Reg. No.																

Question Paper Code	14192

M.E. / M.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2025

First Semester

M.E. - Computer Science and Engineering

(Common to Computer Science and Engineering (With Specialization in Networks))

24PCSPC101 – ADVANCED DATA STRUCTURES AND ALGORITHMS

Regulations - 2024

Duration: 3 Hours Max. Marks: 100

PART - A (MCQ) (10 × 1 = 10 Marks)

Answer ALL Questions

		Marks	K – Level	CO
1.	The Substitution Method is typically used to solve: (a) Linear equations. (b) Recurrence relations. (c) Insertion Sort's running time in the best case. (d) The time complexity of graph traversal.	1	K1	CO1
2.	In the Recursion-Tree Method, the total running time is found by: (a) Finding the average cost of all levels. (b) Finding the minimum cost of all levels. (c) Summing the costs of all levels. (d) Multiplying the height by the cost of the root node.	1	K1	CO1
3.	In a Red-Black Tree, which of the following properties must always be true? (a) Every path from the root to a leaf has the same number of nodes. (b) Every node is either red or black. (c) Every red node has exactly two black children. (d) Every simple path from a node to a descendant leaf contains the same number of red nodes.	1	K1	CO2
4.	The minimum degree t of a B-Tree determines the minimum number of keys in any non-root node. This minimum number of keys is: (a) t−1 (b) 2t−1 (c) t (d) 2t	1	K1	CO2
5.	Which graph traversal algorithm uses a queue to explore vertices and is suitable for finding the shortest path in an unweighted graph? (a) Depth-First Search (DFS) (b) Topological Sort (c) Breadth-First Search (BFS) (d) Kruskal's Algorithm	1	K1	CO3
6.	The Floyd-Warshall Algorithm is used to solve which graph problem? (a) Single-Source Shortest Paths (b) Minimum Spanning Tree (c) All-Pairs Shortest Paths (d) Strongest Connected Components	1	K1	CO3
7.	The Matrix-Chain Multiplication problem, when solved with dynamic programming, seeks to: (a) Minimize the number of matrices in the product. (b) Find the optimal order for multiplying a chain of matrices to minimize the total number of scalar multiplications. (c) Maximize the size of the resultant matrix. (d) Determine if the matrices are compatible for multiplication.	1	K1	CO4
8.	What is a key step in solving the Longest Common Subsequence problem using Dynamic Programming? (a) Sorting both sequences first. (b) Defining a recurrence relation for the length of the LCS of prefixes. (c) Using a priority queue. (d) Applying a greedy approach to find the next matching character.	1	K1	CO4

9.	Which famous problem is often used as the first problem to be proven NP-Complete? (a) Traveling Salesperson Problem (TSP) (b) Matrix-Chain Multiplication (c) Satisfiability Problem (SAT) (d) Shortest Path Problem	*1*	*K1*	*CO5*
10.	A problem is in the complexity class P if it can be solved by a deterministic Turing machine in: (a) Exponential time. (b) Polynomial time. (c) Logarithmic time. (d) Factorial time.	*1*	*K1*	*CO6*

PART - B (12 × 2 = 24 Marks)

Answer ALL Questions

11.	Compare between the Big O and Big Ω notations.	*2*	*K2*	*CO1*
12.	What is the primary difference in the operational principle between the Substitution Method and the Recursion-Tree Method for solving recurrences?	*2*	*K1*	*CO1*
13.	Show the Red-Black Tree Property related to the color of the root and the leaves (NIL nodes).	*2*	*K2*	*CO2*
14.	Define the minimum degree (t) of a B-Tree.	*2*	*K1*	*CO2*
15.	When is Breadth-First Search (BFS) preferred over Depth-First Search (DFS) in graph traversal?	*2*	*K1*	*CO3*
16.	Explain the purpose of the relax operation in the context of single-source shortest path algorithms.	*2*	*K2*	*CO3*
17.	What are the two key components that a problem must exhibit to be efficiently solved using Dynamic Programming?	*2*	*K1*	*CO4*
18.	Compare between a Greedy Algorithm and a Dynamic Programming algorithm.	*2*	*K2*	*CO4*
19.	Interpret the recurrence relation for LCS.	*2*	*K2*	*CO5*
20.	Infer any two real-life applications of greedy algorithms.	*2*	*K2*	*CO5*
21.	Explain in detail about NP compete problem with an example.	*2*	*K2*	*CO6*
22.	Compare NP Completeness and NP Hard.	*2*	*K2*	*CO6*

PART - C (6 × 11 = 66 Marks)

Answer ALL Questions

23.	a)	Apply an algorithm for Insertion Sort and analyze its worst-case time complexity using O-notation.	*11*	*K3*	*CO1*
		OR			
	b)	Make use of the Recursion-Tree Method to determine the asymptotic bound for the recurrence T(n)=3T(n/2)+O(n).	*11*	*K3*	*CO1*
24.	a)	Analyze the process of Insertion into a Red-Black Tree. Clearly describe the scenarios that require rotations and color changes to maintain the properties.	*11*	*K4*	*CO2*
		OR			
	b)	Examine the structure of a Fibonacci Heap and explain the efficient Mergeable-heap operation UNION(H1,H2).	*11*	*K4*	*CO2*
25.	a)	Explain the steps of Dijkstra's Algorithm. Trace its execution on a small weighted, directed graph to find the shortest paths from a source vertex S.	*11*	*K2*	*CO3*
		OR			
	b)	Compare and contrast Kruskal's Algorithm and Prim's Algorithm for finding the Minimum Spanning Tree (MST), focusing on the data structures they typically use and how they "grow" the tree.	*11*	*K2*	*CO3*
26.	a)	Apply the concept of Single-Source Shortest Path (SSSP) algorithm for Directed Acyclic Graphs (DAGs) and also analysis of time complexity.	*11*	*K3*	*CO4*
		OR			

	b)	Apply the Greedy Strategy and apply it to construct Huffman Codes for a set of characters with given frequencies.	*11*	*K3*	*CO4*
27.	a)	Explain the Matrix Chain Multiplication problem using dynamic programming for the following. a) Derive the recurrence relation. b) Construct the cost table for the sequence: A1(10×30), A2(30×5), A3(5×60). c) Find the minimum number of scalar multiplications.	*11*	*K2*	*CO5*
		OR			
	b)	Explain the Fractional Knapsack problem using the greedy method with an example.	*11*	*K2*	*CO5*
28.	a)	Construct the Travelling Salesman Problem and prove that it is NP-Complete.	*11*	*K3*	*CO6*
		OR			
	b)	Apply the concept of NP-Completeness to a real-world computational problem like job scheduling, resource allocation etc.	*11*	*K3*	*CO6*