

JK Lakshmipat University Jaipur
INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Semester Examination, May 2025
B.Tech, Semester IV, 2024-25

Roll No.....

CS1105: Design and Analysis of Algorithms

Time: 2.5 hours

Max. Marks: 30

Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Mention all the assumptions for your answers clearly.

	For the following questions, you may choose any programming language. <u>You can assume basic functions for sorting are already written. There is no need to write the main() method.</u>	
Q1.A	There are items $\{i_1, i_2, \dots, i_n\}$ and placed at $\{d_1, d_2, \dots, d_n\}$. We have to place guards to protect the items. Each guard can protect only 1 unit distance to his right and 1 unit distance to his left. Using a Greedy approach, find the minimum number of guards required to guard the items. Write the necessary functions. Input: $\{i_1, i_2, i_3, i_4\}$ placed at $\{12, 7, 11, 4\}$. Output: the number of guards needed is 3	4 (LO 3)
	<u>Answer any two out of the following three programs/functions:</u>	3+3
Q.1.B	We want to write code for the two-coloring problem for a graph (No two adjacent nodes of a graph can have the same color). Write a modified BFS function for this.	(LO 3)
Q.1.C	Write the necessary functions for implementing Bellman-Ford algorithm. Check for the presence of negative weight cycle (don't have to print it). <i>Again, there is no need to write the main function.</i>	
Q.1.D	Write the necessary functions for implementing fractional knapsack. <i>Again, there is no need to write the main function.</i>	

Q.2.1	In the traveling-salesman problem, a salesman must visit n cities. Modeling the problem as a complete graph on n vertices, we can say that the salesman wishes to make a hamiltonian cycle, visiting each city exactly only once and finishing at the city he starts from. Formulate the traveling salesman problem as a recurrence relation. OR To test the primality of a number n, if $\sqrt{n}$ divisions are performed, what is the complexity. Explain how you arrived at it.	2 (LO1,5)
Q2.2	Explain how divide and conquer can be used to solve the closest pair problem. Further, clearly explain, the number of comparisons that are considered enough in the strip. You can construct an example to explain concepts clearly.	2 (LO2)
Q3	Given the following three matrices: A1: 10 X 100 A2: 100 X 5 A3: 5 X 50 Perform Matrix Chain multiplication using dynamic programming approach to (a) find the total number of scalar multiplications, and (b) find the optimal parenthesization. OR 1. Prove $\sqrt{6n^3 - 7n^2 + 3n + 5} = \Omega(n^{1.5})$ 2. Find the complexity of an algorithm that solves the problem of size n by dividing it into eight subproblems of size $n/2$, recursively solving each subproblem, and then combining the solutions in $O(n^2)$ time. Write the recurrence relation. What is the complexity based on Master's theorem?	2+1 (LO4) 2+1 (LO1)
Q.4	Prove Vertex Cover is NP Complete. For this use the following input instance of a 3-SAT problem $\varphi = (\neg x_1 \vee x_2 \vee x_3) \wedge (x_1 \vee \neg x_2 \vee \neg x_3) \wedge (\neg x_1 \vee \neg x_2 \vee x_3)$ 1) What is the equivalent instance (graph) for Vertex Cover. 2) Show that the instance (graph) obtained above is satisfiable and also show satisfiability of 3-SAT in polynomial time.	2 3 (LO6)

Q.5	Consider the following bipartite graph. Each member of the Group has to be allotted exactly one slot and for one slot there is exactly one group member. a) Convert the bipartite graph given into a network flow graph. b) Assume that the first iteration of Ford Fulkerson algorithm returns the matching a-1. Draw the residual graph c) Now, using the residual and augmented graph obtained above, perform the remaining iterations to obtain maximum matching	1 1 2 (LO5)
Q.6	A small delivery company operates in a town with 5 warehouses located at points A, B, C, D, and E. The roads connecting the warehouses have the following cost: • A - B: 1 • A - C: 4 • B - C: 2 • B - D: 5 • C - E: 3 • D - E: 1 You are given four algorithms: Prim's, Kruskal's, Dijkstra's, Bellman Ford. a) As the logistics manager, you want to build a network of roads connecting all the warehouses with the least total travel cost for general maintenance or emergency access. i. Which algorithm would you choose for this? Apply your chosen algorithm to find the desired roads. b) A delivery truck needs to go from warehouse A to warehouse D with least cost. i. What route should it take? Apply your chosen algorithm to find the route?	2 2 (LO3)

