

Time : 3.00 Hours]

**IMSc (CS) Sem.-9**  
**Design and Analysis of Algorithms**  
**December-2025**

[Max.Marks : 70

**Instructions:**

- Write both the Sections in the separate answer book.
- Both Sections having equal weightage.
- Draw Diagrams wherever necessary.
- Make Assumptions wherever necessary.

**SECTION – I**

Que.1 Answer any five. [10 Marks]

1. What is a red-black tree?
2. Give two examples of a divide and conquer algorithm.
3. In BFS, which data structure is typically used to explore nodes?
4. What is the formal definition of BST?
5. What is Dijkstra's algorithm used for?
6. Which method (Substitution, Recursion Tree, and Master) is fastest for standard recurrences?

Que.2 (A) Describe the breadth-first search algorithm with an example and analyze its complexity. [05 marks]

(B) Describe the divide and conquer paradigm. Give two examples. [05 marks]

**OR**

(A) Explain the Substitution and Recursion Tree methods for solving recurrences with examples. [05 marks]

(B) Define NP, P, and NP-Complete classes with suitable examples. [05 marks]

Que.3 (A) Solve the following: [08 marks]

1. Construct a max-heap for the input [10, 20, 15, 30, 40, 24, 68, 15, 50, 17, 1]

2. Solve the recurrence  $T(n)=9T(n/3)+n$  using the Master Theorem.

(B) Explain dynamic programming with the matrix-chain multiplication example. [07 marks]

**OR**

(A) Explain Red-Black trees. Explain properties and rotations with example diagrams. [07 marks]

(B) Search the string using mentioned algorithm. [08 marks]

1.  $T=ABCABABCDD$ ,  $S=AB$  using Naïve String Matching Algorithm2.  $T=3141592653589793$ ,  $p=26$ ,  $q=11$  using Robin-Karp Algorithm

## SECTION - II

Que 4 Answer any five. [10 marks]

1. Define the Travelling Salesman Problem (TSP).
2. What is the time complexity of merge sort?
3. State two examples of a greedy algorithm.
4. Define the shortest path problem.
5. In a max-heap, where is the largest element stored?
6. Which data structure is used to implement a priority queue efficiently?

Que 5 (A) Explain heap and its' types. Explain insertion, deletion, and heapify operations. [07 marks]

(B) Solve the following; [08 marks]

1. Construct a Binary Search Tree (BST) for [10, 5, 20, 15, 25, 55, 5, 14, 8, 2] and perform in-order traversal.
2. Insert 25 into the max-heap [41, 33, 15, 50, 2, 12, 8, 10, 59], and show the new heap. Delete the root node and show the new heap.

OR

(A) Explain DFS with example. Differentiate DFS and BFS. [07 marks]

(B) Solve the following: [08 marks]

1. Solve the Travelling Salesman Problem for 4 cities using a cost matrix.
2. Show step-by-step insertion sort and merge sort for [9, 1, 5, 46, 22, 13, 10, 2, 50, 39, 87, 12].

Que 6 (A) Compare the Substitution, Recursion Tree, and Master methods for solving recurrences. [05 marks]

(B) Explain Huffman coding with an example. [05 marks]

OR

(A) Explain the Travelling Salesman Problem (TSP) and discuss brute-force and dynamic approaches. [05 marks]

(B) Explain Bellman-Ford algorithm and show step-by-step working on a sample graph. [05 marks]

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