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Vellore Institute of Technology
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CHENNAI

Reg. No

Final Assessment Test(FAT) - Apr/May 2025

Programme	**M.Tech. (Integrated)**	Semester	**Winter Semester 2024-25**
Course Code	**ISWE102L**	Faculty Name	**Prof. Rishikeshan C A**
Course Title	**Data Structures and Algorithms**	Slot	**B1+TB1**
		Class Nbr	**CH2024250503007**
Time	**3 hours**	Max. Marks	**100**

Instructions To Candidates

- Write only your registration number in the designated box on the question paper. Writing anything elsewhere on the question paper will be considered a violation.

Course Outcomes

CO1:Analyze and understand stack, queue and linked list operations and its applications while solving real world problems.
CO2: Comprehend the pros and cons of various linear and non-linear data structures.
CO3: Calculate the time and space complexities of various algorithms.
CO4: Familiar with various sorting, searching and hashing algorithms.
CO5: Apply suitable data structures and algorithms for the specified problem.

Section - I
Answer all Questions (7 × 10 Marks)

01. A document processing system needs to scan a text paragraph to detect and track occurrences of specific keywords. Given a string T representing a text passage and a list of keywords $K = [k_1, k_2, \ldots, k_m]$, determine:

a) The first occurrence position of each keyword in T using Linear Search. (3 Marks)

b) Write a pseudocode for substring search and multiple occurrences check. Analyze the time complexity of your approach. (7 Marks)

Sample Input:
Text T: "machine learning is a subset of artificial intelligence. deep learning is a subset of machine learning."
List of Keywords K: ["machine", "learning", "subset"]
Sample Output:
First Occurrence:
"machine" found at index 0
"learning" found at index 8
"subset" found at index 22
Multiple Occurrences:
"machine" appears more than once
"learning" appears more than once
"subset" appears more than once

[10] (CO4/K4)

02. Write a pseudocode to merge the elements of one linked list into another at alternate positions. Given two linked lists, L1 and L2, insert each node of L2 into the alternate positions of L1 while maintaining their original order. After the merge operation, L2 should become empty.
For example,
L1 = 5->7->17->13->11
L2 = 12->10->2->4->6.
The resultant list L1 = 5->12->7->10->17->2->13->4->11->6

[10] (CO1/K3)

03. a) Write an algorithm for evaluating a postfix expression. Also, convert the given infix expression: (x+y)*z−w/u+v to its postfix form, illustrating each step using a stack. (6 Marks)
b) Evaluate the obtained postfix expression using a stack. Assume the values:
x = y = z = 2, w = u = v = 1. (4 Marks)

[10] (CO1/K5)

04. a. Consider the following function.

```
int Compute(int n) {
if (n <= 1) return 1;
int x = Compute(n/2) + Compute(n/2);
for (int i = 0; i < n; i++) {
for (int j = i; j > 0; j /= 2) {
printf("%d ", j);
  }
 }
   return x;
}
```

Derive the recurrence relation for the given function. Use the Master Theorem to determine the time complexity. (8 Marks)

b. Arrange the given complexities in ascending order:
$O(1), O(n), O(n^2), O(\log n), O(n \log n), O(2^n), O(n^3), O(\sqrt{n})$. (2 Marks)

[10] (CO3/K4)

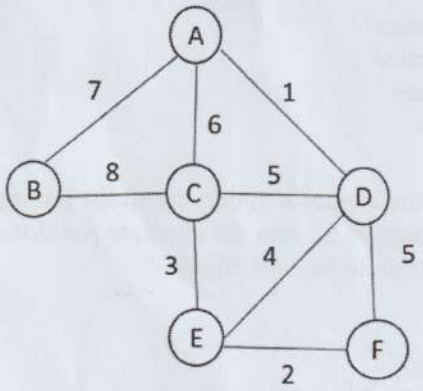
05. The unique heights of 10 different students seated in seats R1 to R10 are as follows (in centimeters):
148, 165, 172, 162, 166, 161, 156, 169, 153, 170
Your task is to arrange the students in ascending order of height, assigning them to seats R1 through R10 accordingly. Identify a suitable sorting technique and implement it to solve the scenario.
a) Mention which sorting technique is most appropriate and explain why. (1 Mark)
b) Write the pseudocode along with the necessary formulae or logic. Also, demonstrate the workflow of the sorting process and analyze its time complexity. (7 Marks)
c) Write the procedure to find the tallest student in the classroom using a suitable searching technique. (2 Marks)

[10] (CO4/K3)

06. A search engine implements an auto-suggestion feature using a Binary Search Tree (BST) to store words in lexicographic order.
a) Construct a BST for a given list of words:
["hello", "apple", "banana", "zebra", "world", "ant", "carrot"] (4 Marks)
b) Perform an inorder traversal to verify that words are stored in sorted lexicographic order. Also, write an algorithm that will print the inorder traversal for the same. (6 Marks)

[10] (CO2/K4)

07. a) Find the minimum spanning tree of the following graph using a suitable algorithm. Show the step-by-step procedure used to form the minimum spanning tree(8 Marks)



b) Discuss how the algorithm handles negative weights. If all edge weights are multiplied by a constant factor, how does this affect the minimum spanning tree? Justify your answer.(2 Marks)

[10] (CO5/K3)

Section - II

Answer all Questions (2 × 15 Marks)

08. A software scheduling system prioritizes background processes using an AVL tree, ensuring efficient insertion, deletion, and balance maintenance. The following priority levels are inserted in sequence:
50, 30, 70, 20, 40, 60, 80, 35, 45.
After all insertions, the following deletions occur: 30, 80.
a) Construct an AVL tree for the above-listed priority levels. For each insertion, check for imbalances and identify the type of rotation required to restore balance. (8 Marks)
b) For each deletion, determine if any imbalance occurs and specify the necessary rotation(s) applied to maintain the AVL property. (5 Marks)
c) What is the final height of the AVL tree after all insertions, deletions, and rotations? (2 Marks).

[15] (CO2/K3)

09. a) A chess grandmaster is exploring a variation of the classic N-Queens problem, where exactly one queen must be placed in each row of an n × n chessboard, ensuring that no two queens can attack each other. Design and implement an efficient algorithm to generate all possible valid configurations. (5 Marks)
b) Given the character frequency list below, construct the Huffman Tree and determine the corresponding Huffman Codes for each character: A: 10, B: 15, C: 30, D: 16, E: 29 Using the generated codes, encode the string "ABCADE". (8 Marks)
c) Assuming standard ASCII encoding uses 8 bits per character, calculate the original size (in bits) of the string "ABCADE", and compare it with the Huffman-encoded size. Determine the compression ratio achieved. (2 Marks)

[15] (CO5/K4)

BL-Bloom's Taxonomy Levels - (K1-Remembering,K2-Understanding,K3-Applying,K4-Analysing,K5-Evaluating,K6-Creating)