



**Final Assessment Test(FAT) - Nov/Dec 2024**

Programme	B.Tech.	Semester	Fall Semester 2024-25
Course Code	BCSE202L	Faculty Name	Prof. Anubha Pearline S
Course Title	Data Structures and Algorithms	Slot	C1+TC1
		Class Nbr	CH2024250101402
Time	3 hours	Max. Marks	100

**General Instructions**

- Write only Register Number in the Question Paper where space is provided (right-side at the top) & do not write any other details.

**Course Outcomes**

1. Understand the fundamental analysis and time complexity for a given problem.
2. Articulate linear, non-linear data structures and legal operations permitted on them.
3. Identify and apply suitable algorithms for searching and sorting.
4. Discover various tree and graph traversals.
5. Explicate hashing, heaps and AVL trees and realize their applications.

**Section - I**

Answer all Questions (10 × 10 Marks)

\*M - Marks

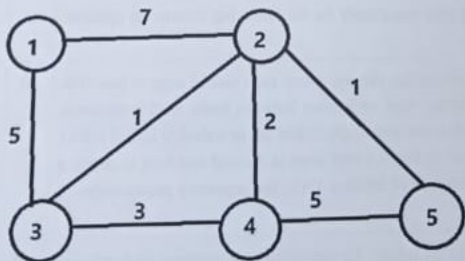
Q.No	Question	*M	CO	BL
01.	Ravi, an algorithmic expert who prioritizes solving problems efficiently, is analyzing the time complexities of two algorithms based on their recurrence relations. Help Ravi by solving the following and determining their time complexities using the specified methods: i) Use the Recursion Tree method to find the time complexity for the following recurrence relation: (6 Marks) $T(n) = T(n/3) + T(2n/3) + n$ ii) Use the Master's Theorem to find the time complexity for the following recurrence relation: $9T(n/3) + n^3$ . (4 Marks)	10	1	3
02.	Consider a browser's back and forward navigation history, where each visited page is linked to both the previous and next pages, facilitating easy navigation between them. In this scenario, which linked list structure is more optimal: a circular singly linked list or a doubly linked list? (1 Mark) Explain along with an example how to insert a new page at the end and how to delete a page using the most suitable linked list structure (4 Marks). Write the necessary pseudocodes (5 Marks).	10	2	
03.	You are organizing a row of unsorted books by height. To sort them, you compare each adjacent pair and swap them if needed, repeating this until everything is in order. This stable sorting algorithm is well suited for small datasets. State the sorting algorithm that swaps adjacent elements and it has a time complexity of $O(n^2)$ . Given the array: {30, 52, 29, 87, 63, 27, 19, 54}, apply the identified algorithm to sort the elements (7 Marks) and provide its pseudocode (3 Marks)	10	3	

04. In a manufacturing plant, quality inspectors use a formula to calculate a "defect priority score" to decide which items need immediate rework. This score depends on factors such as material defects (A), machine wear (B), production line speed (C), and various adjustments made for environmental impacts (D, E, F, G and H). Due to the complexity of these checks, the score calculation involves multiple operations and layers of priority. The current formula for score calculation written in infix is:  $A - (B / C + (D \% E * F) / G) * H$ . To streamline processing, the inspectors want to convert this formula to postfix notation, making it easier for the automated quality control system to evaluate and flag priority items.
- i) Convert the infix expression  $A - (B / C + (D \% E * F) / G) * H$  to postfix expression and show the step-by-step processing (6 Marks).
- ii) Apply the values:  $A=9, B=8, C=4, D=6, E=4, F=3, G=3, H=4$  and evaluate the postfix expression using stack operation (4 Marks).

05. A boy has three disks and three poles: Pole1 (source), Pole2 (temporary), and Pole3 (destination). His task is to move all disks from Pole1 to Pole3 while following these rules:
- Only the top disk on a pole can be moved.
  - No larger disk can be placed on a smaller disk.
- Identify the most suitable data structure to implement this solution (1 Mark). Provide a diagram of each step showing disk movement (6 Marks) and write the corresponding pseudocode to complete the task (3 Marks). (Hint: This problem is commonly recognized as a classic recursion-based challenge.)

06. Imagine you are building a website that organizes content by popularity scores using a binary search tree, with lower scores on the left and higher on the right. Using the scores {40, 30, 50, 10, 25, 45, 55, 8, 11, 20, 42, 60}, construct this tree (2 Marks). Show different access paths through tree traversal methods (3 Marks), with visuals and pseudocode (5 Marks) for each approach.

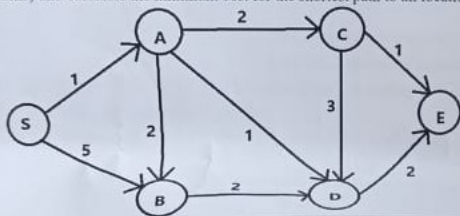
07. A Volvo bus aims to connect multiple cities, where each city is a vertex, and the cost of traveling between cities is represented by weighted edges. To minimize the total route cost while ensuring all cities are connected without forming cycles, an appropriate algorithm must be used. This algorithm sorts the route costs in ascending order. Identify this algorithm, provide its pseudocode, and calculate the minimum cost to connect all cities using the provided graph.



08.	Devansh is working on a data structures project focused on efficient data management. He has been provided with a set of unique product IDs for warehouse items: {4371, 1323, 6173, 4199, 4344, 9679, 1986}. His goal is to organize these IDs in a hash table to facilitate quick lookup. He has chosen the hash function $h(x) = x \bmod 9$ , meaning each product ID will be stored at an index based on its remainder when divided by 9. As Devansh, identify and apply the following methods to organize the IDs:	10	5	3
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- Use linked lists at each index to handle collisions, storing multiple IDs at the same index if necessary. (3 Marks)
- Resolve collisions by finding alternative positions in the table using secondary hash function,  $h_2(k) = 7 - x \bmod 7$  when a position is already occupied. (5 Marks)
- Find the load factor for the identified problem. (2 Marks)

09.	Uber has ride-sharing service that aims to connect various pickup and drop-off locations in a city, represented as nodes in a graph with weighted edges indicating travel time or cost. For the below given graph, G with nodes S, A, B, C, D, E, apply the appropriate algorithm to find the minimum path from the source vertex S to all other nodes (6 Marks). Provide the pseudocode (3 Marks) and calculate the minimum cost for the shortest path to all locations (1 Mark).	10	4	3
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10.	Raghu, a novice learner in data structures, has been tasked with organizing the scores from a recent quiz competition to determine the rankings of participants. He has to construct a complete binary tree using the scores: {15, 19, 10, 7, 17, 16} such that the parent nodes have higher values than their child nodes. Identify the concept used in creating such a tree and write the pseudocode (3 Marks). Also, show how to extract the root element iteratively to sort the scores, including step-by-step processing of the algorithm (7 Marks).	10	5	4
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BL-Bloom's Taxonomy Levels - (1.Remembering, 2.Understanding, 3.Applying, 4.Analysing, 5.Evaluating, 6.Creating)

