B.E. ELECTRONICS AND TELE-COMMUNICATION ENGINEERING
SECOND YEAR SECOND SEMESTER EXAM - 2025

Data Structures And Algorithms **Time: 3 hours** **Full Marks: 100**

Answer All Questions. Please answer all parts of the same question in the same place.

MODULE 1 (Based on CO 1 and CO 2)

Q.1 (a) Define a stack. State and explain its two primitive operations. 5(CO 1)
(b) Show using pseudocodes how a stack can be used to reverse an inputted string. Give a proper example. 5 (CO 2)
(c) Define a queue. State and explain its two primitive operations. 5 (CO 1)
(d) Show using pseudocodes how a queue can be used to model traffic control at a turning point. Give a proper example. 5 (CO 2)

Q.2 (a) Define a strictly binary tree. Prove that a strictly binary tree with n leaf nodes has $(2n - 1)$ non-leaf nodes. 5 (CO 1)
(b) Construct the binary tree with the preorder traversal form: *ABDGCEHIF* and the inorder traversal form: *DGBAHEICF*. Show your steps. 5 (CO 2)
(c) Consider the dataset: 8, 6, 10, 4, 7, 9, 11, 3, 5, 2. How can you apply a suitable binary tree representation of this data that can help in sorting and searching? Show a step-by-step construction of such a tree with the first data (*i.e.*, 8) as the root. 5 (CO 2)
(d) Show that the tree in (c) is not height balanced. Apply a suitable strategy to make this tree height balanced. 5 (CO 2)

OR

(a) Write a pseudocode for building a max-heap and state its complexity. 5 (CO 1)
(b) Show how a max-heap can realize a max-priority queue for the following data: 5 (CO 2)

Process Index -	P1	P2	P3	P4	P5	P6
Priority Value -	1	4	2	5	6	8

(c) Draw the graph K_4. Prove that - A complete graph is always connected but the converse is not true. 5 (CO 1)
(d) Show how graphs can be used for solving the following problems: 5 (CO 2)
i) puzzle solving, e.g., Sudoku
ii) a postman visiting a set of streets to deliver mails/packages should start and return to the same post-office visiting each street exactly once
You should essentially show that problems in (d) can be modeled as graph problems.

MODULE 2 (Based on CO 3)

Q.3 (a) Define O, Θ, Ω notations. 6

(b) Find the solution to the recurrence relation $T(n) = T\left(\lfloor \frac{n}{2} \rfloor\right) + 1$ using the substitution method. 10

(c) Apply Master Theorem to solve the above recurrence relation. 4

OR

(a) Prove that for any two functions $f(n)$ and $g(n)$, $f(n) = \Theta(g(n))$ iff $f(n) = O(g(n))$ and $f(n) = \Omega(g(n))$. 6

(b) Find the solution to the recurrence relation $T(n) = 4T\left(\frac{n}{2}\right) + cn$ using the recursion tree approach. 10

(c) Apply Master Theorem to solve the recurrence relation in (b). 4

MODULE 3 (Based on CO 4)

Q.4 (a) Consider the following dataset for the ascending order sort: 12, 55, 37, 48, 48, 36, 66, 61, 75, 72, 78. Choose an algorithm which can achieve the above task with a time-complexity better than $O(n^2)$, where n is the size of the input. Justify your choice a with proper time-complexity analysis. 4

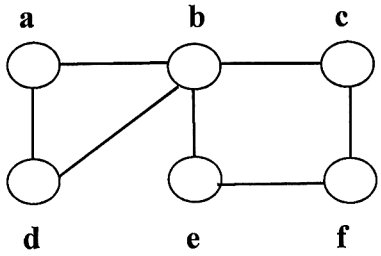
(b) Show the trace of your algorithm on the above dataset. 6

(c) How can you efficiently find the *key* = 75 in the dataset in (a) after sorting has taken place? Trace your solution. Defend your choice with a proper time-complexity analysis. 6

(d) Will you prefer a binary tree based search for the original dataset? Justify your answer from a time-complexity perspective. 4

MODULE 4 (Based on CO 5)

Q.5 (a) Consider a set of locations in a GPS navigation system, which can be represented using the following graph:



Suppose the task is to find all neighboring nodes starting from the node **b**. Write a procedure for a suitable graph algorithm to achieve the above task. Show the trace of your algorithm on the above graph. Analyze the time-complexity of your solution. 4+4+2

(c) Build a Huffman tree for an optimal prefix coding of the following frequency distribution of characters:

Characters	-	a	b	c	d	e
Frequency (in thousands)	-	40	10	11	9	30

You should write a procedure for your solution, show its trace on the above data, and analyze its time-complexity. 4+4+2