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-2024 (Autumn Semester)

Subject: Data Structures & Algorithms ***Subject Code(s): MCS 2101B***

Full marks: 50 ***Time allotted: 3 hrs***

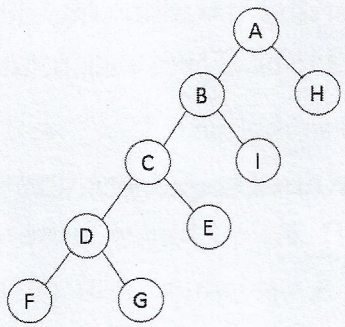
Instruction: Answer Q1 and any five questions from the rest.

Best of luck for your exam!

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

i) If a recursive function with input size n, takes $T(n) = T(\frac{n}{2}) + cn$, where c is a constant, calculate the upper-bound for the average-case.

ii) Is the following tree i) a fully binary tree, ii) a complete tree?

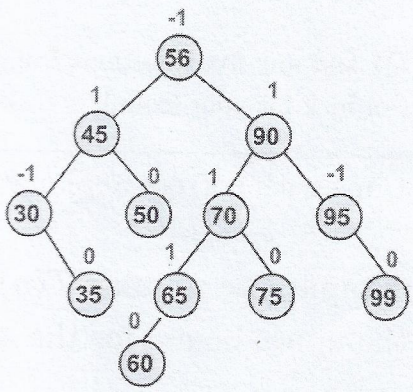


iii) Name a sorting algorithm that naturally (without any additional variable or modification) provides a best-case time complexity $\sim O(n)$? Explain your answer.

iv) What would be the sum of degrees, over all nodes in an undirected graph? Explain your answer.

v) Given a $G = (V, E)$, $|V| = 12$, $|E| = 28$. 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 to delete the node with 45, and replace it with the in-order successor. **{7 Marks}**



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

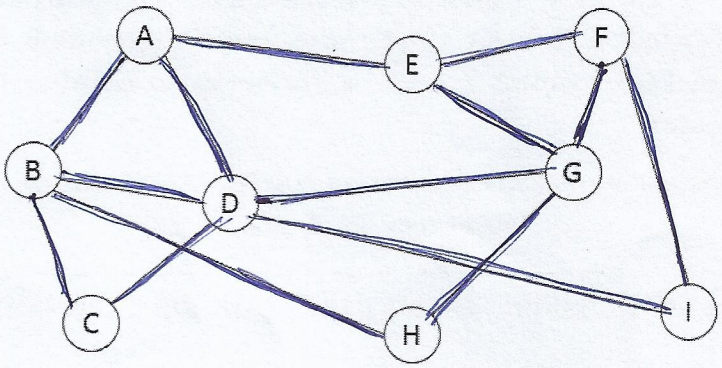
Q4. i) Given the following traversal sequences, can you build the tree?
Pre-order: A B C D F G I E H J
In-order: F D G I C E J H B A
ii) Can a binary tree be constructed, only from its Pre-order and Post-order traversal sequences? Explain. **{5+2 Marks}**

Q5. Write the pseudo-code/algorithm for Mergesort with two different functions *merge* and *mergesort* clearly written. Explain it with a short example. **{7 Marks}**

Q6. i) Write down the code for Quicksort and explain the code with a short example.

ii) Why do we use Quicksort although it has worst-case time complexity $O(n^2)$? **{5+2 Marks}**

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



The starting node for the traversal would be the first alphabet of your first name. If the first alphabet of your first name (say X) is not within A-I, map it as (ascii(X)-ascii(A))%9 + ascii(A). For example, names starting with A/J/S will start from A, B/K/T will start from B, C/L/U will start from C, etc. Show the adjacency list and stack clearly.**{7 Marks}**

Q8. Draw the breadth first tree (with tree-edges shown as solid lines and cross-edges shown as dotted lines) from the graph shown in Q7.
The starting node for the traversal would be the first alphabet of your first name. If the first alphabet of your first name (say X) is not within A-I, map it as (ascii(X)-ascii(A))%9 + ascii(A). For example, names starting with A/J/S will start from A, B/K/T will start from B, C/L/U will start from C, etc. Show the adjacency list and ~~stack~~ queue clearly.**{7 Marks}**