

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 the time complexity of inserting a new node at the beginning of a singly linked list?
 (a) $O(1)$ (b) $O(n)$
 (c) $O(\log n)$ (d) $O(n \log n)$
- (ii) void fun1(struct node* head)
 {
 if(head == NULL)
 return;
 fun1(head→next);
 printf("%d", head→data);
 }
 (a) Print all nodes in the list (b) Print all nodes in reverse order
 (c) Prints alternate nodes of Linked List (d) Prints alternate nodes in reverse order
- (iii) What is the result of the following sequence of operations on a stack: Push(1), Push(2), Pop(), Push(3), Pop()?
 (a) 1 (b) 2
 (c) 3 (d) Stack is empty
- (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) Which of the following is true about an AVL tree?
 (a) It is a self-balancing binary search tree (b) It is an unbalanced tree
 (c) It allows duplicate keys (d) It has no height restrictions
- (vi) In graph theory, what does the degree of a vertex represent?
 (a) The number of edges connected to the vertex (b) The number of vertices connected to the graph
 (c) The shortest path from the vertex to the root (d) The maximum number of children a vertex can have
- (vii) Which of the following graph traversal methods explores as far as possible along each branch before backtracking?
 (a) Depth-First Search (DFS) (b) Breadth-First Search (BFS)
 (c) Level-order traversal (d) Topological Sort
- (viii) In bubble sort, how many comparisons are made in the worst case for an array of n elements?
 (a) $O(n)$ (b) $O(n \log n)$
 (c) $O(n^2)$ (d) $O(\log n)$
- (ix) Which of the following collision resolution techniques uses linked lists?
 (a) Open addressing (b) Linear probing
 (c) Chaining (d) Double hashing
- (x) Which of the following is true about binary search?
 (a) It can be applied to any list, sorted or unsorted.
 (b) It has a worst-case time complexity of $O(n)$.
 (c) It requires the list to be sorted before the search is performed.
 (d) It works faster than linear search on all types of lists.

Fill in the blanks with the correct word

- (xi) In a row-major representation of a 2D array, elements are stored in _____ order in memory.
- (xii) A _____ traversal processes the root of the binary tree first, then the left subtree, and finally the right subtree.
- (xiii) In a B-Tree of order m, a node can have at most _____ children.
- (xiv) _____ is a graph traversal technique that uses a stack to explore as far as possible along each branch before backtracking.

(xv) _____ notation is used to describe the asymptotic behavior of an algorithm's time or space complexity.

Group - B

2. (a) Consider a List implemented using an array. What is the time complexity of the following operations?

- (i) Insert at the end of the list (when there is no need to resize)
- (ii) Delete from the end of the list
- (iii) Insert at the beginning of the list
- (iv) Delete from the beginning of the list
- (v) Access an element at a specific index
- (vi) Search for an element in the list.

[[CO2](Understand/IOCQ)]

(b) What are the demerits of implementing a List using an array?

[[CO2](Understand/IOCQ)]

(c) Consider the following loop and calculate its time complexity.

```
for(i = 1; i <= n; i++) {  
    printf("Algorithm\n");  
    for(j = 1; j <= i*i; j++) {  
        printf("Data Structures\n");  
    }  
}
```

[[CO1](Evaluate/HOCQ)]

6 + 2 + 4 = 12

3. (a) Consider two different polynomials $X_1 = 4x^3 + 5x^2 + 7x$ and $X_2 = 8x^2 + 9x + 4$. The degree of X_1 is 3 and the degree of X_2 is 2. Show the steps to add the polynomials using an array.

[[CO2](Apply/HOCQ)]

(b) Consider a doubly linked list.

Write pseudo codes for the following points:-

- (i) Print the linked list in reverse order.
- (ii) Append an element to the list.
- (iii) Delete the first element.

[[CO2](Apply/HOCQ)]

4 + (2 + 3 + 3) = 12

Group - C

4. (a) Convert the following infix to postfix notation: $K+L-M*N+(O^P)*W/U/V*T+Q$.

[[CO3](Apply/IOCQ)]

(b) Explain how your algorithm handles operator precedence and parentheses.

[[CO1](Remember/IOCQ)]

(c) When a deque will act like a simple queue?

[[CO2](Understand/LOCQ)]

6 + 4 + 2 = 12

5. (a) Explain how the problem of find G.C.D of two numbers can be solved using tail recursion.

[[CO2](Understand/IOCQ)]

(b) Explain the output of following code:

```
#include<stdio.h>  
void f1();  
void f2();  
void f2(int n)  
{  
    if(n==0)  
        return;  
    f1(n-1);  
    printf("f2 called :=%d\n",n);  
}  
void f1(int n)  
{  
    if(n==0)  
        return;  
    f2(n-1);  
    printf("f1 called :=%d\n",n);  
}  
  
int main()  
{  
    f1(5);  
}
```

[[CO2](Apply/IOCQ)]

(c) What is the Time complexity of the following recursive code:

```
int fib(int n)
{
    if (n == 0)
        return 0;
    if (n == 1)
        return 1;

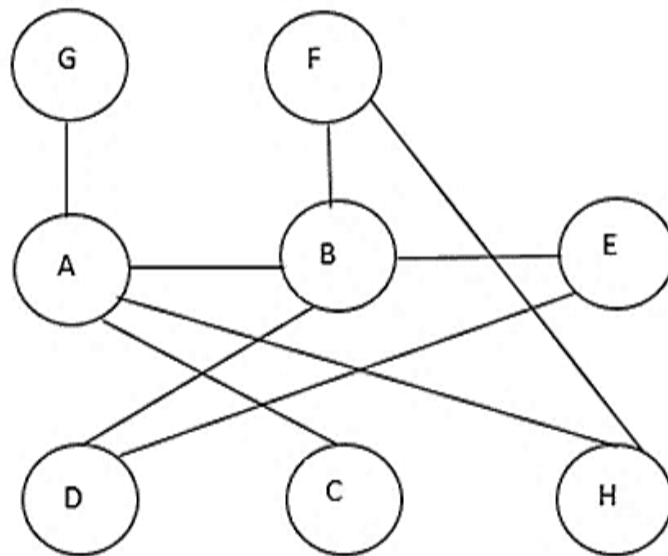
    else return(fib(n-1)+fib(n-2));
}
```

[[CO2](Understand/IOCQ)]
4 + 6 + 2 = 12

Group - D

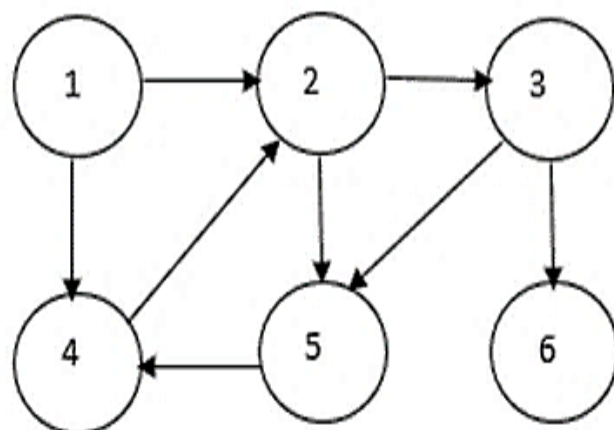
6. (a) Write down the differences between a binary search tree and an AVL tree using appropriate points of differences. [[CO6](Analyse/LOCQ)]
- (b) Given the expression, $Exp = a + b / c * d - e$, construct the corresponding binary tree. [[CO3](Analyse/IOCQ)]
- (c) Create a Binary Search Tree (BST) with the input sequence: 50, 30, 70, 20, 40, 60, 80
- (i) Insert the values 25 and 65 into the created BST.
- (ii) Delete the value 30 from the BST.
- (iii) After deletion, explain how the structure of the BST changes and discuss the properties that are maintained. [[CO6](Apply/HOCQ)]
- 2 + 4 + 6 = 12**

7. (a) Write the pseudo-code for Breadth First Search traversal & show all steps of running your code on the given input graph taking G as the source node:-



[[CO3](Apply/IOCQ)]

- (b) (i) Write the pseudo-code for Depth First Search traversal & mention the time complexity of the algorithm.
- (ii) Show the Depth First Search Traversal Sequence of the following graph starting from the source vertex numbered 1, along with the discovery & finishing time of each vertex of the graph.



[[CO3](Apply/IOCQ)]
6 + (4 + 2) = 12

Group - E

8. (a) Given a hash table of 100 locations (0 to 99), calculate the hash value using the folding method for keys 500098, 351899, and 777709. [[CO1](Remember/LOCQ)]
- (b) Consider a hash table of size 10. Using linear probing, insert the keys 72, 27, 36, 24, 63, 81, 92, and 101 into the table. [[CO1](Analyze/IOCQ)]
- 6 + 6 = 12**

9. (a) Provide the algorithm for quick sort.
(b) Explain the working of quick for a sorted array. Provide its time complexity for the sorted array.

[[CO4](Understand/IOCQ)]

[[CO5](Analyse/HOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	10.4	47.9	41.7