

**DATA STRUCTURE AND BASIC ALGORITHMS  
(CSEN 2001)**

**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) Entries in a stack are “ordered”. What is the meaning of this statement?  
 (a) A collection of stacks is sortable  
 (b) Stack entries may be compared with the ‘<’ operation  
 (c) The entries are stored in a linked list  
 (d) There is a sequential entry that is one by one.
- (ii) In Breadth First Search of graph, which of the following data structures is used?  
 (a) Stack (b) Queue  
 (c) Linked list (d) None of the above.
- (iii) Linked list is considered as an example of \_\_\_\_\_ type of memory allocation.  
 (a) dynamic (b) static  
 (c) compile time (d) none of the above.
- (iv) The degree of a node is  
 (a) the number of arcs going away from the node  
 (b) the number of arcs connected to that node  
 (c) the total number of arcs present in the graph  
 (d) the number of arcs incident to the node.
- (v) Fibonacci function  $\text{fib}(n) = \text{fib}(n-1) + \text{fib}(n-2)$  is an example of  
 (a) linear recursion (b) binary recursion  
 (c) multiple recursion (d) none of the above.
- (vi) Heap can be used as \_\_\_\_\_  
 (a) priority queue (b) stack  
 (c) a decreasing order array (d) none of the above.

- (vii) The adjacency matrix of an undirected graph is  
 (a) unit matrix (b) asymmetric matrix  
 (c) symmetric matrix (d) none of the above.
- (viii) The postfix equivalent of the prefix  $*+ab-cd$  is  
 (a)  $ab+cd-*$  (b)  $ab+-cd*$  (c)  $ab+cd*-$  (d)  $abcd+-*$ .
- (ix) Which data structure would you most likely see in a non-recursive implementation of a recursive algorithm?  
 (a) Linked List (b) Stack (c) Queue (d) Tree.
- (x) Given an array  $\text{arr} = \{5,6,77,88,99\}$  and  $\text{key} = 88$ ; using binary search how many iterations are done until the element is found?  
 (a) 1 (b) 3 (c) 4 (d) 2.

**Group - B**

2. (a) Find out the time complexity of the following:

```
(i) A(int n)
{
  int i,j;
  for(i=1;i<=n;i++){
    for(j=1;j<i*i;j++){
      printf("HITK");
    }
  }
}

(ii) A(int n)
{
  int i,j,k;
  for(i=1;i<=n;i++)
  for(j=1;j+1<=n;j++)
  for(k=1;k<=n;k=k*2)
  printf("HITK");
}

(iii) A(int n)
{
  int i,s=1;
  while(s<=n)
  {
    i++;
    s=s+i;
    printf("HITK");
  }
}
```

- (b) Define Omega-notation and Theta-notation. What is abstract data type? Why array is called abstract data type?

$$(3 \times 2) + (3 + 3) = 12$$

3. (a) How polynomials can be represented using linked list? Write an algorithm to add two polynomial using linked lists.
- (b) Define sparse matrix. Write an algorithm to display the content of a circular linked list (Consider all possible conditions).

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

### Group - C

4. (a) Construct the following queue of characters where queue is of type circular which is allocated six memory cells.  
Front = 2, Rear = 4, Queue = ....., A, B, C, ....., .....

Describe the queue as the following operations are performed:

- (i) F is added to the queue  
 (ii) Two characters are deleted from the queue.  
 (iii) K, L, M are added to the queue  
 (iv) One character is deleted from the queue  
 (v) S, P are added to the queue

- (b) Convert the following infix expression to its equivalent postfix expression using stack.  
 $(A+B)*(C^{(D-E)+F})-G$ .

- (c) Write a function/algorithm to implement queue data structure using stack.

$$5 + 4 + 3 = 12$$

5. (a) Define tail recursion. Write a tail recursive function to calculate GCD of two numbers. Also draw the recursive tree for the same.

- (b) Define deque.

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

### Group - D

6. (a) Write an algorithm to count the number of leaf nodes in a binary tree.
- (b) Prove that a binary tree of n nodes has height at most n-1.
- (c) Two binary trees are similar if they are both empty or if they are both nonempty and left and right sub-trees are similar. Write an algorithm to determine if two binary trees are similar.

$$4 + 2 + 6 = 12$$

7. (a) Show the result of inserting 7, 6, 9, 10, 14, 8, 11, 12 into an initially empty AVL tree. Specify the type of rotation after each insertion.

- (b) How would you represent a graph in the memory of a computer?

- (c) Why is time complexity of BFS and DFS  $O(V + E)$ ? Explain the significance of + sign in this context.

$$5 + 3 + 4 = 12$$

### Group - E

8. (a) Suppose we have an array of numbers  $a[1], \dots, a[n]$  in which the first i numbers  $a[1], \dots, a[i]$  have been sorted into ascending order, and the remaining numbers  $a[i+1], \dots, a[n]$  have been sorted in descending order. The aim is to sort the entire array in ascending order. Write a sorting algorithm that takes time  $O(n)$ .

- (b) Define hash table. What is collision?

$$7 + (2 + 3) = 12$$

9. (a) Show the steps of sorting the following sequence in ascending order using quick sort method. Show the snapshots after every interchange.  
35, 45, 25, 15, 95, 5, 85, 65.

- (b) Deduce the time complexity of quick sort under worst case situation.

- (c) Consider a hash table with size = 10. Using quadratic probing insert the keys 27, 72, 63, 42, 36, 18, 29 and 101 into the table. Take  $c_1 = 1$  and  $c_2 = 3$ .

$$6 + 4 + 2 = 12$$