

**DATA STRUCTURE AND BASIC ALGORITHMS
(CSEN 2004)**

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) If a tree with n number of nodes is a full binary tree, what can be the value of n ?
(a) 8 (b) 15 (c) 13 (d) 14.
 - (ii) The running time of a linear time algorithm is
(a) $O(1)$ (b) $O(n)$ (c) $O(n \log n)$ (d) $O(\log n)$
 - (iii) How much time does an AVL tree take to perform a single search, insert or delete operation in the average case as well as the worst case?
(a) $O(n)$ (b) $O(\log n)$ (c) $O(n^2)$ (d) $O(n \log n)$.
 - (iv) The minimum number of edges required to connect all the nodes of a graph containing m nodes is
(a) $2m$ (b) m^2 (c) $m - 1$ (d) $m + 1$.
 - (v) Which of the following Data Structure is essential for the conversion of an infix expression to postfix?
(a) Queue (b) Operator Stack (c) Operand Stack (d) None of these.
 - (vi) The memory address of fifth element of an array can be calculated by the formula
(a) $LOC(\text{Array}[5]) = \text{Base}(\text{Array}) + w(5 - \text{lower bound})$, where w is the number of words per memory cell for the array
(b) $LOC(\text{Array}[5]) = \text{Base}(\text{Array}[5]) + (5 - \text{lower bound})$, where w is the number of words per memory cell for the array
(c) $LOC(\text{Array}[5]) = \text{Base}(\text{Array}[4]) + (5 - \text{Upper bound})$, where w is the number of words per memory cell for the array
(d) None of above
 - (vii) What is not true about insertion sort?
(a) Exhibits the worst case performance when the initial array is sorted in reverse order.

- (b) Worst case and average case performance is $O(n^2)$.
(c) Can be compared to the way a card player arranges his card from a card deck.
(d) None of the above.
- (viii) Suppose we are sorting an array of eight integers using quicksort, and we have just finished the first partitioning with the array looking like this:
2 5 1 7 9 12 11 10
Which statement is correct?
(a) The pivot could be either the 7 or the 9
(b) The pivot could be the 7, but it is not the 9
(c) The pivot is not the 7, but it could be the 9
(d) Neither the 7 nor the 9 is the pivot.
- (ix) Given an integer array `arr[ ]`; the *i*-th element can be accessed by writing
(a) `*(arr+i)` (b) `arr[i]` (c) both (a) and (b) (d) `*arr + i`
- (x) Level of a node is distance from root to that node. For example, level of root is 1 and level of left or right children of root is 2. The maximum number of nodes on level *i* of a binary tree is
(a) 2^{i-1} (b) 2^i (c) $2^{(i+1)}$ (d) $2^{[(i+1)/2]}$

Group – B

2. (a) Write an algorithm to reverse a single-linked list.
(b) Write an algorithm to insert a node in the *k*th position of a doubly linked list.
(c) What is an upper triangular matrix? Give Example. How is an upper triangular matrix stored in the computer memory?
 $4 + 4 + (2 + 2) = 12$
3. (a) Define Omega-notation and Theta-notation. What is an abstract data type? Why array is called an abstract data type?
(b) What is the difference between a linear and a nonlinear data structure?
(c) Explain that $10n^3 + 20n \neq O(n^2)$.
 $(3 + 3) + 2 + 4 = 12$

Group – C

4. (a) Write a program to implement insertion and deletion of elements in a circular queue (using array). Also, incorporate the checking for underflow and overflow.
(b) Write a program to find gcd (greatest common divisor) of two integers using recursion.
(c) What is tail recursion? Explain with example.
 $5 + 4 + (1 + 2) = 12$

5. (a) Write an algorithm to convert an infix expression to postfix. Convert the expression given below into its corresponding postfix expression. Show each step of the conversion.

$$10 + ((7-5) + 2 * 3^2^2) / 2$$

- (b) Predict the output of the following program and explain.

```
#include <stdio.h>
int fun(int n)
{
    if (n == 4)
        return n;
    else
        return 2*fun(n+1);
}

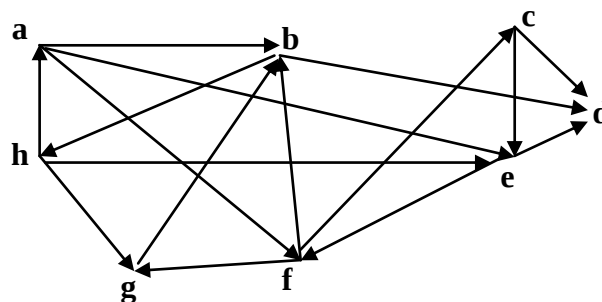
int main()
{
    printf("%d ", fun(2));
    return 0;
}
```

- (c) Write an algorithm to check whether a given expression contains balanced parentheses or not, note that only '(' and ')' are allowed here as parentheses.

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

Group - D

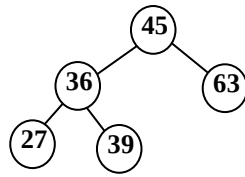
6. (a) What is a complete binary tree and a full binary tree? Give example.
- (b) How are graphs represented inside computer's memory? Discuss with example.
- (c) Write the result of running BFS and DFS on the directed graph given below using vertex 'a' as the source. Show the status of the data structure used at each stage. Write down the in-degree of the vertices.



- (d) "Graphs have a purely parent-to-child relationship among their nodes" – comment on the statement (whether true or false). Give an explanation of your comment.

$$2 + 3 + 5 + 2 = 12$$

7. (a) Consider the AVL tree given below and insert 18, 81, 29, 15, 19, 25, 37, and 1 in it. Then delete nodes 63, 15, and 1 from the AVL tree. Show the tree after each intermediate step.



- (b) The inorder and preorder traversal of a binary tree are given below:
 Inorder: s q t p u r v , Preorder: p q s t r u v
 Find the postorder traversal of the binary tree.
- (c) What is the advantage of AVL tree over Binary Search Tree? Explain with an example.

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

Group – E

8. (a) Discuss various collision resolution techniques in hashing. Consider a hash table of size 10. Using linear probing, insert keys 72, 27, 36, 24, 63, 81, 92, and 101 into the table.
- (b) Write a program for implementing quick sort algorithm using recursion.
9. (a) Write a function to implement Binary Search on an n-element array. What is its asymptotic time complexity?
- (b) Can binary search be implemented on a linked list? If no, explain the reason. If yes, provide an estimation of the number of traversal of the linked list for searching any element that is not in the list.
- (c) Compare the best case, worst case, and average case running time complexities of insertion sort, bubble sort, selection sort, and quick sort.

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

Department & Section	Submission Link
AEIE	https://classroom.google.com/c/MzExOTEzNDkwNjc0/a/Mzc0Mjk0NzA4MTg0/details