VIT
Vellore Institute of Technology

Reg. No. : 23MCA1030

## Final Assessment Test (FAT) - November/December 2023

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|---|---|---|---|
| Programme | **M.C.A.** | Semester | **FALL SEMESTER 2023 - 24** |
| Course Title | **DATA STRUCTURES AND ALGORITHMS** | Course Code | **PMCA501L** |
| Faculty Name | **Prof. Jayasudha M** | Slot | **A1+TA1** |
| | | Class Nbr | **CH2023240101712** |
| Time | **3 Hours** | Max. Marks | **100** |

**Section (10 X 10 Marks)**
**Answer all questions**

01. Solve the following recurrence relations using Master's method and find the time complexity. **[10]**
    a. $T(n) = 3\,T(n/4) + n/2$ (5 Marks)
    b. $T(n) = 7\,T(n/3) + n^2$ (5 Marks)

02. Given two arrays A1 and A2, sort the elements of A1 in such a way that the relative order among the elements of A1 will be the same as those in A2. For the elements not present in A2, append them at last in sorted order. Write an algorithm or pseudocode for the same. Your pseudocode should handle all cases, like when the number of elements in A2 may be more or less compared to A1. The elements of A1 and A2 may not be the same, and vice versa is also possible. **[10]**

    **Example:**
    Input: A1[ ] = {2, 1, 2, 5, 7, 1, 9, 3, 6, 8, 8}
    A2[ ] = {2, 1, 8, 3}
    Output: A1[ ] = {2, 2, 1, 1, 8, 8, 3, 5, 6, 7, 9}

03. Develop a pseudocode or algorithm to perform queue operations using two stacks. Examine how long the queue activities are taking to complete. **[10]**
    a. Prove that the implementation has a worst-case running time of O(n) for a series of 'n' queue operations. (5 Points)
    b. What is the worst-case running time for completing a single queue action, assuming that there can be up to 'k' elements in the queue at any given time? (5 Points)
    You can only use the stack commands makenew(S), top(S), pop(S), push(x, S), and isempty(S) when using the stack for algorithm queues. Remember to describe how you would create an algorithm for each of the queue operations, such as isempty (Q), makenew (Q), enqueue (x, Q), and dequeue (Q).

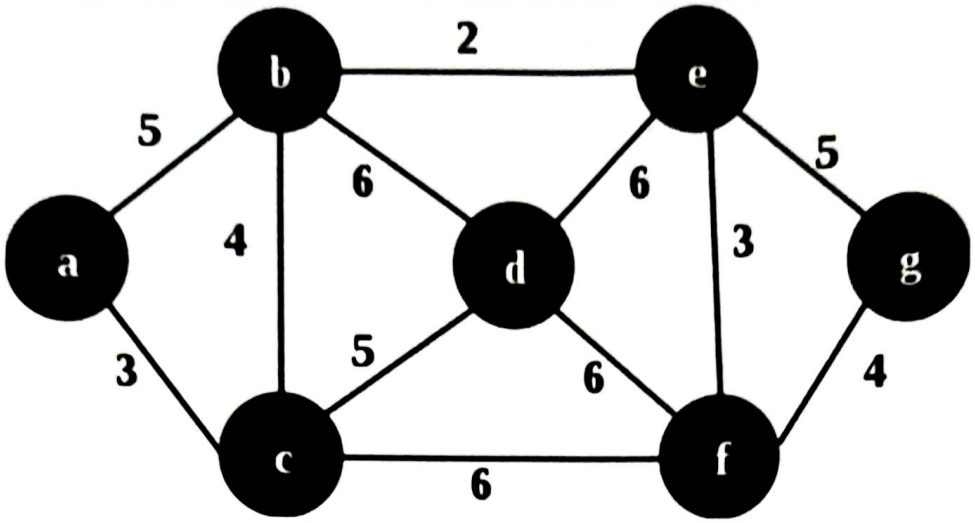
04. Write an algorithm/pseudocode to remove all duplicate elements from the linked list, so that only the first occurrence of each value remains in the list. For example, if the input linked list is: 1 -> 2 -> 2 -> 3 -> 4 -> 4 -> 5, the modified linked list should be: 1 -> 2 -> 3 -> 4 -> 5. **[10]**

05. Suppose we know the preorder and postorder traversal sequences of a binary tree T. **[10]**
    a. Can we uniquely determine the binary tree if the preorder and postorder traversal of a binary Tree is given? Justify your answer. (1 Marks)
    b. Assume that every non-leaf node in T has two offspring. Describe how we can recover T from the two sequences using an algorithm. (6 Marks)

c. Let the preorder traversal sequence of T be 100, 34, 16, 9, 8, 38, 11, 4, 81 and postorder traversal sequence of T be 34, 9, 11, 4, 38, 81, 8, 16, 100. Assume that all non-leaf nodes of T have two children, Identify the tree T. (3 Marks)

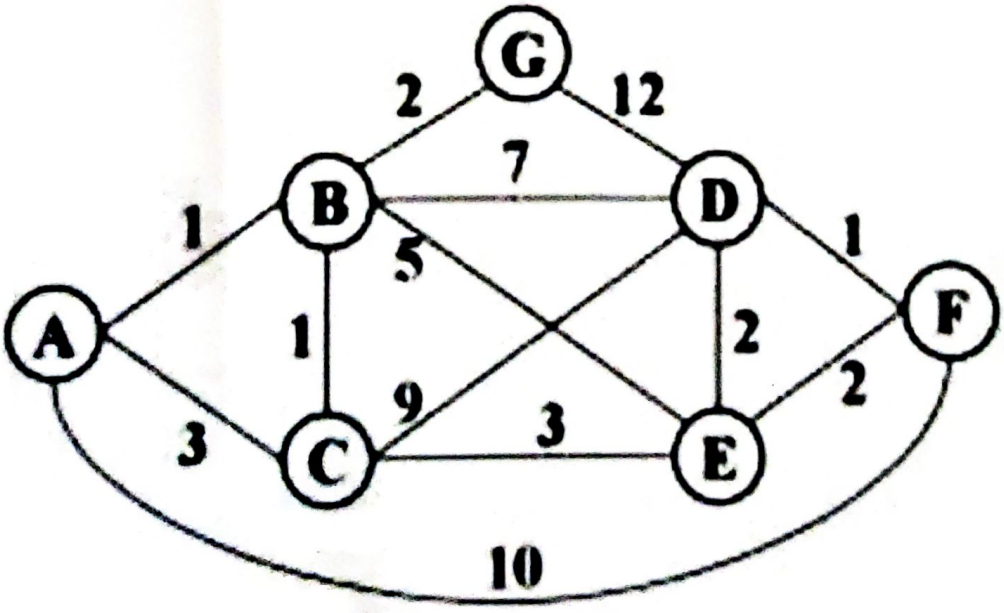
06. Consider a database which stores and retrieves data most efficiently by resolving collision, having a hash table of size=10. Using double hashing, insert keys 72, 27, 36, 24, 63, 81, 92, and 101 into the table. Consider h1=(k mod 10) and h2=(k mod 8) [10]

07. [10]




Apply minimum spanning tree algorithm and find the minimum cost and spanning tree for the above graph.

08. Assume that, the management of a school (located in place A) has decided to operate the school buses for the convenience of their staff and students. They wanted to cover all the places that are interconnected as shown in figure below. Suggest a suitable algorithm to find the shortest route from the school to all other locations for helping the management to plan their bus service. Illustrate the step by step procedure for calculation of shortest path with the identified algorithm/pseudocode. [10]




09. For data transmission purpose, it is often desirable to have a code with a minimum variance of code-word lengths (among codes of the same average length). Construct the Huffman Tree using greedy strategy for the symbols and its occurrences shown in Table 1. [10]

Table 1

| Symbol | A | B | C | D | E |
|---|---|---|---|---|---|
| Frequency (in Thousands) | 0.4 | 0.1 | 0.2 | 0.14 | 0.16 |

Compute the following:

(i) Compression ratio (1 Marks)

(ii) Encode ABACABAD (6 Marks)

(iii) Decode 100010111001010 (3 Marks)

10. The important tourist spots in the United States and their interconnections are shown in Figure 1. **[10]**

(i) Find the single-source (Arlington) shortest path to reach the destination (Everett) (5 Marks)

(ii) Is there any correlation between Dijkstra's single-source shortest path and Floyd's all-pairs shortest path? Justify your answer. (5 Marks)

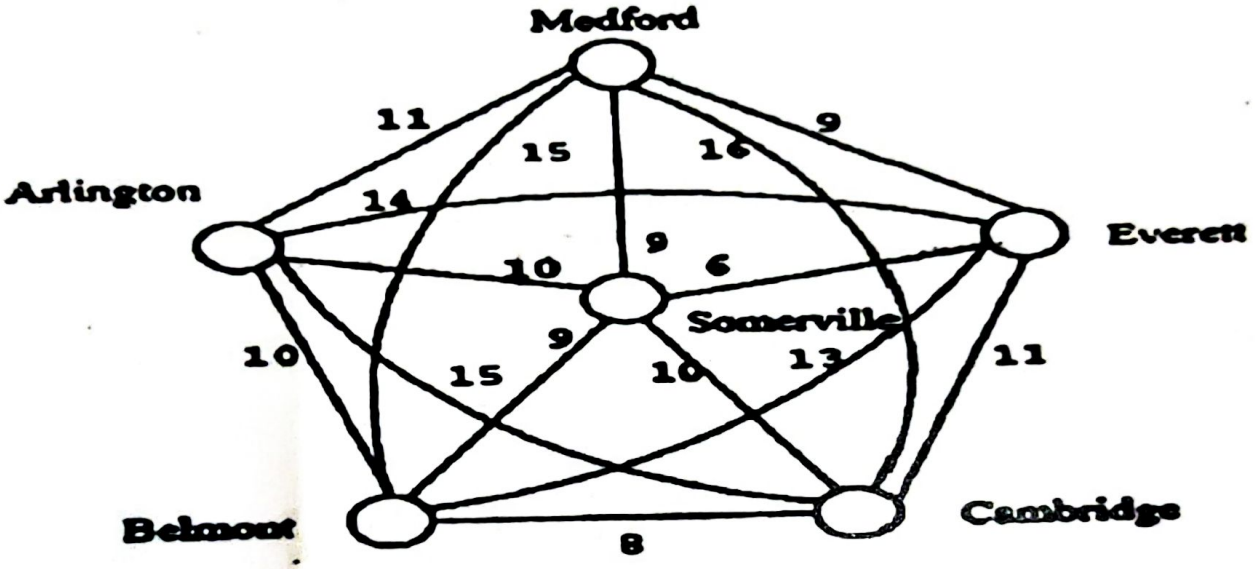



**Figure 1**

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