INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

COMPUTER SCIENCE AND ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**ESSENTIALS OF PROBLEM SOLVING**				
Course Code	ACSD05				
Program	B.Tech				
Semester	Two				
Course Type	Core				
Regulation	**BT 23**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	0	3	-	-
Chief Coordinator	Dr. B Padmaja, Associate Professor, CSE (AI & ML)				

COURSE OBJECTIVES:

The students will try to learn:	
I	The fundamental concepts of graph theory and its properties.
II	The basics related to paths and cycles using Eulerian and Hamiltonian cycles.
III	The applications of graph colouring and traversal algorithms for solving real-time problems.
IV	The numerical methods to solve algebraic equations.

COURSE OUTCOMES (COs):

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

Course Outcomes		Knowledge Level (Bloom's Taxonomy)
CO 1	**Outline** the graph terminologies, graph representation techniques, and relate them to practical examples.	Understand
CO 2	**Build** efficient algorithms for various optimization problems on graphs.	Apply
CO 3	**Use** effective techniques from graph theory to solve problems in networking and telecommunication.	Apply
CO 4	**Interpret** the fundamental concepts of polynomials, roots of equations and solve corresponding problems using computer programs.	Understand
CO 5	**Apply** the knowledge of numerical methods to solve algebraic and transcendental equations arising in real-life situations.	Apply
CO 6	**Solve** numerical integrals and ordinary differential equations to simulate discrete time algorithms.	Apply

MAPPING OF TOPIC LEARNING OUTCOMES (TLO) TO COURSE OUTCOMES

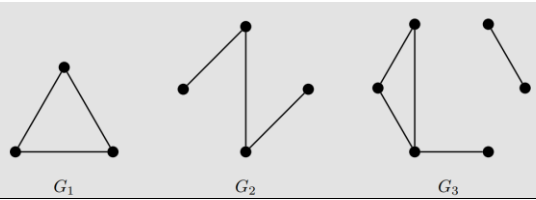
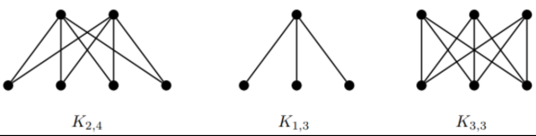
TLO No	Topic(s)	Topic Learning Outcome	Course Outcome	Blooms Level
1	Introduction to graph terminology	**Understand**the graph terminologies to solve real-time problems.	CO 1	Understand
2	Diagraphs, weighted graphs, complete graphs	**Understand**the basics of graph theory and their various propertiesin various cutting-edge applications of such as traffic networks, navigable networks and optimal routing.	CO 1	Understand
3	Graph complements	**Apply**graph complements and graph combinations to solve real world applications like routing, TSP/traffic control.	CO 1	Apply
4	Bipartite graphs			
5	Graph combinations			
6	Isomorphisms			
7	Matrix representations of graphs	**Show**the matrix representations of graphsto know whether pairs of vertices are adjacent or not in the graph.	CO 1	Understand
8	Degree sequence			
9	Eulerian circuits – Konigsberg bridge problem	**Solve**the Konigsberg bridge problem using Eulerian circuitsto solve problems for shortening any path.	CO 2	Apply
10	Touring a graph			
11	Eulerian graphs			
12	Hamiltonian cycles	**Apply**Hamiltonian cycles to solve the traveling salesman problem.	CO 2	Apply
13	The traveling salesman problem			
14	Shortest paths – Dijkstra's algorithm	**Use**Dijkstra's algorithmto calculate shortest path from source to destination node.	CO 2	Apply
15	Walks using matrices			
16	Four color theorem	**Relate**the concept of vertex coloring to assign colors to the vertices of a graph using four color theorem.	CO 3	Understand
17	Vertex coloring			
18	Edge coloring	**Understand** proper edge coloring of a graph to apply in scheduling problems.	CO 3	Understand
19	Coloring variations			
20	First-fit coloring algorithm			
21	Depth-first search	**Apply**breadth first or depth first search techniquein finding shortest paths and all possible paths.	CO 3	Apply
22	Bread-first search			
23	Minimum spanning trees: Kruskal's algorithms	**Use**minimum spanning tree conceptin network design and optimization.	CO 3	Apply

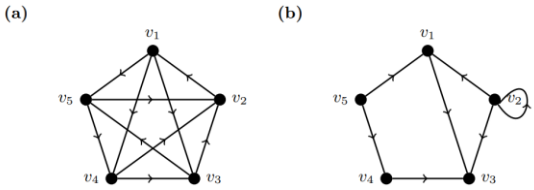
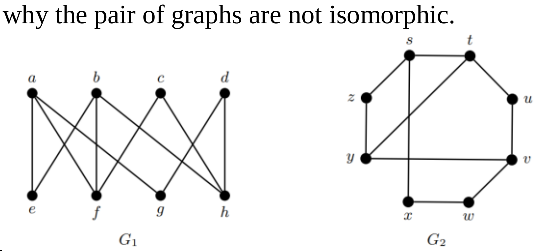
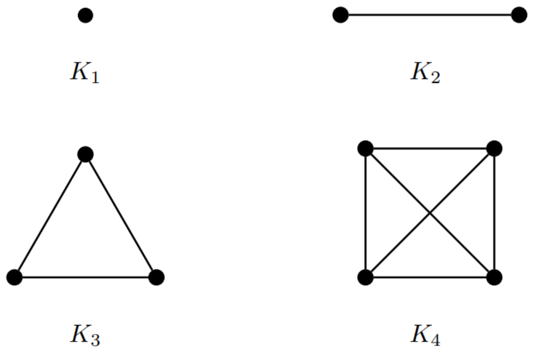
24	Prim’s algorithm			
25	Union-find structure			
26	Algebraic equations	**Solve** algebraic and transcendental equationsto solve single variable function over the interval.	CO 5	Apply
27	Bisection method			
28	Method of false position			
29	Iteration method			
30	Newton-Raphson method	**Solve**polynomials, logarithmic and exponential functions to solve real-time applications.	CO 4	Apply
31	Ramanujan’s method			
32	Secant method			
33	Muller’s method			
34	Numerical integration	**Solve**problems using numerical integration to compute numerical approximations to the integral of the function.	CO 6	Apply
35	Trapezoidal rule			
36	Simpson’s 1/3 rule			
37	Simpson’s 3/8 rule			
38	Solution by Taylor’s series			
39	Euler’s method	**Use**Euler’s methodfor approximating solutions to differential equations and curve with line segments.	CO 6	Apply
40	Runge-Kutta’s method	**Apply**Runge-Kutta method for solving initial-value problems of differential equations.	CO 6	Apply

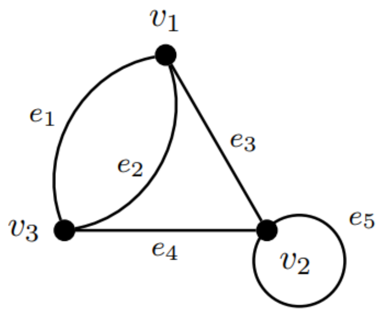
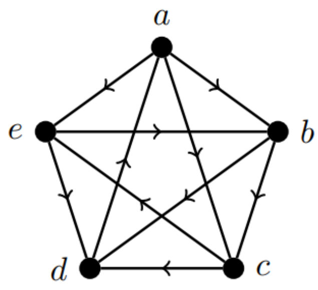
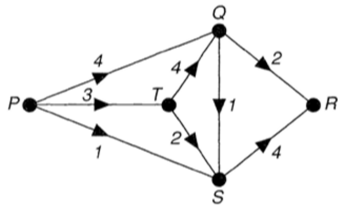
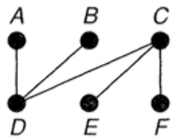
MAPPING OF EACH CO WITH PO(s), PSO(s):

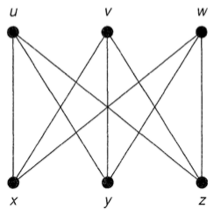
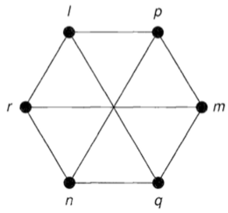
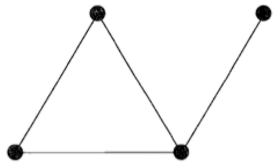
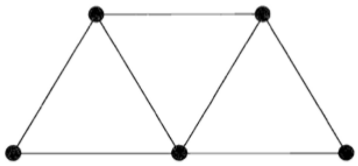
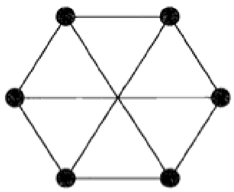
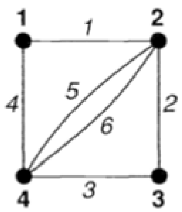
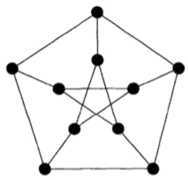
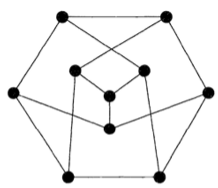
Course Outcomes	Program Outcomes												PSO’s		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	✓	-	-	-	✓	-	-	-	-	-	-	-	✓	-	-
CO2	✓	✓	✓	-	✓	-	-	-	-	-	-	-	✓	-	✓
CO3	✓	-	✓	-	✓	-	-	-	-	-	-	-	✓	-	✓
CO4	✓	-	✓	-	✓	-	-	-	-	-	-	✓	✓	-	✓
CO5	✓	✓	✓	-	✓	-	-	-	-	-	-	-	✓	-	-
CO6	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	✓	-	✓

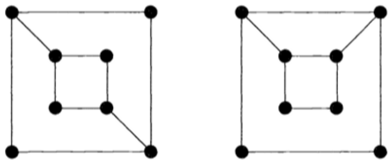
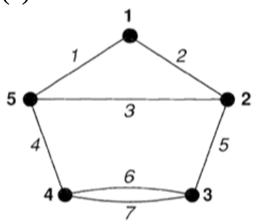
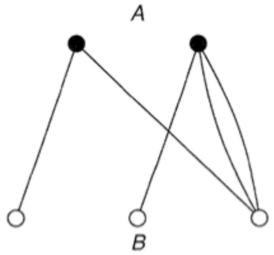
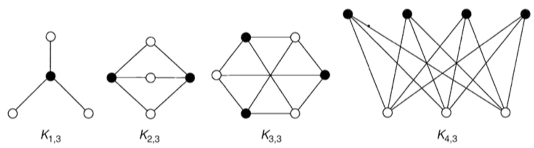
TUTORIAL QUESTION BANK:

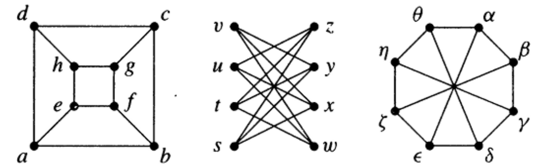
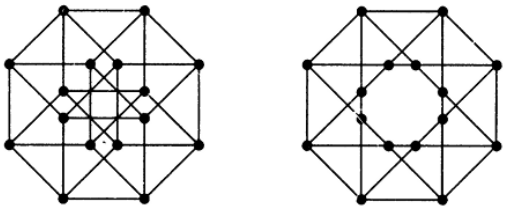
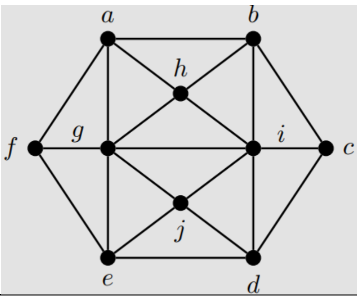
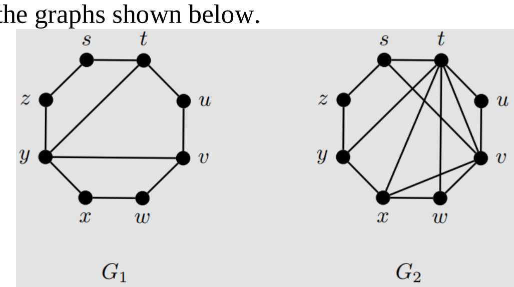
MODULE – I				
GRAPH THEORY				
PART - A (SHORT ANSWER QUESTIONS)				
S No	**QUESTIONS**	**Blooms Taxonomy Level**	**How does this Subsume the level below**	**Course Outcomes**
1	Define a graph?	Remember		
2	Define the conditions for two graphs G1 and G2 to be isomorphic with example?	Remember		
3	Define the following (a) Weighted Graph (b) Complete Graphs	Remember		
4	Draw the graph whose adjacency matrix is shown below? 0 1 0 0 1 1 1 0 1 1 0 0 0 1 1 0 0 0 0 1 0 0 3 0 1 0 0 3 0 1 1 0 0 0 1 0	Understand		
5	Find the complements of each graph shown below. 	Understand		
6	What distinguishes a weighted graph from an unweighted one?	Remember		
7	Define a bipartite graph and check the following graphs are complete bipartite graph or not. 	Understand		
8	Let G be a graph with vertex set V (G) = {a, b, c, d, e, f} and edge set E(G) = {ab, ae, bc, cc, de, ed}. (a) Draw G. (b) Is G simple? (c) List the degrees of every vertex. (d) Find all edges incident to b. (e) List all the neighbors of a. (f) Give the adjacency matrix for G.	Understand		
9	Let G be a graph with vertex set V (G) = {a, b, c, d} and edge set E(G) = {ab, ad}. (a) Draw G. (b) Is G simple? (c) List the degrees of every vertex. (d) Give the adjacency matrix for G.	Understand		
10	Let G be a graph with vertex set V (G) = {a, b, c, d, e, f} and edge set E(G) = {ad, ae, bd, bf, cd, ce, cf}. (a) Draw G.	Understand		

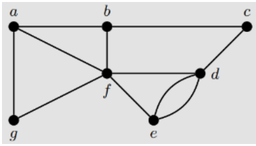
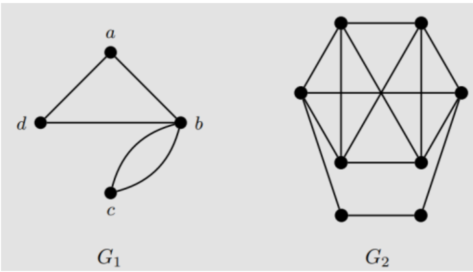
	(b) Is G simple? (c) Is G bipartite? (d) List the degrees of every vertex. (e) Give the adjacency matrix for G.			
11	Draw the graph for each of the adjacency matrices given below. (a) 0 2 0 1 2 0 1 0 0 1 1 1 1 0 1 0 (b) 0 1 2 1 1 2 1 0 2 1 0 0 1 0 0 0	Understand		
12	Draw the digraph for each of the adjacency matrices given below. (a) 0 1 1 1 0 0 0 0 0 0 1 0 0 0 1 0 (b) 0 1 0 0 0 0 1 0 0 0 0 1 1 0 0 0	Understand		
13	Find the adjacency matrix for each of the digraphs or tournaments givenbelow.  	Understand		
14	For each of the problems below, determine if the given pair of graphs are isomorphic. For those that are isomorphic, explicitly give the vertex correspondenceand check that edge relationships are maintained. Otherwise, provide reasoningfor why the pair of graphs are not isomorphic.  	Apply		
15	List the properties of complete graphs and identify the complete graphs from the following:  	Understand		

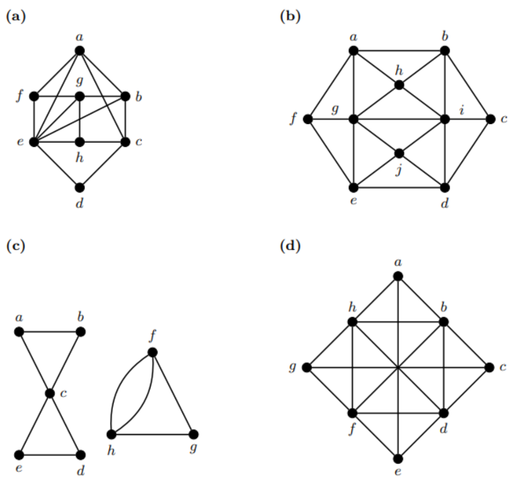
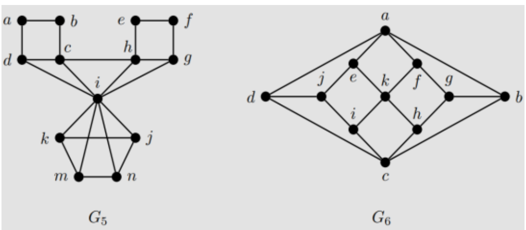
16	Define a degree sequence of a graph?	Remember		
17	Define the conditions for union of two graphs G and H?	Remember		
18	Why matrix representations of graphs are useful for computer programs. Also write the adjacency matrix for the following graph. 	Understand		
19	Define incidence matrix with an example?	Remember		
20	Write the adjacency matrix for the following digraph 	Understand		
PART - B (LONG ANSWER QUESTIONS)				
1	Write down the number of vertices, the number of edges, and the degree of each vertex, in: (i) the graph in Fig. (a) (ii)the tree in Fig. (b)  (a)  (b)	Understand		
2	Draw a digraph for the following: (a) Snakes eat frogs and birds eat spiders; birds and spiders both eat insects; frogs eat snails, spiders and insects. Draw a digraph representing this predatory behaviour. (b) John likes Joan, Jean and Jane; Joe likes Jane and Joan; Jean and Joan like each other. Draw a digraph illustrating these relationships between John, Joan, Jean, Jane and Joe.	Apply		

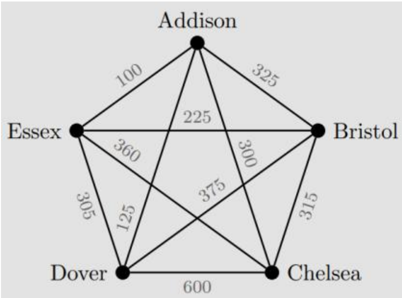
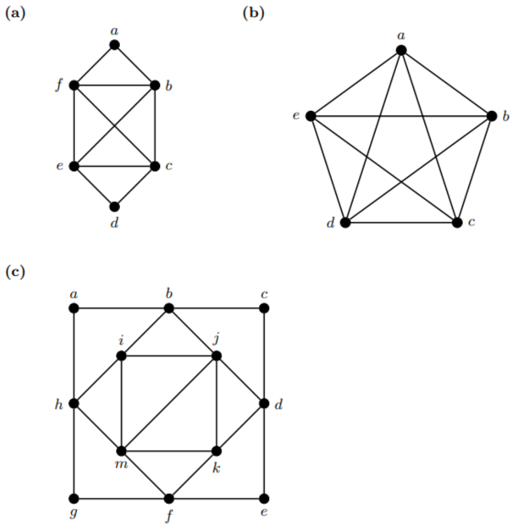
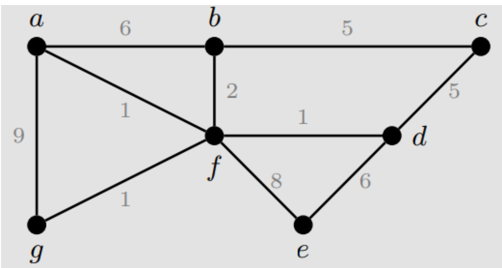
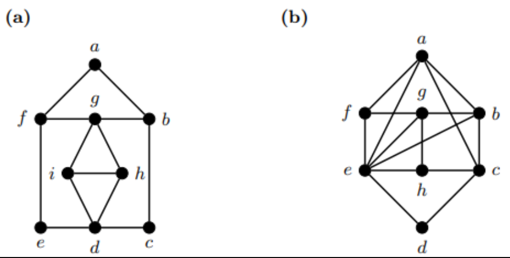
3	Define isomorphism of graphs? State the two labelled graphs are isomorphic or not with reasons. 	Understand		
4	Define a subgraph in a graph? Verify the graph in (a) is a subgraph of the graph in (b), but is not a subgraph of the graph in (c).  (a)  (b)  (c)	Apply		
5	Explain the following: (a) Adjacency matrix (b) Incidence matrix Write the adjacency and incidence matrix for the following graph given below: 	Understand		
6	Explain and draw the following graphs (i) a simple graph, (ii) a non-simple graph with no loops, (iii)a non-simple graph with no multiple edges, each with five vertices and eight edges.	Understand		
7	Show that the two graphs in Fig. (a) are isomorphic by suitably labelling the vertices, and also explain why the two graphs in Fig. (b)are not isomorphic.  (a)	Understand		

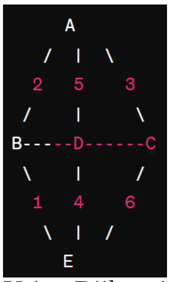
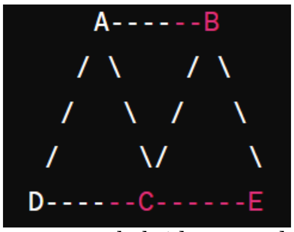
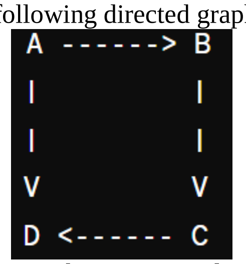
	 (b)			
8	Draw a graph on six vertices with degree sequence (3, 3, 5, 5, 5, 5); and verify does there exist a simple graph with these degrees?	Understand		
9	(i) Write down the adjacency and incidence matrices of the graph in Fig. (a) (ii) Draw the graph whose adjacency matrix is given in Fig. (b) (iii) Draw the graph whose incidence matrix is given in Fig. (c)  (a) $\begin{pmatrix} 0 & 1 & 1 & 2 & 0 \\ 1 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 1 & 1 \\ 2 & 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 \end{pmatrix}$ (b) $\begin{pmatrix} 0 & 0 & 1 & 1 & 1 & 1 & 1 & 0 \\ 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 0 & 0 & 1 & 0 & 0 \end{pmatrix}$ (c)	Understand		
10	Define bipartite graphs and complete bipartite graphs. Justify the graph in fig. (a) is a bipartite graph or not and also the graphs in fig. (b) are complete bipartite graphs or not.  (a)  (b)	Understand		
PART - C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)				
1	Determine which pairs of graphs below are isomorphic?	Apply		

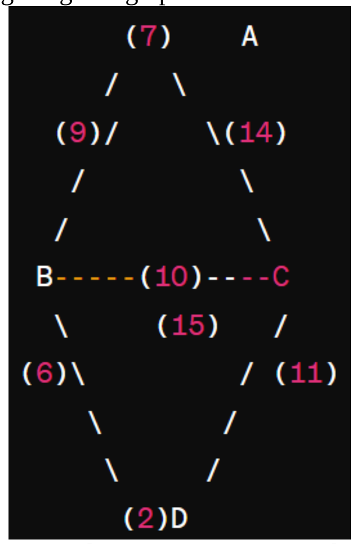
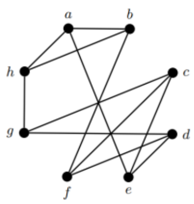
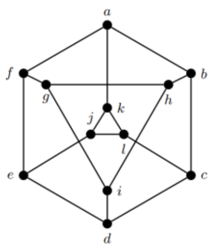
				
2	Determine whether the graphs below are bipartite and whether they are isomorphic. 	Apply		
3	Draw the following graphs: (i) the null graph N_5 (ii) the complete graph K_6 (iii) the complete bipartite graph $K_{7,4}$ (iv) the union of $K_{l,3}$ and W_4	Apply		
4	Define a directed graph or digraph? Let G5 be a digraph where V (G5) = {a, b, c, d} andA(G5) = {ab, ba, cc, dc, db, da}. Draw the digraph for G5?	Apply		
5	Consider the graph G below. Find two subgraphs of G,both of which have vertex set V` = {a, b, c, f, g, i}. 	Apply		
6	Find the clique-size of a graph, ω(G)for each of the graphs shown below. 	Apply		
MODULE – II				
GRAPH ROUTES				
PART – A (SHORT ANSWER QUESTIONS)				
1	Let G be a graph. Define the following terms: (a) Walk (b) Trail (c) Path (d) Closed Walk	Remember		

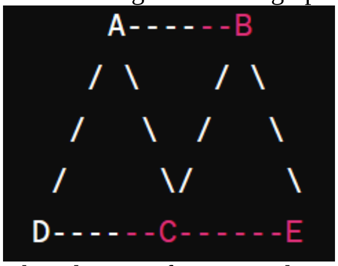
2	 Given the graph above, find a trail (that is not a path)from a to c,a path from a to c, a circuit (that is not a cycle) starting atb, and a cycle starting at b.	Understand		
3	Define an Eulerian circuit?	Remember		
4	Let G be a graph with vertex set V (G) = {a, b, c, d, e} and edge setE(G) = {ab, ae, bc, cd, de, ea, eb}. (a) Find a walk, trail, and path in G, each of which has length 3.	Understand		
5	Give an example of a graph that has a Hamiltonian cycle but not an Eulerian circuit.	Understand		
6	Write the properties of Hamiltonian Graphs?	Remember		
7	Define a walk using matrices?	Remember		
8	For each of the graphs below, determine if they haveHamiltonian cycles (and paths) and Eulerian circuits (and trails). 	Understand		
9	Define the K¨onigsberg bridge problem with example?	Understand		
10	State the conditions for a graph G is to be Eulerian?	Remember		
11	Write at least 2 applications which uses an Eulerian circuit.	Remember		
12	Let G be a graph. Define the following terms with an example: (a) Hamiltonian cycle (b) Hamiltonian path	Understand		
13	Eulerian circuits focus on traversing edges exactly once, while Hamiltonian cycles focus on visiting vertices exactly once. Justify the statement with an example.	Understand		
14	Define the following for a graph G: (a) Cycle (b) Circuit (c) Length	Remember		
15	Define a connected graph with example?	Understand		
PART - B (LONG ANSWER QUESTIONS)				
1	Let G be a graph with vertex set V (G) = {a, b, c, d, e} and edge setE(G) = {ab, ae, bc, cd, de, ea, eb}. (a) Draw G. (b) Is G connected? (c) Is G simple? (d) List the degrees of every vertex. (e) Find all edges incident to b.	Apply		

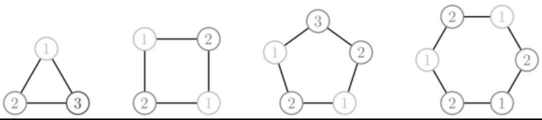
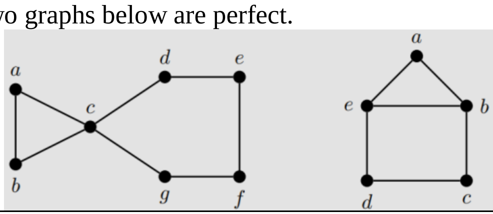
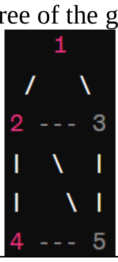
	(f) List all the neighbors of a. (g) Find a walk, trail, and path in G, each of which has length 3. (h) Find a closed walk, circuit, and cycle in G, each of which starts at e. (i) Is G eulerian, semi-eulerian, or neither? Explain your answer.			
2	Which of the following scenarios could be modeled using (i) an Eulerian circuitor trail? (ii) Hamiltonian cycle or path? Explain your answer. (a) A photographer wishes to visit each of the seven bridges in a city, takephotos, and then return to his hotel. (b) Salem Public Works must repave all the streets in the downtown area. (c) Frank’s Flowers needs to deliver bouquets to 6 customers throughout thecity, starting and ending at the flower shop.	Apply		
3	 For each of the graphs above (a) find the degree of each vertex (b) use yourresults from (a) to determine if the graph is Eulerian, semi-Eulerian, or neither,and (c) find an Eulerian circuit or Eulerian trail if it exists. Explain your answer.	Apply		
4	Write the properties of Hamiltonian Graphs? Use the properties of Hamiltonian graphs to show that the graphs below are not Hamiltonian. 	Apply		
5	Write the brute force algorithm for Travelling salesman problem?	Understand		

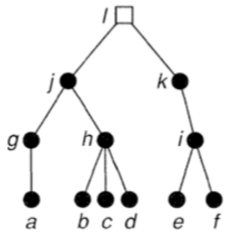
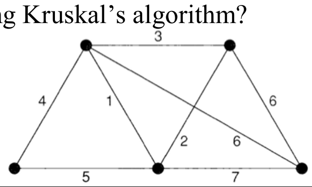
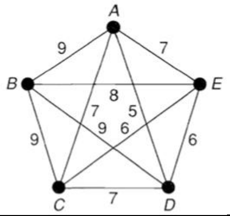
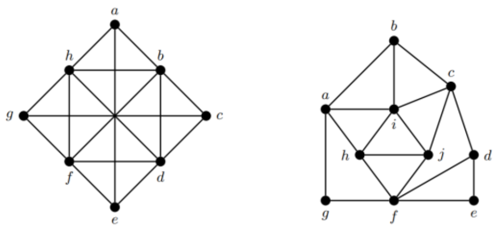
6	Sam is planning his next business trip from his home-town of Addison and has determined the cost for travel between any ofthe five cities he must visit. This information is modeled in the weightedcomplete graph on the next page, where the weight is given in terms ofdollars. Use Brute Force to find all possible routes for his trip. 	Apply		
7	Find an Eulerian circuit or Eulerian trail for each of the graphs below. 	Apply		
8	Explain Dijkstra's algorithm? Apply Dijkstra's Algorithm to the graph below where Start = g. 	Apply		
9	Determine if each of the graphs below are Hamiltonian. For those that are, find a Hamiltonian cycle. Otherwise, provide a clear and concise argument as to why the graph is not Hamiltonian. 	Apply		
10	Explain with example the concept of an Eulerian circuit. How does it differ from a Hamiltonian	Understand		

	cycle?			
11	Consider the following weighted graph:  Using Dijkstra's algorithm, find the shortest paths from vertex A to all other vertices in the graph. Show the step-by-step process including the intermediate distances and the selected vertices.	Apply		
12	In the city of Königsberg, there are seven bridges connecting the four landmasses as shown below:  Can you traverse each bridge exactly once and return to your starting point? Explain your reasoning.	Apply		
13	Consider the following directed graph:  Represent this graph using an adjacency matrix. Then, compute the matrix representation of a walk of length 2 starting from vertex A. Finally, determine the number of walks of length 3 from vertex A to vertex C.	Apply		
14	Given an undirected graph with the following adjacency matrix: 0 1 1 0 1 1 0 1 1 1 1 1 0 1 0 0 1 1 0 1 1 1 0 1 0 Determine whether the graph has an Eulerian circuit. If it does, provide an example of such a circuit. If not, explain why an Eulerian circuit does not exist.	Apply		
15	Explain the following methods to tour a graph: (a) Eulerian Tours (b) Hamiltonian Paths/Cycles (c) Dijkstra's Algorithm	Understand		
PART – C (PROBLEM SOLVING AND CRITICAL THINKING)				
1	The Traveling Salesman Problem (TSP) is a classic optimization problem in which a salesman is tasked with visiting a set of cities exactly once and returning to the starting city, all while minimizing the total distance traveled. Consider a salesman needs to visit four cities (A,	Apply		

	B, C, D) and return to the starting city (A). The distances between the cities are as follows: Distance from A to B: 10 units Distance from A to C: 15 units Distance from A to D: 20 units Distance from B to C: 35 units Distance from B to D: 30 units Distance from C to D: 40 units Find the shortest possible route that visits each city exactly once and returns to the starting city.			
2	Explain Dijkstra's algorithm to find the shortest path between a starting vertex and all other vertices in a weighted graph.Consider the following weighted graph:  The above graph represents a network of cities (A, B, C, D) connected by roads with corresponding distances between them. Find the shortest path from a starting vertex to all other vertices.	Apply		
3	Determine if each of the graphs below are Hamiltonian. For those that are, find a Hamiltonian cycle.   	Apply		
4	A salesman needs to visit 5 cities (A, B, C, D, E) exactly once and return to the starting city. The distances between the cities are as follows: A to B: 10 units A to C: 15 units A to D: 20 units A to E: 25 units B to C: 35 units B to D: 30 units B to E: 35 units C to D: 40 units C to E: 45 units D to E: 50 units Using the brute-force approach, find the shortest possible route for the salesman to visit all cities	Apply		

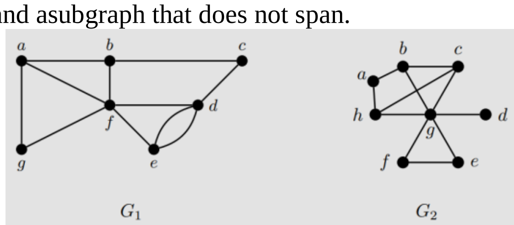
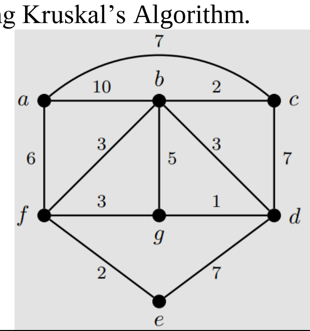
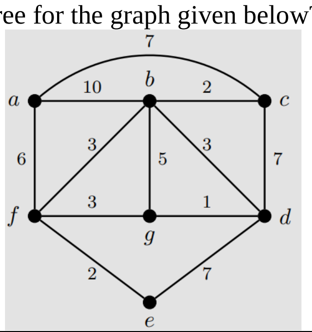
<table>
<tr><td></td><td>and return to the starting city. Show the step-by-step process including all permutations and calculations of total distances.</td><td></td><td></td><td></td></tr>
<tr><td>5</td><td>Consider the following undirected graph:


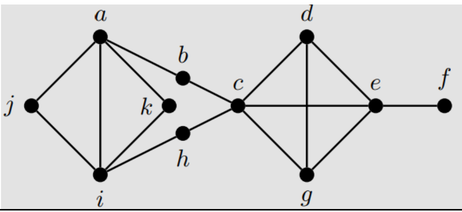
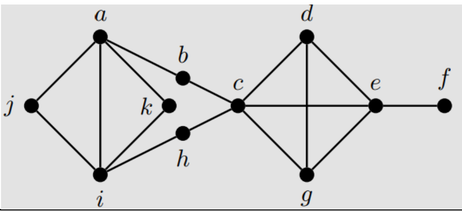
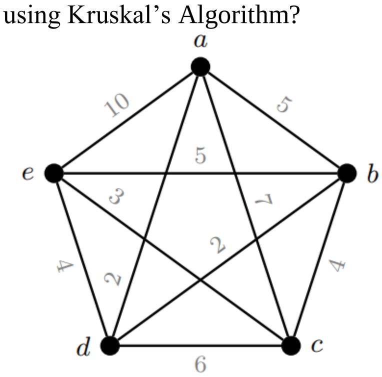
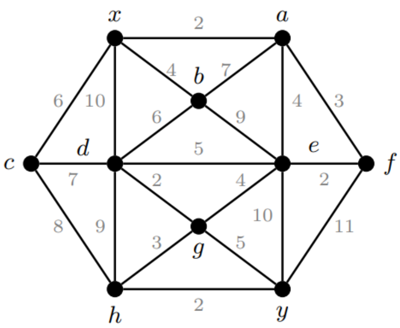
Is this graph Eulerian? If so, provide an Eulerian circuit for the graph. If not, explain why it is not Eulerian.</td><td>Apply</td><td></td><td></td></tr>
<tr><td colspan="5">MODULE – III</td></tr>
<tr><td colspan="5">GRAPH COLORING AND GRAPH ALGORITHMS</td></tr>
<tr><td colspan="5">PART - A (SHORT ANSWER QUESTIONS)</td></tr>
<tr><td>1</td><td>Define k-coloring of a graph G with an example?</td><td>Remember</td><td></td><td></td></tr>
<tr><td>2</td><td>What is independence number of a graph G?</td><td>Remember</td><td></td><td></td></tr>
<tr><td>3</td><td>Define chromatic number of a graph?</td><td>Remember</td><td></td><td></td></tr>
<tr><td>4</td><td>Consider a graph G, a cycle on n vertices is denoted C_n. Find the optimal colorings graphs given below.
</td><td>Understand</td><td></td><td></td></tr>
<tr><td>5</td><td>Define a clique in a graph?</td><td>Remember</td><td></td><td></td></tr>
<tr><td>6</td><td>Define an equitable coloring of a graph with an example?</td><td>Remember</td><td></td><td></td></tr>
<tr><td>7</td><td>Define a perfect graph? Determine if either of the two graphs below are perfect.

</td><td>Understand</td><td></td><td></td></tr>
<tr><td>8</td><td>Define the following for a graph G.
(a) Edge coloring
(b) Chromatic Index</td><td>Understand</td><td></td><td></td></tr>
<tr><td>9</td><td>State the real-world applications of graph coloring?</td><td>Remember</td><td></td><td></td></tr>
<tr><td>10</td><td>Define the chromatic index of a graph?</td><td>Remember</td><td></td><td></td></tr>
<tr><td colspan="5">CIE-II</td></tr>
<tr><td>11</td><td>Define a spanning tree of the graph given below?

</td><td>Understand</td><td></td><td></td></tr>
</table>

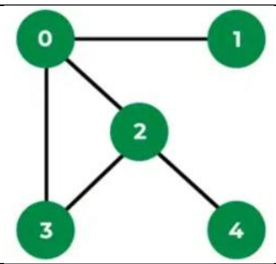
12	Define minimumspanning tree or MST of a graph G?	Remember		
13	Perform a breadth first search and a depth first search on the tree. 	Apply		
14	Find a minimum-weight spanning tree in the graph using Kruskal’s algorithm? 	Apply		
15	Find a minimum-weight spanning tree in the graph using Prim’s algorithm? 	Apply		
16	What are some practical applications of depth-first search (DFS) in real-world scenarios?	Understand		
17	What are the key steps of Prim's algorithm for finding a minimum spanning tree?	Remember		
18	In what scenarios would you prefer to use Prim's algorithm over Kruskal's algorithm, and vice versa?	Understand		
19	Explain the difference between DFS and Breadth-First Search (BFS)?	Understand		
20	What is the role of a union-find structure in Kruskal's algorithm?	Understand		
PART – B (LONG ANSWER QUESTIONS)				
1	For each of the graphs below, complete the following. (a) Find the chromatic number $\chi(G)$. Include an argument why fewer colorswill not sufficient. (b) Find the chromatic index $\chi'(G)$. (c) Determine which graphs are perfect. Explain your answer.  G_1 G_2	Apply		
2	Explain with an example the minimum number of colors needed to properly color the vertices of any planar graph according to the rules of vertex coloring?	Understand		
3	Explain edge coloring and how does it differ from vertex coloring?	Understand		

<table>
<tr><td>4</td><td>Explain chromatic number in the context of vertex coloring with an example?</td><td>Understand</td><td></td><td></td></tr>
<tr><td>5</td><td>Explain the procedure for First-Fit coloring algorithm with an example graph?</td><td>Understand</td><td></td><td></td></tr>
<tr><td>6</td><td>Consider a simple graph with vertices A, B, C, and D connected as follows: A-B, A-C, A-D, B-C, and C-D. Explain first-fit vertex coloringalgorithm?</td><td>Apply</td><td></td><td></td></tr>
<tr><td>7</td><td>Describe with an example graph the first-fit coloring algorithm colors its vertices?</td><td>Understand</td><td></td><td></td></tr>
<tr><td>8</td><td>Write a Python program for vertex coloring using a simple graph representation and the first-fit coloring algorithm?</td><td>Apply</td><td></td><td></td></tr>
<tr><td>9</td><td>Explain the edge coloring process with the following graph given below.

```
0 -- 1
|    |
2 -- 3
```
</td><td>Apply</td><td></td><td></td></tr>
<tr><td>10</td><td>Explain the vertex coloring process with the following graph given below.

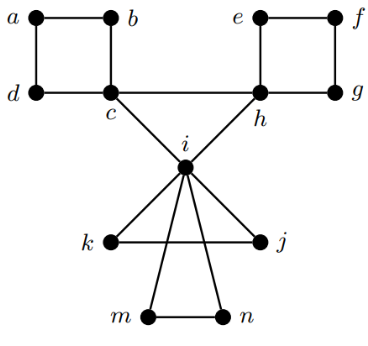
```
    0
   / \
  1---2
 / \ / \
3---4---5
```
</td><td>Apply</td><td></td><td></td></tr>
<tr><td colspan="5">CIE-II</td></tr>
<tr><td>11</td><td>For each of the graphs below, find a spanning tree and asubgraph that does not span.

</td><td>Understand</td><td></td><td></td></tr>
<tr><td>12</td><td>Find the minimum spanning tree of the graph G belowusing Kruskal’s Algorithm.

</td><td>Apply</td><td></td><td></td></tr>
<tr><td>13</td><td>Use Prim’s algorithm to find a minimum spanning tree for the graph given below?

</td><td>Apply</td><td></td><td></td></tr>
</table>

<table>
<tr><td>14</td><td>Find the depth-first search tree for the graph below withthe root a.

</td><td>Apply</td><td></td><td></td></tr>
<tr><td>15</td><td>Consider the following undirected graph.
<pre>
    A
   / \
  B---C
 / \ / \
D---E---F
</pre>
In theabove graph, vertices are labeled from A to F, and edges connect the vertices. Find a spanning tree for this graph using Prim’s algorithm?</td><td>Understand</td><td></td><td></td></tr>
<tr><td>16</td><td>Find the breadth-first search tree for the graph below with the root a.

</td><td>Apply</td><td></td><td></td></tr>
<tr><td>17</td><td>Explain the procedure for union-find structure with an example?</td><td>Apply</td><td></td><td></td></tr>
<tr><td>18</td><td>Find a minimum spanning tree for the graph given below using Kruskal’s Algorithm?

</td><td>Apply</td><td></td><td></td></tr>
<tr><td>19</td><td>Write Python implementation of the Union-Find data structure?</td><td>Apply</td><td></td><td></td></tr>
<tr><td>20</td><td>Find a minimum spanning tree for the graph represented by the table below using Kruskal’s algorithm?

</td><td>Apply</td><td></td><td></td></tr>
<tr><td colspan="5">PART – C (PROBLEM SOLVING AND CRITICAL THINKING)</td></tr>
<tr><td>1</td><td>Explain with illustration depth-first search algorithm for the graph given below</td><td>Apply</td><td></td><td></td></tr>
</table>

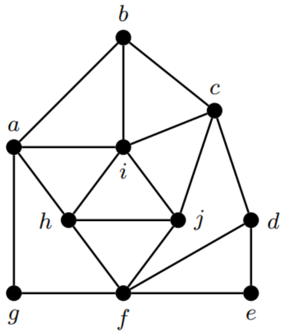
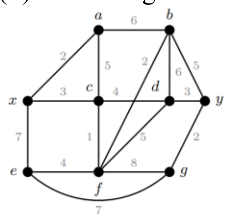
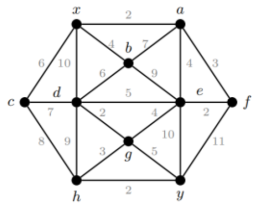
<table>
<tr><td></td><td>
</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td>Write the applications, advantages and disadvantages of Breadth First Search (BFS) algorithm with an example?</td><td>Understand</td><td></td><td></td></tr>
<tr><td>3</td><td>Given a matrix of size M x N consisting of integers, the task is to print the matrix elements using Breadth-First Search traversal.

Input: grid[][] = {{1, 2, 3, 4}, {5, 6, 7, 8}, {9, 10, 11, 12}, {13, 14, 15, 16}}
Output: 1 2 5 3 6 9 4 7 10 13 8 11 14 12 15 16

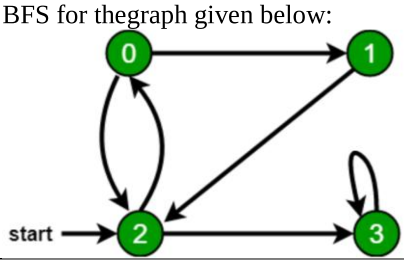
Input: grid[][] = {{-1, 0, 0, 1}, {-1, -1, -2, -1}, {-1, -1, -1, -1}, {0, 0, 0, 0}}
Output: -1 0 -1 0 -1 -1 1 -2 -1 0 -1 -1 0 -1 0 0</td><td>Apply</td><td></td><td></td></tr>
<tr><td>4</td><td>Write a Python program to find the number of sink nodes in a graph?

Input : n = 4, m = 2
Edges[] = {{2, 3}, {4, 3}}
Output : 2</td><td>Apply</td><td></td><td></td></tr>
<tr><td>5</td><td>Find a minimum spanning tree for the graph represented by the table below using Prim’s algorithm?
<table>
<tr><th></th><th>a</th><th>b</th><th>c</th><th>d</th><th>e</th><th>f</th><th>g</th></tr>
<tr><td>a</td><td>·</td><td>5</td><td>7</td><td>8</td><td>10</td><td>3</td><td>11</td></tr>
<tr><td>b</td><td>5</td><td>·</td><td>2</td><td>4</td><td>1</td><td>12</td><td>7</td></tr>
<tr><td>c</td><td>7</td><td>2</td><td>·</td><td>6</td><td>7</td><td>5</td><td>4</td></tr>
<tr><td>d</td><td>8</td><td>4</td><td>6</td><td>·</td><td>2</td><td>10</td><td>12</td></tr>
<tr><td>e</td><td>10</td><td>1</td><td>7</td><td>2</td><td>·</td><td>6</td><td>9</td></tr>
<tr><td>f</td><td>3</td><td>12</td><td>5</td><td>10</td><td>6</td><td>·</td><td>15</td></tr>
<tr><td>g</td><td>11</td><td>7</td><td>4</td><td>12</td><td>9</td><td>15</td><td>·</td></tr>
</table></td><td>Apply</td><td></td><td></td></tr>
<tr><td colspan="5">CIE-II</td></tr>
<tr><td>6</td><td>Complete each of the following on the two graphs shown below.
(a) Find the breadth-first search tree with root a.
(b) Find the breadth-first search tree with root i.
(c) Find the depth-first search tree with root a.
(d) Find the depth-first search tree with root i.


G_1</td><td>Apply</td><td></td><td></td></tr>
</table>

	 G_2			
7	Find a minimum spanning tree for each of the graphs below using (i) Kruskal'sAlgorithm and (ii) Prim's Algorithm.  	Apply		
8	Nour must visit clients in six cities next month and needs to minimize herdriving mileage. The table below lists the distances between these cities. Use theminimum spanning tree Algorithm to find a good plan for her travels if she must start and endher trip in Dallas. Include the total distance. (Hint: Choose Prim's algorithm)	Apply		

	Austin	Dallas	El Paso	Fort Worth	Houston	San Antonio
Austin	·	182	526	174	146	74
Dallas	182	·	568	31	225	253
El Paso	526	568	·	537	672	500
Fort Worth	174	31	537	·	237	241
Houston	146	225	672	237	·	189
San Antonio	74	253	500	241	189	·

9	Write Python program for Breadth First Search or BFS for thegraph given below: 	Apply		
10	Write Python program for Depth First Search or DFS for a Graph Input: n = 4, e = 6 0 -> 1, 0 -> 2, 1 -> 2, 2 -> 0, 2 -> 3, 3 -> 3 Output: DFS from vertex 1 : 1 2 0 3 Input: n = 4, e = 6 2 -> 0, 0 -> 2, 1 -> 2, 0 -> 1, 3 -> 3, 1 -> 3 Output: DFS from vertex 2 : 2 0 1 3	Apply		

MODULE –IV

ALGEBRAIC AND TRANSCENDENTAL EQUATIONS

PART – A (SHORT ANSWER QUESTIONS)

1	Find the real root of the equation $f(x) = x^3 – x – 1 = 0$ using bisection method.	Apply		

2	Find a real root of the equation $f(x) = x^3 - 2x - 5 = 0$ using bisection method.	Apply		
3	Find a root, correct to three decimal places and lying between 0 and 0.5, of the equation $4e^{-x}\sin x - 1 = 0$ using bisection method.	Apply		
4	Find a real root of the equation $f(x) = x^3 - 2x - 5 = 0$ using false position method.	Apply		
5	Given that the equation $x^{2.2} = 69$ has a root between 5 and 8. Use the method of regula-falsi to determine it.	Apply		
6	Find a real root of the equation $x^3 = 1 - x^2$ on the interval [0, 1] with an accuracy of 10^{-4} using iteration method.	Apply		
7	Find a real root, correct to three decimal places, of the equation $2x - 3 = \cos x$ lying in the interval $[3/2, \pi/2]$ using iteration method.	Apply		
8	Use the Newton-Raphson method to find a root of the equation $x^3 - 2x - 5 = 0$.	Apply		
9	Find a root of the equation $x\sin x + \cos x = 0$ using Newton-Raphson method.	Apply		
10	Find the smallest root of the equation $f(x) = x^3 - 9x^2 + 26x - 24 = 0$ using Ramanujan's method.	Apply		
	PART – B (LONG ANSWER QUESTIONS)			
1	Find a real root of the equation $f(x) = x^3 + x^2 + x + 7 = 0$ correct to three decimal places using bisection method.	Apply		
2	Find the positive root, between 0 and 1, of the equation $x = e^{-x}$ to a tolerance of 0.05% using bisection method.	Apply		
3	The equation $2x = \log_{10}x + 7$ has a root between 3 and 4. Find this root, correct to three decimal places, by regula-falsi method.	Apply		
4	Find the root of the equation $4e^{-x}\sin x - 1 = 0$ by regular-falsi method given that the root lies between 0 and 0.5.	Apply		
5	Use the method of iteration to find a positive root of the equation $xe^x = 1$, given that a root lies between 0 and 1.	Apply		
6	Use the iterative method to find a real root of the equation $\sin x = 10(x - 1)$. Give your answer correct to three decimal places.	Apply		
7	Find a real root of the equation $x = e^{-x}$Newton-Raphson method.	Apply		
8	Use Newton-Raphson method, find a real root, correct to 3 decimal places, of the equation $\sin x = x/2$ given that the root lies between $\pi/2$ and π.	Apply		
9	Given the equation $4e^{-x} \sin x - 1 = 0$, find the root between 0 and 0.5 correct to three decimal places.	Apply		
10	Find a root of the equation $xe^x = 1$ using Ramanujan's method.	Apply		
11	Find a double root of the equation $f(x) = x^3 - x^2 - x + 1 = 0$ using Newton-Raphson method.	Apply		
12	Find the smallest root, correct to 4 decimal places, of the equation $f(x) = 3x - \cos x - 1 = 0$ using Ramanujan's method.	Apply		
13	Using Ramanujan's method, find a real root of the equation $1 - x + x^2 / (2!)^2 - x^3 / (3!)^2 + x^4 / (4!)^2 - \ldots = 0$	Apply		
14	Find a real root of the equation $x^3 - 2x - 5 = 0$ using secant method.	Apply		
15	Using the secant method, find a real root of the equation $f(x) = xe^x - 1 = 0$	Apply		

16	Using Muller's method, find the root of the equation $f(x) = x^3 - x - 1 = 0$ with the initial approximations $x_{i-2} = 0$, $x_{i-1} = 1$, $x_i = 2$	Apply		
PART – C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)				
1	Explain the bisection method for finding a real root of the equation $f(x) = 0$ and write an algorithm for its implementation with a test for relative accuracy of the approximation. Obtain a root, correct to three decimal places, of each of the following equations using the bisection method. (a) x3 − 4x − 9 = 0 (b) x3 + x2 − 1 = 0 (c) 5x log10x − 6 = 0 (d) x2 + x − cos x = 0	Apply		
2	Give the sequence of steps in the regula−falsi method for determining a real root of the equation $f(x) = 0$. Use the method of false position to find a real root, correct to three decimal places, of the following equations. (a) x3 + x2 + x + 7 = 0 (b) x3 − x − 4 = 0 (c) x = 3e–x (d) x tan x + 1 = 0	Apply		
3	Find the real root, which lies between 2 and 3, of the equationx $\log_{10} x - 1.2 = 0$using the methods of bisection and false−position to a tolerance of 0.5%.	Apply		
4	Explain briefly the method of iteration to compute a real root of the equation $f(x) = 0$, stating the condition of convergence of the sequence of approximations. Use the method of iteration to find, correct to four significant figures, a real root of each of the following equations. (a) $e^x = 3x$ (b) $x = 1 / (x+1)^2$ (c) $1 + x^2 = x^3$ (d) x- sin x = 1/2	Apply		
5	Establish an iteration formula to find the reciprocal of a positive number N by Newton−Raphson method. Hence find the reciprocal of 154 to four significant figures.	Apply		
6	Explain Newton−Raphson method to compute a real root of the equation $f(x) = 0$ and find the condition of convergence. Hence, find a non-zero root of the equation $x^2 + 4\sin x = 0$.	Apply		
7	Using Newton−Raphson method, derive a formula for finding the kth root of a positive number N and hence compute the value of $(25)^{1/4}$. Use the Newton−Raphson method to obtain a root, correct to three decimal places, of each of the following equations: (a) $e^x = 4x$ (b) $x^3 – 5x + 3 = 0$ (c) $x e^x= \cos x$	Apply		
8	Compute, to four decimal places, the root between 1 and 2 of the equation$x^3 - 2x^2 + 3x - 5 = 0$ by (a) Method of False Position and (b) Newton−Raphson method. Using Ramanujan's method, find the smallest root of each of the following equations:	Apply		

	(a) $x^3 - 6x^2 + 11x - 6 = 0$ (b) $x + x^3 - 1 = 0$ (c) $\sin x + x - 1 = 0$			
9	Determine the real root of the equation $x = e^{-x}$, using the secant method.	Apply		
10	Describe briefly Muller's method and use it to find (a) the root, between 2 and 3, of the equation $x^3 - 2x - 5 = 0$ and (b) the root, between 0 and 1, of the equation $x = e^{-x} \cos x$.	Apply		
MODULE –V				
NUMERICAL INTEGRATION AND ORDINARY DIFFERENTIATIAL EQUATIONS				
PART – A (SHORT ANSWER QUESTIONS)				
1	State the main principle behind Simpson's 1/3 rule?	Understand		
2	What is the basic idea behind Simpson's 3/8 rule?	Remember		
3	State the key differences between Simpson's 1/3 rule and Simpson's 3/8 rule?	Understand		
4	Describe the limitations of both Simpson's 1/3 rule and Simpson's 3/8 rule?	Understand		
5	Describe the basic idea behind Euler's Method?	Understand		
6	What are the key steps in implementing Euler's Method?	Understand		
7	State the formula for the Trapezoidal Rule?	Remember		
8	Describe the basic principle behind the Trapezoidal Rule.	Understand		
9	Describe the basic idea behind the Runge-Kutta method?	Understand		
10	What is the most commonly used order of the Runge-Kutta method?	Remember		
PART - B (LONG ANSWER QUESTIONS)				
1	Using Simpson's 1/3 rule with h = 1, evaluate the integral $I = \int_3^7 x^2 \log x\, dx.$	Apply		
2	Determine the maximum error in evaluating the integral $I = \int_0^{\pi/2} \sin x\, dx$ By both the trapezoidal and Simpson's 1/3 rules using four subintervals.	Apply		
3	Use the trapezoidal rule to evaluate the double integral $\int_{-2}^{2} \int_0^4 (x^2 - xy + y^2)\, dx\, dy.$	Apply		
4	From the Taylor series for y(x), find y(0.1) correct to four decimal places if y(x) satisfies $y' = x - y^2$ and $y(0) = 1$	Apply		
5	Given the differential equation $y'' - xy' - y = 0$ with the conditions $y(0) = 1$ and $y'(0) = 0$, use Taylor's series method to determine the value of	Apply		

	y(0.1).			
6	Given dy/dx = y-x where y(0) = 2, find y(0.1) and y(0.2) correct to four decimal places using Runge-Kutta method.	Apply		
7	Given dy/dx = 1 + y2, where y = 0 when x = 0, find y(0.2), y(0.4) and y(0.6) using Runge-Kutta method.	Apply		
8	Find, by Taylor's series method, the value of y(0.1) given that $y'' - xy' - y = 0,\ y(0) = 1 \text{ and } y'(0) = 0.$	Apply		
9	Using Taylor's series, find y(0.1), y(0.2) and y(0.3) given that $\frac{dy}{dx} = xy + y^2, \quad y(0) = 1$	Apply		
10	Use Runge-Kutta fourth order formula for solving an initial value problem. Find y(0.1), y(0.2) and y(0.3) given that $y' = 1 + \frac{2xy}{1+x^2},\ y(0) = 0$	Apply		
PART – C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)				
1	Write an algorithm to evaluate $\int_{x_0}^{x_{2n}} y\,dx$ using Simpson's 1/3 rule when y(x) is given at x_0, $x_0 + h$, ….., $x_0 + 2nh$. Evaluate $\int_0^1 e^{-x^2} \sin x\,dx$ Using Simpson's 1/3 rule with h = 0.1	Apply		
2	Estimate the value of the integral $I = \int_0^{1/2} \frac{dx}{\sqrt{x}\sqrt{1-x}}$ Using the trapezoidal rule, What is its exact value?	Apply		
3	Compute the values of $I = \int_0^1 \frac{dx}{1+x^2}$ Using the trapezoidal rule with h = 0.5, 0.25 and 0.125.	Apply		
4	Derive Simpson's 3/8 rule $\int_{x_0}^{x_3} y\,dx = \frac{3}{8}h\,(y_0 + 3y_1 + 3y_2 + y_3)$ Using this rule, evaluate $\int_0^1 \frac{1}{1+x}dx$ With h = 1/6. Evaluate the integral by Simpson's 1/3 rule and compare the results.	Apply		
5	Evaluate $\int_0^2 \frac{dx}{x^3+x+1}$ By Simpson's 1/3 rule with h = 0.25.	Apply		

6	Given $\frac{dy}{dx} = 1 + xy, \ y(0) = 1,$ Obtain the Taylor series for y(x) and compute y(0.1), correct to four decimal places.	Apply		
7	Using Euler's method, solve the following problems: (a) $\frac{dy}{dx} = \frac{3}{5}x^3 y, y(0) = 1$ (b) $\frac{dy}{dx} = 1 + y^2, y(0) = 0$	Apply		
8	Use Runge-Kutta fourth order formula to find y(0.2) and y(0.4) given that $y' = \frac{y^2 - x^2}{y^2 + x^2}, \quad y(0) = 1.$	Apply		
9	Solve the initial value problem defined by $\frac{dy}{dx} = \frac{3x + y}{x + 2y}, \quad y(1) = 1$ And find y(1.2) and y(1.4) by Runge-Kutta fourth order formula.	Apply		
10	Given the initial value problem defined by $\frac{dy}{dx} = y(1 + x^2), \quad y(0) = 1$ Find the values of y for x = 0.2, 0.4, 0.6, 0.8 and 1.0 using the Euler and fourth order Runge-Kutta methods. Compare the computed values with the exact values.	Apply		

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