

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

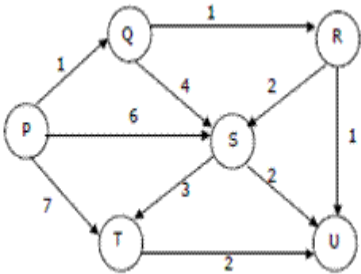
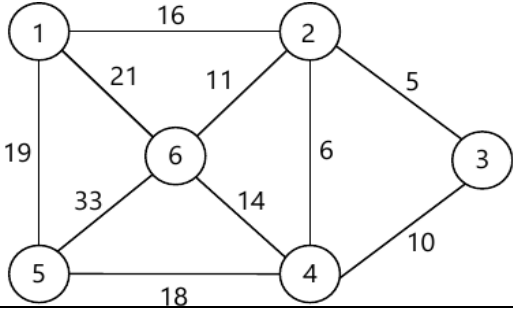
Semester: 5/9  
 Subject Code: 303105218  
 Subject Name: Design and Analysis of Algorithm

Date: 28/04/2025  
 Time: 10:30am to 1:00pm  
 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																		
Q.1	Answer the following questions.																					
	A. Write appropriate answer only.																					
	i. What technique does the Rabin-Karp algorithm use for string matching?	[01]	4	1																		
	ii. What is the main difference between BFS and DFS?	[01]	3	1																		
	iii. The Travelling Salesman Problem (TSP) is classified under which complexity class?	[01]	5	2																		
	iv. Which data structure is used in Krushkal’s algorithm for finding the Minimum Spanning Tree?	[01]	2	2																		
	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]	1	3																		
	vi. Which data structure is commonly used in the Branch and Bound algorithm to store nodes?	[01]	2	2																		
	a. Answer the following questions.																					
	i. Explain the difference between a directed and an undirected graph.	[02]	3	2																		
	ii. Compare dynamic programming and divide-and-conquer approaches.	[02]	2	4																		
	iii. Differentiate between the three cases of the Master theorem.	[02]	1	4																		
Q.2	a) Apply the <b>Rabin-Karp algorithm</b> to find all occurrences of the pattern <b>ABC</b> in the text <b>ABCDABCABC</b> using <b>Base=101</b> and <b>Modulus=13</b> .	[04]	4	3																		
	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: <table><tr><td>Item</td><td>Weight (kg)</td><td>Value(\$)</td></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	[05]	2	5
Item	Weight (kg)	Value(\$)																				
1	10	60																				
2	20	100																				
3	30	120																				
4	15	90																				
5	25	75																				
	OR																					
	b) Show the result of applying Algorithm Matrix-Chain-Multiplication to find the minimum number of scalar multiplication required to compute the	[05]	2	5																		

	product of the following five matrices: $M1 : 5 \times 10$ , $M2 : 10 \times 4$ , $M3 : 4 \times 6$ , $M4 : 6 \times 10$ , $M5 : 10 \times 2$ .			
<b>Q.3</b>	<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 <math>X</math>, <math>X \in P</math>.</p>	<b>[04]</b>	<b>5</b>	<b>2</b>
	<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> 	<b>[05]</b>	<b>3</b>	<b>5</b>
	<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> 	<b>[05]</b>	<b>3</b>	<b>5</b>

SECTION-B																									
Q.1	Answer the following questions.																								
	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																					
Q.2	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</b> in <b>Dynamic Programming</b> and discuss how it differs from the <b>Greedy Choice Property</b> in <b>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. <table><tr><th>Activity</th><th>Start Time</th><th>Finish Time</th></tr><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></table>	Activity	Start Time	Finish Time	A1	1	3	A2	2	5	A3	4	6	A4	6	8	A5	5	7	A6	8	9	[05]	2	5
Activity	Start Time	Finish Time																							
A1	1	3																							
A2	2	5																							
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A4	6	8																							
A5	5	7																							
A6	8	9																							
Q.3	a) How Dynamic Programming is different from Recursion and Memoization? Illustrate use of Memoization for finding $N^{\text{th}}$ 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																					