FUNDAMENTALS OF DATA STRUCTURES
(CSBS 2101)

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) Stack is also called
(a) First In First Out (b) Last In Last Out
(c) First In Last Out (d) None of the above.

(ii) In order to reverse a string of characters, a _____ is used.
(a) Queue (b) Linked List (c) Stack (d) graph

(iii) Linked List is considered as an example of _____ type of memory allocation.
(a) dynamic (b) static (c) compile time (d) none of the mentioned

(iv) The postfix form of the expression A*B+C*D is
(a) AB*+CD* (b) AB*CD*+ (c) ABC+*CD* (d) none of the given.

(v) A machine needs a minimum of 100 sec. to sort 1024 names by Merge sort. The minimum time needed to sort 512 names will be approximately
(a) 49.5 sec (b) 45 sec (c) 72.7 sec (d) 50 sec.

(vi) If a node having two children is deleted from a binary tree, it is replaced by its
(a) inorder predecessor (b) inorder successor
(c) preorder predecessor (d) none of the above.

(vii) A hash function f defined as f(key) = key mod 7, with linear probing, is used to insert the keys 37, 38, 72, 48, 98, 11, 56 into a table indexed from 0 to 6. What will be the location of key 11?
(a) 3 (b) 4 (c) 5 (d) 6.

(viii) Inserting a node after a given node in a doubly linked list requires
(a) one pointer changes (b) two pointer changes
(c) three pointer changes (d) four pointer changes.

(ix) Which one of the following is better computing time (in analysis of algorithm)?
(a) O(N) (b) $O(2^N)$ (c) $O(\log_2 N)$ (d) $O(N^2)$.

(x) Which of the following statements is true?

(a) The time complexity of interpolation search is always better than binary search.

(b) The time complexity of binary search is always better than interpolation search.

(c) The worst-case complexity of interpolation search is better than worstcase complexity of binary search

(d) The average case complexity of interpolation search is better than average case complexity of binary search.

Group- B

2. (a) Determine the time complexity of the following program segments in term of Big-Oh.

```
void function (int n)
{   int sum=0;
     for(int i=0; i<n; i++)
     {       if(i>j)
               sum=sum+1;
             else
              {  for(int k=0; k<n; k++)
                   sum=sum-1;
               }
     }
}
```

[(CO1)(Evaluate/HOCQ)]

(b) Find the sparse representation (triple format) for the following matrix. Check whether it is useful to use the sparse representation instead of the original matrix.

0	4	0	5
0	0	3	6
0	0	2	0
2	0	0	0
1	0	0	0

[(CO2)(Understand/LOCQ)]

(c) Each element of an array DATA[20][50] requires 4 bytes of storage. Base address of DATA is 2000, determine the location of DATA[10][10] when the array is stored as column-major order. [(CO2)(Apply/IOCQ)]

4 + (3 + 2) + 3 = 12

3. (a) Distinguish between linear and non-linear data structures.

[(CO2) (Understand/LOCQ)]

(b) Polynomials can be represented either by an array or linked list. Compare and contrast these two types of representation. How can a polynomial such as $7y^4 – 4x^3 + 16x – 23$ be represented by a linked list? [(CO2)(Apply/IOCQ)]

(c) Let p be a pointer to the first node in a doubly linked list and x an arbitrary node in the list. Write an algorithm to delete x from the list. [(CO2)(Apply/IOCQ)]

2 + (2+3) + 5= 12

Group - C

4. (a) Consider the following circular queue where QUEUE is allocated 6 memory cells. Front=2, Rear=5. QUEUE:- __, London, Berlin, Delhi, NewYork, __ .
Describe the queue, including Front and Rear, as the following operations take place:-
(i) Madrid and Beijing is added to the queue
(ii) Moscow is added to the queue
(iii) Two cities deleted from the queue
(iv) Kolkata, London added to the queue
(v) One city deleted from the queue
(vi) At some point, if Front = 5 and Rear = 2, how many cities are there in the queue?
[(CO3)(Understand/LOCQ)]

(b) How do you convert a linear queue into circular queue using C code?
[(CO3)(Understand/IOCQ)]

(c) Write a recursive algorithm for solving Towers of Hanoi problem with n disks.
[(CO3)(Understand/IOCQ)]

6 + 2 + 4 = 12

5. (a) Evaluate the following expression using Stack : 5 + (2*3 - (9/3^2)*7) *1. Show every step using table. [(CO3)(Apply/IOCQ)]

(b) Let N be an integer and suppose H(N) is recursively defined by

$$H(N) = \begin{cases} 3*N & \text{if } N > 5 \\ 2*H(N-5) + 7 & \text{otherwise} \end{cases}$$

Find the values of H(2), H(8) and H(24). [(CO3)(Apply/IOCQ)]

7 + (1 + 2 + 2) = 12

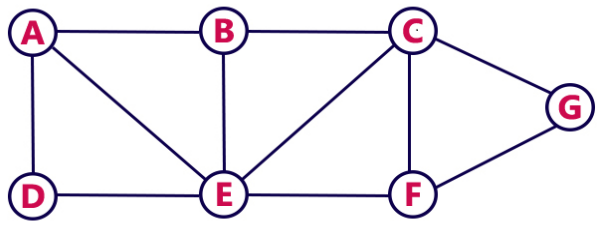
Group - D

6. (a) A binary tree T has 12 nodes. The Inorder and Preorder traversals of T yield the following sequences of nodes:
Inorder : Q B K C F A G P E D H R
Preorder: G B Q A C K F P D E R H
Draw the tree. State briefly the logic used to construct the tree.
[(CO4)(Analyse/IOCQ)]

(b) Draw the BST for the following sequence of numbers, step by step :-
45, 36, 76, 23, 89, 115, 98, 39, 41, 56, 69, 23, 48.
[(CO4)(Apply/IOCQ)]

6 + 6 = 12

7. Consider the following graph for BFS and DFS traversal. Starting from node A, what will be BFS & DFS traversal? Show every step in BFS & DFS.



[(CO4) (Apply/IOCQ)]

(6 + 6) = 12

Group - E

8. (a) What is in-place sorting? [(CO5)(Remember/LOCQ)]
   (b) Write an algorithm to perform interpolation search. How is it different from binary search? [(CO5)(Understand/LOCQ)]
   (c) Sort the following list in ascending order using selection sort.
   33, 51, 27, 85, 66, 23, 13, 57 [(CO5)(Apply/IOCQ)]
   2 + (4 + 2) + 4 = 12

9. (a) What do you mean by Hashing and Hash functions? [(CO5)(Understand/LOCQ)]
   (b) Consider a hash table of size 11 indexed through 0 to 10 and that the following keys are to be mapped on to the table:
   10, 22, 31 ,4, 15, 28, 17, 59, 88
   Determine the hash addresses and find how many collisions occurs, when the keys are reduced using the hashing function h(k)=k mod 11 and linear probing.
   [(CO5)(Analyse/IOCQ)]
   (c) Sort the list of 14 names given below using insertion sort. Tim, Dot, Eva, Roy, Tom, Kim, Guy, Amy, Jon, Aun, Jim, Kay, Ron, Jan. [(CO5)(Apply/IOCQ)]
   2 + 6 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	23.95	71.87	4.16

Course Outcome (CO):

After the completion of the course students will be able to
CSBS2101.1. Demonstrate the standard data structures covered in this course, in relevant applications.
CSBS2101.2. Identify the application of ordered and unordered lists in relevant problems of data structures.
CSBS2101.3. Apply stack and queue data structure to solve mathematical and real-life problems.
CSBS2101.4. Explore tree and graph approaches, mentioned in this course, to solve a given problem definition.
CSBS2101.5. Analyse algorithms related to sorting, searching and hashing covered in this course, in related applications.
CSBS2101.6. Compare the performance of alternative approaches built using different data structures covered in this course, with respect to their efficiency

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