2022

(July)

MCA

Paper Code: MCA- 0802

(Data Structure and Algorithms)

Full Marks: 75

Time: 3 Hours

(The figures in the margin indicate full marks for the question)

Attempt ONE question from each UNIT

UNIT-I

1. a) Write short notes on - (4x2=8)
   i. Best Case and Average Case analysis.
   ii. Big-Oh (O) and Theta (Θ) Notation.

   b) Solve the following Recurrence relations using master theorem and substitution method. (2+3+4=9)
   i. $T(n) = 2T(\frac{n}{2}) + n^2$
   ii. $T(n) = 3T(\frac{n}{4}) + n\log n$
   iii. $T(n) = 2T(\frac{n}{2}) + 4n, \quad if\ n = 1, T(1) = 4$

   c) If $T(n) = 2n + 5$ and $g(n) = n$ then show that $T(n) = O(g(n))$. Also find the value of initial condition n_0 and the constant c. (3)

2. a) What is a linked list? Write a function to insert a node in the beginning of a list. (2+4=6)
   b) How are multidimensional arrays represented in memory? Illustrate how address of an individual item is calculated in a 2-dimensional array. (2+3=5)
   c) Write down the method with illustration to delete an element from a specific position in a doubly linked list. (6)
   d) Find out complexity of the following code: (3)

```
for( i =1;  i < n; i++) {
  for( j =1; j < n; j = 2*j) {
     sum = i+j;  } }
```

UNIT-II

3. a) What are the operations that can be performed on a stack? Convert the following expression to *postfix* and *prefix*. (2+6=8)

   (X + Y) * T + (R - S) * (H + G)

   b) What is the limitation of a normal queue? How can this limitation be overcome? (2+2=4)
   c) What is Binary Search Tree? Construct a Binary Search Tree for the following elements: (2+3=5)

   21, 32, 11, 10, 22, 28, 98, 31, 25, 100, 9, 12, 19, 55, 20, 5

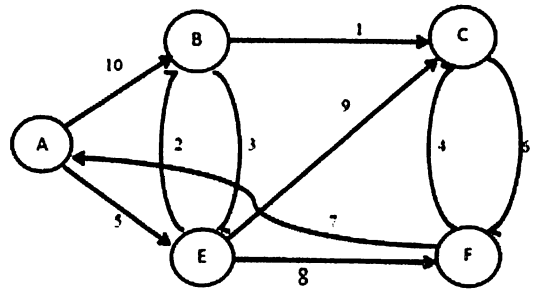
   d) Define Binary Tree, Complete Binary Tree and Full Binary Tree. (3)

4. a) Explain the *inorder*, *post order* and *pre order* tree traversal algorithms with proper example. (6)
   b) Explain the various cases which may occur while deleting a node from a Binary Search Tree. (6)
   c) Define strongly connected component of a graph. Explain the working principle of Depth First Search algorithm for traversing a graph. (2+6=8)

UNIT-III

5. a) Use Strassen's Algorithm to compute the matrix multiplication $\begin{bmatrix} 2 & 3 \\ 7 & 5 \end{bmatrix} X \begin{bmatrix} 6 & 8 \\ 4 & 5 \end{bmatrix}$. (6)

   b) Explain in detail how Dijkstra's Algorithm works to find out the shortest path on the following graph. (7)



   c) Define *minimal spanning tree*. Apply Kruskal's algorithm to find out minimum cost spanning tree for the above graph. (2+5=7)

6. a) Design the Huffman codes and Huffman tree for the following symbols: a, b, c, d, e, f and g having relative frequencies 2, 4, 6, 8, 10, 12, 16 respectively. (6)

   b) What do you understand by the term *divide and conquer* algorithm design strategy? Sort the given elements by using merge sort algorithm: 12, 9, 17, 8, 32, 56, 37, 89, 7, 99, 106, 108, 200, 10, 37, 909, 1002, 552. Also, analyze the time complexity of merge sort algorithm. (2+4+2=8)

   c) Apply Prim's algorithm to find out minimum cost spanning tree for the given graph. (6)

Vertices	*Adjacent vertices/weight*
1	2/3 3/5 5/2 6/7
2	1/3 4/2 5/1 6/3
3	1/5 5/4
4	2/2 5/5 6/1
5	1/2 2/1 3/4 4/5
6	1/7 2/3 4/1

UNIT-IV

7. a) What do you understand by the following complexity classes? (4x3=12)
   i. NP
   ii. NP-hard
   iii. NP-Complete

   b) How does Dynamic programming algorithm design paradigm differ from Divide and Conquer and Greedy approaches? Explain. (3)

8. a) Find out the Longest Common Subsequence from the given two DNA sequences using Dynamic programming approach: (9)

$$X = \{TAGTCACG\} \text{ and } Y = \{AGACTGTC\}$$

   b) How are decision problems different from optimization problem? What is 0-1 Knapsack problem? (3+3=6)

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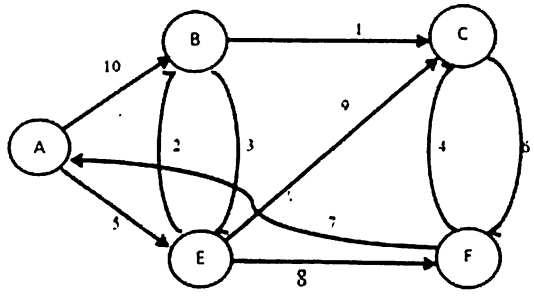

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