COMSATS University Islamabad

Department of Computer Science
Terminal Examination Fall - 2023
BS (CS) III SEMESTER

Course: CSC211-Data Structures & Algorithms **Instructor: Anum Zehra**
Maximum Marks: 50 **Date:** January 9, 2024 **Time Allowed:** 180 Minutes

- *All questions are self-explanatory and require no further explanations during exam time.*
- *Make sure that you have signed the attendance sheet before leaving the examination room.*
- *Return the question paper along with the answer sheet.*
- *Attempt all questions.*

(CLO – 1: Employ linear data structures to solve computing problems.)

QUESTION 1: **Marks: 10**

Suppose you are working on a project to develop an inventory management system for a retail chain that has multiple stores in different cities across the country. The system should be able to maintain the records of the items in each store. Each store has different sections, and each section has different products. To implement this system, use best suitable Data Structure to maintain the records of items, locations, stores, and sections. Write the methods to perform following operations:

a) Add a new section in a store (toys, grocery, fruits….)
b) Store an item in a particular section of a particular store.
c) Remove an item in a particular section of a particular store.
d) Display the list of all items of a particular section of a store.
e) Display the list of items for a given store.

Stores
↓
section
↓
items

For example, to store an item in a location in a particular store, you can search for the node that represents the store, then search for the node that represents the section in the store, and then search for the node that represents the location in the section. Then, you can add a new node to the linked list that represents the items stored in the location. Same procedure will be for deletion operation.

QUESTION 2: **Marks: 08 (4+4)**

A palindrome is a word that reads the same backward or forward. Given a paragraph such as following,

"Mr. Bob is a professional guitarist and his wife Ada is a dress designer, they have two daughters, Anna and Aleela. They went on a foreign tour, where they stayed in district Akasaka, Japan. They hired a car that looked like a racecar - Honda Civic. They were inspired by the Japanese technology and traditions. Every noon they visited sushi bar, and play land to enjoy their holidays. The family has highest level of excitement to visit such a great landscape."

Assume that Stack is already implemented, and you can create the objects of that Stack, however; you have to write the enqueue method for the Queue as per your requirement.

a) You are required to read the paragraph word by word and each word is store at different index of the array, your task is to check if a word is palindrome or not, using stack.

b) If a word is palindrome, it should be placed in a queue with lowest length of word in front.

Hint: the input is given as array of strings. e.g. string paragraph []={"Mr.", "Bob",:..}
he case of letters should not matter, e.g. bob and Bob are similar and bob is a palindrome word}

(CLO-2: Use non-linear data structures to solve computing problems.)

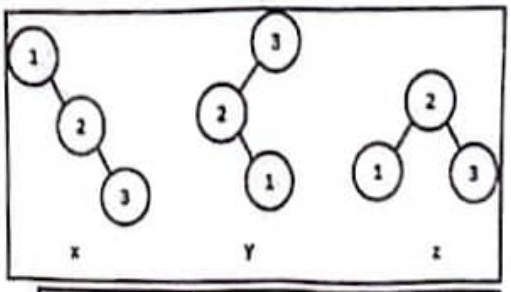
QUESTION 3: **Marks: 15 (2+3+5+5)**

Part-1: Implement the following operations on the Tree ADT:

a) You are required to write a function which will find the sum of all the nodes of a binary search tree.

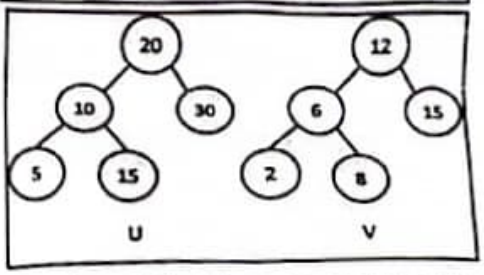
b) Write a function which will return true if two binary search trees have same values in all the nodes, however they may have different structures e.g. BST x, y and z have same values but different structures. To implement the task, you can use any additional ADT. The method prototype is:

```
bool SameValue(TreeNode *r1, TreeNode *r2)
```



c) Write a function which will determine if two binary search trees have identical structure. The BST u and v have same structure but different values. The method prototype is:

```
bool SameStructure(TreeNode *r1, TreeNode *r2)
```



Part-2: Assume that you have record of products with remaining expiry dates. You have to organize the data in such a way that the record of product with minimum remaining expiry could be accessed in constant time.

QUESTION 4: **Marks: 8 (2+3+3)**

Suppose the Pakistani government is working on a major infrastructure project to improve intercity connectivity by building a new railway network. Five key cities: Islamabad, Lahore, Karachi, Peshawar, and Quetta have been identified as priority destinations. Your task is to design the most efficient railway network that connects all five cities while minimizing the total track length.

- Islamabad to Lahore there are 250 KM
- Islamabad to Karachi there are 1000 KM
- Islamabad to Peshawar there are 200 KM
- Islamabad to Quetta there are 1900 KM
- Lahore to Karachi there are 800 KM
- Lahore to Peshawar there are 400 KM
- Lahore to Quetta there are 700 KM
- Karachi to Peshawar there are 1200 KM
- Karachi to Quetta there are 300 KM
- Peshawar to Quetta there are 500 KM

Consider the following distances.

a) Convert the said cities and distances into a weighted directed graph.

b) Consider the graph in part-1 as an undirected graph and simulate Prim's algorithm on it to find the minimum spanning tree which will then be used to design different rail routes going through multiple cities.

c) Write code in C++ to solve the above problem using Prim's algorithm.

(CLO-3: Analyze the time complexity of various algorithms.)

QUESTION 5: **Marks: 9 (5+4)**

Part-1: A book seller has to keep different story books in a corner of his shop. For this he has a shelf with 26 compartments. If someone visits his shop and asks for a book "Treasure Ireland" he goes to a specific compartment where there are different story books like "The Tower", "Treasure Ireland", "Time" and "Trumpet of Swan". He looks there for "Treasure Ireland", picks and gives that to customer. Write the C/C++ code to propose the efficient algorithm to solve the above problem.

Part-2: You have to write a program to store the information of Employees with attributes SSNo. Name, Salary, Experience_in_Years. You cannot fix the number of employees as it can vary from time to time. Select a suitable data structure for this scenario. Later on you are required to sort the employees with respect to their seniority in that organization. Choose, implement and analyze a sorting algorithm for this problem which should help you achieve your goal with minimum complexity.

I L K P G

250 200 1000

1900

400 500 12000