ST.ANNE'S

COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi. Affiliated to Anna University, Chennai)

(An ISO 9001 **:** 2015 Certified Institution)

ANGUCHETTYPALAYAM, PANRUTI – 607 110.

QUESTION BANK

JULY 2018 - NOV 2018 / ODD SEMESTER

BRANCH: CSE **YR/SEM:** IV/VII **BATCH**: 2015 - 2019

SUB CODE/NAME: CS6702 – GRAPH THEORY AND APPLICATIONS

UNIT I

INTRODUCTION

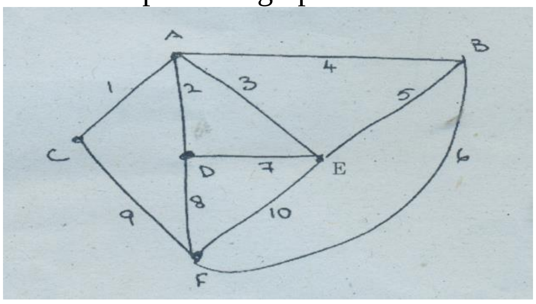
PART-A

1. What is a graph?
2. Define parallel edges?
3. What is a simple graph and a self loop?
4. What are the applications of graph and give some examples?
5. Define regular graph and Null graph?
6. How can you say that the two graphs are isomorphic?
7. Define open walk and closed walk?
8. Define walk, path and circuit in a graph. ND 2016
9. Define connected graph, disconnected graph and components?
10. What is Euler line and Euler graph? AM 2017
11. Define Unicursal line and Unicursal graph?
12. Define Hamiltonian circuit and Hamiltonian path.
13. Define rooted tree.
14. What is meant by Eccentricity of a vertex? ND 2016
15. What is meant by distance and centre in a tree.
16. What do you meant by metric.
17. If a tree has a center or two centers does it have a radius also? Explain
18. List out the applications of graph theory in computer science.
19. Show that an Euler graph is connected except for any isolated vertices the graph may have.
20. Can there be a path longer than a Hamiltonian path (if any) in a simple, connected, undirected graph? Why?

PART-B

1. Define Graph and Explain about applications of graph with example. (16)
2. Explain in detail about (10)
   - i. Finite and Infinite graphs.
   - ii. Incidence and Degree.
   - iii. Isolated vertex, Pendant vertex and Null graph with examples

3. Explain in detail about (10)
   i. Isomorphism
   ii. Edge-disjoint subgraph.
   iii. Walk, path and circuit with examples.
4. Explain in detail about connectedness.(8)
5. Explain Euler graph with suitable examples. (8)
6. Explain in detail about the Hamiltonian paths and circuits.(8)
7. What do you meant by a tree? Explain the various properties of trees.(16)
8. What do you meant by distance and centre in graph and also prove that Every tree has either one or two centers.(10)
9. What do you meant by rooted and binary tree.(8)
10. Define the following terms:
    (i) Walk (ii) Euler path (iii) Hamiltonian path
    (iv) Subgraph (v) Circuit (vi) Complete graph (6)
11. From the given graph draw the following:
    i. Walk of length 6.
    ii. Is this an Euler graph? Give reasons.
    iii. Is there a Hamiltonian path for this graph? Give reasons.
    iv. Find atleast two complete subgraphs (10) ***(AM 2017)***



12. (i) List any five properties of trees. (6)
    (ii) Define eccentricity of a vertex V in a tree T and give an example tree and its eccentricity from the root. (10) ***(AM 2017)***

Theorems

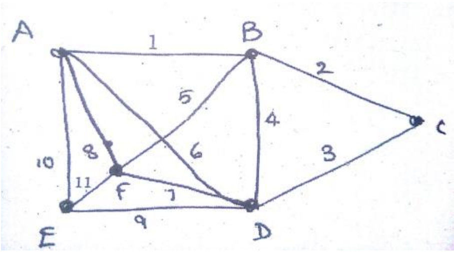
1. Show that a connected graph G is an Euler graph iff all vertices are even degree. (6)
2. Prove that a simple graph with n vertices and k components can have at most (n-k)(n-k+1)/2 edges. (6)
3. Prove that in a complete graph with n vertices there are (n-1)/2 edges-disjoint Hamiltonian circuits, if n is odd number ≥3. (8)
4. In a graph the number of the vertices with odd degree is even.(6)
5. If a graph has exactly two vertices of odd degree, there must be a path joining these two vertices.(4)
6. A connected graph is an Euler graph if and only if it can be decomposed into circuits.(6)
7. Prove that graph G is disconnected if and only if its vertex set V can be partitioned into two nonempty subsets V1 and V2 such that there exists no edge in G whose one end vertex is in V1 and the other in V2.(8)
8. In a connected graph *G* with exactly 2k odd vertices, there exist *k* edge-disjoint subgraphs such that they together contain all edges of *G* and that each is a unicursal graph.(8)
9. Show that the maximum number of edges in a simple graph with *n* vertices is *n*(*n*-1)/2.(5)

10. Prove that, there is one and only one path between every pair of vertices in a tree T. (4)
11. Prove the given statement, A tree with *n* vertices has *n*-1 edges. (8)
12. Prove that, any connected graph with *n* vertices has *n*-1 edges is a tree. (5)
13. Show that a graph is a tree if and only if it is minimally connected.(4)
14. Prove that, a graph G with *n* vertices has *n*-1 edges and no circuits are connected. (6)
15. If in a graph *G* there is one and only one path between every pair of vertices, *G* is a tree.(4)
16. Prove that every tree has either one or two centers.(5)
17. Prove that in any tree, there are atleast two pendant vertices. (5)

UNIT II
TREES, CONNECTIVITY & PLANARITY

PART-A

1. Define Spanning trees.
2. Define Branch and chord.
3. Define complement of tree.
4. Define Rank and Nullity.
5. Define fundamental circuit. How they are created?
6. Define Spanning trees in a weighted graph.
7. Define degree-constrained shortest spanning tree.
8. Define cut sets and give example. Write the Properties of cut set.
9. Define Fundamental circuits and Fundamental cut sets.
10. Define edge Connectivity and vertex Connectivity.
11. Define separable and non-separable graph.
12. Define articulation point.
13. What is Network flow?
14. Define max-flow and min-cut theorem (equation).
15. Define component (or block) of graph.
16. Define 1-Isomorphism. **(*ND 2016)***
17. Define 2-Isomorphism.**(*ND 2016)***
18. Briefly explain Combinational and geometric graphs.
19. Define Planar and non-planar graphs and distinguish between them.
20. Define embedding graph.
21. Define region or face of graph.
22. Why the graph is embedding on sphere?
23. What is elementary tree transformation?
24. What are the applications of planar graph?*NOV/DEC 2016*
25. Define Minimum spanning tree.
26. Define Planar graph. APR/MAY 2017
27. Identify two spanning trees for the following graph. APR/MAY 2017



28. Define maximal tree?
29. What is cyclic interchange?
30. Define central tree and tree graphs?
31. Define weight of a spanning tree
32. Define minimum cut-set and maximum cut-set?
33. Define cut-vertex.
34. What do you meant by the term circuit correspondence.
35. Write the properties of Kuratowski's graph.
36. Define regular graph.
37. What is meant by a plane representation of a graph?
38. Define Self-Dual Graphs.

PART-B

SUBGRAPHS

1. Discuss about the Spanning tree in a weighted graph with example. Write a Kruskal's and prim's algorithm to find the shortest spanning tree with an example.(16) ***(AM 2017)***
2. Explain in detail about spanning trees with examples, Rank and Nullity, Chord Set or Cotree. (10)

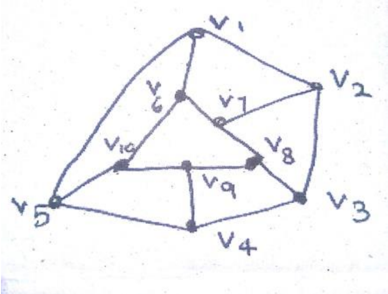
CUTSETS

3. Explain in detail about cut-sets with examples. Explain properties of cut-set.(10)
4. Explain 1 - isomorphism and 2 - isomorphism of graphs with example. (12)
5. Explain about Fundamental cut set and Fundamental circuit in a graph.(6) ***(ND 2016)***.
6. Explain network flow problem in detail. (10)
7. Explain max-flow-min-cut theorem.(10) ***(ND 2016)***

CONNECTIVITY AND SEPERABILITY

8. Explain the terms edge connectivity, Vertex connectivity and separable graph.(8)
9. Explain in detail about Planar graphs and Kuratowskis two graphs .(10)
10. Explain in detail about detection of planarity?(8)
11. Explain in detail about geometric dual and combinatorial dual.(8)
12. A farm has six walled plots full of water. The graph representation of it is given below. Use the concepts of spanning tree, cut sets appropriately to determine the following: (10) ***(AM 2017)***

a. How many walls will have to be broken so that all the water can be drained out?
b. If only one plot was full of water and this had to be drained into all other plots, then how many walls need to be broken?



13. State the Eulers formula relating the number of vertices ,edges and faces of a planar connected graph. Give two conditions for testing for planarity of a given graph. Give a sample graph that is planar and another that is non-planar. (16) ***(AM 2017)***
14. Write all possible spanning trees for K5. (6)
15. Prove the graphs K5 and K3,3 are not planar.(10) ***(ND 2016)***

Theorems

SUBGRAPHS

1. Show that every connected graph has at least one spanning tree.(5)
2. Prove that if any of its spanning trees, a connected graph of n vertices and e edges has $n — 1$ tree branches and $e — n + 1$ chords.(6)
3. Prove that a connected graph G is a tree if and only if adding an edge between any two vertices in G creates exactly one circuit.(6)
4. Prove that a spanning tree T(of a given weighted connected graph *G)* is a shortest spanning tree (of *G)* if and only if there exists no other spanning tree (of *G)* at a distance of one from T whose weight is smaller than that of T .

CUTSETS

5. Show that the ring sum of any two cut-sets in a graph is either a third cut set or en edge disjoint union of cut sets. (8)

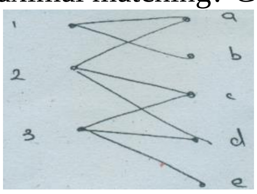
CONNECTIVITY AND SEPERABILITY

6. The vertex connectivity of any graph G can never exceed the edge connectivity of G.(4)
7. The edge connectivity of a graph G cannot exceed the degree of the vertex with the smallest degree in G. Prove it.(4)
8. Prove that the maximum flow possible between two vertices a and b in a network is equal to the minimum of the capacities of all cut-sets with respect to a and b.(8)
9. If G1 and G2 are two 1-isomorphic graphs, the rank of G1equals the rank of G2 and the nullity of G1 equals the nullity of G2. Prove it.(6)
10. Prove that any 2 graphs are 2-isomorphic if and only if they have circuit correspondence.(6)

UNIT III
MATRICES, COLOURING AND DIRECTED GRAPH

PART-A

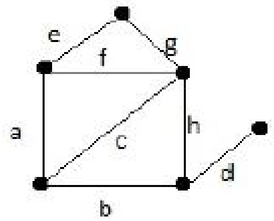
1. What is proper coloring?
2. List some applications of graph coloring.
3. Define chromatic number.
4. Write the properties of chromatic numbers (observations).
5. Define Chromatic partitioning.
6. What is chromatic polynomial?
7. What is bipartite graph and p-partite?
8. Define Dominating Sets?
9. What is k-chromatic graph?
10. What is largest maximal matchings and matching number?
11. What is covering and give some examples?
12. Define Vertex Coloring versus Region Coloring.
13. Define independent set.
14. Define uniquely colorable graph.
15. Define Matching (Assignment).
16. Define minimal cover.
17. What is dimer covering?
18. Define four color problem / conjecture.
19. State five color theorem.
20. Define minimal dominating set and maximal independent set. (***ND 2016)***
21. Find the Chromatic number of a complete graph of n vertices. (***ND 2016)***
22. The following graph have a maximal matching? Give reason. (***AM 2017)***
23. Define the terms directed walks and directed paths.
24. What are the different types of digraphs?
25. What is meant by simple symmetric and simple asymmetric digraph.
26. What is meant by regularization of a planar graph?
27. Define Directed graphs and directed path.
28. List out some types of directed graphs.
29. Define Simple Symmetric Digraphs and Asymmetric Digraphs.
30. Give example for Complete Digraphs.
31. Define Complete Symmetric Digraphs and Complete Asymmetric Digraphs (tournament).
32. Define Euler graphs.
33. Does the following graph have a maximal matching? Give reason.



PART-B

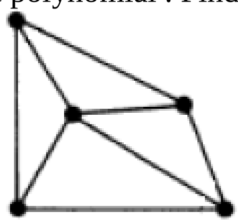
MATRICES

1. Describe the steps to find adjacency matrix and incidence matrix for a directed graph with suitable example.(16) (***AM 2017)***
2. Generate the circuit matrix for the following graph.(5)



COLOURING

3. Explain in detail about chromatic polynomial with examples and its applications.(16) ***(AM 2017)***
4. Define chromatic polynomial . Find the chromatic polynomial for the following graph. (8)



5. Illustrate four-color problem. (10)
6. Explain in detail about chromatic partitioning with example and write an algorithm for finding maximal independent sets, all maximal independent sets, independence and chromatic numbers, minimal dominating sets. (or) Briefly explain about the chromatic partitioning with suitable examples.
7. Discuss about coloring of graph with example, bipartite, P-partite, k-chromatic graph.
8. Explain in detail about matching, maximal matching, complete matching, deficiency with suitable examples.
9. Discuss about coverings and its applications.

DIRECTED GRAPH

10. Explain Euler digraphs in detail.(10) (***ND 2017)***
11. What is a directed graph? Discuss about some types of digraph with suitable example.(6) (***ND 2017)***
12. Explain in detail about digraphs and binary relations and explain the different types of relations. (10)
13. Explain in detail about Directed paths and connectedness.(10)

Theorems

1. Prove that every tree with two or more vertices is 2-chromatic.(6) (***ND 2016)***
2. Prove that a graph with at least one edge is 2-chromatic if and only if it has no circuits of odd length.(6)
3. Prove that a graph of n vertices is a complete graph iff its chromatic polynomial is $P_n(\lambda) = \lambda (\lambda - 1) (\lambda - 2) \dots (\lambda - n + 1)$. (6) (***ND 2017)***
4. Show that the chromate polynomial of a tree an n vertices is given by $p_n(\lambda) = \lambda(\lambda-1)^{n-1}$
5. Prove that Let *a* and *b* be two non-adjacent vertices in a graph *G*. Let *G'* be a graph

obtained by adding an edge between a and b. Let G'' be a simple graph obtained from G by fusing the vertices a and b together and replacing sets of parallel edges with single edges. Then

$$P_n(\lambda) \text{ of } G = P_n(\lambda) \text{ of } G' + P_{n-1}(\lambda) \text{ of } G''. \quad (10)$$

6. Prove that a complete matching of v_1 into V_2 in a bipartite graph exists if and only if every subset of r vertices in v_1 is collectively adjacent to r or more vertices in V_2 for all values of *r.(8)*
7. Prove that the vertices of every planar graph can be properly colored with five colors. (10)
8. Prove that a covering g of a graph is minimal iff g contains no path of length three or more.(5) ***ND 2017***

UNIT IV
PERMUTATIONS & COMBINATIONS

PART – A

PERMUTATION

1. Define Fundamental principles of counting. OR Point out two basic principles of counting.
2. Define rule of sum and rule of product. Give one example for each.
3. Define permutation. Give an example.
4. Write down the general formula for permutation of r in n object. OR Write the formula for nPr.
5. Find the number of permutations in the word *COMPUTER* if only five of the letters are used.
6. In how many different ways can the letters of the word 'LEADING' can be arranged in such a way that the vowels always come together? ***ND 2016***
7. Develop all the permutations for the letters *a,c,t* .
8. Show how many permutations are there for the eight letters *a, c, f, g, i, t, w, x*?
9. How many different strings are there of length seven.
10. How many permutation are there in word MISSISSIPPI?
11. Find value of 'n' if $np_3 = 5\, np_2$.
12. What is the number of arrangements of all the six letters in the word PEPPER?

COMBINATION

1. Write the formula for nC_r.
2. Define Combinations.
3. State binomial theorem.
4. Evaluate C(10, 4).
5. Define the term combination with repetition.
6. Express Binomial coefficient.
7. Find the Binomial coefficient of x^5y^2 .
8. How many ways are there to assign five different jobs to four different employees if every employee is assigned atleast one job?

9. How many ways 20 coins can be selected from four level container filled with pennies, nickels, dimes, and quarters
10. A student taking a history examination is directed to answer any seven of 10 essay questions. There is no concern about order here. Explain how many ways the student can answer the examination.
11. A donut shop offers 4 kinds of donuts. (Assume 2 of each kind). How many ways we can select 2 donuts.
12. If eight distinct dice are rolled, What is the probability that all six numbers appear? Explain.
13. In how many ways can you invite at least one of your six friends to a dinner?
14. From 5 consonants and 4 vowels how many words can be created using 3 consonants and 2 vowels?
15. A committee including 3 boys and 4 girls is to be formed from a group of 10 boys and 12 girls. How many different committees can be formed from the group? ***ND 2016***

INCLUSION AND EXCLUSION

1. Define principle of inclusion and exclusion and write the formula.
2. How many positive integers not exceeding 100 that is divisible by 5
3. How many integer between 1 to 100 that divisible by 3 but not by 7.
4. Write the formula for │AUBUCUD│
5. Find the number of de-arrangements of 1,2,3,4.
6. Show how many permutations of *1,2,3,4,5,6,7* is not dearrangement?

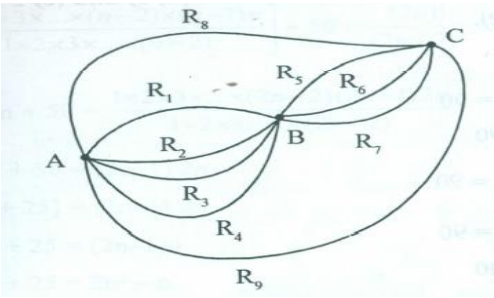
PART-B

PERMUTATION

1. In a class of 10 students, five are to be chosen and seated in a row for a picture. How many such linear arrangements are possible? (4)
2. How many permutations of size 3 can one produce with the letters m,r,a,f and t?(4) (***ND 2016)***
3. Find the number of distinict permutations that can be formed from all the letters of each Words (1) RADAR (2) UNUSUAL. (6)
4. (a) If six people, designated as A, B, . . . , F, are seated about a round table, how many different circular arrangements are possible, if arrangements are considered the same when one can be obtained from the other by rotation? In Fig. 1.2, arrangements (a) and (b) are considered identical, whereas (b), *(c),* and (d) are three distinct arrangements.] (5)

   (b) Suppose now consider that from the six people of the above problem are three married couples and that A, B, and C are the females. We want to arrange the six people around the table so that the sexes alternate. (Once again, arrangements are considered identical if one can be obtained from the other by rotation.) (10)
5. The number of (linear) arrangements of the four letters in BALL is 12, not 4! (= 24). Explain the reason? (3)
6. Determine the number of (staircase) paths in the xy-plane from (2, 1) to (7, 4), where each such path is made up of individual steps going one unit to the right (R) or one unit upward (U) .The dark line in the figure shows two of these path. (5)
7. How many arrangements of the letters in MISSISSIPPI has no consecutive S's? (4) (***ND 2016)***

8. There are three small towns, designated by A, B, C are interconnected by a system of two road ways, as shown in the figure. (6)
   (a) In how many ways can Linda travel from town A to town C?
   (b) How many different round trips can Linda travel from town A to town C and then back to town A.



COMBINATION

9. At Rydell High School, the gym teacher must select nine girls from the junior and senior classes for a volleyball team. If there are 28 juniors and 25 seniors a) in what ways she can make the selection b) If two juniors and one senior are the best spikers and must be on the team, then in what ways the rest of the team can be chosen c) For a certain tournament the team must comprise four juniors and five seniors. (6)
10. The gym teacher of a school must make up four volleyball teams of nine girls each from the 36 freshman girls in her P.E. class. In how many ways can she select these four teams? Call the teams A, B, C, and D. (5)
11. The number of arrangements of the letters in TALLAHASSEE is $\frac{11!}{3!2!2!2!1!1!}$ = 831,600. How many ways of these arrangements have no adjacent A's?(4)
12. Expand $(1-x)^{10}$ using binomial theorem.(4)
13. Find the number of ways to select 4 sodas from 3 brands say Pepsi, Coke and Miranda.(3)
14. A gym coach must select 11 seniors to play on a football team. If he can make his selection in 12,376 ways, how many seniors are eligible to play?(4) ***ND 2016***
15. Rama has two dozen each of n different colored beads. If she can select 20 beads (with repetitions of colors allowed) in 220,230 ways,what is the value of n? (4) ***ND 2016***

16. Find the values of n in each of the following (each 4 marks)
    (a) $P(n,2)= 90$ (b) $P(n,3)=3P(n,2)$ (c) $2P(n,2)+50=P(2n,2)$
17. Determine the co-efficient of (each 3 marks)
    (a) xyz^2 in $(x + y + z)^4$ (b) xyz^2 in $(w + x + y + z)^4$
    (c) xyz^2 in $(2x - y - z)^4$ (d) xyZ^{-2} in $(x - 2y + 3z^{-1})^4$
    (e) $w^3x^2yz^2$ in $(2w-x+3y-2z)^8$

INCLUSION AND EXCLUSION

17. How many positive integer not exceeding 1000 are divisible by 7 or 11.(5)
18. While at the racetrack, Ralph bets on each of the ten horses in a race to come in according to how they are favored. In how many ways can they reach the finish line so that he loses all of his bets? (5)
19. Let A = {*1,2,3,4*} and B={*u,v,w,x,y,z*}. How many one to-one function f:A->B satisfy none of the following conditions. (10)

    C1: f(1)= *u* or *v*,

    C2: f(2)=*w*,

C3:f(3)=*w* or *x*,

C4:f(4)=*x*,*y* or *z*

20. In making seating arrangements for their son's wedding reception, Grace and Nick are down to four relatives, denoted for $1 \leq i \leq 4$, who do not get along with one another. There is a single open seat at each of the five tables T1, where $1 \leq j \leq 5$. Because of family differences

a) R1 will not sit at T1 or T2. b) R2 will not sit at T2.

c) R3 will not sit at T3 or T4. d) R4 will not sit at T4 or T5,

In how many ways Grace and Nick can seat their four relatives ? (10)

UNIT V
GENERATING FUNCTIONS
PART A

1. Define recurrence relation. ***(ND 2016)***
2. Define generating function. ***(ND2016)***
3. Define Exponential generating function.
3. What is Partitions of integer?
4. Define Maclaurin series expansion of e^x and e^{-x}.
5. Define Summation operator
6. Define First order linear recurrence relation
7. Define Second order recurrence relation
8. Briefly explain Non-homogeneous recurrence relation.
9. Find the generating function for the sequence 3,-3,3,-3,…
10. If the sequence $a_n = 3.2^n$,$n \geq 1$, then find the corresponding recurrence relation.
10. Find the recurrence relation for $s(n) = 6(-5)^n$.
11. Find the generating function for the sequence S with terms 1,2,3,4,…
12. What is the generating function for the sequence 1,1,1,1,1?
13. Find the recurrence relation for the Fibonacci sequence.
14. Determine the generating function for the number of ways to distribute 35 pennies (from an unlimited supply) among five children if
    (a) there are no restrictions;
    (b) each child gets at least 10;
    (c) each child gets at least 20;
    (d) the oldest child gets at least 100; and
    (e) the two youngest children must each get at least 100
15. In how many ways can 3000 identical envelopes be divided, in packages of 25, among four student groups so that each group gets at least 150, but not more than 1000, of the envelopes?
16. If a fair die is rolled 12 times, what is the probability that the sum of the rolls is 30?
17. Show that $(1 - 4x)^{-1/2}$ generates the sequence $\binom{2n}{n}$, $n \in$ N.
18. What is the generating function for the sequence 1, 1, 0, 1, 1, 1, . and 1, 1, 1, 3, 1, 1, . .
19. Find the generating function for the sequence 0,2,6,12,20,30,42
20. Verify that for all $n \in Z^+$

$$\binom{2n}{n} = \sum_{i=0}^{n} \binom{n}{i}^2$$

21. Find the coefficient of x^5 in $(1 - 2x)^{-7}$
22. Solve the recurrence relation $a_n = 7a_{n-1}$ where $n \geq 1$ and $a_2=98$.
23. A company hires 11 new employees, each of whom is to be assigned to one of four subdi visions. Each subdivision will get at least one new employee. In how many ways can these assignments be made?
24. Give explanation for the following: Generating function for the no. of ways to have n cents in pennies and nickels $=(1+x+x^2+...)(1+x^5+x^{10}+...)$
25. Solve the recurrence relation $a_{n+1} - a_n = 3n^2 - n$, $n>=0$, $a_0=3$

PART B

1. While shopping one Saturday, Mildred buys 12 oranges for her children, Grace, Mary, and Frank. In how many ways can she distribute the oranges so that Grace gets at least four,and Mary and Frank get at least two, but Frank gets no more than five?
2. If there is an unlimited number (or at least 24 of each color) of red, green, white, and black jelly beans, in how many ways can Douglas select 24 of these candies so that he has an even number of white beans and at least six black ones?
3. Find the generating function for the sequence $\binom{-n}{0}, \binom{-n}{1}, \binom{-n}{2}, \binom{-n}{3}$..
4. There is one such partition of the integer 1 —namely, 1— but there are *no* such partitions of the integer 2. For the integer 3 we have two of these partitions: 3 and 1 + 1 + 1. When we examine the possibilities for the integer 4, we find the one partition 3 + 1.
5. A ship carries 48 flags, 12 each of the colors red, white, blue, and black. Twelve of these flags are placed on a vertical pole in order to communicate a signal to other ships.

a) How many of these signals use an even number of blue flags and an odd number of black flags?

b) How many of the signals have at least three white flags or no white flags at all? In this situation we use the exponential generating function.

6. Solve the recurrence relation $a_n + a_{n-1} - 6a_{n-2} = 0$, where $n \geq 2$ and $a_o = -1, a_1 = 8$.
7. Solve the recurrence relation of the fibonacci sequence of number

   $f_n = f_{n-1} + f_{n-2}, \quad n > 2$ with initial condition , $f_1 = 1,$ *and* $f_2 = 1.$

8. In many programming languages one may consider those legal arithmetic expressions, without parentheses, that are made up of the digits 0, 1, 2, , , 9 and the binary operation symbols +, *, /. For example, 3 + 4 and 2 + 3 * 5 are legal arithmetic expressions; 8 + *9 is not. Here 2 + 3 * 5 = 17, since there is a hierarchy of operations: Multiplication and division are performed before addition. Operations at the same level are performed in their order of appearance as the expression is scanned from left to right. Determine the recurrence relation for a_n.
9. Suppose we have a 2 x n chessboard, for n E Z^+. The case for n = 4 is shown in part (a) of Fig.10.5. We wish to cover such a chessboard using 2 x 1 (vertical) dominoes, which can also be used as 1 x 2 (horizontal) dominoes. Such dominoes (or tiles) are shown in part (b) of Fig.10.5. Find the recurrence relation .
10. Solve the recurrence relation $a_{n+2}-5a_{n+1}+6a_n$ using the generating functions.
11. Solve the relation $a_n-3a_{n-1} = n$, $n \geq 1$, $a_0=1$.

12. (i) Discuss about exponential generating function with an example.(10) (**ND 2016)**
    (ii) Find the unique solution of the recurrence relation.$6a_n - 7a_{n-1} = 0$, $n \geq 1$, $a_3 = 343$.(6)
    (ND 2016)
13. (i) The population of Mumbai city is 6,000,000 at the end of the year 2015. The number of immigrants is 20000n at the end of year n. the population of the city increases at the rate of 5% per year. Use a recurrence relation to determine the population of the city at the end of 2025. (8) **(ND 2016)**
    (ii) Write short note on Summation operator. (8) **(ND 2016)**
14. If a_n is count of number of ways a sequence of 1s and 2s will sum to n, for n>=0.Eg a_3= 3. (i) 1, 1, 1; (ii) 1, 2, and (iii) 2, 1 sum up to 3. Find and solve a sequence relation for a_n.
    (16)
15. What are Ferrers diagrams? Describe how they are used to (i) represent integer partition (ii) Conjugate diagram or dual partitions (iii) self-conjugates (iv) representing bisections of two partition.(16)
16. Solve the recurrence relation $a_{n+2} - 4a_{n+1} + 3a_n = -200$ with $a_0 = 3000$ and $a_1 = 3300$.
17. Solve the Fibonacci relation $F_n = F_{n-1} + F_{n-2.}$
18. Find the recurrence relation from the sequence 0, 2, 6, 12, 20, 30, 42, … .