DATA STRUCTURE AND BASIC ALGORITHMS
(CSEN 2004)

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) Which of the following is not the property of an algorithm
(a) Central Objective (b) Random
(c) Specific (d) Finite.

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

(iii) Consider the usual algorithm for determining whether a sequence of parentheses is balanced. The maximum number of parentheses that appear on the stack AT ANY ONE TIME when the algorithm analyzes: (()(())(()))?
(a) 1 (b) 2 (c) 3 (d) 4 or more.

(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) 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.

(vii) A normal queue, if implemented using an array of size MAX_SIZE, gets full when?

(a) Rear = MAX_SIZE – 1
(b) Front = (rear + 1)mod MAX_SIZE
(c) Front = rear + 1
(d) Rear = front

(viii) In Quick sort the time complexity in worst case is

(a) O(n log n) (b) O(log n)
(c) O(n) (d) $O(n^2)$.

(ix) How many nodes does a complete binary tree of level 5 have?

(a) 15 (b)25 (c)63 (d) 30.

(x) 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

Group – B

2. (a) Examine the code snippet below where n is some positive integer.

```
for (i=0; i<n; i++)
{
    for (j=0; j<i; j++)
        printf("\n Hello! \n");
}
```

Deduce how many times 'Hello' will be printed when n=6. Show your work.

(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) Define Big-Oh notation

Let $f(n) = n^3 + 20n + 1$. Show that f(n) is $O(n^3)$.

4 + 4 + (2 + 2) = 12

3. (a) Explain an efficient way of storing a sparse matrix in memory. Distinguish between row-major and column-major representations of an array with suitable examples.

(b) Write a C function to search a node in a singly linked list.

(c) Explain with a diagram how the end node of a circular linked list is deleted. Write down the corresponding C code for the operation.

(2+3) + 3 + (2 +2) = 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 take place.

(1) F is added to the queue (2) Two letters are dequeued.
(3) K, L and M are added to the queue (4) Two letters are dequeued.
(5) R is added to the queue (6) Two letters are dequeued.

(b) 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;
```

6 + 6=12

5. (a) Convert the following infix expression into postfix expression using Stack: -

A^B*C-D+E/F/(G+H)

Draw the corresponding stack and show what happens with proper explanations. Here '^' denotes exponentiation and ' * ' denotes multiplication and ' /' denotes division operation. Every other symbol has its usual meaning.

(b) What is tail recursion? How can we convert a non-tail recursive function into a tail recursive function?

(c) Explain with an example, how to implement a queue using stack.

5 + (1+2) + 4 = 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

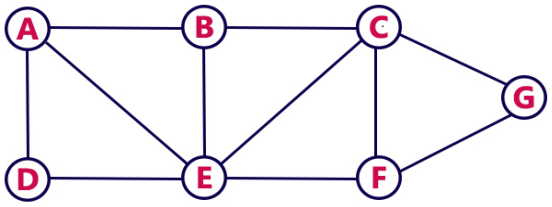
Preorder: G B Q A C K F P D E R H

Draw the tree. State briefly the logic used to construct the tree.

(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

6 + 6 = 12

7. Consider the following graph for BFS and DFS traversals. Starting from node A, what will be the output of BFS & DFS traversals? Show every step the using the corresponding data structure.



6 + 6 = 12

Group – E

8. (a) Consider the list of numbers :- **99, 78, 72, 66, 54, 48, 42, 34, 22, 19, 11, 7, 4, 2.** Assume that your target is **4** and the value of lo and hi are 0 and 13 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) What are the different techniques that are used to resolve a collision in Hashing? Which technique do you think is better and why?

(c) You are given a total of 1024 ten digit phone numbers. 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.

(2 + 2)+ (2 + 3)+ 3 =12

9. (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 that you are using optimized Bubble Sort algorithm. Show every step in the process.

(b) Consider a hash table with size 10. Using linear probing, insert the keys 27, 72, 63,42, 36, 18, 29 and 101 into the table.

7 + 5 = 12

Department & Section	Submission Link
ECE A	https://classroom.google.com/w/MTIyNzgyNDE4Nzgx/tc/Mjc0ODUzMzI3NzI2
ECE B	https://classroom.google.com/c/MjQxNjY2NTk4NTQx/a/Mjc0NTc0Njk3MTky/details
ECE C	https://classroom.google.com/w/MTIyNzgyNDE4NDE4/tc/Mjc0ODUzNjc0MDU3

Department & Section	Submission Link (Backlog)
ECE	https://classroom.google.com/c/Mjk4MjQyNDAzNjMz Class Code: wktqip3