DATA STRUCTURE AND BASIC ALGORITHMS
(CSE2004)

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 the space needed to store a linked list of n nodes?
(a) O(1) (b) O(n) (c) $O(n^2)$ (d) None of the above.

(ii) What is the time complexity to insert an element to the rear of a Linked List (head pointer given)?
(a) O(1) (b) O(n) (c) $O(n^2)$ (d) None of the above.

(iii) What is the time complexity of push and pop operations in a stack implemented using an array?
(a) O(1) (b) O(n) (c) O(log n) (d) $O(n^2)$

(iv) In a circular queue, if front = rear + 1, the queue is
(a) Empty (b) Full (c) Half full (d) None of the above

(v) What is the worst case time complexity of the Breadth First Search algorithm on a graph having V vertices & E edges?
(a) O(V+E) (b) $O(V^2)$ (c) O(V*E) (d) $O(E^2)$

(vi) What is the worst case time complexity of searching a key in a binary search tree having 'n' nodes?
(a) O(n) (b) $O(\log_2 n)$ (c) $O(n^2)$ (d) O(1)

(vii) Which of the following cannot be the value of the balance factor of a node in an AVL tree?
(a) 0 (b) -1 (c) 1 (d) 2

(viii) A graph has 8 nodes and 10 edges. What could be the maximum number of connected components in such a graph?
(a) 2 (b) 5 (c) 4 (d) 3

(ix) A hash function f is defined as f(key)= key mod 7, with a linear probing insert the keys 37, 38, 72, 48, 98, 11, 56, into a table indexed from 0, in which location the key 11 will be stored (Count table index 0 as 0^{th} location)?
(a) 1 (b) 2
(c) 5 (d) 6

(x) Which of the following algorithms use recursion for sorting an array of numbers?
(a) Bubble Sort and Insertion Sort (b) Quick Sort and Merge Sort
(c) Bubble Sort and Merge Sort (d) Bubble Sort and Quick Sort.

Fill in the blanks with the correct word

(xi) Sparse matrix _____ format is used to save the memory space of sparse matrix.

(xii) A stack can be implemented using an array or a _____.

(xiii) The minimum number of nodes in a binary heap of height 'h' is _____.

(xiv) A full binary tree of 'n' nodes has _____ leaf nodes.

(xv) The total number of comparisons performed in the best case of the Selection Sort algorithm on an array of 'n' elements is _____.

Group - B

2. (a) What is Big-Oh notation? *[(CO1)(Remember/LOCQ)]*
(b) Prove that the following function f(n) is the $O(n^3)$.
$f(n)= 7n^3 + 2n^2 +5$ *[(CO1)(Analyse/HOCQ)]*
(c) What is Data structure? *[(CO1)(Remember/LOCQ)]*
(d) What are the basic properties of an algorithm? *[(CO1)(Remember/LOCQ)]*

2 + 5 + 1 + 4 = 12

3. (a) Suggest an algorithm to find the middle element of a single linked list in a single pass. *[(CO2)(Implement/HOCQ)]*
(b) State the differences between linear and non-linear data structure. *[(CO2)(Remember/LOCQ)]*
(c) State the advantages and disadvantages of linked list over array. *[(CO2)(Remember/LOCQ)]*

6 + 3 + 3 = 12

Group - C

4. (a) Write the pseudo code of stack operations (PUSH, POP, PEEK) using an array. *[(CO2)(Analyse/HOCQ)]*
(b) Explain the Tower of Hanoi problem with the algorithm. How it can be solved using recursion [trace for 3 discs]. *[(CO2)(Analyse/HOCQ)]*

6 + 6 = 12

5. (a) Convert the following infix expression as a postfix expression notation using STACK:
K+L-M*N+(O^P)*(W/U)*T+Q. *[(CO2)(Analyse/HOCQ)]*

(b) Explain how your algorithm handles operator precedence and parentheses. *[(CO1)(Apply/IOCQ)]*

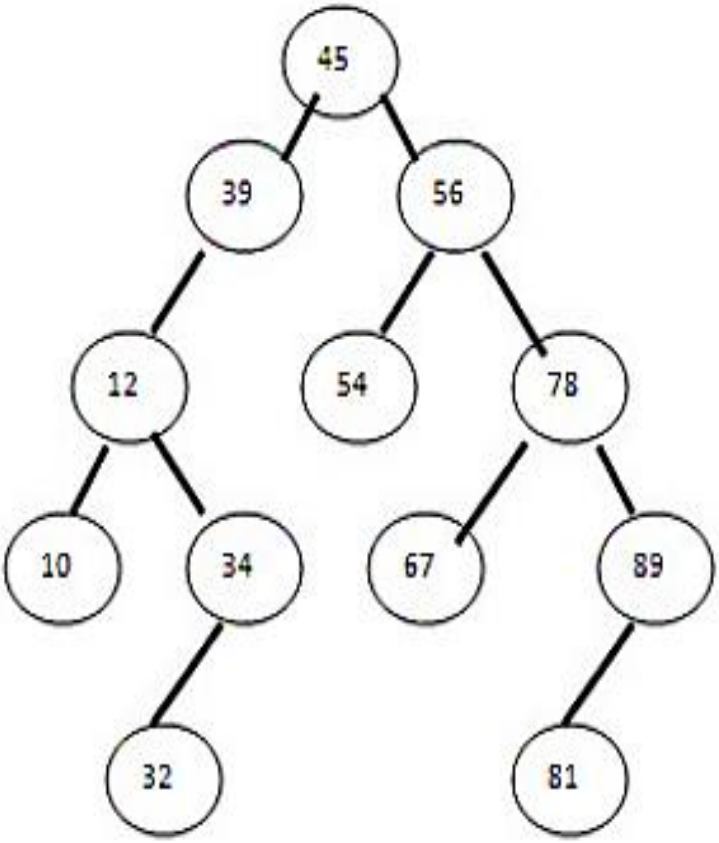
(c) What is an abstract data type? Explain with examples. *[(CO1)(Remember/LOCQ)]*

6 + 3 + 3 = 12

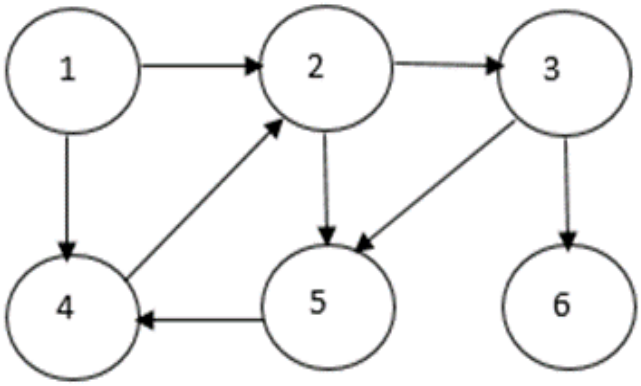
Group - D

6. (a) Given a full binary tree of 'n' nodes, find the number of internal nodes & leaf nodes in terms of 'n'. *[(CO3)(Remember/LOCQ)]*

(b) Obtain the preorder, inorder and postorder traversals of the following binary search tree. *[(CO3)(Evaluate/HOCQ)]*



(c) Show the Depth First Search and Bread First Search Traversal Sequence of the following graph starting from the source vertex numbered 1.



[(CO3)(Applyr/IOCQ)]

2 + 6 + (2 + 2) = 12

7. (a) Consider the following sequence of keys:
40, 15, 65, 35, 55, 45, 75, 95, 85 ,5, 30
Show all steps of inserting the keys in the given sequence in an AVL tree data structures which IS initially empty. *[(CO3)(Analyse/HOCQ)]*

(b) There after delete the value 35 maintaining the structure of AVL tree. *[(CO3)(Analyse/HOCQ)]*

6 + 6 = 12

Group - E

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

(b) Consider the following data sequence in the array.
10,100,85,65,95, 150,75,80.
Apply the Quick Sort algorithm to sort the array. Discuss all the passes with relevant figures. *[(CO4)(Apply/IOCQ)]*

6 + 6 = 12

9. (a) Discuss the different collision resolution techniques used in hashing, focusing on open addressing and chaining. *[(CO4)(Understanding/IOCQ)]*

(b) Provide examples of each technique and analyse their advantages and disadvantages. *[(CO4)(Remember/LOCQ)]*

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	31.25	19.79	48.96