VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of the UGC Act, 1956)

Reg. No. :

## Final Assessment Test(FAT) - Nov/Dec 2024

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| Programme | M.C.A. | Semester | Fall Semester 2024-25 |
| Course Code | PMCA501L | Faculty Name | Prof. Jayasudha M |
| Course Title | Data structures and Algorithms | Slot | G1+TG1 |
| | | Class Nbr | CH2024250103007 |
| Time | 3 hours | Max. Marks | 100 |

**General Instructions**

- Write only Register Number in the Question Paper where space is provided (right-side at the top) & do not write any other details.

**Course Outcomes**

CO1: To provide basic techniques of algorithm analysis and exhibit the capacity to implement various linked data structures.

CO2: To become familiar with several sorting algorithms and demonstrate the applications of graph algorithms.

CO3: To practice the various algorithm design techniques

### Section - I

**Answer all Questions (10 × 10 Marks)**

*M - Marks

| Q.No | Question | *M | CO | BL |
|---|---|---|---|---|
| 01. | Determine the space complexity of the following code segment. Justify your answer. [6 Marks]<br>(a) sum = 0;<br>for (int i = 1; i <= n; i++)<br>for (int j = 1; j <= n; j *= 4)<br>sum += 1;<br>int *arr ;<br>arr = new int[sum] ;<br>(b) sum = 0;<br>for (int i=1; i<= n; i++)<br>for (int j=i ; j<= n; j++)<br>sum += i + j ;<br>(c) sum = 0;<br>i = n;<br>while ( i > 0) {<br>sum += i ;<br>i /= 2; }<br>(d) Compute the time complexity of the following recursive function using master method [4 Marks]<br>(i) $T(n) = 2T(n/2) + n / \log n$<br>(ii) $T(n) = 8T(n/2) + n^3 \log n$. | 10 | 1 | 1 |

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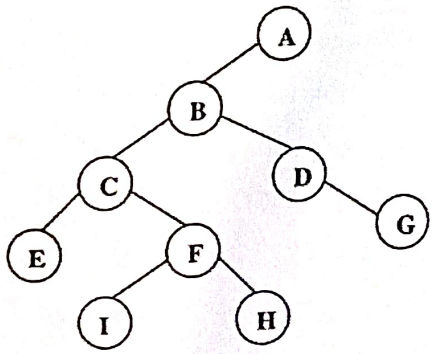
| 02. | (a) Given a singly linked list of n nodes where n is not known, write an algorithm to find its middle node [n/2] in a single pass. [4 Marks]<br>For example:<br>i) Linked List: 13 → 26 → 35 → 43 → 17. Middle Node: 35<br>ii) Linked List: 91 → 12 → 13 → 24 → 56 → 61. Middle Node: 13<br>(b) Convert the infix expression into prefix expression using stack data structure. Show how each step of the process and explain how the stack is used at each stage. [6 Marks]<br>A + M – L * S ÷ (N * M) * P/Q/R * O + B | 10 | 1 | 1 |
| 03. | Mr. John is a chemist who receives ten medicine boxes with batch numbers 35, 33, 42, 10, 14, 19, 27, 44, 26, 31 printed on them. He always arranges the boxes manually and gets frustrated every time. He thought he would have a lot of problems in the future arranging the boxes if the number of boxes of medicine was large. He wants to make<br>this task easier. As you are a good programmer, kindly help Mr. John to implement an optimal sort algorithm to arrange the boxes in increasing order of batch numbers and show each step of the algorithm in detail using the above sequence of batch numbers. Also, write the best case and worst case time complexity of the algorithm?. | 10 | 2 | 1 |
| 04. | Consider a database containing n files in it. Each file is named by its sequence number (starting from 1 to n) as a primary key. Your task is to suggest a randomized search algorithm with pseudo-code to find out whether the requested file with the given sequence number(=k) is present in the database or not. Assume the cases where files are<br>arranged:<br>(a) Randomly, i.e., without any order. [5 Marks]<br>(b) Increasing order of sequence number. [5 Marks] | 10 | 2 | 1 |
| 05. | Harish is working on constructing a hash table (table size = 10) with collision resolution using the division method. He needs your assistance in writing an algorithm/pseudocode that accepts a series of integer keys 1245,2365,4125,3215,5214,4658,2314, hashes them into a table, resolves collisions using quadratic probing, and then identifies and reports the middle element from the table. | 10 | 3 | 1 |
| 06. | a)Write the preorder, inorder, and postorder traversal of the following binary tree:[5 Marks]<br>  <br><br>b) If the given preorder traversal for a binary search tree is {10, 3,1, 7, 15, 20, 25}, construct the binary search tree and its algorithm.[5 Marks] | 10 | 3 | 1 |

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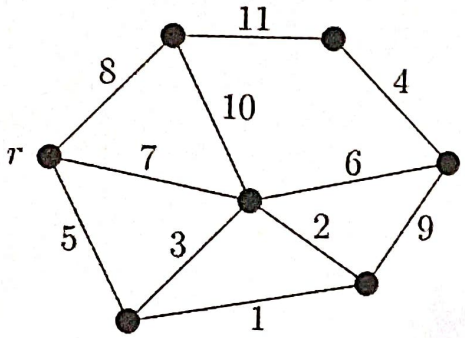
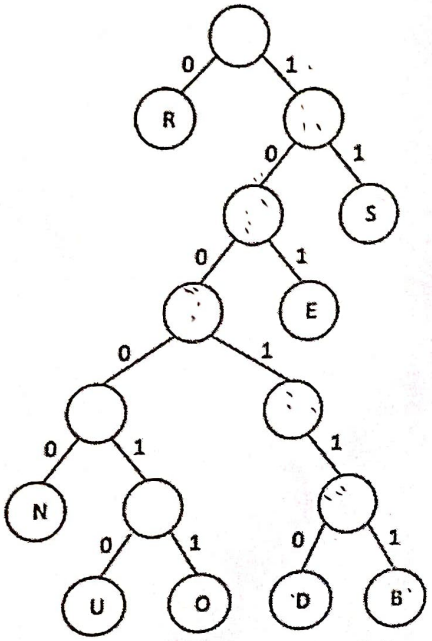
| 07. | Illustrate the step by step process of traversing through the edges in the graph.<br>  <br><br>a) To create a minimum cost spanning tree using Kruskal's Algorithm. [5 Marks]<br>b) To find the shortest path from vertex r to all other vertices. [5 Marks] | 10 | 4 | 1 |
| 08. | Consider the following Huffman tree<br>  <br><br>What word is represented by the following binary string[3 Marks], based on the Huffman tree (we have inserted spaces purely for readability): 111 000 111 000 101 000 010 011 010 10 and write an algorithm/pseudocode for the above scenario[7 Marks]. | 10 | 4,5 | 1 |
| 09. | The n-queens problem consists in placing n non-attacking queens on an n-by-n chess board. A queen can attack another queen vertically, horizontally, or diagonally. E.g. placing a queen on a central square of the board blocks the row and column where it is placed, as well as the two diagonals (rising and falling) at whose intersection the queen was placed. Write an algorithm/pseudocode to solve this problem using recursion as well as without recursion. | 10 | 5 | 1 |
| 10. | Write a dynamic programming-based solution to find the longest triangular subsequence from the given sequence. Here, triangular subsequence refers to a subsequence where numbers are first strictly increasing then strictly decreasing. Also, discuss the time complexity and space complexity of your solution.<br>Example: If given sequence is [6 16 7 15 9 10 7 6] then its longest triangular subsequence will be [6, 7, 15, 9, 7, 6] Or [6, 16, 15, 10, 7, 6] Or [6, 7, 9, 10, 7, 6]. | 10 | 6 | 1 |

**BL-Bloom's Taxonomy Levels - (1.Remembering, 2.Understanding, 3.Applying, 4.Analysing, 5.Evaluating, 6.Creating)**