

**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI  
(END SEMESTER EXAMINATION)**

CLASS: IMSC  
BRANCH: MATHS

SEMESTER : III  
SESSION : MO/2025

SUBJECT: CS231 DATA STRUCTURES

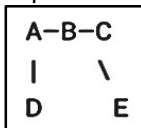
TIME: 3 Hours

FULL MARKS: 50

**INSTRUCTIONS:**

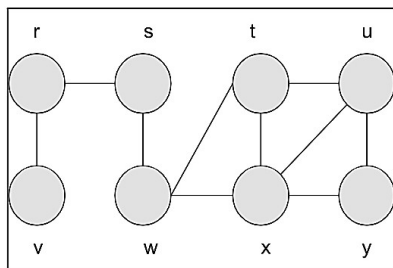
1. The question paper contains 5 questions each of 10 marks and a total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

- |   |     | CO | BL |
|---|-----|----|----|
| Q.1(a) Define a linked list. Explain the difference between a singly linked list and a doubly linked list with neat diagrams.   | [5] | 1  | 1  |
| Q.1(b) Construct a binary search tree (BST) using the elements [40, 20, 60, 10, 30, 50, 70]. Write the inorder and postorder traversals of the tree.                                    | [5] | 3  | 3  |
| Q.2(a) Suppose you have a complete binary tree of height h. Derive a formula for the number of nodes in the tree. What is the maximum and minimum height of a binary tree with n nodes? | [5] | 1  | 2  |
| Q.2(b) Represent the following graph using both adjacency matrix and adjacency list.  | [5] | 5  | 4  |



Which representation is more efficient for a sparse graph and why?

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|---|-----|---|---|
| Q.3(a) Explain the difference between average-case and worst-case time complexity with suitable examples. Derive the time complexity of the following algorithm. Also determine the space complexity assuming each variable occupies constant space.<br><pre> sum = 0; for (i = 1; i &lt;= n; i++){     for (j = 1; j &lt;= n; j++){         for (k = 1; k &lt;= j; k++){             sum++;         }     } }                     </pre> | [5] | 4 | 3 |
| Q.3(b) Add the polynomials $6x^3+4x^2-18x+26x^4+4x^5$ and $26x^3+4x^2-5x+2$ using a linked list. Explain what each node contains.   | [5] | 2 | 2 |
| Q.4(a) How would you best implement a stack and a queue, if you are given single, circular, and double linked lists? Justify your choices.  | [5] | 5 | 5 |
| Q.4(b) Show the step-by-step process of Heap Sort on the array [80, 40, 30, 90, 70, 20, 60]. Write the array after each heapify and extraction step. Also derive the time complexity of Heap Sort.  | [5] | 3 | 3 |
| Q.5(a) Write the Breadth-First Search algorithm and execute it on the given graph:  | [5] | 3 | 3 |



State the time complexity of the BFS algorithm.

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|---|-----|----|---|
| Q.5(b) Write the algorithm for Binary Search. Consider the sorted array:<br>$A = [5, 10, 15, 20, 25, 30, 35, 40, 45, 50]$ Trace the steps of binary search to find the key 35.<br>Show: (a) mid index in each iteration, (b) comparison made, and (c) subarray considered next. | [5] | 1, | 3 |
|   |     | 2  |   |