विश्वजीवनामृतं ज्ञानम्

ABV- Indian Institute of Information Technology & Management, Gwalior

Design and Analysis of Algorithms (IT203)

Major Examination (Session 2023–24)

Maximum Time: 3 Hours **Max Marks: 100**

Note: Answer all questions. All questions carry equal marks.

1. (a) Define asymptotic notations (Big-O, Big-, Big-) with examples. (b) Compare polynomial vs exponential time algorithms with suitable examples. (10 Marks)

2. (a) Solve the recurrence $T(n) = T(n/2) + n$ using: (i) Recursion tree method (ii) Master Theorem. (b) Write and explain the algorithm for Merge Sort. (10 Marks)

3. (a) Differentiate between Linear Search, Binary Search, and Interpolation Search in terms of complexity and applications. (b) Apply Binary Search to find the key 72 in the sorted list: {12, 18, 27, 36, 45, 54, 63, 72, 81}. Show step-by-step iterations. (10 Marks)

4. (a) Explain the Divide and Conquer strategy with reference to the Maximum Subarray Problem. (b) Write pseudocode for Strassen's Matrix Multiplication. Analyze its time complexity. (10 Marks)

5. (a) Define Graph, Directed Graph, and Weighted Graph with examples. (b) Explain Dijkstra's Algorithm for Single-Source Shortest Path. Apply it on the following graph: Vertices: {A, B, C, D, E} Edges (with weights): A-B(6), A-D(1), B-D(2), B-E(2), D-C(1), C-E(5). Show step-by-step working. (10 Marks)

6. (a) State and explain the Greedy Choice Property and Optimal Substructure property. (b) Solve the Fractional Knapsack Problem for items with weights {10, 20, 30} and profits {60, 100, 120} with capacity $W = 50$. Show all steps. (10 Marks)

7. (a) Explain the Dynamic Programming approach with reference to the Longest Common Subsequence (LCS) problem. (b) Apply Dynamic Programming to compute the minimum cost of Matrix Chain Multiplication for dimensions: $A_1(10 \times 30), A_2(30 \times 5), A_3(5 \times 60)$. (10 Marks)

8. (a) Define NP, NP-Hard, and NP-Complete problems with examples. (b) Prove that the Hamiltonian Cycle problem is NP-Complete (outline proof via reduction). (10 Marks)

9. (a) Write short notes on any two: (i) Red-Black Trees (ii) Huffman Coding (Greedy Algorithm) (iii) Floyd–Warshall Algorithm. (10 Marks)

10. Case Study: A logistics company wants to minimize delivery costs across multiple warehouses and cities. Model this as a graph problem and discuss which algorithms (Greedy, DP, Graph-based) can be applied. Justify your choice. (10 Marks)