

**PARUL UNIVERSITY**  
**FACULTY OF ENGINEERING & TECHNOLOGY**  
**B. Tech/ Int. B. Tech Summer 2024 - 25 Examination**

Semester: 5/9

Date: 28/04/2025

Subject Code: 303105218

Time: 10:30am to 1:00pm

Subject Name: Design and Analysis of Algorithm

Total Marks: 60

**Instructions:**

1. This question paper comprises of two sections. Write answer of both the sections in separate answer books.
2. From Section A, **Q.1 is compulsory**, From Section B, **Q.1 is compulsory**.
3. Figures to the right indicate full marks.
4. Draw neat and clean drawings & Make suitable assumptions wherever necessary.
5. Start new question on new page.
- 6.BT- Blooms Taxonomy Levels – Remember-1, Understand -2, Apply-3, Analyse-4, Evaluate-5, Create-6

SECTION-A			Marks	CO	BT																		
<b>Q.1</b>	<b>Answer the following questions.</b>																						
	<b>A. Write appropriate answer only.</b>																						
	i. What technique does the Rabin-Karp algorithm use for string matching?	[01]	<b>4</b>	<b>1</b>																			
	ii. What is the main difference between BFS and DFS?	[01]	<b>3</b>	<b>1</b>																			
	iii. The Travelling Salesman Problem (TSP) is classified under which complexity class?	[01]	<b>5</b>	<b>2</b>																			
	iv. Which data structure is used in Krushkal's algorithm for finding the Minimum Spanning Tree?	[01]	<b>2</b>	<b>2</b>																			
	v. In a divide-and-conquer algorithm, the recurrence relation $T(n)=2T(n/2)+O(n)$ represents the time complexity of which algorithm?	[01]	<b>1</b>	<b>3</b>																			
	vi. Which data structure is commonly used in the Branch and Bound algorithm to store nodes?	[01]	<b>2</b>	<b>2</b>																			
	<b>a. Answer the following questions.</b>																						
	i. Explain the difference between a directed and an undirected graph.	[02]	<b>3</b>	<b>2</b>																			
	ii. Compare dynamic programming and divide-and-conquer approaches.	[02]	<b>2</b>	<b>4</b>																			
	iii. Differentiate between the three cases of the Master theorem.	[02]	<b>1</b>	<b>4</b>																			
<b>Q.2</b>	a) Apply the <b>Rabin-Karp algorithm</b> to find all occurrences of the pattern ABC in the text ABCDABCABC using Base=101 and Modulus=13.	[04]	<b>4</b>	<b>3</b>																			
	b) A <b>thief</b> breaks into a house intending to <b>steal valuable items</b> . He carries a bag that can hold a <b>maximum weight of 60 kg</b> . Inside the house, there are <b>5 items</b> , each with a specific <b>weight and value</b> . What items should thief take if he can even take the fraction of any item with him? Given the following details:	[05]	<b>2</b>	<b>5</b>																			
	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <th>Item</th> <th>Weight (kg)</th> <th>Value(\$)</th> </tr> <tr> <td>1</td> <td>10</td> <td>60</td> </tr> <tr> <td>2</td> <td>20</td> <td>100</td> </tr> <tr> <td>3</td> <td>30</td> <td>120</td> </tr> <tr> <td>4</td> <td>15</td> <td>90</td> </tr> <tr> <td>5</td> <td>25</td> <td>75</td> </tr> </table>	Item	Weight (kg)	Value(\$)	1	10	60	2	20	100	3	30	120	4	15	90	5	25	75				
Item	Weight (kg)	Value(\$)																					
1	10	60																					
2	20	100																					
3	30	120																					
4	15	90																					
5	25	75																					
	<b>OR</b>																						
	b) Show the result of applying Algorithm Matrix-Chain-Multiplication to find the minimum number of scalar multiplication required to compute the	[05]	<b>2</b>	<b>5</b>																			

	product of the following five matrices: M1 : $5 \times 10$ , M2 : $10 \times 4$ , M3 : $4 \times 6$ , M4 : $6 \times 10$ , M5 : $10 \times 2$ .			
Q.3	<p>a) Design and discuss the relationships between the four complexity classes. Prove that <math>NP = P</math> if and only if for some NP-complete problem X, <math>X \in P</math>.</p> <p>b) Suppose we run Dijkstra's single source shortest-path algorithm on the following edge weighted directed graph with vertex P as the source. In what order do the nodes get included into the set of vertices for which the shortest path distances are finalized?</p>	[04]	5	2
		[05]	3	5
	<b>OR</b>			
	<p>b) What do you mean by spanning tree of a graph? Find the minimum spanning tree of the following graph using suitable algorithm which grows multiple trees (i.e., a forest) at the same time and trees are merged together using <b>safe</b> edges.</p>	[05]	3	5

SECTION-B																									
<b>Q.1</b>	<b>Answer the following questions.</b>																								
	i. Explain the three steps for proving correctness using the loop invariant technique.	[02]	1	1																					
	ii. Why is the time complexity of Bubble Sort $O(n^2)$ ?	[02]	1	2																					
	iii. Explain why Strassen's algorithm is more efficient than the standard matrix multiplication algorithm for large matrices.	[02]	2	2																					
	iv. What is the primary advantage of Merge Sort over Quick Sort?	[02]	1	2																					
	v. Explain why the statement, "The running time of algorithm A is at least $O(n^2)$ ," is meaningless.	[02]	1	3																					
	vi. Design an algorithm using the Divide and Conquer approach to find both the maximum and minimum elements in a given array.	[02]	2	3																					
<b>Q.2</b>	a) Define the binary search and describe its basic concept. Demonstrate the algorithm with an example by performing binary search on a sorted array.	[04]	2	2																					
	b) Explain the <b>Principle of Optimality in Dynamic Programming</b> and discuss how it differs from the <b>Greedy Choice Property in Greedy Algorithms</b> . Illustrate the difference with suitable examples.	[05]	2	2																					
	<b>OR</b>																								
	b) Explain the <b>Activity Selection Problem</b> and how it can be solved using a <b>Greedy Algorithm</b> . You are given a list of activities with their <b>start</b> and <b>finish times</b> . You need to select the <b>maximum number of activities</b> that can be performed by a <b>single person</b> without any overlap.	[05]	2	5																					
	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Activity</th><th>Start Time</th><th>Finish Time</th></tr> </thead> <tbody> <tr><td>A1</td><td>1</td><td>3</td></tr> <tr><td>A2</td><td>2</td><td>5</td></tr> <tr><td>A3</td><td>4</td><td>6</td></tr> <tr><td>A4</td><td>6</td><td>8</td></tr> <tr><td>A5</td><td>5</td><td>7</td></tr> <tr><td>A6</td><td>8</td><td>9</td></tr> </tbody> </table>	Activity	Start Time	Finish Time	A1	1	3	A2	2	5	A3	4	6	A4	6	8	A5	5	7	A6	8	9			
Activity	Start Time	Finish Time																							
A1	1	3																							
A2	2	5																							
A3	4	6																							
A4	6	8																							
A5	5	7																							
A6	8	9																							
<b>Q.3</b>	a) How Dynamic Programming is different from Recursion and Memoization? Illustrate use of Memoization for finding $N^{th}$ Fibonacci number?	[04]	2	2																					
	b) Describe the step-by-step procedure of the Merge Sort algorithm, including how it follows the divide-and-conquer approach. Discuss the time and space complexity of Merge Sort algorithm in the best, worst, and average cases.	[05]	1	3																					
	<b>OR</b>																								
	b) Solve given recurrence relation using recursion tree method. $T(n) = T(n/4) + T(n/2) + c n^2$	[05]	1	4																					