ST. ANNE'S COLLEGE OF ENGINEERING AND TECHNOLOGY
(Approved by AICTE, New Delhi. Affiliated to Anna University, Chennai)
Accredited by NAAC
ANGUCHETTYPALAYAM, PANRUTI -607 106.

QUESTION BANK

EVEN SEMESTER

BRANCH: Mech **YR/SEM:** II/IV

SUB CODE/NAME: ME3491/ THEOARY OF MACHINES

UNIT I

BASICS OF MECHANISMS

PART – A

1. Sketch and define Transmission angle of a four-bar mechanism. What are the worst values of transmission angle?
2. What is the condition for correct steering of an automobile?
3. Write Grashoff s law for 4-bar mechanism.
4. What is meant by indexing mechanism? Where do we use it?
5. What is Kutzbach criterion for planar mechanism?
6. Sketch an exact straight line mechanism, with link proportions.
7. Give any two inversions of a single slider chain.
8. What is meant by Kinematic Pair?
9. State the difference between mechanism and structure.
10. Differentiate the machine and structure.
11. Classify the constrained motion.
12. Differentiate rotation and translation.
13. What is meant by Ackermann steering?
14. Write down the Grashoff's Law for a four bar mechanism?
15. Explain the working principle of bicycle bells.
16. Whether a cycle chain is kinematic chain or not?
17. Define instantaneous centre.
18. What is instantaneous axis?
19. What is resistant body?
20. What is link?
21. What are the different types of links?
22. What is meant by spatial mechanism?
23. What is the use of oldham's coupling?

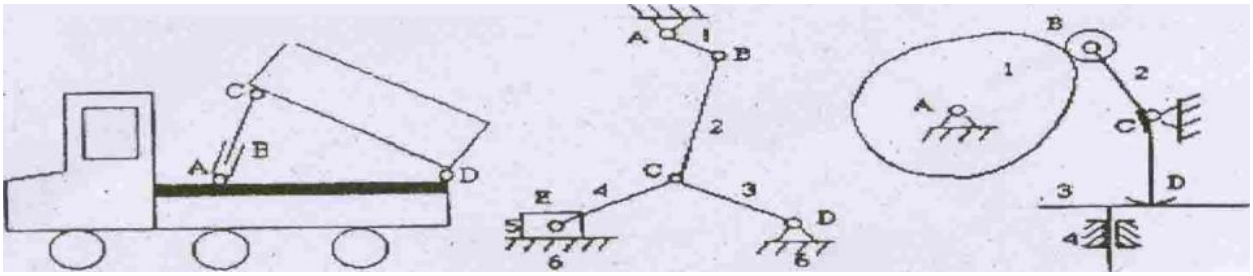
PART B & C

1. Explain the working of two different types of quick return mechanisms. Derive an expression for the ratio of time taken in forward and return stroke for one of these mechanisms. (16)

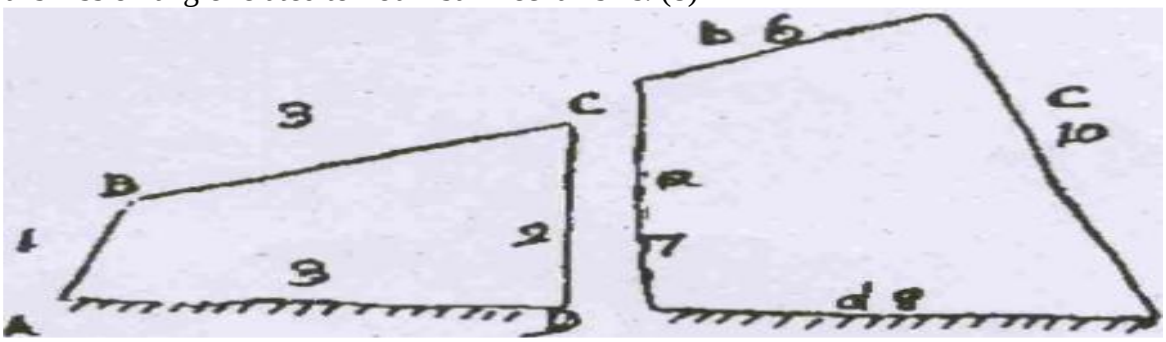
2. Sketch and explain Explain the inversions of four bar chain with examples. (16)

3. Sketch and explain the following:
   (i) Elliptical trammel (8)
   (ii) Scotch yoke mechanism. (8)

4. Sketch and explain the four inversions of Single-slider crank chain. (16)
5. (i) What is kinematic inversion? Explain the four different inversions of double slider crank mechanism. (10)
   (ii) Determine the degree of freedom for following linkages. (6)

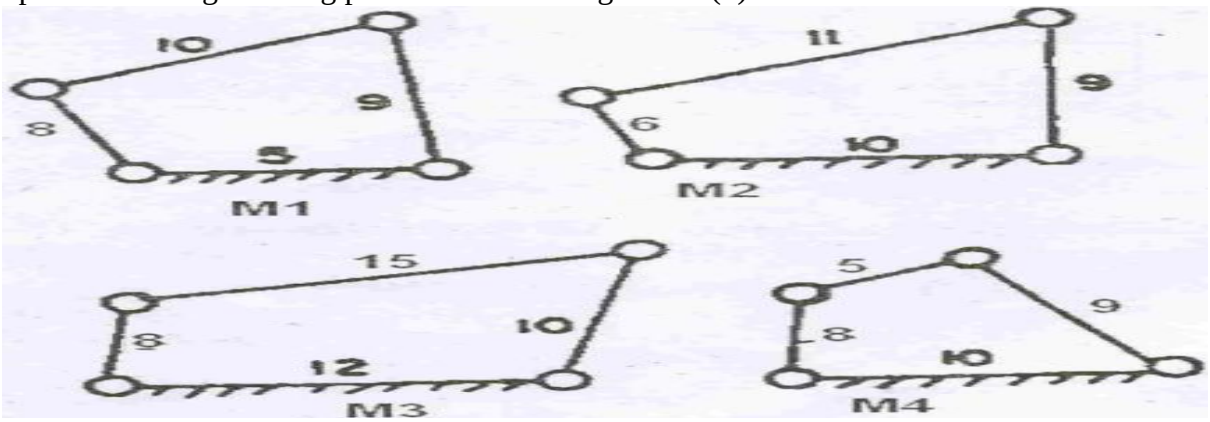


6. (i) Find the maximum and minimum transmission angles for the mechanisms shown in The figures indicate the dimensions in standard units of length. (Or) Explain mechanical advantage and transmission angle related to Four- bar mechanisms. (8)



(ii) Write short notes on toggle mechanism. (8)

7. (i) What are straight-line mechanisms? Sketch the Peaucellier straight-line motion mechanism and prove that the generating point moves in straight line. (8)



(ii) Sketch a Hooke's joint and derive the condition for equal speeds of driving and driven shafts. (8)

8. (i) Explain Kutzbach criterion for the mobility of a mechanism with suitable example. (4) Dimensions are in cm M1, M2, M3 and M4 are four-bar linkages as shown in figure. The numbers on the figure indicate the respective link lengths in cm. Identify the nature of the mechanism, i.e. whether double crank, crank rocker or double rocker. Give reasons in brief. (4 x 3 = 12)

9. (i) Explain, with a neat sketch, how an offset slider crank mechanism can be used as a quick-return motion mechanism. Derive an expression to find the quick-return ratio. (10)
(ii) With a suitable diagram, explain how a pantograph works. What are its uses? (6)

10. Explain the working of a toggle mechanism and its application with a neat sketch.

11. (i) Explain the inversions of four bar chain, with neat sketches. (8)
(ii) Explain with neat sketches the following: (8)
Offset slider mechanism. An indexing mechanism.

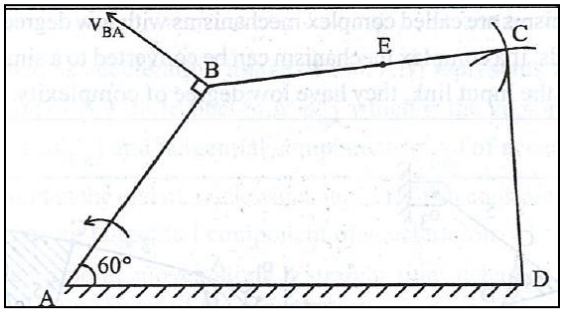
UNIT II
KINEMATICS LINKAGE MECHANISM
PART – A

1. What is kinematic analysis?
2. Write down the different types of motion.
3. What is rectilinear motion?
4. What is curvilinear motion?
5. What is the difference between velocity and speed?
6. What is configuration diagram (or) space diagram?
7. What is Instantaneous axis?
8. Write down the different types of Instantaneous centres.
9. Define Kennedy's theorem.
10. What is angular velocity ratio theorem?
11. How will you determine the direction of Coriolis component of acceleration?
12. Explain normal component of acceleration.
13. Define - Rubbing Velocity
14. Define - Coriolis Component of Acceleration
15. Illustrate the space centrode and body centrode.
16. Name any two mechanisms having coriolis component.
17. How will you determine the total acceleration of a point on a link, when the normal component of acceleration and the tangential component of acceleration are known?
18. For what type of mechanism Coriolis component of acceleration is taken into account.
19. What is the need for finding acceleration of linkage in a mechanism?

PART B & C

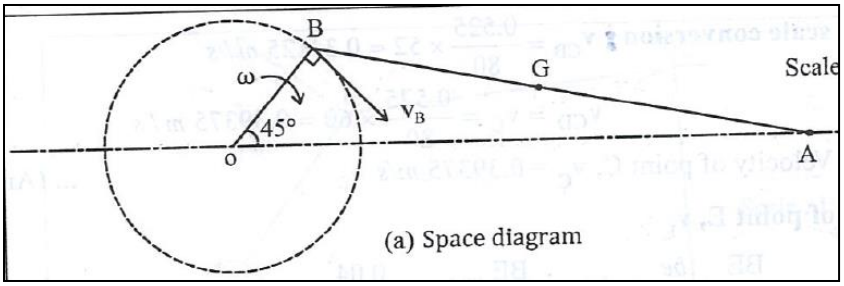
FOUR BAR CHAIN - VELOCITY AND ACCELERATION DIAGRAM

1. In a four bar chain ABCD, AD is fixed and is 120 mm long. The crank AB is 30 mm long and rotates at 100 rpm clockwise while the link CD = 60 mm oscillates about D;BC =120 mm. Find the angular velocity and angular acceleration of link BC When angle BAD = 60°. [**AU, Nov/Dec 2012**]
2. Following data refer to the dimensions of the links of a four-bar mechanism: AB = 50 mm; BC = 66 mm; CD = 56 mm and AD (fixed link) = 100 mm. At the instant when <DAB = 60°, the link AB has an angular velocity of 10.5 rad /sec in the counter clockwise direction. Determine the velocity of point C, velocity of point E on the link BC while BE = 40 mm and the angular velocities of the links BC and CD**.** [**AU, May/ June 2013**]

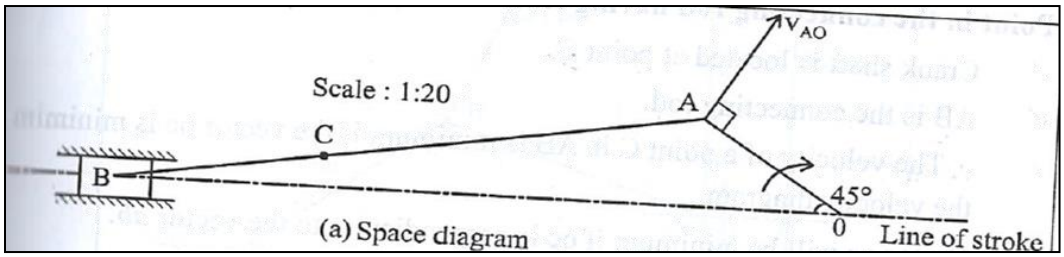


SLIDER CRANK - VELOCITY AND ACCELERATION DIAGRAM

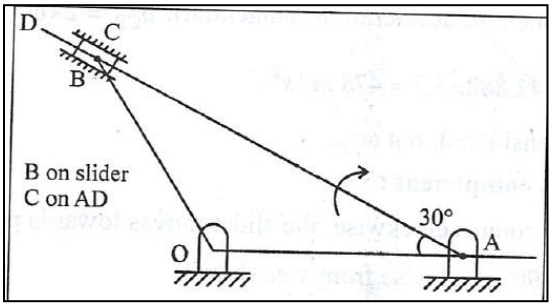
3. In a slider crank mechanism, the length of crank OB and connecting rod AB are 125 mm and 500 mm respectively. The centre of gravity G of the connecting rod is 275 mm from the slider A. The crank speed is 600 rpm clockwise, when the crank has turned 45**º** from the inner dead centre. Determine the velocity of the slider A, velocity of the point G and angular velocity of connecting rod AB.
[**AU, May/ June 2014**]



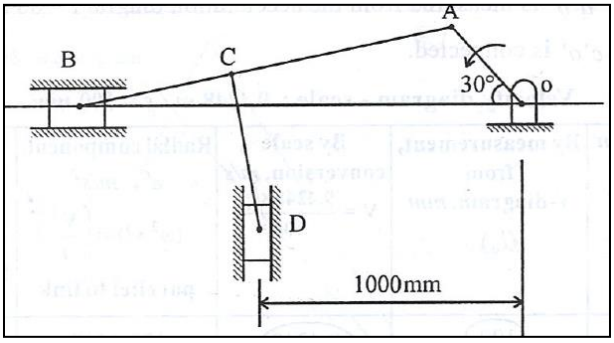
4.The crank and connecting rod of a theoretical steam engine are 0.5 m and 2 m respectively. The crank makes 180 rpm in the clockwise direction. When it has turned 45^0 from the inner dead centre position, determine: [i] velocity of piston [ii] angular velocity of connecting rod [iii] position and linear velocity of any point on the connecting rod which has the least velocity relative to crank shaft. [**AU, April/ May 2015**]



5. A single cylinder rotary engine is shown below. OA is the fixed link, 200 mm long. OB is the connecting rod and is 520 mm long. The line of stroke is along AD and at the instant is inclined at 30^0. The body of the engine consisting of cylinder rotates at a uniform speed of 400 rpm, about fixed centre A. Determine the acceleration of the slider B and angular acceleration of connecting rod. [**AU, April/ May 2015**]

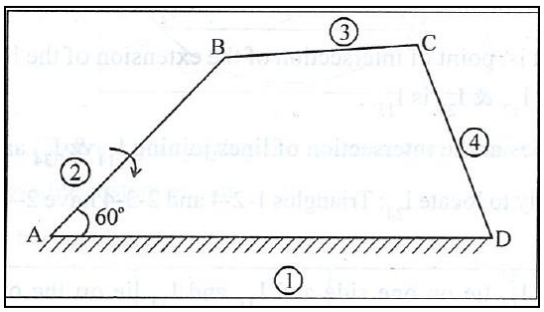


6. The crank OA of a slider crank mechanism shown rotates uniformly at 20 rpm counter clockwise. The dimensions of different links are: OA=300 mm; AB =1200 mm; BC = 450 mm; CD = 450 mm; determine the linear acceleration of sliders B and D.

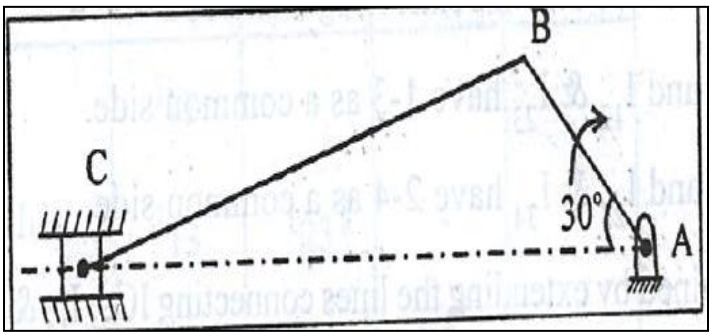


INSTANTANEOUS CENTRE

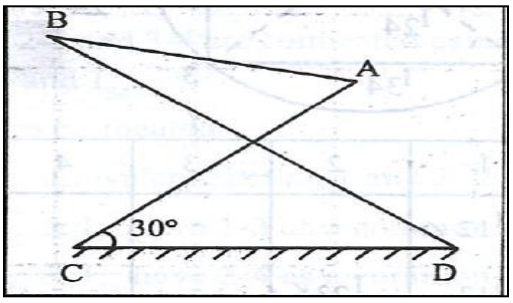
7. Locate all the instantaneous centers for the four bar mechanism shown. Lengths of various links are: AD = 125 mm; AB = 62.5 mm; BC = CD =75 mm. If the crank AB rotates at a uniform speed of 10 rpm in clockwise, find the angular velocity of link BC and CD.



8. The crank AB of the slider-crank mechanism shown is 60 mm long and rotates at a uniform speed of 300 rpm. The connecting rod BC is 250 mm long. Locate all the instantaneous centres and find the angular velocity of the connecting rod and velocity of the slider.



9. Locate all the instantaneous centers for the crossed four bar mechanism shown, the dimension of various link are: AB = 55 mm; BD = 80 mm; AC = 60 mm and CD = 65 mm. Find the angular velocities of the link AB and BD if the crank CA rotates at 100 r.p.m in the counter clockwise direction.



10. Derive the expressions of coriolis component of acceleration.

UNIT III

KINEMATICS OF CAM MECHANISMS

PART – A

1. What is cam? What are the different basic types of cam?
2. What are the important components of a cam and follower mechanism?
3. What are the applications of a cam and follower mechanism? Give their merits and demerits.
4. What are the three derivatives of Follower motion with respect to times?

5. State the fundamental law of a cam design.
6. State the three import measurements (parameters) to be considered while designing a cam.
7. Why it is required to minimize the size of the cam?
8. What are the effects of designing a very small cam?
9. What are the different types of motions of a follower?
10. Give the different types of followers used in a cam mechanism
11. Why roller follower is preferable over a knife edge follower?
12. Define undercutting in a cam mechanism? **(AU, Nov/Dec 2010)**
13. How can we prevent undercutting in cams?
14. Define pressure angle of a cam mechanism and state the ideal value of the value? **(AU, Nov/Dec 2013)**
15. State the advantages of a tangent cam and sketch it? **(AU, Apr/May 2011)**
16. Why sometimes the axes of translating roller followers in cam follower mechanism are offset from the axis of rotation of the cam? **(AU, Nov/Dec 2012)**
17. Which type of cam follower motion is used in high speed engines? Why? **(AU, Apr/May 2012)**
18. Why large pressure angle is not used in cam curves? **(AU, Apr/May 2012)**
19. Define angle of dwell. **(AU, Apr/May 2013)**
20. Write the procedure to draw cam profile? **(AU, Nov/Dec 2013)**

PART B & C

1. A cam rotates in clockwise direction with uniform angular velocity has a knife -edge follower and to give the following motion: The rise of the cam is 60^o with an outstroke of 25 mm, Dwells for next 30^0, the cam returns to its original position during next 90^0 and; Dwells for the remaining cam rotation. The follower follows SHM for both outstroke and return stroke. The follower is in line with the can axis. Draw the cam profile, if the maximum cam radius is 40 mm.

2. A cam operates with an oscillating roller follower has a minimum cam radius of 30 mm and the roller radius is 10 mm. The length of the follower arm = 45 mm and the distance fulcrum center from the cam center=55 mm. The angle of ascent=120^0 and the angle of descent=90^0, angle of dwell at maximum lift = $40^{\mathbf{0}}$**.** Draw the cam profile assuming a uniform velocity motion throughout.

3. Draw the profile of a cam rotating clockwise to raise a valve with uniform acceleration and retardation through 40 mm in 90^0, keep it fully raised through $30^{\mathbf{0}}$ and to lower it with the same type of motion in $120^{\mathbf{0}}$.The valve remains closed during the rest of the revolution. The minimum radius is 30 mm and the roller follower has a radius of 10 mm. The axis of the valve rod passes through the axis of the cam shaft.

4. A cam operates a flat faced follower which moves with Cycloidal motion during rise and fall. The minimum radius of cam=30 mm; Lift of follower=40 mm; angle of rise=120^0; angle dwell=60^0; angle of descent=90^0.Draw the cam profile if the cam rotates in anticlockwise direction.

OFFSET

5. Draw the cam profile for the following data: Base circle radius of cam=50 mm; Lift =40 mm; angle of ascent with cycloidal=60^0; angle of dwell=90^0; angle of descent with uniform velocity=90^0; Speed of cam=300 rpm follower offset =10 mm, type of follower –knife edge. Take Anti-clockwise and offset from RHS.

6. A knife edge follower with its axis 10 mm offset to the right of the axis of a cam. The follower rises with SHM during 120^0 of cam rotation. The dwell period for next 30^0 of cam rotation. First half of the fall takes place with uniform acceleration and second half with uniform velocity during 120^0 of cam rotation. The remaining is dwell period for 90^0.The minimum cam radius is 30 mm and follower lift is 40 mm. Draw the cam profile. Take clockwise and offset from RHS.

7. Following data is related to a cam profile, in which the follower moves with SHM during the lift and returning it with uniform acceleration and deceleration, acceleration being half the deceleration.

Minimum radius of cam=30 mm; Roller radius=10 mm; lift of follower =40 mm; offset of follower axis=12 mm; Angle of ascent=70^0; Angle of descent=120^0; Angle of dwell between ascent and descent=45^0; Speed of cam=300 rpm; Draw the cam profile and determine maximum velocity and maximum acceleration during lift. Take Anti-clockwise and offset from RHS.

8. A cam with minimum radius of 25 mm rotating clockwise at a uniform speed of 300 rpm is to be designed to give motion to a roller follower at the end of a valve rod as described below.
   (i) To raise the valve through 50 mm during 120^0 rotation of the cam.
   (ii) To keep the valve fully raised through next 30^0.
   (iii) To lower the valve in the next 60^0 and
   (iv) To keep the valve closed during rest of the revolution.
   The diameter of the roller is 20 mm and the diameter of the cam shaft is 25 mm. The line of stroke is offset by 15 mm from the axis of the cam shaft. The displacement of the valve, while being raised and lowered is to take place with SHM. Draw the displacement diagram and cam profile.
   (AU, Nov/Dec 2012)
9. A cam with minimum radius of 25 mm rotating clockwise at a uniform speed of 300 rpm is to be designed to give motion to a flat faced mushroom follower as described below.
   (i) To raise through a distance of 25 mm during 120^0 rotation of the cam.
   (ii) To remain at rest for the next 30^0.
   (iii) To lower during further 120^0 rotation of the cam.
   (iv) To remain in the same position during rest of the revolution.
   The raising of the follower takes place with cycloidal motion and the lowering with uniform acceleration and retardation. However, the uniform acceleration is 2/3 of the uniform retardation. Draw the displacement diagram and cam profile. **(AU, Apr/May 2013)**

UNIT IV

GEARS AND GEAR TRAINS

PART – A

1. Define (i) pressure angle and module.
2. What are the roles of "Idlers" in gear trains?
3. Define the term 'arc of contact' in gears. .
4. Name two applications of reverted gear train.
5. State the law of gearing.
6. What are the methods to avoid interference?
7. Define gear ratio.
8. Write short notes on differentials
9. Define cycloidel tooth profile and involute tooth profile.
10. Define Backlash.
11. What is gear train?
12. What are the types of gear trains?
13. Write velocity ratio in compound train of wheels? .
14. Define simple gear train.
15. What is meant compound gear train?
16. What is reverted gear train?
17. What is the externally applied torques used to keep the gear train in equilibrium?
18. Where the epicyclic gear trains are used?
19. Define interference.

20. Where will the interference occur in an involute pinion and gear are in mesh having same size of addendum?

PART- B&C

GEARS

1. Two Involute gears of 20° pressure angle are in mesh. The number of teeth on pinion is 20 and the gear ratio is 2. If the pitch expressed in module is 5mm and pitch line speed is 1.2 m/s. Assuming addendum as standard and equal to one module. Find (1) the angle turned through by pinion when one pair of teeth is in mesh and. (2) maximum velocity of sliding.
2. Calculate (1) length of path of contact (2) length of arc of contact (3) contact ratio when a pinion having 23 teeth drives a gear having teeth 57. The profile of gears is involute with pressure angle 20° module 8mm and addendum equal to one module.
3. Two 15mm module 20° pressure angle spur gears have addendum equal to one module. The pinion has 25 teeth and the gear 50 teeth. Determine whether interference will occur (or) not. I If it is occurs , to what value should the pressure angle be changed to eliminate interference.
4. Two mating gears have 20 and 40 involute teeth of module 10mm and 20° pressure angle. The addendum on each wheel is to be made of such a length that the line of contact on each side of the pitch point has half the maximum possible length. Determine the addendum height for each gear wheel, length of path of contact, arc of contact and contact ratio.
5. The pressure angle of two gears is 20° and has a module of 10mm.The number of the teeth on pinion is 24 and gear is 60. The addendum of the pinion and gear is same and equal to one module determine,
   (i) The number of pairs of teeth in conduct.
   (ii) The angle of action of pinion and gear.
   (iii) Ratio of sliding to rolling velocity at the beginning of contact.
6. Two gears wheel mesh externally and one to give a velocity ratio of 3 to 1 .The teeth are of involute form module =6mm ,addendum=1 module, pressure angle =18°.The pinion rotates at 90 rpm . Find,
   (i)Number of teeth on pinion to avoid interference on it and the corresponding number on the wheel.
   (ii) The length of path and arc of contact.
   (iii) The number of pairs of teeth in contact.
   (iv) Sliding velocity during engagement and disengagement.
7. Two spur gears of 24 teeth and 36 teeth of 8mm module and 20° pressure angle are in mesh. Addendum of each gear is 7.5mm .The teeth are of involute form .determine
   (i)The angle through which the pinion turns while any pair of teeth are in contact.
   (ii)The velocity of sliding between the teeth when the contact on the pinion is at a radius of 102mm.the speed of the pinion is 450 rpm.

GEAR TRAINS

8. In an epicyclic gear train shown, the arm C carries two external two external gears A and B having 30 and 40 teeth respectively. Find the speed and direction of gear B when the arm makes 120 rpm clockwise about the centre of gear A which is fixed.
9. In a reverted epicyclic gear train, the arm A carries two gears B and C and a compound gear D-E. The gear B meshes with gear E and the gear C meshes with gear D. The number of teeth on gears B,C and D are 75,30 and 90 respectively. Find the speed and direction of gear C when gear B is fixed and the arm makes 100 rpm clockwise.

10. A compound gear train as shown, wheels A, D and E are free to rotate independently on spindle O, while B and C are compound and rotate together on spindle P, on the end of arm OP. All the teeth on different wheels have the same modules. A has 12 teeth, B has 30 teeth and C has 14 teeth cut externally. Find the number of teeth on wheels D and E which are cut internally. If the wheel A is driven CW at 1 rps while D is driven CCW at 5rps. Determine the magnitude and direction of the angular velocities of arm OP and wheel E.
11. In a gear train as shown, gear B is connected to the input shaft and gear F is connected to the output shaft. The arm A carrying the compound wheels D and E, turns freely on the output shaft. If the input speed is 1000rpm CCW when seen from the right, determine the speed of the output shaft under the following conditions. When gear C is fixed and when gear C is rotated at 10 rpm CCW.

UNIT V

FRICTION IN MACHINE ELEMENTS

PART – A

1. What is the difference between sliding friction and rolling friction? **(AU,Nov./Dec.2011)**
2. Define 'coefficient of friction'?
3. What are the laws of solid dry friction? **(AU,Nov./Dec.2014)**
4. What is the limiting angle of friction? **(AU,Nov./Dec.2011)**
5. List down the laws of friction? (**AU**, **May/June 2013**)
6. Why self-locking screws have less efficiency**? (AU, May/June 2016)**
7. Define self-locking and overhauling with respect to screw jack? **(AU, April/May 2015)**
8. Which type of screw thread is preferable in power transmission? **(AU, April/May 2008)**
9. Define mechanical efficiency of screw and nut assembly. **(AU, May/June 2006)**
10. What is the maximum efficiency of a screw jack? **(AU, (May/June 2014)**
11. Define anti-friction bearing**.(AU, Nov/Dec 2013)**
12. Which of the two assumptions- uniform intensity of pressure or uniform rate of wear, would you make use of in designing friction clutch and why? **(AU, April/May 2015)**
13. Differentiate a multiplate clutch and cone clutch. **(AU, Nov/Dec 2013)**
14. State the functional difference between a clutch and a brake. **(AU, Nov/Dec 2011)**
15. State the law of belting.
16. What is a centrifugal tension in a belt? How does it affect the power transmitted? **(AU, April/May 2015)**
17. What is the relation between the ratio of tensions, angle of lap and coefficient of friction for a belt drive? **(AU, April/May 2015)**
18. What is meant by crowning of pulleys in flat belt drives? Also write its purpose. **(AU, Nov/Dec 2014)**
19. Give the effects of centrifugal tension in belt drives? **(AU, Nov/Dec 2014)**
20. Distinguish between open and cross belt drive in terms of its application.**(AU, May/June 2014)**
21. What are the advantages and disadvantages of V-belt drive over flat belt drive? (**AU, Nov/Dec 2011)**
22. What is creep in the case of belt? **(AU, April/May 2008)**
23. What are the advantages of wire ropes over fabric ropes? **(AU, May/June 2007)**
24. List any four desirable characteristics of brake lining material. **(AU, Nov/Dec 2007)**
25. Explain briefly the significance of friction in braking. **(AU, Nov/Dec 2006)**
26. What is meant by self-locking and self energized brakes? **(AU, Nov/Dec 2012)**

27. Distinguish between brakes and dynamometers. **(AU, April/May 2015)**

PART- B&C

FLAT BELT

1. A Flat belt 8 mm thick 100 mm wide transmits power between two pulleys, running at 1600 m/min. The mass of the belt is 0.9 kg/m length. The angle of lap in the smaller pulley is 165° and the coefficient of friction between the belt and the pulley is 0.3 if the maximum permissible stress in belt is 2 MN/m^2 .Find:[i] Maximum power transmitted and [ii] Initial tension in the belt. **[AU.Apr /May 2015]**
2. The power transmitted between two shafts 3.5 meters apart by a cross belt round the pulleys 600 mm and 300 mm in diameters, is 6 KW. The speed of the larger pulley (driver) is 220 rpm. The permissible load on the belt is 25 N/mm which is 5 mm thick. The coefficient of friction between the smaller pulley surface and the belt is 0.35. Determine [i] Necessary length of the belt [ii] Width of the belt and, [iii] Necessary initial tension in the belt.**[AU,Apr/May 2015]**

V-BELLT

3. A Compressor requiring 90 KW is to run at about 250 rpm the drive is by V-belts from an electric motor running at 750 rpm. The diameters of the pulley on the compressor shaft must not be greater than 1 meter while the centre distance between the pulleys is limited to 1.75 metre. The belt speed should not exceed 1600 m/min. Determine the number of V-belts required to transmit the power if each belt has a cross sectional area of 375 mm^2 , density 1000 kg/m^3 and an allowable tensile stress of 2.5 MPa. The groove angle of the pulley is 35°. The coefficient of friction between the belt and the pulley is 0.25. Calculate also the length required at each belt. **[AU, Nov./Dec2008]**

ROPE

4. Following data is given for a rope pulley transmitting 23.628 KW. Diameter of pulley =40cm; speed=110 rpm; angle of groove=45°; angle of lap=160°; coefficient of friction =0.28; no. of rope=10. Mass in kg/m of ropes= $0.0053 \times C^2$ and working tension is limited to 12.2 C^2 N where C= girth of rope in cm. Find[i] initial tension, and [ii] diameter of each rope. **[AU, May/June 2016]**

SINGLE PLATE CLUTCH

5. A single plate clutch transmits 20 kW at 900 rpm. Maximum pressure intensity between plates is 85 KN/m^2. The outer diameter of the plate is 360 mm. Both the sides of the plate are effective and the coefficient of friction is 0.25. Determine the inner radius of the plate and axial force to engage the clutch. **[AU, Nov./Dec.2014]**

MULTI PLATE CLUTCH

6. A plate clutch has three discs on the driving shaft and two discs on the driven shaft, providing four pairs of contact surfaces. The outside diameter of the contact surfaces is 240 mm and inside diameter 120 mm. Assuming uniform pressure and coefficient of friction as 0.3; find the total spring load pressing the plates together to transmit 25 KW at 1575 rpm if there are 6 springs each of stiffness 13 KN/m and each of the contact surfaces has worn away by 1.25 mm find the maximum power that can be transmitted assuming uniform wear. **[AU Apr /May 2015]**
7. A multi plate disc clutch transmits 55 KW of power at 1800 rpm .Coefficient of friction for the friction surface is 0.1 .Axial intensity of pressure is not to exceed 160 KN/m^2 .The internal radius is 80 mm and 0.7 times the external radius. Find the number of plates needed to transmits the required torque **[AU, Nov/Dec.2013]**

BRAKE

8. A brake drum of diameter 400 mm is rotating in anticlockwise direction at 500 rpm. The fulcrum of the single block brake lies 25 mm above the line of action of the friction force. The angle of contact is 30^o and the distance between the fulcrum and the applied 300 N force is 1000 mm. Assuming a co-efficient of friction of 0.3 determine; (i) The braking torque if normal reaction acts 300 mm from the fulcrum. (ii) The value of 'C' for self-locking of the brake, keeping other things the same.