B.E. ELECTRONICS AND TELE-COMMUNICATION ENGINEERING
SECOND YEAR SECOND SEMESTER EXAM - 2023

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

Answer All Questions.

Q1 (a) Define a list. What is the basic component of a list and what are the attributes of this component? 1+2

(b) Show with an example how a sparse matrix can be represented using a linear linked list. 3

(c) Define a stack and mention its two primitive operations. 1+2

(d) How can you deploy a stack to compute $n!$? Show the trace of your solution for $n = 4$, by indicating how the two primitive operations in (c) will be invoked. 4

(e) State and explain the Tower of Hanoi problem. Prove that the number of primitive operations to transfer n discs in a Tower of Hanoi problem is $f(n) = 2^n - 1$. 2+5

OR

(a) Define a queue and mention its two primitive operations. 1+2

(b) Draw an analogy between the set of primitive operations in a queue with that of a stack. 2

(c) Discuss a fixed memory implementation of queue. Clearly initialize your marker(s). 5

(d) State one limitation of a linear queue. How can you overcome this limitation? 2+4

(e) Explain which type of list can be used for - i) a typical video game, and, ii) process scheduling in operating systems. 2+2

Q2 (a) Define a strictly binary tree with an example. Draw all possible strictly binary trees of depth three. 2+2

(b) Draw a binary tree with root A, B and C as respective left and right child of A, D and E as respective left and right child of B, F as the left child of C and G as the right child of F. Show the step-by-step symmetric order traversal of this tree. 2+3

(c) Define a graph with an example. State a similarity and a difference between a graph and a tree. 2+2

(d) Define a planar graph. State one utility of such a graph. Draw a planar and a non-planar graph of order 4. Verify your solutions with Euler's formula. 1+1+2+3

OR

(a) Define a binary search tree with an example. Draw a binary search tree with following data as the nodes: 8, 6, 9, 4, 7, 11, 12, 3, 5 and 2. Show your steps. 2+3

(b) Identify a potential problem with the tree in (a). How can you solve this problem? 2+5

(c) Define size of a graph. Show that the difference in the sizes of the two graphs - $K_{n,n}$ and K_n is $n(n+1)/2$. 1+3

(d) Explain how the problems of – i) project allocation among a given set of students and a given set of teachers in a department, and, ii) providing cable connections in a village with minimum cost of wiring, can be modeled as graph problems. 2+2

Q3 (a) Define O, Θ, Ω notations. 6

(b) Prove or disprove: $\max(f(n), g(n)) = \Theta(f(n) + g(n))$. 4

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

OR

(a) Given: $T(n) = T\left(\frac{3n}{4}\right) + 1$. Find the tight asymptotic bound for $T(n)$. 5

(b) Prove or disprove: $3n^2 + 4n^2 \log\log n + 5n + 2 = O(n^2 \log n)$. 5

(c) Find the solution to the recurrence relation $T(n) = 3T\left(\frac{n}{2}\right) + n$ using the recursion tree approach. 10

Q4 (a) Consider a situation where input data is generated by first drawing samples from $U[10,100]$ (a Uniform distribution with range [10, 100]) and then by converting the samples to their nearest integers. Explain what could be a suitable algorithm to sort this data. 2

(b) Write a pseudocode for the algorithm in (a) and analyze its time-complexity. 5+2

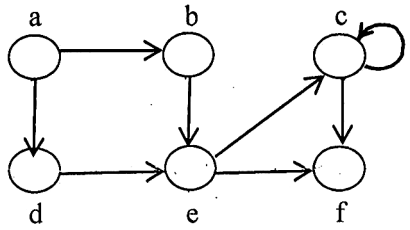
(c) Analyze whether the algorithm in (a) is suitable for sorting the following dataset: 3
12, 25, 37, 48, 56, 56, 66, 68, 75, 92, 85
Suggest an alternative strategy if you consider the choice in (a) to be unsuitable.

(d) How can you find a *key* = 66 in the dataset in (c) after sorting has taken place? Write your algorithm. Trace the solution. Analyze the time-complexity of your algorithm. 3+3+2

Q5 (a) What do you mean by Depth-First Search (DFS) algorithm in a graph? How it is different from Breadth-First Search (BFS) algorithm? 2+2

(b) Write a procedure for the DFS algorithm and analyze its time-complexity. 5+2

(c) Apply the procedure in (b) on the following directed graph G = G(V, E) with the starting node as 'a'. Clearly show i) your steps and ii) the final output forest marking different types of edges. 6



(d) Show how a nested parenthesis structure can be obtained from the start and finish timestamps in (c). 3