JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -3 EXAMINATION- 2025

M. Tech-II (CSE/IT)

COURSE CODE (CREDITS): 10M11CI211 (3)

MAX. MARKS: 35

COURSE NAME: Advanced Algorithms

COURSE INSTRUCTORS: Dr. Aman Sharma

MAX. TIME: 2 Hours

Note: (a) All questions are compulsory.

(b) The candidate is allowed to make Suitable numeric assumptions wherever required for solving problems

Q.No	Question	CO	Marks
Q1	**1.1** You are given the following directed graph with 5 vertices (numbered 0 to 4) and weighted edges: Edge (from → to) Weight 0 → 1 6 0 → 2 7 1 → 2 8 1 → 3 5 1 → 4 -4 2 → 3 -3 2 → 4 9 3 → 1 -2 4 → 0 2 4 → 3 7 a) Describe the main idea and steps of the Bellman-Ford algorithm. ***(3 marks)*** b) Using vertex 0 as the source, perform the first two iterations of the Bellman-Ford algorithm. Show the distance array after each iteration. ***(3 marks)*** c) Explain how the Bellman-Ford algorithm detects negative weight cycles. Would this graph trigger such a detection? Justify your answer. ***(2 mark)*** **1.2** Given the recurrence: T(n) = 2T(n/2) + n a) Identify which method (Substitution, Recursion Tree, or Master's Theorem) is most efficient to solve this recurrence and justify your choice briefly. (2 mark) b) Using the selected method, determine the asymptotic time complexity of T(n). **(2 mark)**	4 1	12
Q2	**2.1** You are given the text: "ABABDABACDABABCABAB" and the pattern: "ABABCABAB" a) Explain the **core idea** behind the Rabin-Karp string matching algorithm, including how hashing is used to improve efficiency. **(2 marks)**	3	13

	b) Compute the **hash value** of the pattern and the **initial window** of the text using a simple hash function: **Hash(s) = (sum of ASCII values of characters in s) mod 101** Then, check whether the hash values match. **(2 marks)** **c)** Briefly explain how Rabin-Karp handles **spurious hits** (when hash values match but the actual strings don't). Why is this step important? **(2 marks)** **2.2** **a)** List any **three key characteristics** that define a good algorithm. **(2 mark)** **b)** Define the following asymptotic notations and explain what each represents in the context of algorithm analysis: i) Big-O (O) ii) Big-Ω (Omega) iii) Big-Θ (Theta) **(3 mark)** **c)** For the Binary Search algorithm, state its best-case, average-case, and worst-case time complexities. (2 mark)		
Q3	**a)** Define the following complexity classes and explain how they are related: i) P ii) NP iii) NP-complete iv) NP-hard (2 marks) **b)** Give one **example problem** from each of the following classes: i) P ii) NP-complete iii) NP-hard **(1.5 marks)** **c)** What would be the implication for computational theory and real-world applications if **P = NP** is proven true? **(1.5 marks)**	2	5
Q4	You are given the following undirected, weighted graph: **Vertices: {A, B, C, D, E}** **Edges with Weights:** • A — B (2) • A — C (3) • B — C (1) • B — D (4) • C — D (5) • C — E (6) • D — E (7) **a)** Define a tree and explain the concept of a **Minimum Spanning Tree (MST). (1.5 marks)** **b)** Use **Prim's Algorithm** to construct the MST starting from vertex A. List the order in which edges are selected. **(1.5 marks)** **c)** Use **Kruskal's Algorithm** to construct the MST. Show how cycle detection is handled using the Union-Find method. **(1.5 marks)** **d)** Explain one real-world application of MST algorithms. **(0.5 mark)**	3	5