr 2015 by James Ma Weiming.

**VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY**

**CES331 SUSTAINABLE INFRASTRUCTURE DEVELOPMENT**

**L T P C**  
**3 0 0 3**

**OBJECTIVE:**

- To impart knowledge about sustainable Infrastructure development goals, practices and to understand the concepts of sustainable planning, design, construction, maintenance and decommissioning of infrastructure projects.

**UNIT I SUSTAINABLE DEVELOPMENT GOALS 9**

Definitions, principles and history of Sustainable Development - Sustainable development goals (SDG): global and Indian – Infrastructure Demand and Supply - Environment and Development linkages - societal and cultural demands – Sustainability indicators - Performance indicators of sustainability and

Assessment mechanism - Policy frameworks and practices: global and Indian – Infrastructure Project finance – Infrastructure project life cycle - Constraints and barriers for sustainable development - future directions.

## **UNIT II SUSTAINABLE INFRASTRUCTURE PLANNING 9**

Overview of Infrastructure projects: Housing sector, Power sector, Water supply, road, rail and port transportation sector, rural and urban infrastructure. Environmental Impact Assessment (EIA), Land acquisition -Legal aspects, Resettlement & Rehabilitation and Development - Cost effectiveness Analysis - Risk Management Framework for Infrastructure Projects, Economic, demand, political, socio-environmental and cultural risks. Shaping the Planning Phase of Infrastructure Projects to mitigate risks, Designing Sustainable Contracts, Negotiating with multiple Stakeholders on Infrastructure Projects. Use of ICT tools in planning – Integrated planning - Clash detection in construction - BIM (Building Information Modelling).

## **UNIT III SUSTAINABLE CONSTRUCTION PRACTICES AND TECHNIQUES 9**

Sustainability through lean construction approach - Enabling lean through information technology – Lean in planning and design - IPD (Integrated Project Delivery) - Location Based Management System - Geospatial Technologies for machine control, site management, precision control and real time progress monitoring - Role of logistics in achieving sustainable construction – Data management for integrated supply chains in construction - Resource efficiency benefits of effective logistics - Sustainability in geotechnical practice – Design considerations, Design Parameters and Procedures – Quality control and Assurance - Use of sustainable construction techniques: Precast concrete technology, Pre-engineered buildings.

## **UNIT IV SUSTAINABLE CONSTRUCTION MATERIALS 9**

Construction materials: Concrete, steel, glass, aluminium, timber and FRP - No/Low cement concrete - Recycled and manufactured aggregate - Role of QC and durability - Sustainable consumption – Eco-efficiency - green consumerism - product stewardship and green engineering - Extended producer responsibility – Design for Environment Strategies, Practices, Guidelines, Methods, And Tools. Eco-design strategies –Design for Disassembly - Dematerialization, rematerialization, transmaterialization – Green procurement and green distribution - Analysis framework for reuse and recycling – Typical constraints on reuse and recycling - Communication of Life Cycle Information - Indian Eco mark scheme - Environmental product declarations – Environmental marketing- Life cycle Analysis (LCA), Advances in LCA: Hybrid LCA, Thermodynamic LCA - Extending LCA - economic dimension, social dimension - Life cycle costing (LCC) - Combining LCA and LCC – Case studies

## **UNIT V SUSTAINABLE MAINTENANCE OF INFRASTRUCTURE PROJECTS 9**

Case Studies - Sustainable projects in developed countries and developing nations - An Integrated Framework for Successful Infrastructure Planning and Management - Information Technology and Systems for Successful Infrastructure Management, - Structural Health Monitoring for Infrastructure projects - Innovative Design and Maintenance of Infrastructure Facilities - Capacity Building and Improving the Governments Role in Infrastructure Implementation, Infrastructure Management Systems and Future Directions. – Use of Emerging Technologies – IoT, Big Data Analytics and Cloud Computing, Artificial Intelligences, Machine and Deep Learning, Fifth Generation (5G) Network services for maintenance .

**TOTAL: 45 PERIODS**

### **OUTCOME:**

On completion of the course, the student is expected to be able to

**CO1** Understand the environment sustainability goals at global and Indian scenario.

**CO2** Understand risks in development of projects and suggest mitigation measures.

**CO3** Apply lean techniques, LBMS and new construction techniques to achieve sustainability in infrastructure construction projects.

**CO4** Explain Life Cycle Analysis and life cycle cost of construction materials.

**CO5** Explain the new technologies for maintenance of infrastructure projects.

**REFERENCES:**

1. Charles J Kibert, Sustainable Construction : Green Building Design & Delivery, 4th Edition , Wiley Publishers 2016.
2. Steve Goodhew, Sustainable Construction Process, Wiley Blackwell,UK, 2016.
3. Craig A. Langston & Grace K.C. Ding, Sustainable Practices in the Built Environment, Butterworth Heinemann Publishers, 2011.
4. William P Spence, Construction Materials, Methods & Techniques (3e), Yesdee Publication Pvt. Ltd, 2016.
5. New Building Materials and Construction World magazine
6. Kerry Turner. R, "Sustainable Environmental Management", Principles and Practice Publisher:Belhaven Press,ISBN:1852930039.
7. Munier N, "Introduction to Sustainability", Springer2005
8. Sharma, "Sustainable Smart Cities In India: Challenges And Future Perspectives", SPRINGER, 2022.
9. Ralph Horne, Tim Grant, KarliVerghese, Life Cycle Assessment: Principles, Practice and Prospects, Csiro Publishing,2009
10. European Commission - Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. Luxembourg. European Union;2010
11. Hudson, Haas, Uddin, Infrastructure management: integrating design, construction, maintenance, rehabilitation, and renovation, McGraw Hill, (1997).
12. GregerLundesjö, Supply Chain Management and Logistics in Construction: Delivering Tomorrow's Built Environment, Kogan Page Publishers, 2015.

**CO's- PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2		1	1		2	3	1	1		2	1	1	2	1
2	3	1	3	2	1	2	2		1	1	1	2	2	2	2
3	2	2	3	1	1	1	1				1	1	1	3	1
4	3	1	3	2	2	1	3	1	1	1	1	2	2	2	2
5	3	1	2	2	2	2	3	1		1	1	2	2	3	2
<b>Avg.</b>	3	1	3	2	2	2	3	1	1	1	1	2	2	3	2

**CES332 SUSTAINABLE AGRICULTURE AND ENVIRONMENTAL MANAGEMENT**

**L T P C  
3 0 0 3**

**OBJECTIVES:**

- To educate the students about the issues of sustainability in agroecosystems, introduce the concepts and principles of agroecology as applied to the design and management of sustainable agricultural systems for a changing world.

**UNIT I AGROECOLOGY, AGROECOSYSTEM AND SUSTAINABLE AGRICULTURE CONCEPTS**

**9**

Ecosystem definition - Biotic Vs. abiotic factors in an ecosystem - Ecosystem processes - Ecological services and agriculture - Problems associated with industrial agriculture/food systems - Defining sustainability - Characteristics of sustainable agriculture - Difference between regenerative and sustainable agriculture systems

**UNIT II SOIL HEALTH, NUTRIENT AND PEST MANAGEMENT****9**

Soil health definition - Factors to consider (physical, chemical and biological) - Composition of healthy soils - Soil erosion and possible control measures - Techniques to build healthy soil - Management practices for improving soil nutrient - Ecologically sustainable strategies for pest and disease control

**UNIT III WATER MANAGEMENT****9**

Soil water storage and availability - Plant yield response to water - Reducing evaporation in agriculture - Earthworks and tanks for rainwater harvesting - Options for improving the productivity of water - Localized irrigation - Irrigation scheduling - Fertigation - Advanced irrigation systems and agricultural practices for sustainable water use

**UNIT IV ENERGY AND WASTE MANAGEMENT****9**

Types and sources of agricultural wastes - Composition of agricultural wastes - Sustainable technologies for the management of agricultural wastes - Useful and high value materials produced using different processes from agricultural wastes - Renewable energy for sustainable agriculture

**UNIT V EVALUATING SUSTAINABILITY IN AGROECOSYSTEMS****9**

Indicators of sustainability in agriculture - On-farm evaluation of agroecosystem sustainability - Alternative agriculture approaches/ farming techniques for sustainable food production - Goals and components of a community food system - Case studies

**TOTAL: 45 PERIODS****OUTCOMES:**

**On completion of the course, the student is expected to be able to**

**CO1** Have an in-depth knowledge about the concepts, principles and advantages of sustainable agriculture

**CO2** Discuss the sustainable ways in managing soil health, nutrients, pests and diseases

**CO3** Suggest the ways to optimize the use of water in agriculture to promote an ecological use of resources

**CO4** Develop energy and waste management plans for promoting sustainable agriculture in non-sustainable farming areas

**CO5** Assess an ecosystem for its level of sustainability and prescribe ways of converting to a sustainable system through the redesign of a conventional agroecosystem

**REFERENCES:**

- Approaches to Sustainable Agriculture – Exploring the Pathways Towards the Future of Farming, Oberc, B.P. & Arroyo Schnell, A., IUCN, Belgium, 2020
- Natural bioactive products in sustainable agriculture, Singh, J. & Yadav, A.N., Springer, 2020
- Organic Farming for Sustainable Agriculture, Nandwani, D., Springer, 2016
- Principles of Agronomy for Sustainable Agriculture, Villalobos, F.J. & Fereres, E., Springer, 2016
- Sustainable Agriculture for Food Security: A Global Perspective, Balkrishna, A., CRC Press, 2021
- Sustainable Energy Solutions in Agriculture, Bundschuh, J. & Chen, G., CRC Press, 2014

**CO – PO Mapping - SUSTAINABLE AGRICULTURE PRACTICES**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		2						2		2			2	2	
2		2		2	2	2							3	2	
3				2		2							3	2	3
4	3	2			2			2	2	2	2		3	2	3
5		2	3	2			1					1		2	
Avg.	3	2	3	2	2	2	1	2	2	2	2	1	3	2	3

1 – Low; 2 – Medium; 3 – High; ‘ – “– No correlation

**OBJECTIVES**

- To Impart knowledge of biomaterials and their properties
- To learn about Fundamentals aspects of Biopolymers and their applications
- To learn about bioceramics and biopolymers
- To introduce the students about metals as biomaterials and their usage as implants
- To make the students understand the significance of bionanomaterials and its applications.

**UNIT I INTRODUCTION TO BIOMATERIALS****9**

Introduction: Definition of biomaterials, requirements & classification of biomaterials- Types of Biomaterials- Degradable and resorbable biomaterials- engineered natural materials- Biocompatibility-Hydrogels-pyrolitic carbon for long term medical implants-textured and porous materials-Bonding types- crystal structure- imperfection in crystalline structure-surface properties and adhesion of materials –strength of biological tissues- performance of implants-tissue response to implants- Impact and Future of Biomaterials

**UNIT II BIO POLYMERS****9**

Molecular structure of polymers -Molecular weight - Types of polymerization techniques–Types of polymerization reactions- Physical states of polymers- Common polymeric biomaterials -Polyethylene -Polymethylmethacrylate (PMMA-Polylactic acid (PLA) and polyglycolic acid (PGA) -Polycaprolactone (PCL) - Other biodegradable polymers –Polyurethan- reactions polymers for medical purposes - Collagens- Elastin- Cellulose and derivatives- Synthetic polymeric membranes and their biological applications

**UNIT III BIO CERAMICS AND BIOCOSITES****9**

General properties- Bio ceramics -Silicate glass - Alumina (Al<sub>2</sub>O<sub>3</sub>) -Zirconia (ZrO<sub>2</sub>)-Carbon- Calcium phosphates (CaP)- Resorbable Ceramics- surface reactive ceramics- Biomedical Composites-Polymer Matrix Composite(PMC)-Ceramic Matrix Composite(CMC)-Metal Matrix Composite (MMC)–glass ceramics - Orthopedic implants-Tissue engineering scaffolds

**UNIT IV METALS AS BIOMATERIALS****9**

Biomedical metals-types and properties-stainless steel-Cobalt chromium alloys-Titanium alloys-Tantalum-Nickel titanium alloy (Nitinol)- magnesium-based biodegradable alloys-surface properties of metal implants for osteointegration-medical application-corrosion of metallic implants – biological tolerance of implant metals

**UNIT V NANOBIMATERIALS****9**

Meatllcianobiomaterials–Nanopolymers-Nanoceramics- Nanocomposites -Carbon based nanobiomaterials - transport of nanoparticles- release rate-positive and negative effect of nanosize-nanofibres-Nano and micro features and their importance in implant performance-Nanosurface and coats-Applications nanoantibiotics- Nanomedicines- Biochips – Biomimetics- BioNEMs -Biosensor-Bioimaging/Molecular Imaging- challenges and future perspective.

**TOTAL : 45 PERIODS****OUTCOMES**

- Students will gain familiarity with Biomaterials and they will understand their importance.
- Students will get an overview of different biopolymers and their properties
- Students gain knowledge on some of the important Bioceramics and Biocomposite materials
- Students gain knowledge on metals as biomaterials
- Student gains knowledge on the importance of nanobiomaterials in biomedical applications.

**REFERENCES**

1. C. Mauli Agrawal, Joo L. Ong, Mark R. Appleford, Gopinath Mani “Introduction to Biomaterials Basic Theory with Engineering Applications” Cambridge University Press, 2014.
2. Donglu shi “Introduction to Biomaterials” Tsinghua University press, 2006.

3. Joon Park, R.S.Lakes “Biomaterials An Introduction” third edition, Springer 2007.
4. M.Jaffe,W.Hammond, P.Tolias and T.Arinzeh “Characterization of Biomaterials” Wood head publishing, 2013.
5. Buddy D.Ratner and Allan S.Hoffman Biomaterials Science “An Introduction to Material in Medicine” Third Edition, 2013.
6. VasifHasirci, NesrinHasirci “Fundamentals of Biomaterials” Springer, 2018
7. Leopoldo Javier Rios Gonzalez. “Handbook of Research on Bioenergy and Biomaterials: Consolidated and green process” Apple academic press, 2021.
8. Devarajan Thangadurai, Jeyabalan Sangeetha, Ram Prasad “Functional Bionanomaterials” springer, 2020.
9. Sujata.V.Bhat Biomaterials; Narosa Publishing house, 2002.

**CES334**

**MATERIALS FOR ENERGY SUSTAINABILITY**

**L T P C**

**3 0 0 3**

**OBJECTIVES**

- To familiarize the students about the challenges and demands of energy sustainability
- To provide fundamental knowledge about electrochemical devices and the materials used.
- To introduce the students to various types of fuel cell
- To enable students to appreciate novel materials and their usage in photovoltaic application
- To introduce students to the basic principles of various types Supercapacitors and the materials used.

**UNIT I SUSTAINABLE ENERGY SOURCES**

**9**

Introduction to energy demand and challenges ahead – sustainable source of energy (wind, solar etc.) – electrochemical energy systems for energy harvesting and storage – materials for sustainable electrochemical systems building – India centric solutions based on locally available materials – Economics of wind and solar power generators vs. conventional coal plants – Nuclear energy

**UNIT II ELECTROCHEMICAL DEVICES**

**9**

Electrochemical Energy – Difference between primary and secondary batteries – Secondary battery (Li-ion battery, Sodium-ion battery, Li-S battery, Li-O<sub>2</sub> battery, Nickel Cadmium, Nickel Metal Hydride) – Primary battery (Alkaline battery, Zinc-Carbon battery) – Materials for battery (Anode materials – Lithiated graphite, Sodiated hard carbon, Silicon doped graphene, Lithium Titanate) (Cathode Materials – S, LiCoO<sub>2</sub>, LiFePO<sub>4</sub>, LiMn<sub>2</sub>O<sub>4</sub>) – Electrolytes for Lithium-ion battery (ethylene carbonate and propylene carbonate based)

**UNIT III FUEL CELLS**

**9**

Principle of operation of fuel cells – types of fuel cells (Proton exchange membrane fuel cells, alkaline fuel cell, direct methanol fuel cells, direct borohydride fuel cells, phosphoric acid fuel cells, solid oxide fuel cells, and molten carbonate fuel cells) – Thermodynamics of fuel cell – Fuel utilization – electrolyte membrane ( proton conducting and anion conducting) – Catalysts ( Platinum, Platinum alloys, carbon supported platinum systems and metal oxide supported platinum catalysts) – Anatomy of fuel cells (gas diffusion layer, catalyst layer, flow field plate, current conductors, bipolar plates and monopolar plates).

**UNIT IV PHOTOVOLTAICS**

**9**

Physics of the solar cell – Theoretical limits of photovoltaic conversion – bulk crystal growth of Si and wafering for photovoltaic application - Crystalline silicon solar cells – thin film silicon solar cells – multijunction solar cells – amorphous silicon based solar cells – photovoltaic concentrators – Cu(InGa)Se<sub>2</sub> solar cells – Cadmium Telluride solar cells – dye sensitized solar cells – Perovskite solar cells – Measurement and characterization of solar cells - Materials used in solar cells ( metallic oxides, CNT films, graphene, OD fullerenes, single-multi walled carbon nanotubes, two-dimensional Graphene, organic or Small molecule-based solar cells materials - copper-



phthalocyanine and perylenetetracarboxylicbis - benzene – fullerenes - boron subphthalocyanine- tin (II phthalocyanine)

## UNIT V SUPERCAPACITORS

9

Supercapacitor –types of supercapacitors (electrostatic double-layer capacitors, pseudo capacitors and hybrid capacitors) - design of supercapacitor-three and two electrode cell-parameters of supercapacitor- Faradaic and non - Faradaic capacitance – electrode materials (transition metal oxides (MO), mixed metal oxides, conducting polymers (CP), Mxenes, nanocarbons, non-noble metal, chalcogenides, hydroxides and 1D-3D metal-organic frame work (MOF), activated carbon fibres (ACF)- Hydroxides-Based Materials - Polyaniline (PANI), a ternary hybrid composite- conductive polypyrrole hydrogels – Different types of nanocomposites for the SC electrodes (carbon–carbon composites, carbon-MOs composites, carbon-CPs composites and MOs-CPs composites) - Two-Dimensional (2D) Electrode Materials - 2D transition metal carbides, carbonitrides, and nitrides.

**TOTAL : 45 PERIODS**

### OUTCOMES

- Students will acquire knowledge about energy sustainability.
- Students understand the principles of different electrochemical devices.
- Students learn about the working of fuel cells and their application.
- Students will learn about various Photovoltaic applications and the materials used.
- The students gain knowledge on different types of supercapacitors and the performance of various materials

### REFERENCES

1. Functional materials for sustainable energy applications; John A. Kilner, Stephen J. Skinner, Stuart J. C. Irvine and Peter P. Edwards.
2. Hand Book of Fuel Cells: Fuel Cell Technology and Applications, Wolf Vielstich, Arnold Lamm, Hubert Andreas Gasteiger, Harumi Yokokawa, Wiley, London 2003.
3. B.E. Conway, Electrochemical supercapacitors: scientific fundamentals and technological applications, Kluwer Academic / Plenum publishers, New York, 1999.
4. T.R. Crompton, Batteries reference book, Newners, 3rd Edition, 2002.
5. Materials for Supercapacitor applications; B.Viswanathan. M.Aulice Scibioh
6. Electrode Materials for Supercapacitors: A Review of Recent Advances, Parnia Forouzandeh, Vignesh Kumaravel and Suresh C. Pillai, catalysts 2020.
7. Recent advances, practical challenges, and perspectives of intermediate temperature solid oxide fuel cell cathodes Amanda Ndubuisi, Sara Abouali, Kalpana Singh and VenkataramanThangadurai, J. Mater. Chem. A, 2022.
8. Review of next generation photovoltaic solar cell technology and comparative materialistic development Neeraj Kant, Pushpendra Singh, Materials Today: Proceedings, 2022.

**CES335**

**GREEN TECHNOLOGY**

**L T P C  
3 0 0 3**

### COURSE OBJECTIVE:

- To acquire knowledge on green systems and the environment, energy technology and efficiency, and sustainability.
- To provide green engineering solutions to energy demand, reduced energy footprint.

- UNIT I PRINCIPLES OF GREEN CHEMISTRY 9**  
 Historical Perspectives and Basic Concepts. The twelve Principles of Green Chemistry and green engineering. Green chemistry metrics- atom economy, E factor, reaction mass efficiency, and other green chemistry metrics, application of green metrics analysis to synthetic plans.
- UNIT II POLLUTION TYPES 9**  
 Pollution – types, causes, effects, and abatement. Waste – sources of waste, different types of waste, chemical, physical and biochemical methods of waste minimization and recycling.
- UNIT III GREEN REAGENTS AND GREEN SYNTHESIS 9**  
 Environmentally benign processes- alternate solvents- supercritical solvents, ionic liquids, water as a reaction medium, energy-efficient design of processes- photo, electro and sono chemical methods, microwave-assisted reactions
- UNIT IV DESIGNING GREEN PROCESSES 9**  
 Safe design, process intensification, in process monitoring. Safe product and process design – Design for degradation, Real-time Analysis for pollution prevention, inherently safer chemistry for accident prevention
- UNIT V GREEN NANOTECHNOLOGY 9**  
 Nanomaterials for water treatment, nanotechnology for renewable energy, nanotechnology for environmental remediation and waste management, nanotechnology products as potential substitutes for harmful chemicals, environmental concerns with nanotechnology

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

- CO1: To understand the principles of green engineering and technology  
 CO2: To learn about pollution using hazardous chemicals and solvents  
 CO3: To modify processes and products to make them green and safe.  
 CO4: To design processes and products using green technology  
 CO5 – To understand advanced technology in green synthesis

**TEXT BOOKS**

1. Green technology and design for the environment, Samir B. Billatos, Nadia A. Basaly, Taylor & Francis, Washington, DC, ©1997
2. Green Chemistry – An introductory text - M. Lancaster, RSC,2016.
3. Green chemistry metrics - Alexi Lapkin and david Constable (Eds) , Wiley publications,2008

**REFERENCE**

1. Environmental chemistry, Stanley E Manahan, Taylor and Francis, 2017

**CES336 ENVIRONMENTAL QUALITY MONITORING AND ANALYSIS**

**L T P C**  
**3 0 0 3**

**OBJECTIVES:**

- to understand and study the complexity of the environment in relation to pollutants generated due to industrial activity.
- To analyze the quality of the environmental parameters and monitor the same for the purpose of environmental risk assessment.

**UNIT I ENVIRONMENTAL MONITORING AND STANDARDS****9**

Introduction- Environmental Standards- Classification of Environmental Standards- Global Environmental Standards- Environmental Standards in India- Ambient air quality standards- water quality standard- Environmental Monitoring-Need for environmental monitoring- Concepts of environmental monitoring- Techniques of Environmental Monitoring.

**UNIT II MONITORING OF ENVIRONMENTAL PARAMETERS****9**

Current Environmental Issues- Global Environmental monitoring programme-International conventions- Application of Environmental Monitoring- Atmospheric Monitoring - screening parameters – Significance of environmental sampling- sampling methods – water sampling - sampling of ambient air-sampling of flue gas.

**UNIT III ANALYTICAL METHODS FOR ENVIRONMENTAL MONITORING****9**

Classification of Instrumental Method- Analysis of Organic Pollutants by Spectrophotometric methods - Determination of nitrogen, phosphorus and, chemical oxygen demand (COD) in sewage; Biochemical oxygen demand (BOD)- Sampling techniques for air pollution measurements; analysis of particulates and air pollutants like oxides of nitrogen, oxides of sulfur, carbon monoxide, hydrocarbon; Introduction to advanced instruments for environmental analysis

**UNIT IV ENVIRONMENTAL MONITORING PROGRAMME (EMP) & RISKASSESSMENT****9**

Water quality monitoring programme- national water quality monitoring- Parameters for National Water Quality Monitoring- monitoring protocol; Process of risk assessment- hazard identification- exposure assessment- dose-response assessment; risk characterization.

**UNIT V AUTOMATED DATA ACQUISITION AND PROCESSING****9**

Data Acquisition for Process Monitoring and Control - The Data Acquisition System - Online Data Acquisition, Monitoring, and Control - Implementation of a Data Management System - Review of Observational Networks -Sensors and transducers- classification of transducers- data acquisition system- types of data acquisition systems- data management and quality control; regulatory overview.

**OTAL: 45 PERIODS****COURSE OUTCOMES**

After completion of this course, the students will know

CO1	Basic concepts of environmental standards and monitoring.
CO2	the ambient air quality and water quality standards;
CO3	the various instrumental methods and their principles for environmental monitoring
CO4	The significance of environmental standards in monitoring quality and sustainability of the environment.
CO5	the various ways of raising environmental awareness among the people.
CO6	Know the standard research methods that are used worldwide for monitoring the environment.

**TEXTBOOKS**

1. Environmental monitoring Handbook, Frank R. Burden, © 2002 by The McGraw-Hill Companies, Inc.
2. Handbook of environmental analysis: chemical pollutants in the air, water, soil, and soil wastes / Pradyot Patnaik, © 1997 by CRC Press, Inc

**REFERENCES**

1. Environmental monitoring / edited by G. Bruce Wiersma, © 2004 by CRC Press LLC.
2. H. H. Willard, L. L. Merit, J. A. Dean and F. A. Settle, Instrumental Methods of Analysis, CBP Publishers and Distributors, New Delhi, 1988.
3. Heaslip, G. (1975) Environmental Data Handling. John Wiley & Sons. New York.

## COURSE ARTICULATION MATRIX

Course Outcome	Program Outcomes														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PSC	PS O2	PSO3
CO1	1	1	1	-	-	-	-	-	-	-	-	-	3	-	-
CO2	1	1	1	1	1	-	-	-	1	-	2	2	2	1	1
CO3	1	1	2	1	1	-	-	-	2	-	1	1	1	-	-
CO4	1	2	3	3	1	-	-	-	2	-	3	3	1	-	-
CO5	1	1	3	2	1	-	-	-	3	-	3	1	2	-	-
CO6	3	2	3	3	2	-	-	-	3	-	3	3	3	1	1
Over all	3	2	3	3	2	-	-	-	3	-	3	3	3	1	1

### CES337 INTEGRATED ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT

**L T P C**  
**3 0 0 3**

#### COURSE OBJECTIVES:

1. To create awareness on the energy scenario of India with respect to world
2. To understand the fundamentals of energy sources, energy efficiency and resulting environmental implications of energy utilisation
3. Familiarisation on the concept of sustainable development and its benefits
4. Recognize the potential of renewable energy sources and its conversion technologies for attaining sustainable development
5. Acquainting with energy policies and energy planning for sustainable development

#### UNIT I ENERGY SCENARIO

**9**

Comparison of energy scenario – India and World (energy sources, generation mix, consumption pattern, T&D losses, energy demand, per capita energy consumption) – energy pricing – Energy security

#### UNIT II ENERGY AND ENVIRONMENT

**9**

Conventional Energy Sources - Emissions from fuels – Air, Water and Land pollution – Environmental standards - measurement and controls

#### UNIT III SUSTAINABLE DEVELOPMENT

**9**

Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG) - Social development: Poverty, conceptual issues and measures, impact of poverty. Globalization and Economic growth - Economic development: Economic inequalities, Income and growth.

#### UNIT IV RENEWABLE ENERGY TECHNOLOGY

**9**

Renewable Energy – Sources and Potential – Technologies for harnessing from Solar, Wind, Hydro, Biomass and Oceans – Principle of operation, relative merits and demerits

#### UNIT V ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT

**9**

National & State Energy Policy - National solar mission - Framework of Central Electricity Authority - National Hydrogen Mission - Energy and climate policy - State Energy Action Plan, RE integration, Road map for ethanol blending, Energy Efficiency and Energy Mix

**TOTAL : 45 PERIODS**

## COURSE OUTCOMES:

Upon completion of this course, the students will be able to

1. Understand the world and Indian energy scenario
2. Analyse energy projects, its impact on environment and suggest control strategies
3. Recognise the need of Sustainable development and its impact on human resource development
4. Apply renewable energy technologies for sustainable development
5. Fathom Energy policies and planning for sustainable development.

## REFERENCES:

1. Energy Manager Training Manual (4Volumes) available at <http://www.em-ea.org/gbook1.asp>, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004
2. Robert Ristirer and Jack P. Kraushaar, "Energy and the environment", Willey, 2005.
3. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012
4. Twidell, J.W. & Weir A., "Renewable Energy Resources", EFNSpon Ltd., UK, 2015.
5. Dhandapani Alagiri, Energy Security in India Current Scenario, The ICFAI University Press, 2006.
6. M.H. Fulekar, Bhawana Pathak, R K Kale, "Environment and Sustainable Development" Springer, 2016
7. <https://www.niti.gov.in/verticals/energy>

**CES338**

**ENERGY EFFICIENCY FOR SUSTAINABLE DEVELOPMENT**

**L T P C**

**3 0 0 3**

## COURSE OBJECTIVES:

1. To understand the types of energy sources, energy efficiency and environmental implications of energy utilisation
2. To create awareness on energy audit and its impacts
3. To acquaint the techniques adopted for performance evaluation of thermal utilities
4. To familiarise on the procedures adopted for performance evaluation of electrical utilities
5. To learn the concept of sustainable development and the implication of energy usage

### UNIT I ENERGY AND ENVIRONMENT

**9**

Primary energy sources - Coal, Oil, Gas – India Vs World with respect to energy production and consumption, Climate Change, Global Warming, Ozone Depletion, UNFCCC, COP

### UNIT II ENERGY AUDITING

**9**

Need and types of energy audit. Energy management (audit) approach-understanding energy costs, benchmarking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments

### UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES

**9**

Energy conservation avenues in steam generation and utilisation, furnaces, Thermic Fluid Heaters. Insulation and Refractories - Commercial waste heat recovery devices: recuperator, regenerator, heat pipe, heat exchangers (Plate, Shell & Tube), heat pumps, and thermocompression

### UNIT IV ENERGY CONSERVTION IN ELECTRICAL UTILITIES

**9**

Demand side management - Power factor improvement – Energy efficient transformers - Energy conservation avenues in Motors, HVAC, fans, blowers, pumps, air compressors, illumination systems and cooling towers

### UNIT V SUSTAINABLE DEVELOPMENT

**9**

Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG). Globalization and Economic growth. Economic development: Economic inequalities, Income and growth. Social development: Poverty, conceptual issues and measures, impact of poverty,

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

1. Understand the prevailing energy scenario
2. Familiarise on energy audits and its relevance
3. Apply the concept of energy audit on thermal utilities
4. Employ relevant techniques for energy improvement in electrical utilities
5. Understand Sustainable development and its impact on human resource development

**REFERENCES:**

1. Energy Manager Training Manual (4Volumes) available at <http://www.em-ea.org/gbook1.asp>, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004
2. Eastop.T.D& Croft D.R, "Energy Efficiency for Engineers and Technologists", Logman Scientific & Technical, ISBN-0-582-03184, 1990
3. W.R. Murphy and G. McKay "Energy Management" Butterworths, London 1987
4. Pratap Bhattacharyya, "Climate Change and Greenhouse Gas Emission", New India Publishing Agency-Nipa,2020
5. Matthew John Franchetti , Defne Apul "Carbon Footprint Analysis: Concepts, Methods, Implementation, and Case Studies" CRC Press,2012
6. Robert A. Ristinen, Jack J. Kraushaar, Jeffrey T. Brack, "Energy and the Environment", 4th Edition,Wiley,2022
7. M.H. Fulekar,Bhawana Pathak, R K Kale,"Environment and Sustainable Development" Springer,2016
8. Sustainable development in India: Stocktaking in the run up to Rio+20: Report prepared by TERI for MoEF, 2011.

