

Time allowed: 3 Hours

Max. Marks: 50

NOTE: Attempt five questions in all, including Question No. 1 (Section -A) which is compulsory and selecting two questions each from Section B-C.

x-x-x

Section-A

- Q1. a) Define Big O, Big Θ , and Big Ω notations and its uses. 10
b) Provide example problem that can be solved using dynamic programming but not with greedy algorithm
c) Explain Floyd-Warshall algorithm and its purpose in graph theory.
d) What will be the running time of quick sort if the selection of pivot always produces a balanced tree but selection of pivot takes linear time.
e) List the key properties of Red-Black Trees.

Section-B

- Q2. a) Solve the following recurrence relation using the Master Theorem: $T(n) = 3T(n/3) + n^2T(n)$ 5
b) Given the following functions, determine the upper (Big O) and average (Θ) complexity bounds: 5
i) A simple linear search algorithm that iterates through an unsorted array of size n.
ii) A binary search algorithm applied to a sorted array of size n.
Q3. a) Define a Minimum Spanning Tree. Explain why a minimum spanning tree is unique if all edge weights in a graph are distinct. Provide a proof or example to support your explanation. 6
b) Given the array $A = [34, 7, 23, 32, 5, 62]$ and quick sort algorithm 4
- Show the result of the first partition using the last element as the pivot.
- What will be the array after the first recursive call to quick sort?
Q4. a) Describe the Traveling Salesperson Problem and explain its significance in computer science. 3
b) Consider the following distance matrix for four cities: 7
Using dynamic programming, calculate the minimum cost of visiting all cities exactly once and returning to the starting city.

$$D = \begin{bmatrix} 0 & 10 & 15 & 20 \\ 10 & 0 & 35 & 25 \\ 15 & 35 & 0 & 30 \\ 20 & 25 & 30 & 0 \end{bmatrix}$$

Section-C

- Q5. a) Given a set of integers $\{10, 7, 5, 18, 12, 20, 15\}$ and a target sum $S = 35$, use backtracking to find all subsets of this set that sum to S. Explain how backtracking can reduce unnecessary computations in this case. 7
b) In the N-Queens problem, what is the advantage of using backtracking over brute force? 3
Q6. a) Describe the key features of Fibonacci Heaps. Why are Fibonacci Heaps used in Dijkstra's algorithm? 3
b) Consider the following sequence of integers: 50, 30, 70, 20, 40, 60, 80. 7
1. **Construct the Binary Search Tree (BST)** using these integers by inserting them one by one.
2. After constructing the BST, perform the following operations:
o **In-order traversal, Pre-order and Post-order traversal** of the BST.
3. **Delete the node with value 70** from the BST.
Q7. a) What is a non-deterministic problem? Explain how non-determinism is modeled in the context of computational complexity. Give an example of a non-deterministic problem and explain how a non-deterministic Turing machine would solve it. 6
b) Compare brute force, Boyer-Moore, and Knuth-Morris-Pratt algorithms in terms of time complexity and practical efficiency. Under what circumstances would you prefer one algorithm over the others. 4

x-x-x