Subject Code: BMICSE0401

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NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

M.Tech. (Integrated)

SEM: IV- THEORY EXAMINATION (2024-2025)

SUBJECT: DATA STRUCTURES AND ALGORITHMS-II

Time: 3Hours Max. Marks:100

General Instructions:

IMP: Verify that you have received question paper with correct course, code, branch etc.

1. *This Question paper comprises of three Sections -A, B, & C. It consists of Multiple Choice Questions (MCQ's) & Subjective type questions.*
2. *Maximum marks for each question are indicated on right hand side of each question.*
3. *Illustrate your answers with neat sketches wherever necessary.*
4. *Assume suitable data if necessary.*
5. *Preferably, write the answers in sequential order.*
6. *No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.*

SECTION – A 20

1. Attempt all parts:-

1-a. Which of the following is true about binary search trees (BSTs)? (CO1, K1) 1

A. All nodes have at most two children

B. Left subtree has keys less than the node

C. Right subtree has keys greater than the node

D. All of the above

1-b. Which data structure is most appropriate for implementing an expression tree? (CO1, K1) 1

A. Queue
B. Stack
C. Binary tree
D. Heap

1-c. Which algorithm is used to find the shortest path in a weighted graph with non-negative weights? (CO2, K2) 1

A. DFS

B. BFS

C. Dijkstra's Algorithm

D. Kruskal's Algorithm

1-d. Which of the following problems is best solved using dynamic programming? (CO2, K2) 1

A. Binary search

B. Factorial computation

C. 0/1 Knapsack Problem

D. Depth-first traversa

1-e. What is the main principle of dynamic programming? (CO3, K1) 1

A. Divide and conquer

B. Greedy choice

C. Recursion

D. Optimal substructure and overlapping subproblems

1-f. Which of the following problems can be solved using backtracking? (CO4, K1) 1

A. N-Queens problem

B. Sudoku solver

C. Hamiltonian circuit

D. All of the above

1-g. Backtracking is a refinement of: (CO4, K2) 1

A. Greedy method

B. Dynamic programming

C. Brute-force approach

D. Divide and conquer

1-h. What is the time complexity of the search operation in a red-black tree? (C5, K1) 1

A. O(1)

B. O(log n)

C. O(n)

D. O(n log n)

1-i. In a red-black tree, which of the following properties is FALSE? (C5, K1) 1

A. Every node is either red or black

B. The root is always black

C. Red node can have red child

D. All paths from a node to descendant leaves contain the same number of black nodes

1-j. B+ tree is preferred over B-tree in databases because: (CO1, K2) 1

A. B+ tree is easier to implement

B. It allows binary search

C. Leaves are linked, supporting efficient range queries

D. B+ tree has fewer nodes

2. Attempt all parts:-

2.a.	What is a binary search tree (BST)? State its properties. (CO1, K1)	2
2.b.	Define a spanning tree of a graph. (CO2, K1)	2
2.c.	What do you understand by memorization in dynamic programming? (CO3, K2)	2
2.d.	Explain the role of recursion in backtracking. (CO4, K2)	2
2.e.	How does a red-black tree ensure balance? (CO5, K2)	2

SECTION – B 30

3. Answer any <u>five</u> of the following-

3-a.	Explain the process of illustrating a binary search tree (BST) with a given sequence of numbers. What is the time complexity for search operations in the best, worst, and average cases? [2,8,3,9,6] (CO1, K3)	6
3-b.	Differentiate between adjacency list and adjacency matrix representations of graphs. Which is better and why? Support your answer with memory and time complexity analysis. (CO2, K4)	6
3-c.	Explain Dijkstra's algorithm with a suitable example for finding the shortest path in a graph with non-negative edge weights. (CO2, K4)	6
3-d.	Discuss the 0/1 Knapsack Problem using dynamic programming. (CO3, K2)	6
3-e.	What is backtracking? How is it applied to the Hamiltonian cycle problem? (CO4, K3)	6
3-f.	Define a red-black tree and list its properties. Discuss the height of a red-black tree with *n* internal nodes? (CO5, K2)	6
3-g.	What is Min Heap? Apply the heap sort algorithm for following sequence of data [4,7,1,9,5,8,3,9] (CO1, K3)	6

SECTION – C 50

4. Answer any <u>one</u> of the following-

4-a.	Briefly explain In-order, Pre-order and Post-order binary tree traversal operation. A Binary tree T has 9 nodes. Illustrate the tree T with following sequences of nodes in in-order and pre-order traversals: (CO1, K3) In-order: E A C K F H D B G Pre-order: F A E K C D H G B	10
4-b.	Illustrate an AVL Tree using the following keys inserted in order: 10, 20, 30, 40, 50, 25 Show all intermediate rotations and draw the final AVL Tree. (CO1, K3)	10

5. Answer any <u>one</u> of the following-

5-a.	Use Kruskal's algorithm to find minimum cost spanning tree for the graph given in figure 1. Analyze the complexity of Kruskal's algorithm. (CO2, K4)	10

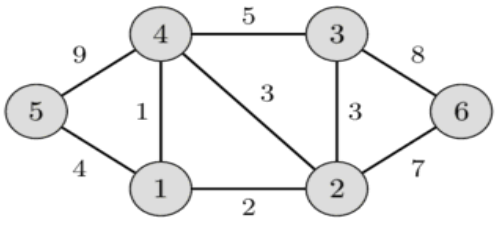

Figure 1

5-b. Describe the working of the Floyd-Warshall algorithm for all-pairs shortest path. Explain how it handles negative weights and analyze its time complexity. (CO2, K4) 10

6. Answer any one of the following-

6-a. What is matrix chain multiplication? Explain how dynamic programming helps in finding the most efficient multiplication order. Analyze the recursive formula and show with an example. (CO3, K4) 10

6-b. Calculate the value of 0/1 Knapsack Problem using dynamic programming: 10
Items: {Weight = [2, 3, 4, 5], Value = [3, 4, 5, 6]} (CO3, K4)
Capacity of Knapsack = 5
(i) Fill the DP table
(ii) Find the maximum value that can be obtained
(iii)Show item selection process

7. Answer any one of the following-

7-a. State the Traveling Sales Person (TSP) problem. Analyze the complexity of backtracking approach to solve the TSP. (CO4. K4). 10

7-b. Differentiate between Algorithms for Breadth First Search (BFS) and Depth First Search (DFS)..Also write the BFS for graph given in Figure 2 staring with vertex "0". (CO4. K4). 10

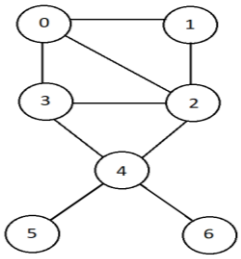

Figure 2.

8. Answer any one of the following-

8-a. Describe red-black trees in terms of structure, height, rotation frequency, and use cases. Discuss the applications of RB Tree.(CO5, K2) 10

8-b. Convert the following sequence of keys into a **B+ Tree of order 3 (max 2 keys per node)** :10, 20, 5, 6, 12, 30, 7, 17 (CO5, K2) 10
(i) Show all intermediate steps and splitting
Final tree with internal and leaf node structure