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) The worst case occurs in linear search algorithm when
(a) Item is somewhere in the middle of the array
(b) Item is not in the array at all
(c) Item is the last element in the array
(d) Item is the last element in the array or is not there at all.

(ii) In a modified Towers of Hanoi problem, you have to move 5 disks from peg 1 to peg 3. To do that first you need to move 4 disks from peg 1 to peg 2.
How many legitimate moves will it take to move 4 disks from peg 1 to peg 2?
(a) 31 (b)16 (c) 32 (d) 15.

(iii) Using Bubble sort, to sort 100 names, the maximum number of comparisons will be
(a) 4950 (b) 9900 (c) 10000 (d) 100.

(iv) A data structure where elements can be added or removed at either end but not in the middle
(a) Linked lists (b) Stacks
(c) Queues (d) Deque.

(v) The following sequence of operations is performed on a stack:
push (10), push (20), pop, push (10), push (20), pop, pop, pop, push(20), pop.
The sequence of values that popped out is
(a) 20, 10, 20, 10, 20 (b) 20, 20, 10, 10, 20
(c) 10, 20, 20, 10, 20 (d) 20, 20, 10, 20, 10

(vi) When inorder traversing a tree resulted E A C K F H D B G; the preordertraversal would return
(a) FAEKCDBHG (b) FAEKCDHGB
(c) EAFKHDCBG (d) FEAKDCHBG.

(vii) Suppose a circular queue of capacity (n – 1) elements is implemented with an array of n elements. Initially, REAR = FRONT = 0. The conditions to detect queue full and queue empty are
(a) full: REAR = = FRONT; empty: (REAR + 1) % n = = FRONT
(b) full: (REAR + 1) % n = = FRONT; empty: (FRONT + 1) % n = = REAR
(c) full: (REAR + 1) % n = = FRONT; empty: REAR = = FRONT
(d) full: (FRONT + 1) % n = = REAR; empty: REAR = = FRONT

(viii) The in-order traversal of a tree will yield a sorted listing of elements of the tree in
(a) Binary trees (b) Binary search trees
(c) Heaps (d) None of these.

(ix) Which data structure should be used for implementing an iterative algorithm of pre-order traversal?
(a) Stack (b) Input and output restricted deque
(c) Queue (d) None of the above.

(x) B-tree of order n is an order-n multiway tree in which each non-root node contains _____
(a) at most (n – 1) keys (b) exact (n – 1) keys
(c) at least 2n keys (d) at least (n – 1)keys.

Group – B

2. (a) Define Sparse matrix and its usefulness. [(CO1) (Understand/LOCQ)]
(b) Consider an array *studentMarks[20][5]*, to store the marks of 20 students in 5 different subjects. Suppose the base address is 1000 and the size of each element is 4 bytes in memory. Find the address of *studentMarks* [15][4], in Row-Major order. Also, find the address of the same element in Column-Major order. [(CO2) (Apply/IOCQ)]
(c) Write a function to multiply two polynomials where the polynomials are allocated dynamically. [(CO2) (Apply/IOCQ)]

2 + 4 + 6 = 12

3. (a) Write a function to delete the node with the minimum value, from a doubly linked list. If there are multiple occurrences, delete all the occurrences. [(CO2)(Apply/IOCQ)]
(b) Discuss the advantages of Linked List over array on the following points
(i) dynamic data structure
(ii) memory wastage. [(CO6) (Analyse/IOCQ)]
(c) Write a function to construct a Linked List containing similar elements from two given Linked Lists and return the newly constructed Linked List. Assume there are no duplicates in the given Linked Lists. [(CO2) (Apply/IOCQ)]

5 + 2 + 5 = 12

Group – C

4. (a) Define tail recursion. What are the advantages of tail recursion? [(CO3) (Remember/LOCQ)]
   (b) Explain the usage of the stack in recursive algorithm implementation. [(CO3) (Analyze/LOCQ)]
   (c) Convert the infix expression X+(Y * Z) – ((N * M +O) /P) in to postfix expression using a stack; clearly mention each step involved. [(CO3)(Analyze/IOCQ)]

(2 + 3) + 3 + 4 = 12

5. (a) Write a function to implement queue using two stacks. [(CO3)(Create/HOCQ)]
   (b) Consider the circular queue of characters, QUEUE, with a size of 5. At some point, *front*=1, *rear*=3 and content of QUEUE: _, A, B, C, _. Here "_" denotes an empty cell in the queue. What will be the value of the ***front***, ***rear,*** and the content of QUEUE after the following operations take place?
      (i) D is added to the queue
      (ii) Two letters are deleted
      (iii) E, F, and G are added to the queue
      (iv) Two letters are deleted. [(CO3) (Apply/IOCQ)]
   (c) Explain the concept of *entry restricted Deque* (Double Ended Queue), with an example. [(CO3) (Understand /LOCQ)]

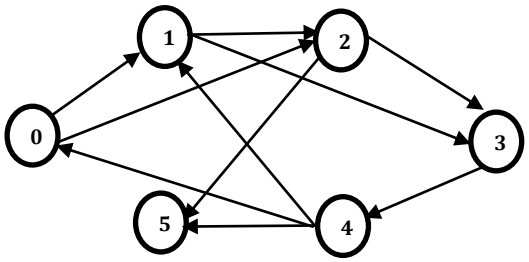
5 + 4 + 3 = 12

Group – D

6. (a) Construct the binary tree from the following traversal sequences
   Pre-Order traversal – ABKGCQFDPERH
   In-Order traversal – KBQCFGADEPHR [(CO4) (Apply /IOCQ)]
   (b) Consider the following sequence of keys 30,10,45,25,50,40,70,90,80,15,20 which will be used to create an AVL tree. Clearly show the rotations while creating the AVL tree. [(CO4) (Create / HOCQ)]
   (c) Write down an algorithm/function to delete a node with two children in a binary search tree (BST). [(CO4) (Apply / IOCQ)]

4 + 5 + 3 = 12

7. (a) Consider the following graph. Traverse the graph with the DFS algorithm, starting from node 0. Show every step. [(CO4) (Apply /IOCQ)]



   (b) Insert the following entries, in the order stated, into an initially empty B-tree of order 5
   A X F B K D H M I E S J R G C L N T U P [(CO4) (Apply/IOCQ)]

6 + 6 = 12

Group – E

8. (a) Transform the array 4, 10, 12, 9, 18, 14, 13, into a heap using any suitable method and use the heap to sort the array. Show all intermediate steps. [(CO5)(Analyse/IOCQ)]
   (b) Explain each step to sort the following list of 14 numbers using selection sort: 6, 4, 2, 25, 52, 38, 28, 20, 14, 23, 50 [(CO5)(Apply/IOCQ)]
   (c) Explain the idea of sentinel used to increase the efficiency of linear search. [(CO6) (Analyse/IOCQ)]

6 + 4 + 2 = 12

9. (a) How searching is associated with sorting? Illustrate with proper example. [(CO5)(Analyse/IOCQ)]
   (b) Transform the array of elements 4, 10, 12, 9, 18, 14, 13 into a heap using any suitable method and use the heap to sort the array. Show all intermediate steps. [(CO5) (Analyse/IOCQ)]
   (c) Explain the idea of sentinel used to increase the efficiency of linear search. [(CO6)(Analyse/IOCQ)]

4 + 6 + 2 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	10.42%	79.17%	10.42%

Course Outcome (CO):

After the completion of the course students will be able to

CO1: Demonstrate the standard data structures covered in this course, in relevant applications.

CO2: Identify the application of ordered and unordered lists in relevant problems of data structures.

CO3: Apply stack and queue data structure to solve mathematical and real-life problems.

CO4: Explore tree and graph approaches, mentioned in this course, to solve a given problem definition.

CO5: Analyse algorithms related to sorting, searching, and hashing covered in this course, in related applications.

CO6: 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

Department & Section	Submission Link
CSBS	https://classroom.google.com/c/NDA1MjE4MTk2MTg4/a/NDczODI4NDgyNjA1/details