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NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech.

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 five 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 one 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) | 10 |
| | In-order: E A C K F H D B G | |
| | Pre-order: F A E K C D H G B | |
| 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 one 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 |
|------|--|----|

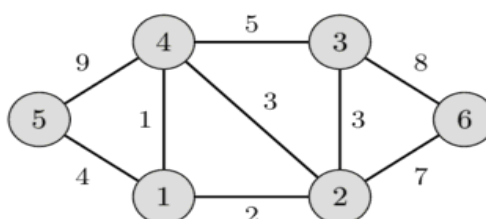


Figure 1

- 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 starting with vertex "0". (CO4, K4). 10

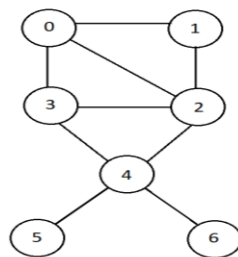


Figure 2.

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