DATA STRUCTURE & ALGORITHM
(CSEN 3106)

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) A linear list of elements in which deletion can be done from one end (front) and insertion can take place only at the other end (rear) is known as a
(a) stack (b) queue (c) linked list (d) tree

(iii) 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

(iv) The worst case time complexity of Merge Sort is
(a) O(n^3) (b) O(n log n) (c) O(n^2) (d) O(a^n)

(v) Average case time complexity of Binary Search is
(a) O(n) (b) O (n log n) (c) O (n^2) (d) log n

(vi) Using Bubble sort, to sort 100 names, the maximum number of comparisons will be
(a) 4950 (b) 5050 (c) 10000 (d) 100

(vii) The postfix equivalent of (A+B) * (C-D) is
(a) ABCD + - * (b) AB+ * CD- (c) AB + CD - * (d) CD- AB+ *

(viii) 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

(ix) A full binary tree with 2n+1 nodes contain
(a) n leaf nodes (b) n non-leaf nodes
(c) n-1 leaf nodes (d) n-1 non leaf nodes.

(x) A graph is a collection of nodes, called ..... and..... connect pair of nodes.
(a) edges, vertices (b) vertices, edges
(d) vertices, path (d) graph node, edges.

Group – B

2. (a) Write down the basic features of an algorithm.

(b)
```
Algorithm RSum(a,n)
{ if (n <= 0) then
  return 0;
else
 return RSum(a, n-1) + a[n];
}
```
Deduce the space complexity of the above algorithm.

(c) Let $f(n) = 3n^2 + 4n+1$. Show $f(n)$ is in $O(n^2)$.

4 + 4 + 4 = 12

3. (a) Consider an array of 50 × 5, called Score, to store the numerical grades of 50 students in five different subjects. Suppose base address of Score is 1000 and w = 4 bytes. What will be the address of Score[27,4], i.e., the 4th subject score of 27th student in Row-Major order? What will be the address of the same in Column-Major order?

(b) Write down the algorithm (not code) to insert a new node at the end of a singly linked list.

(c) Write a C function to count the number of nodes in a singly linked list.

4 + 4 + 4 = 12

Group – C

4. (a) Consider the following queue of characters, where QUEUE is a circular queue with a size of 6. At some point, FRONT=2, REAR=4 and QUEUE: _, A,C,D, _, _
Here "_" denotes an empty cell in the array. What will be the value of FRONT and REAR, also describe the QUEUE as the following operations takes place.
(a) F is added to the queue (b) Two letters are deleted
(c) K,L and M are added to the queue (d) Two letters are deleted
(e) R is added to the queue (f) Two letters are deleted.

(b) Let a and b denote positive integers. Suppose a function Q is defined recursively as follows:-

$$Q(a,b) = \begin{cases} 0 & \text{if } a < b \\ Q(a-b, b) + 1 & \text{if } b <= a \end{cases}$$

Find the value of Q(2,3) and Q(14,3).

6 + (1 + 5) = 12

5. (a) Suppose STACK is an array of size 6 and initially STACK is empty, i.e., TOP = 0. A, B and ITEM are integer variables, and STACK operates on LIFO principle. Find the output of the following:

```
Set A:= 2 and B := 5;
PUSH (STACK, A);
PUSH (STACK, 4);
PUSH (STACK, B+2);
PUSH (STACK, 9);
PUSH (STACK, A+B);
Repeat while (TOP is not equal to zero)
{  POP (STACK, ITEM)
  PRINT: ITEM;
}[ End of loop]
Return;
```

(b) Evaluate the following postfix expression by using Stack: 12,7,3,-,/,2,1,5,+,*,+ Draw stack and show what happens with proper explanations.

5 + 7 = 12

Group – D

6. (a) A binary tree T has 7 nodes. The Inorder and Preorder traversals of T yield the following sequences of nodes:
Inorder : E A C K F H D B G
Preorder: F A E K C D H G B
Draw the tree. State briefly the logic used to construct the tree.

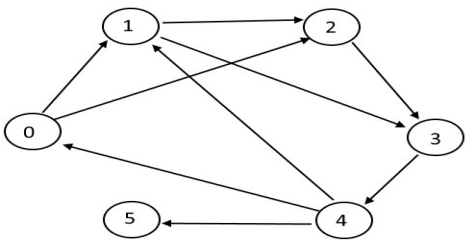
(b) Construct an expression tree for the expression E = (a-b) / ((c*d)+e)

(c) Write the algorithm for Postorder traversal of a binary tree.

6 + 3 + 3 = 12

7. (a) What is Adjacency Matrix and Adjacency list, explain with example.

(b) Consider the following graph for BFS traversal. Starting from node 0, what will be BFS traversal? Show every step .



6 + 6 = 12

Group – E

8. (a) Consider the list of numbers :- **99, 78, 72, 66, 54, 48, 42, 34, 22, 19, 11, 7**

Assume your target is **34** and the value of lo and hi are 0 and 11 respectively at the beginning. You are applying **Binary Search** algorithm to find it.

(i) What will be the value of **hi** and **lo** when you find your target?

(ii) What will be the exact number of key comparisons to find your target? Show every step.

(b) 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? Show your work.

(c) Deduce the average case time complexity of Linear Search.

6 + 3 + 3= 12

9. (a) Consider the initial list:- 60,33,40,22,55,88,66,11,81,20,75
You are going to sort the above numbers by Quick sort and your pivot is the first number. Show step by step, how pivot will partition the list in the first iteration only such that on the left side of the pivot will be the numbers less than or equal to pivot and on the right side of the pivot, only those numbers which are greater than the pivot.

(b) Under what circumstances, the time complexity of quick sort is $O(n^2)$.

(c) Deduce the average case time complexity of Merge Sort.

7 + 2 + 3 = 12

Department & Section	Submission link:
BT	https://classroom.google.com/c/MjgyNTg5MTkwNDkz/a/MjgyNTg5MTkwNjQz/details