VIT Vellore Institute of Technology

Reg. No. :

Final Assessment Test (FAT) - November/December 2023

Programme	**B.Tech.**	Semester	**FALL SEMESTER 2023 - 24**
Course Title	**DATA STRUCTURES AND ALGORITHMS**	Course Code	**BCSE202L**
Faculty Name	**Prof. Karthikeyan .N**	Slot	**A1+TA1**
		Class Nbr	**CH2023240100647**
Time	**3 Hours**	Max. Marks	**100**

Section A (10 X 10 Marks)
Answer all questions

01. Consider an array containing the integer values $a_1, a_2, \ldots, a_n$. Write an algorithm ***hasUniqueElements*** to return TRUE if the number of occurrences of each value in the array is one; otherwise, return FALSE. The signature of the algorithm is ***bool hasUniqueElements(int n, int a[]).*** [10]

Analyze the time and space complexity of ***hasUniqueElements*** algorithm with a proper explanation.

02. a) Write the recurrence relation for the following algorithm and find its time complexity. [10]

[5 Marks]

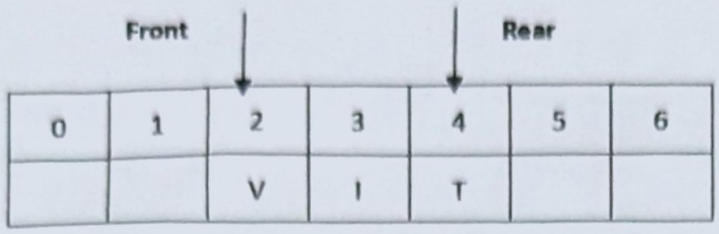
Algorithm : power(x, n)

```
{
if (n==0)
 return 1;
if (n==1)
 return x;
if ((n % 2) == 0)
 return power(x*x, n/2);
else
 return power(x*x, n/2) * x;
}
```

b) You are a software developer working on a compiler project. As part of your task, you need to convert infix expressions to postfix notation using stack. Consider the following infix expression : **(A + B * (C - D)) / E**; convert it into a postfix expression along with the conversion table.
[5 Marks]

03. Consider the following circular queue that consists of characters of size 7. The front is pointing to index 2, and the rear is pointing to index 4, as shown in the figure given below. Write an algorithm to perform the following operations on a circular queue by considering queue overflow and underflow conditions and show the status of queue, front and rear after performing each operation. [10]

- Elements A, B, X, Y and Z are added to the queue.
- Two characters are removed from the queue.



04. Consider the linked list which consists of 'N' nodes that are connected in bidirectional order. In bidirectional, forward iteration starts at the first node, and the process ends at the last node. In reverse, iteration starts at the last node, and the process ends at the first node. **[Each 5 Marks]** **[10]**

i) Write an algorithm to interchange the first node and last node in the linked list.

ii) Write an algorithm to connect the next pointer of the last node to the first node in the forward process, and to connect the previous pointer of the first node to the last node in the reverse process after implementing the algorithm(i).

05. In a distributed environment, a server receives multiple requests from various systems. Each request is formatted as **(system_id, task size)**, where system_id represents the source system and task size indicates the amount of work required. The server aims to process requests in ascending order of task size, prioritizing those with the least size work first. To achieve this, the server must sort the requests based on their respective task sizes. Given the requests from various systems along with their corresponding task sizes: **[(A, 5), (B, 1), (C, 2), (D, 1), (E, 4), (F, 6), (G, 3), (H, 1), (I, 9), (J, 7), (K, 2)]**, perform the sorting of requests based on task size using divide and conquer algorithm. Choose an algorithm with a worst-case time complexity of **O(n log n)**. **[10]**

06. Assume you are given two binary search trees T1 and T2 with n1 and n2 nodes, respectively, and a target value X. Find the number of distinct pairs (v1, v2) such that v1 belongs to T1, v2 belongs to T2, and **v1+v2=X**. Write an algorithm to find the distinct pairs from T1, T2 and explain each step with neat sketch. **[10]**

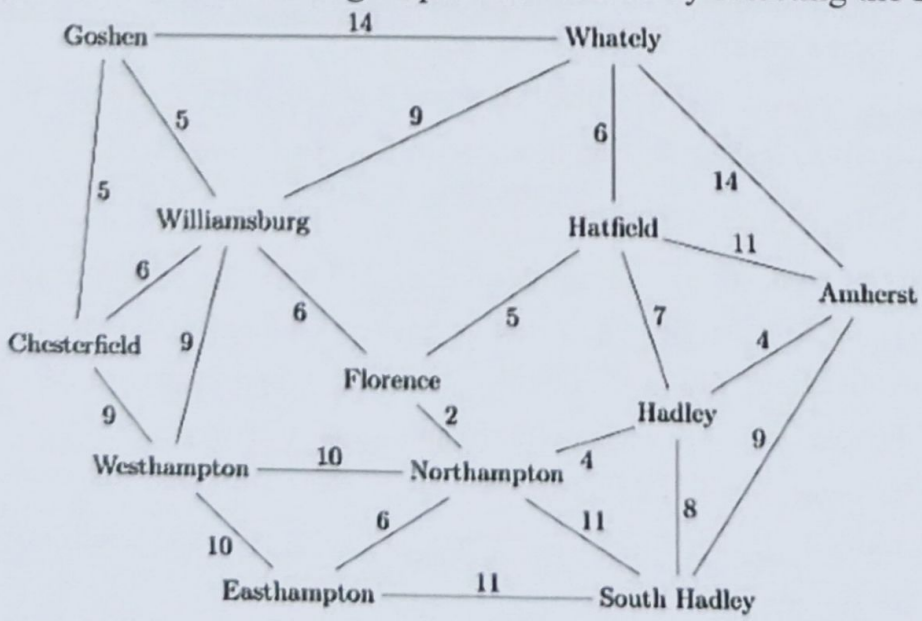
Note: Assume that every BST node has a unique key.

07. The provided graph shows the city of New York. Each city in the network is connected, and the edges indicate the distance between any two cities. Assume that you are a tourist guide, and you need to take the travellers to visit all the cities in New York.**[Each 5 Marks]** **[10]**

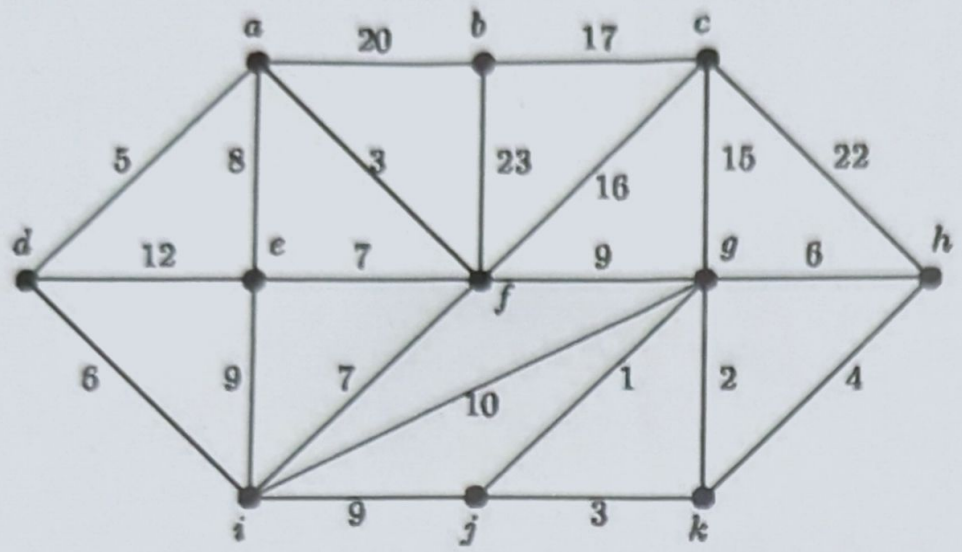
Write down the algorithm for the given conditions.

(i) To visit all cities using Breadth First Search by selecting the **Easthampton city** as starting city.

(ii) To visit all cities using Depth First Search by selecting the **Easthampton city** as starting city.



08. Write prim's algorithm to find the **Minimum Spanning Tree (MST)** for the given graph. Illustrate the step-by-step process, including the selection of the starting vertex and the addition of edges to the MST at each step. Provide the final MST with all its edges and the total cost of the MST. [10]



09. Consider a game scenario where you have many keys with the 4-digit number written on it. Your task is to find the correct bucket to place the key using the hashing techniques namely 1. Linear probing 2. Quadratic probing 3. Separate chaining, and a hash-function **h(key) = key mod m** for the following numbered keys {5471, 2523, 6173, 6199, 4344, 7674, 2374, 7486}.
Assume there are nine keys overall, represented by the character **m**. Show the steps for assigning keys to buckets using the above three techniques and illustrate the process of handling collisions. [10]

10. (a) Construct the AVL tree using the following keys: **{H, I, J, B, A, E, C, F, D, G, K, L}**. Show all the steps required for constructing a tree with a balance factor. **[6 Marks]** [10]
(b) Draw the resultant AVL tree after removing the root node. If the resultant tree is unbalanced, apply suitable rotation to obtain a balanced tree. **[2 Marks]**
(c) Delete node H from the resultant AVL tree from (b) and show the final tree. **[2 Marks]**