DATA STRUCTURE
(CSE2005)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) What is a data structure?
(a) A programming language (b) A collection of algorithms
(c) A way to store and organize data (d) A type of computer hardware.

(ii) What is a characteristic feature of a circular linked list?
(a) The last node is connected back to the first node
(b) Each node has two pointers, one pointing to the next node and the other to the previous node
(c) Each node contains a random pointer
(d) The list can only grow in size and cannot be reduced.

(iii) What does the Big-O notation (O(n log n)) typically represent?
(a) Linear time complexity (b) Logarithmic time complexity
(c) Quadratic time complexity (d) Linearithmic time complexity.

(iv) Which of the following is true about a stack?
(a) It operates on the FIFO principle
(b) It is an abstract data type
(c) It allows insertion at both ends
(d) It can be implemented using only arrays

(v) In a queue, where is the new element inserted?
(a) Front (b) Rear (c) Middle (d) None of the above.

(vi) Which of the following is NOT a characteristic of recursion?
(a) Base case is required
(b) Recursive call with a smaller input
(c) It always requires more memory than iteration
(d) Can solve problems naturally that have a repetitive structure.

(vii) Which of the following is true about a binary tree?
(a) Every node has at most one child
(b) Every node has at most two children
(c) It is a type of graph
(d) Nodes in a binary tree can have any number of children.

(viii) Which of the following is a characteristic of an adjacency matrix representation of a graph?
(a) It uses less space for sparse graphs
(b) It can be used to store weights of edges
(c) It is efficient for graphs with a large number of vertices
(d) It uses linked lists for storing edges.

(ix) Quick sort uses which of the following methods to implement sorting?
(a) partitioning (b) selection
(c) exchanging (d) merging

(x) Which sorting algorithm has the best average case time complexity for a large number of elements?
(a) Quick sort (b) Bubble sort
(c) Insertion sort (d) Selection sort.

Fill in the blanks with the correct word

(xi) _____ is a collection of data elements organized and stored in a computer so that they can be accessed and modified efficiently.

(xii) The time complexity of an algorithm is often expressed using _____ notations.

(xiii) The worst-case time complexity of the bubble sort algorithm is _____.

(xiv) Recursion is a programming technique where a function calls _____.

(xv) In a _____ linked list, each node contains a reference to both the next and the previous node in the sequence.

Group - B

2. (a) Explain why we need data structures in computer programming?
[(CO1)(Remember/LOCQ)]

(b) Prove that the function h(n) = (5n^4 + 3n^3 + 2n^2 + 1) is (O(n^4) .
[(CO1)(Analyse/IOCQ)]

(c) Explain the differences between Big-O, Big-Ω (Omega), and Big-Θ (Theta) notations. *[(CO1)(Remember/LOCQ)]*

(d) What is an algorithm? What are the key characteristics of a good algorithm?
[(CO1)(Understand/LOCQ)]

3 + 3 + 3 + 3 = 12

3. (a) What is the time complexity of inserting an element into a sorted array?
[(CO1)(Analyse/LOCQ)]

(b) What is the difference between row-major and column-major order in a 2D array? How does this impact memory? *[(CO1)(Understand/IOCQ)]*

(c) Consider the following 2D array and convert it to a column-major order

$$\text{Array} = \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix}$$

representation. *[(CO2)(Apply/IOCQ)]*

(d) What is the time complexity of accessing an element in a 2D array stored in column-major order? *[(CO4)(Analyze/IOCQ)]*

2 + (2 + 2) + 4 + 2 = 12

Group - C

4. (a) Write the pseudo code of stack operations (PUSH, POP, PEEK) using linkedlist. *[(CO2)(Understand/LOCQ)]*

(b) How stack can be used to check the validity of parentheses in any algebraic expression? *[(CO2)(Apply/HOCQ)]*

(c) How reversing a list can be done using stack? *[(CO2)(Apply/IOCQ)]*

6 + 3 + 3 = 12

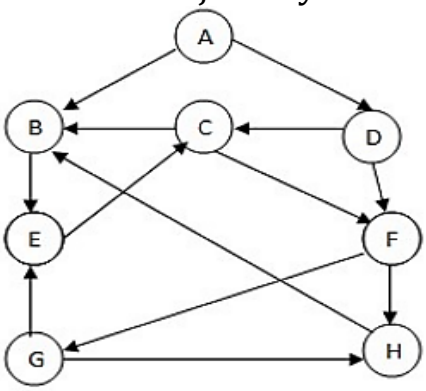
5. (a) Explain the Tower of Hanoi problem with the algorithm. How it can be solved using recursion () [trace for 3 discs]. *[(CO2)(Understand/IOCQ)]*

(b) Explain how the problem of finding factorial can be solved using a recursive function (using both direct and indirect recursion). *[(CO2)(Understand/LOCQ)]*

(3 + 3) + (3 + 3) = 12

Group - D

6. (a) Obtain the adjacency matrix & adjacency list of the following graph.



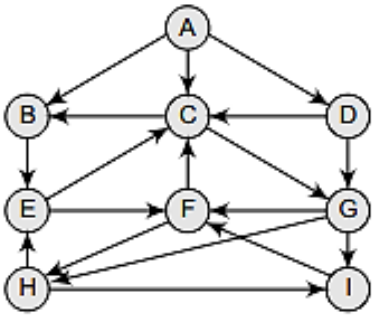
[(CO3)(Apply/IOCQ)]

(b) Create a binary search tree with the input:- 98, 2, 48, 12, 56, 32, 4, 67, 23, 87, 21, 55, 46.
Thereafter, delete the values 23, 56 and 2. Show all steps. *[(CO3)(Apply/HOCQ)]*

(3 + 3) + (3 + 3) = 12

7. (a) Write the algorithm for Depth First Search. *[(CO3)(Understand/IOCQ)]*

(b) Consider the graph G given below. We want to print all the nodes that can be reached from the node H (including H itself). Use a depth-first search of G starting at node H. Explain the procedure. *[(CO3)(Apply/HOCQ)]*



(c) State the time complexity for this traversal. *[(CO3)(Apply/IOCQ)]*

(d) State the applications of DFS. *[(CO3)(Apply/IOCQ)]*

4 + 6 + 1 + 1 = 12

Group - E

8. (a) Write the algorithm for binary search operation for an element in a sorted array. What is the time complexity of the Binary search operation? *[(CO4)(Understand/LOCQ)]*

(b) Consider the following data sequence in the array.
int A[] = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10}. Explain binary search operation to find the value 9. *[(CO5)(Understand/LOCQ)]*

(c) Apply the Quick Sort algorithm to the following array. Discuss all the passes with relevant figures.

27	1	36	18	25	45

[(CO4)(Apply/IOCQ)]

4 + 4 + 4 = 12

9. (a) Explain the methodology of Heap sort with examples. What is the time complexity of the Heap sort methodology? *[(CO5)(Apply/IOCQ)]*

(b) Explain the methodology of Merge sort with examples. What is the time complexity of the Merge sort algorithm? *[(CO5)(Apply/IOCQ)]*

(5 + 1) + (5 + 1) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	32.29	52.08	15.63