DATA STRUCTURES AND APPLICATIONS
(CBS2101)

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

(ii) Which type of linked list stores the address of the header node in the next field of the last node?
(a) Singly linked list (b) Doubly linked list
(c) Circular linked list (d) None of the above.

(iii) Convert the infix to postfix for A-(B+C)*(D/E)
(a) ABC+DE/* (b) ABC-DE/*
(c) ABC-DE*/ (d) None of the above

(iv) Consider a standard Circular Queue \'q\' implementation (which has the same condition for Queue Full and Queue Empty) whose size is 11 and the elements of the queue are q[0], q[1], q[2].....,q[10]. The front and rear pointers are initialized to point at q[2] . In which position will the ninth element be added?
(a) q[0] (b) q[1] (c) q[9] (d) q[10]

(v) The five items P, Q, R, S, T are pushed in to a stack, one after the other starting from P. The stack is popped four times and each element is inserted in a queue. Then two elements are deleted from the queue and pushed back on the stack. Now one item is popped from the stack, the popped item is
(a) P (b) R (c) Q (d) S

(vi) What data structure is used for breadth first traversal of a graph?
(a) Queue (b) Stack
(c) Linked list (d) None of the mentioned.

(vii) The height of a binary tree is the maximum number of edges in any root to leaf path. The maximum number of nodes in a binary tree of height h is
(a) 2^h -1 (b) 2^(h-1) – 1
(c) 2^(h+1) – 1 (d) 2*(h+1)

(viii) As a part of the maintenance work, you are entrusted with the work of rearranging the library books in a shelf in proper order, at the end of each day. The ideal choice will be

(a) Bubble sort (b) Insertion sort
(c) Selection sort (d) Heap sort

(ix) 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.

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

Fill in the blanks with the correct word

(xi) The best case time complexity of optimised bubble sort is _____.

(xii) The best case time complexity of Insertion sort is _____.

(xiii) An AVL tree is a _____ binary search tree where the difference between the heights of left and right sub trees of any node cannot be more than one.

(xiv) Worst case time complexity of searching in a binary search tree is _____.

(xv) The number of edges from the node to the deepest leaf is called _____ of the tree.

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 matrix shown. Check whether it is useful to use the sparse representation instead of the original matrix. *[(CO2)(Understand/LOCQ)]*

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

(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) Which of the following permutation can be obtained in the same order using a stack assuming that input is the sequence 5, 6, 7, 8, 9 in that order?
Examine each option carefully with the help of proper diagram and justify the right ermutation.
(i) 7, 8, 9, 5, 6 (ii) 5, 9, 6, 7, 8 (iii) 7, 8, 9, 6, 5 (iv) 9, 8, 7, 5, 6 *[(CO3)(Evaluate/HOCQ)]*

(b) Convert the following infix expression into postfix expression using Stack:
A^B*C-D+E/F/(G+H)
Draw stack and show what happens with proper explanations. Here '^' denotes exponentiation and ' * ' denotes multiplication and ' / ' denotes division operation. Every other symbols have their usual meaning. *[(CO3)(Apply/IOCQ)]*

6 + 6 = 12

5. (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 values, 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)(Analyse/HOCQ)]*

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

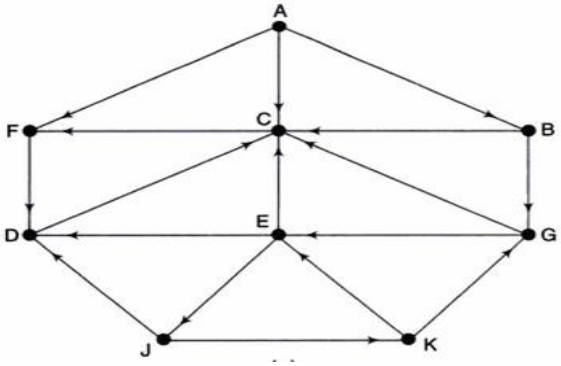
(c) Let a and b denote positive integers. Suppose a function Q is defined recursively as follows:
Q(a,b) = 0 if a < b
Q(a,b) = Q(a-b, b) + 1 if b <= a
What does this function do? Find Q(586,7). *[(CO3)(Understand/LOCQ)]*

6 + 2 + 4 = 12

Group - D

6. (a) What is Adjacency Matrix and Adjacency List? Explain with example.
[(CO4)(Remember/LOCQ)]

(b) Consider the graph in the figure below. Suppose the graph represents the daily flights between cities of some airline, and suppose we want to fly from city A to city J with the minimum number of stops. Find out the minimum path from A to J using BFS traversal. Show every step with explanation. *[(CO4)(Apply/IOCQ)]*

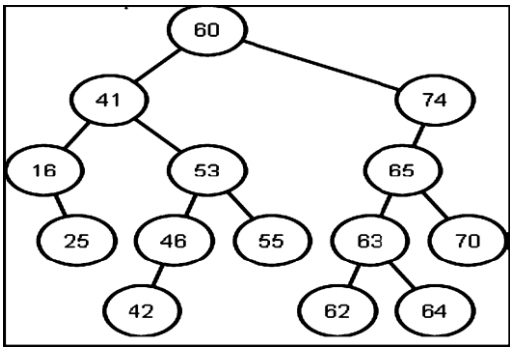


Adjacency lists	
A:	F, C, B
B:	G, C
C:	F
D:	C
E:	D, C, J
F:	D
G:	C, E
J:	D, K
K:	E, G

4 + 8 = 12

7. (a) Insert the following elements into a binary search tree:-
45, 29, 56, 12, 34, 78, 32, 10, 89, 54, 67, 81. *[(CO4)(Understand/LOCQ)]*

(b) Traverse the following tree using pre-order, in-order and post-order traversal algorithm :- *[(CO4)(Apply/IOCQ)]*



6 + (2 + 2 + 2) = 12

Group - E

8. (a) Using the Bubble Sort algorithm, find the number of key comparisons(C) and the number of swaps (D) in the 6 letter word PEOPLE. Assume you are using optimized Bubble Sort algorithm to sort. Show every step in the process. *[(CO5)(Apply/IOCQ)]*

(b) Using Radix sort, show step by step how you will sort the following numbers:-
12, 25, 374, 111, 9, 29, 232, 81, 188. *[(CO5)(Apply/IOCQ)]*

7 + 5 = 12

9. (a) Consider the initial list:- 11,7,12,14,19,1,6,18,8,29,3
Show step by step, how you are going to sort the above list using Shell sort.
[(CO5)(Analyse/IOCQ)]

(b) Write down the algorithm (not code) for merge sort. *[(CO5)(Understand/LOCQ)]*

(c) You are given a total of 1024 ten digit phone numbers in random order. You have to search for a number and your target could be anywhere in the list. What will be the average number of key comparisons to find your target number? Deduce it. *[(CO5)(Apply/IOCQ)]*

6 + 3 + 3 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	31.25	52.08	16.67