Indian Association for the Cultivation of Science

(Deemed to be University under the *de novo* category)

Integrated Bachelor's – Master's program

END-Semester Examination-2025 (Autumn Semester)

Subject: Data Structures & Algorithms *Subject Code(s): COM 1201*

Full marks: 50 *Time allotted: 3 hrs*

Instruction: Answer Q1 and any five questions from the rest.

Best of luck for your exam!

Q1. Answer the following questions with correct explanation. **{5 ×3 Marks}**

i) Write a recursive C program or pseudo-code to compute a^n in $O(logn)$ time.

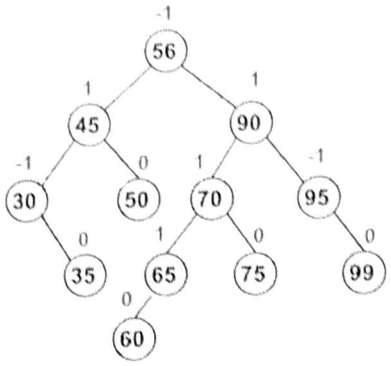
ii) Find out a unique solution for the 4-queen problem and draw the state-space tree for it, showing how the tree leads to the solution.

iii) Name a sorting algorithm that naturally (without any additional variable or modification) provides a best-case time complexity $\sim O(n)$? Explain your answer.

iv) Write the recursive pseudo-codes for pre-order, in-order and post-order tree traversals.

v) Given a $G = (V, E)$, $|V| = 16$, $|E| = 46$. Can you draw the topological structure of the graph, with i) maximum number of weakly connected components (WCC), and ii) minimum number of WCCs? Explain your answer.

Q2. Given the following AVL tree, show the steps (including self-balancing) to delete the node with 56, and replace it with the in-order predecessor. **{7 Marks}**



Q3. Build an AVL tree by inserting the following elements in the given order, 23 34 37 45 12 21 4 62 79 128 65 102 56. Show every step, including self-balancing.{**7 Marks**}

Q4. i) Given the following traversal sequences, can you build the tree, step-by-step?

Pre-order: A B D E G H I J F C

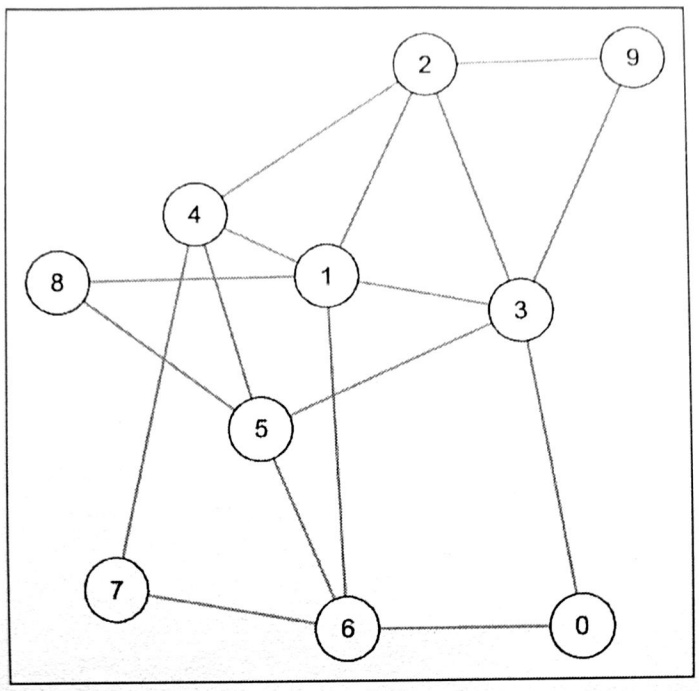
in-order: B G E H I J D F A C

ii) Find out the Post-order traversal sequence for this tree. {**5+2 Marks**}

Q5. Write the pseudo-code/algorithm for modified Bubblesort. Explain with an example how the *modification* leads to a best-case time complexity of $O(n)$. {**7 Marks**}

Q6. Write down the pseudo-code for MAX-HEAPIFY and BUILD-MAX-HEAP to explain how we can build a MAX-HEAP from an unsorted list, e.g., 54 76 32 98 87 23 12 120 65 43.{**7 Marks**}

Q7. Draw the depth first tree (with tree-edges shown as solid lines and the back-edges shown as dotted lines) **step-by-step**, from the following graph,



The starting node for the traversal would be the number in the one's digit of your class roll number. Example - if your roll number is 2020UG023, your starting node would be 3. Show the adjacency list and the stack *clearly.*{**7 Marks**}

Q8. Draw the breadth first tree (with tree-edges shown as solid lines and the cross-edges shown as dotted lines) **step-by-step**, from the graph shown in Q7. The starting node for the traversal would be the number in the one's digit of your class roll number. Example - if your roll number is 2020UG023, your starting node would be 3. Show the adjacency list and the queue clearly.{**7 Marks**}