B.TECH / AEIE/IT /3RD SEM/ CSEN 2001/2017
DATA STRUCTURE & BASIC ALGORITHMS
(CSEN 2001)

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) A matrix "a" is called lower triangular if and only if for all j > i, $a_{ij} = 0$. If such a matrix is to be stored in a one dimensional array, A then a_{ij} could be mapped to which of the following index of A?
(a) ½ * i(i + 1) +(j+1) (b) ½ * i + j
(c) ½ * i(i - 1) + j (d) none of these.

(ii) Here is an infix expression: 4 + 3 * (6 * 3 - 12). Suppose that we are using the usual stack algorithm to convert the expression from infix to postfix notation. What is the maximum number of symbols that will appear on the stack at one time during the conversion of this expression?
(a) 4 (b) 3 (c) 2 (d) 1.

(iii) Which of the following operations is not efficiently supported by a singly-linked list?
(a) accessing the element in the current position
(b) insertion after the current position
(c) insertion before the current position
(d) moving to the position immediately following the current position.

(iv) A Binary Tree of Height h has at most
(a) h – 1 elements (b) 2^h elements
(c) 2^{h-1} elements (d) 2^h - 1 elements.

(v) In a circular queue with array length n, if front = (rear +1) % n then
(a) Queue is empty (b) Queue is overflow
(c) Queue has only one element (d) None of the above

(vi) If a set of sorted integers is inserted in a Binary Search Tree then to search a certain item it's time complexity will be?
(a) O(n) (b) O(log(log n)) (c) O(log n) (d) $O(n^2)$.

(vii) If h is a hash function and key is key then _____ is called the hash of key.
(a) h-key (b) key(h) (c) h(k) (d) h(key).

(viii) Let G be a graph with n vertices and m edges. What is the complexity of Depth First Search of G? Assume that the graph is represented using adjacency matrix.
(a) O(n) (b) O(m+n) (c) $O(n^2)$ (d) O(mn).

(ix) The recurrence relation for an algorithm is given as:
T(n) = T(n/4) + c * n, for any constant c. The asymptotic complexity of the algorithm will be
(a) O(n) (b) $O(\log^2 n)$ (c) $O(n^2)$ (d) $O(\log^4 n)$

(x) The data structure used to check balanced parenthesis of an infix expression is
(a) Graph (b) Queue (c) Tree (d) Stack.

Group - B

2. (a) Define Big-O notation. Show that $10n^3 + 950n^2 - 8000 = O(n^3)$.

(b) What is the difference between linear and nonlinear data structure?

(c) Derive the addressing formula for any element of upper triangular sparse matrix represented in column major order.

(2 + 3) + 3 + 4 = 12

3. (a) Write a C function to reverse a singly linked list, assuming that the list already exists.

(b) Polynomials can be represented either by an array or linked list. Compare and contrast these two types of representation. How can a polynomial such as $7y^4 – 4x^3 + 16x – 23$ be represented by a linked list?

(c) Write a function which will accept a number n as its argument. The function will break this number into its individual digits and then store every single digit in a separate node thereby forming a linked list. The function must be a return type function which is going to return the head node address of the created linked list at the end. (for example if the number is 13579, then there will be 5 nodes in the list containing nodes with values 1, 3, 5, 7, 9.

Group - D

6. (a) Prove that, for any non-empty binary tree, T, if n_0 be the number of terminal (leaf) nodes and n_2 be the number of nodes of degree 2, then $n_0=n_2+1$.

(b) Write an algorithm to delete a node from a binary search tree. Explain the working of your algorithm with an example.

(c) Given the pre-order & in-order sequence draw the resultant binary tree & write its post-order traversal. (State briefly the logic used to construct the tree.)

4 + (2 + 2) + 4 = 12

Group - C

Pre-order : **A B D E F C G H J I K.**

In-order : **D B F E A G C I J H K.**

3 + (4 + 2) + 3 = 12

4. (a) Construct the following Queue of characters where Queue is a circular array which is allocated six memory cells:

FRONT = 2 REAR = 4 QUEUE: __ , *1, 3, 4,* __ , __

Describe the Queue (along with FRONT REAR values) as the following operations take place:

i) 5 is added to the Queue.

ii) Two letters are deleted from the Queue.

iii) 6, 7, 8 are added to the Queue.

iv) Two letters are deleted from the Queue.

v) 9 is added to the Queue.

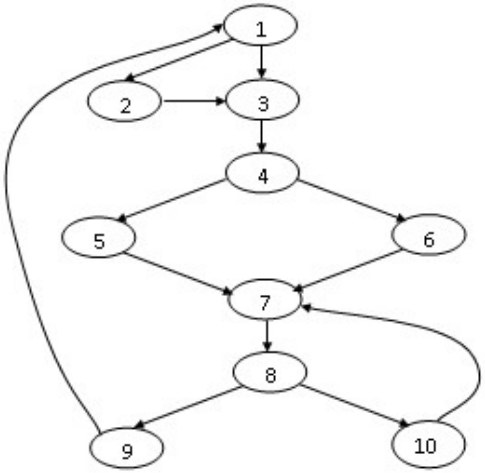
vi) One letter is deleted from the Queue.

7. (a) Prove that the maximum number of edges possible in a simple graph of *n* nodes is n(n-1).

(b) Show the stages in growth of an order-3 B-tree when the following keys are inserted in the order given:

84, 82, 29, 99, 65, 12, 50, 28.

(c) Consider the graph given below:



Find the adjacency list and its traversal for the above graph.

(b) Given an ex… a stack convert the expressi…

(c) With the hel… ression:

… + 3 + 3 = 12

5.(a) Write an alg… e.

(b) Write a r… nacci number. Compute t… ve function by drawing th…

(c) Consider a … many actions (operations) will be appropriate to store this individual operations and why?

3 + 4 + (2 + 3) = 12

4 + (3 + 3) + 2 = 12

Group - E

8. (a) Write down the algorithm for mergesort. Show that the running time for mergesort algorithm is $O(n \log_2 n)$.

(b) Show the operation of quicksort algorithm with a suitable set of data? Derive its complexity in worst case.

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

9. (a) Write a recursive algorithm for binary search. How can it be modified so that we can get interpolation search?

(b) Insert the integers 13, 5, 22, 8, 34, 19, 21 into an initially empty hash table of size 7 using the hash function H (K) = K mod 7. Now to avoid collisions, use a double hash function *H1(K) = (K+C) mod 7*, where *C=1+(K mod 6)*, to avoid collisions. If the table still has collisions use linear probing to avoid it.

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