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) Average case complexity to search an element in Binary Search Tree with 'n' nodes is
(a) O(n) (b) O(log(n))
(c) $O(n^2)$ (d) $O(\log(n^2))$

(ii) Which notation provides a strict upper bound for f(n)?
(a) Big Omega notation (b) Big O notation
(c) Small o notation (d) Theta notation

(iii) Advantages of linked list representation of binary trees over arrays?
(a) Dynamic size
(b) Ease of insertion/deletion
(c) Ease in randomly accessing a node
(d) Both dynamic size and ease in insertion/deletion

(iv) When sorting the array {11, 22, 33, 44, 55} in ascending order, the sorting algorithm that takes the least amount of time is:
(a) Bubble Sort (b) Selection Sort
(c) Insertion Sort (d) Quick sort

(v) Any binary tree can be accurately reconstructed from its:
(a) Preorder & Postorder sequences (b) Inorder sequence only
(c) Inorder & Postorder sequences (d) None of the above are true.

(vi) A binary search tree whose left subtree and right subtree differ in height by at most 1 unit is called
(a) AVL Tree (b) Red-Black Tree
(c) Syntax tree (d) Lemma tree.

(vii) The postfix expression for the infix expression:
R + B * (C+D)/F + D * E is
(a) RB+CD+*F/D+E* (b) RBCD+*F/+DE*+
(c) R*B+CD/F*DE++ (d) R+*BCD/F*DE++

(viii) Total number of nodes at the h-th level of a binary tree can be given as
(a) 2^h (b) $2^{\log h}$ (c) 2^{h+1} (d) 2^{h-1}

(ix) Which data structure is needed to convert infix notation to postfix notation?
(a) Queue (b) Stack (c) Tree (d) Graph.

(x) Which of the open addressing technique is free from clustering problems?
(a) Linear probing (b) Quadratic probing
(c) Double hashing (d) Rehashing.

Group - B

2. (a) Show that $400n^3 + 20n^2 = O(n^3)$. [(CO2) (identify/LOCQ)]
(b) Consider A[][] as a two-dimensional array of integers with starting address 2000. The number of rows and columns are 5 and 6. Now calculate the address of A[3][5] using row-major and column-major addressing policy. [(CO3) (Learn/IOCQ)]
(c) Distinguish between the adjacency matrix and adjacency list methods of representation. [(CO2) (Understand/LOCQ)]

4 + (2.5 + 2.5) + 3 = 12

3. (a) Write an algorithm to sort a single linked list. Use any sorting algorithm you are taught. [(CO4) (Describe and Design/IOCQ)]
(b) Given a circular linked list, write an algorithm to insert an element after a given element, in the list. [(CO3) (Understand/IOCQ)]
(c) Distinguish between *path* and *cycle* in the case of a regular graph. [(CO2) (Remember/LOCQ)]

6 + 4 + 2 = 12

Group - C

4. (a) Implement the Queue ADT using a linked list with head and tail pointers. [(CO4) (Describe and Design)/IOCQ)]
(b) Convert the following infix expression to postfix expression and evaluate the postfix expression.
5 * (2+8) ^2^2+ 5*5
What is the time complexity of converting infix expression to postfix expression and evaluation of postfix expression? [(CO5) (Analyze/HOCQ)]

4 + (6 + 2) = 12

5. (a) Consider a character Queue which has FRONT=1, REAR=5 and SIZE=10.
Now perform the following operations on the queue and show the FRONT and REAR Positions

(i) Delete two letters
(ii) Add H
(iii) Delete four letters
(iv) Add I. [(CO5) (Analyze/HOCQ)]

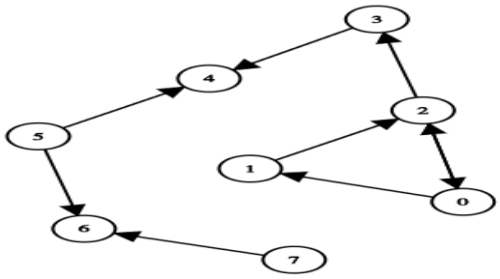
(b) Write a recursive GCD (Greatest Common Divisor) program. What is the time complexity of your program?
[(CO4)(Describe and Design/IOCQ), (CO5)(Analyze/HOCQ)]

(c) What is the recurrence relation of Tower of Hanoi problem? Can you derive the number of comparisons to execute the Tower of Hanoi problem using 5 discs from the recurrence relation? [(CO5) (Analyze/HOCQ)]

4 + (2 + 1) + (2 + 3) = 12

Group - D

6. (a) Consider the following graph.



Construct adjacency list and adjacency matrix of the above graph.
[(CO1) (Understand/LOCQ)]

(b) Apply the Depth First Search (DFS) algorithm to the above mentioned graph. Assume '1' as the start node. What is the time complexity of the DFS algorithm?
[(CO4) (Describe and Design/IOCQ)]

(2 + 2) + (6 + 2) = 12

7. (a) What is the advantage of a Height Balanced Tree? [(CO3)(Learn/IOCQ)]

(b) Create an AVL tree with the input given below:
99, 2, 48
(i) Insert 21 and 39 into the tree
(ii) Delete the value 39. [(CO6)(Develop/HOCQ)]

2 + (4 + 2 + 2 + 2) = 12

Group - E

8. (a) Fill in the following table for n integers:

	Space Complexity	Average Case Time Complexity	Worst Case Time Complexity
Merge Sort			
Quick Sort			

[(CO1) (Understand/LOCQ)]

(b) Consider the following sequence in the array and apply Quick sort algorithm to sort the array.
Discuss all the passes with relevant figures.

70, 45, 85, 60, 95, 100, 75, 80. [(CO1) (Understand/LOCQ)]

6 + 6 = 12

9. (a) Given a hash table of 100 locations, calculate the hash value using the folding method for keys 5668, 351 and 345678. [(CO3) (Learn/IOCQ)]

(b) Explain why double hashing is preferred over linear probing and quadratic probing with examples. [(CO3) (Learn/IOCQ)]

(2 + 2 + 2) + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	26.04%	44.79%	29.16%

Course Outcomes (CO):

After the completion of the course students will be able to

- To understand the data structures, their advantages and drawbacks.
- To identify the efficiency aspects of the graph and sorting algorithms covered in this course.
- To learn about the data structures/ methods/ algorithms mentioned in the course with a comparative perspective.
- To describe problem statements and to design the solutions using programming language.
- To analyze and apply most appropriate data structure/ method/algorithm in a program to enhance the efficiency.
- To develop an efficient program modifying an efficient one using the knowledge gathered from this course.

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

Department & Section	Submission Link
ECE - A	https://classroom.google.com/w/MzQ1Nzc4MTk4MTgx/tc/NDc3MzE3NDcyMDEw
ECE - B	https://classroom.google.com/c/NDA0OTA0NjIwMzgy/a/NDc0ODI5NjQxMTIz/details
ECE - C	https://classroom.google.com/c/NDA1NjA2ODQzOTQ0/a/NDc5NDIyOTY0MjM2/details