DATA STRUCTURE
(CSEN 2005)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) What is the running time of a linear algorithm?
(a) O(1) (b) O(log n) (c) O(n) (d) O(n log n).

(ii) What is the corresponding postfix expression of the infix expression "a+b*c+(d*e)"
(a) abc*+de*+ (b) abc+*de*+ (c) a+bc*de+* (d) abc*+d*e+

(iii) The minimum number of nodes required to connect all the vertices of a graph having n nodes is
(a) n – 1 (b) n + 1 (c) n^2 (d) 2n

(iv) The following sequence of operations is performed on a stack
Push(1), push(2), pop, push(1), push(2), pop, pop, pop, push(2), pop
The sequence of popped out values are
(a) 2, 2, 1, 2, 1 (b) 2, 2, 1, 1, 2 (c) 2, 1, 2, 2, 1 (d) 2, 1, 2, 2, 2

(v) Which sorting algorithm takes the least time to run if the input array is already sorted in the desired order?
(a) Selection sort (b) Insertion sort (c) Quicksort (d) Merge sort.

(vi) The number of children of a node in an AVL tree is called
(a) Height (b) Depth (c) Degree (d) Balance factor.

(vii) In a complete graph the number of edges with 8 vertices is
(a) 56 (b) 28 (c) 16 (d) 24.

(viii) Which data structure is used to perform Breadth First Search on a graph?
(a) Sorted array (b) Stack (c) Queue (d) AVL tree.

(ix) Suppose the address of the first node of a linked list is stored in a variable named "start". What is the expression to get the value stored in the second node of the list?
(a) start (b) start->data (c) start->next (d) start->next->data.

(x) Which of the following sorting algorithm is of divide and conquer type?
(a) Bubble sort (b) Quick sort (c) Insertion sort (d) Selection sort.

Group- B

2. (a) Explain how the following polynomial can be stored using an array of structures:
$7n^{15} - 3n^6 + n^2 + 2$
[(CO1)(Remember/LOCQ)]

(b) What is an abstract data type? Explain with an example.
[(CO1)(Remember/LOCQ)]

(c) Write a code snippet to insert a new node at position k of a singly-linked list.
[(CO1)(Understand/LOCQ)]

3 + (2 + 1) + 6 = 12

3. (a) Define a sparse matrix and what is the use of the sparse matrix?
[(CO1)(Remember/LOCQ)]

(b) Write the triplet and the linked representation of the following sparse matrix.
[(CO1)(Understand/LOCQ)]

$$A = \begin{vmatrix} 0 & 0 & 6 & 0 & 9 & 0 & 0 \\ 2 & 0 & 0 & 7 & 8 & 0 & 4 \\ 10 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 12 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 3 & 0 & 0 & 5 \end{vmatrix}$$

(c) How is a circular linked list different from a doubly linked list? Which of the two would be better suited for implementing a deque and why?
[(CO1)(Remember/LOCQ)]

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

Group - C

4. (a) What is the tail recursion? How is it different from normal recursion? Explain with a suitable example. [(CO1)(Understand/LOCQ)]

(b) "Iteration is a better choice than recursion". Critically comment on this statement. [(CO5)(Analyze/IOCQ)]

(c) Write the algorithm to enqueue an element into a circular queue whose maximum capacity is denoted by MAX_SIZE. Your algorithm must guard against any overflow or underflow errors if applicable. [(CO2)(Analyze/IOCQ)]

(1 + 1+ 2) + 4 + 4 = 12

5. (a) Convert the following infix expression into postfix using appropriate data structure:

(a + b)/(c – d*2) + e

Show the contents of your data structure as they get modified.

[(CO2)(Understand/LOCQ)]

(b) Write an algorithm to evaluate a postfix expression using stack and hence evaluate the following postfix expression P: 5,6,2,+,*,12,4,/,-.

[(CO2)(Understand/LOCQ)]

(c) Assume Fib(n) is a recursive function. Draw a recursive tree for Fib(6).

[(CO1)(Understand/LOCQ)]

4 + (4 + 2) + 2 = 12

Group – D

6. (a) Create an AVL tree using the following keys: (Mention different rotation and balance factor in each step)
50, 20, 60, 10, 8, 15, 3, 46, 11, 48 [(CO6)(Design/HOCQ)]

(b) What are the two ways of representing a graph? Explain their benefits and drawbacks. [(CO3)(Remember/LOCQ)]

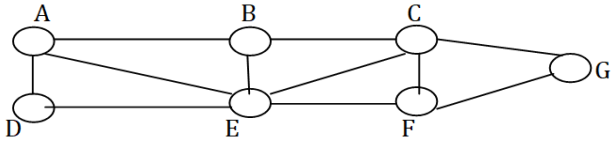
(c) Construct a B-tree of order 5 using the following key values (Show intermediate steps):
Keys: 1, 12, 8, 2, 25, 6, 14, 28, 17, 7, 52, 16, 48, 68, 3, 26, 29, 53, 55, 45, 67

[(CO6)(Design/HOCQ)]

5 + (1 + 2) + 4 = 12

7. (a) Reconstruct a binary tree from its traversal sequences given below:
Inorder : A, B, D, E, C, G, I, H, K, J, F
Preorder : A, B, C, D, E, F, G, H, I, J, K
Write the postorder traversal sequence of the tree. [(CO3)(Understand/IOCQ)]

(b) Explain the operation of Breadth First Search of the following undirected graph taking vertex 'A' as source.



[(CO3)(Implement/IOCQ)]

(c) Prove that maximum number of nodes possible in a binary tree of height h is 2^h-1.

[(CO3,CO5)(Analyze/IOCQ)]

(4 + 1) + 4 + 3 = 12

Group - E

8. (a) Explain the different types of collision resolution techniques in hashing. Use linear probing, to insert the keys 35, 60, 89, 87, 56, 14, 85, 44 into a hash table having size 10. Write the array containing your answer.

[(CO6)(Understand/LOCQ)]

(b) Write the algorithm to implement quicksort algorithm. What is the time complexities of quicksort in the best case and worst case scenarios?

[(CO5)(Understand/IOCQ)]

(c) Is the following statement correct "Quicksort performs better than Insertion sort"? Justify your answer. [(CO5)(Understand/IOCQ)]

(2 + 3) + (4 + 1 + 1) + 1 = 12

9. (a) Perform insertion sort on the given list to arrange the values in ascending order. Show all the different iterations that the algorithm goes through.
20, 27, 33, 40, 37, 23, 13, 30 [(CO5)(Understand/IOCQ)]

(b) Write the algorithm to search for a number in a sorted array of integers using binary search. [(CO4)(Understand/LOCQ)]

(c) Construct a 'max heap' using the given numbers:
82, 90, 10, 12, 15, 77, 55, 23 [(CO6)(Design/HOCQ)]

5 + 4 + 3 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	54.17	33.33	12.50

Course Outcome (CO):

Upon successful completion of this course students should be able to:

1. Identify and select appropriate data structures as applied to specified problem definition.
2. Implement operations like searching, insertion, deletion, traversal etc. on linear data structures like array, stack and queue.
3. Implement operations like searching, insertion, deletion, traversal etc. on nonlinear data structures like tree and graph.
4. Apply appropriate sorting/searching technique for given problem.
5. Analyze and compare the different sorting algorithms.
6. Design advanced data structure using Non-linear data structures.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question