DATA STRUCTURE AND BASIC ALGORITHMS
(CSEN 2004)

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) The best case complexity of Insertion Sort is
(a) $O(n^2)$ (b) O(n log n)
(c) O(n) (d) O(log n).

(ii) Which of the following is a collection of heterogeneous elements?
(a) Array (b) Stack
(c) Queue (d) Structure.

(iii) Which data structure is used to manage Printer Buffer?
(a) Stack (b) Queue
(c) Linked List (d) Tree.

(iv) A binary search tree is generated by inserting the following integers: 50, 15, 62, 5, 20, 58, 91, 3, 8, 37, 60, and 24. The number of nodes in the left subtree and right subtree of the root respectively is
(a) (4, 7) (b) (7, 4)
(c) (8, 3) (d) (3, 8).

(v) Which sorting method runs fastest for file which is already sorted?
(a) Selection Sort (b) Insertion Sort
(c) Quick Sort (d) Merge Sort.

(vi) The postfix equivalent of the prefix expression * + a b – c d is
(a) a b + c d - * (b) a b c d + - *
(c) a b + c d * - (d) a b + - c d *

(vii) In a circularly linked list organization, insertion of a record at the end involves the modification of
(a) no pointer (b) 1 pointer
(c) 2 pointers (d) 3 pointers.

(viii) Which of the following is not true for stack?
(a) Arrays can be used to implement stack
(b) Stack follows FIFO concept
(c) Top of the stack contain last inserted element
(d) Stack follows LIFO concept.

(ix) 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.

(x) Which types of traversal of Binary search tree outputs the value in sorted order?
(a) Pre-order (b) In-order
(c) Post-order (d) None.

Fill in the blanks with the correct word

(xi) The open addressing technique is free from clustering problems is_____.

(xii) The _____ is a double ended queue that allows deletion at one end only, but allows insertion at both ends.

(xiii) Maximum possible height of an AVL Tree with 7 nodes is_____.

(xiv) _____ is a term coined for insertion of elements in a stack.

(xv) The worst case time complexity of quick sort is _____.

Group - B

2. (a) Consider M[][] as a two-dimensional array of integers with starting address 1000. The number of rows and columns are 10 and 5. Calculate the address of M[6][3] using row-major and column-major addressing policy.
[(CO3)(Understand/LOCQ)]

(b) Consider the following stack of characters, where STACK is allocated N = 8 memory cells
STACK : B,C,D,F,K,_,_,_. (_ means empty allocated cell)
Describe the stack as the following operations takes place:
- POP(STACK, ITEM)
- POP(STACK, ITEM)
- POP(STACK, ITEM)
- PUSH(STACK, R)
- PUSH(STACK,L)
- PUSH(STACK, S)
- PUSH(STACK,P)
- POP(STACK, ITEM)

for this problem, (i) When will overflow occur?
(ii) When will C be deleted before R? *[(CO3)(Understand/IOCQ)]*

(c) Prove that $T(n)= 3n^2 + 10n + 5$ is $O(n^2)$. *[(CO1)(Remember,Apply/LOCQ)]*

4 + 5 + 3 = 12

3. (a) Given a circular linked list, write an algorithm to insert an element after a given element, in the list. *[(CO3)(Understand/IOCQ)]*

(b) Implement the Stack ADT using a linked list. *[(CO4)(Apply)/IOCQ)]*

(c) What do you mean by abstract data type? *[(CO1)(Understand/LOCQ))]*

5 + 5 + 2 = 12

Group - C

4. (a) Consider a circular queue with size 5. Now insert 10, 20, 30, 40 and 50. (i) What is the present front index value and present rear index value? (ii) After deletion of two elements what will be the front index value and rear index value? (iii) Next insert 60 and 70. What will be the front index value and rear index value? *[(CO3)(Understand/LOCQ]*

(b) Implement an algorithm, which can perform "delete at front" of a circular linked list. Can you modify your algorithm such that time complexity will be O(1). Justify your answer with proper reasoning. *[(CO6)(Understand,Analyze/HOCQ)]*

6 + 6 = 12

5. (a) What will be the result when you evaluate the following postfix expression?

12 , 7 , 3 , - , / , 2 , 1 , 5 , + , * , + *[(CO5)(Apply/IOCQ)]*

(b) Write a program in C to find the middle node of a linked list using 1 loop. *[(CO6)(Analyze/HOCQ)]*

(c) Write a recursive function fib(.....) where function fib(.....) returns the n^{th} Fibonacci number. Ensure that the time complexity of that fib (.....) function is O(n). *[(CO6)(Understand/LOCQ)]*

2 + 5 + 5 = 12

Group - D

6. (a) Draw a binary Tree for the expression: A * B - (C + D) * (P / Q). *[(CO2)(Understand/LOCQ)]*

(b) The in-order traversal and pre-order traversal of a binary tree are given below:
preorder: 45 32 25 11 27 39 66 55 51 58 70 88
Inorder : 11 25 27 32 39 45 51 55 58 66 70 88 respectively.
Construct the tree and what would be the post-order traversal for the same binary tree? *[(CO2)(Analyze/IOCQ)]*

(c) What do you mean by balance factor? *[(CO2)(Understand/LOCQ)]*

4 + (4 + 2) + 2 = 12

7. (a) What is the difference between binary search tree and AVL tree? *[(CO5)(analyze/IOCQ)]*

(b) Write a pseudo code/ C Function for INODER TRAVERSAL of Binary tree. *[(CO4)(apply/LOCQ)]*

(c) Consider the following data sequence
14, 17, 11, 7, 53, 4, 13, 12, 8, 60, 19, 16, 20
Construct an AVL tree with the above data sequence. *[(CO5)(Evaluate/HOCQ]*

2 + 3 + 7 = 12

Group - E

8. (a) Write a pseudo code/function to merge two sorted arrays into one sorted array. *[(CO2)(Analyze/IOCQ)]*

   (b) State the best case and worst case complexity of the following algorithms:
   (i) Bubble Sort (ii) Merge Sort (iii) Binary Search. *[(CO2)(Understand/LOCQ)]*

6 + (3 × 2) = 12

9. (a) Given a hash table of 100 locations (0 to 99), calculate the hash value using the folding method for keys 500078, 351899 and 777709. *[(CO1) (remember /LOCQ]*

   (b) Explain why double hashing is preferred over linear probing and quadratic probing with examples. *[(CO1) (analyze /IOCQ)]*

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	42.71	38.54	18.75

Course Outcome (CO):

After the completion of the course students will be able to
1. To understand the data structures, their advantages and drawbacks
2. To identify the efficiency aspects of the graph and sorting algorithms covered in this course.
3. To learn about the data structures/ methods/ algorithms mentioned in the course with a comparative perspective.
4. To describe problem statements and to design the solutions using programming language.
5. To analyze and apply most appropriate data structure/ method/algorithm in a program to enhance the efficiency.
6. 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.*