The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical and Computer Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: EEX4435/EEX4535/ECX4235 Data Structures and Algorithms**
Academic Year	: 2019/20
Date	: 13th August 2020
Time	: 1330-1630hrs

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Seven (7) questions** in **Six (6)** pages.
3. Answer any **five (5)** questions only. All questions carry equal marks.
5. Answer for each question should commence from a new page.
6. This is a Closed Book Test **(CBT).**
7. Answers should be in clear hand writing.
8. Do not use Red colour pen.

Question 1.

Due to the Covid 19 pandemic situation, treating outdoor patients in hospitals has become a complicated process. Patients need to undergo many routine checks before they are directed to a doctor.

(i) Assume this scenario and summarize the scenario in 8 steps and write them down. (5 marks)

(ii) Draw a flow chart for the steps you identified in part (i). (5 marks)

(iii) Write a pseudo code algorithm to automate the flow chart drawn in part (ii). (5 marks)

(iv) Calculate the worst case running time for the pseudo code algorithm written in part (iii). (5 marks)

Question 2.

(i) Name two algorithm design techniques and briefly explain each of them using example/s. (4 marks)

(ii) Assume that you are given a set of elements stored in an array and asked to reverse the order. For example, if the elements are in the order (12, 45, 18, 23) then the reverse order after executing the program will be (23, 18, 45, 12). Write a pseudocode algorithm to reverse the elements in a given array. (5 marks)

(iii) Write a pseudocode for a basic sorting algorithm to sort the above reversed array into ascending order of the elements. (5 marks)

(iv) Separately find the worst case time complexity of the algorithms you have written in part(ii) and part (iii). (6 marks)

Question 3.

The Fibonacci sequence is the series found by adding up the two numbers before it, as shown below

0, 1, 1, 2, 3, 5, 8, 13.....

The pseudocode algorithm given below calculates the Fibonacci sequence

```
int fib(int n){

      int f[n+1];

      f[1] = f[2] = 1;

      for (int i = 3; i <= n; i++)

            f[i] = f[i-1] + f[i-2];

      return f[n];

}
```

(i) Assume n=5 and hand trace the above pseudocode algorithm to calculate the value of fib[5]. You need to give the calculations of intermediate steps. (5 marks)

(ii) Calculate the worst case running time of the above pseudocode algorithm showing the calculations for the intermediate steps as well. (4 marks)

(iii) Rewrite the above iterative pseudocode algorithm using recursive approach. (4 marks)

(iv) Assume that you are given the binary trees shown in Figure 1. The binary tree on the right side is the mirror image of the binary tree on the left side. Write a pseudocode algorithm to obtain the binary tree on the right side from the left binary tree.

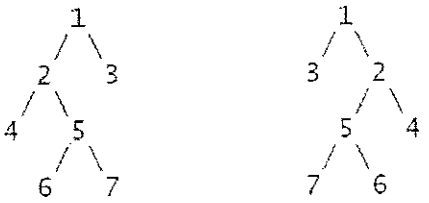

Figure 1 - Binary trees

(7 marks)

Question 4.

The table given below contains the time taken to travel between two cities given in minutes. The cities are named from A to H and some of these cities are directly connected as shown in the below table. Sometimes the time taken to travel from A→B is different from the time taken to travel from B→A due to road conditions.

Table 1-Distance between cities

From / To	A	B	C	D	E	F	G	H
A	0	7	5	-	20	-	-	-
B	10	0	-	-	-	-	10	-
C	5	-	0	20	-	10	-	-
D	-	-	10	0	-	-	-	-
E	20	-	10	-	0	-	-	30
F	-	-	10	-	10	0	-	-
G	-	5	-	-	-	-	0	35
H	-	-	-	-	30	-	25	0

(i) Draw a directed weighted graph according to the information given above. The direction should be "From" to "To", for example from town A to town B has an edge A→B and edge weight is 10. However, the edge weight B→A will be 7.

(6 marks)

(ii) Calculate the minimum time to travel from town A to town H by applying Dijkstra's shortest path algorithm (Single Source All Destinations). Show the predecessor and distance arrays following each step of Dijkstra's algorithm. (6 marks)

(iii) Write the pseudocode algorithm for Depth First Search for the graph you created in part(i) and give the sequence of the output nodes starting from node A. (5 marks)

(iv) Briefly describe the impact of having a cycle in a graph. (3 marks)

Question 5.

Consider the data set given below.

87, 36, 22, 15, 56, 85, 48, 90, 72, 6

(i) Write a pseudocode algorithm for merge sort. (5 marks)

(ii) Give the output data set after applying merge sort to the above data set. (3 marks)

(iii) Write a pseudocode algorithm for binary search to find the value 56 from the sorted data set obtained from part (ii). (4 marks)

(iv) Figure 2 contains an edge-weighted graph G, where edge-weights represent cost of moving from one edge to the other.

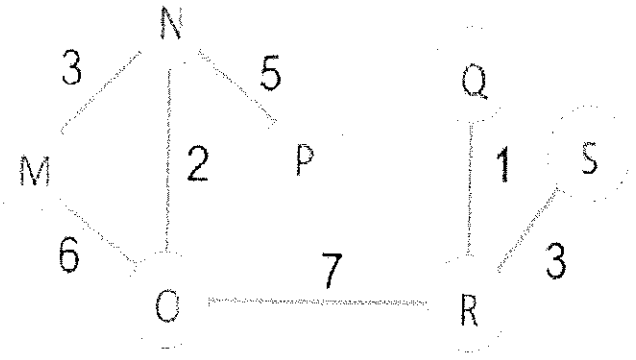

Figure 2- Edge weighted graph

a. List the vertices of G that have degree > 1 (2 marks)
b. Describe a simple cycle in G and give its overall cost (2 marks)
c. Represent the graph G using an adjacency matrix. (4 marks)

Question 6.

(i) Create a binary search tree with the following set of values taking the first value as the root.

50,10,40,25,75,70,35,37,90,60 (4 marks)

(ii) Write a pseudo code algorithm for pre-order traversal of the tree and give the resulting output. (4 marks)

(iii) Write a recursive pseudo code algorithm to insert a given value into a binary search tree and modify the binary search tree drawn in part(i) to insert value 65. (5 marks)

(iv) The below given Java method uses recursion to search for a key. If the search key was found, the corresponding data item will be returned otherwise *null* will be returned.

```
Public static objectSearch(Node root, int key) {
        if (root = = null)
                return null;
        else if (key = = root.key)
                return root.data;
        else if (key < root.key)
                return searchTree(root.left, key);
        else
                return searchTree(root.right, key);
        }
```

Rewrite the above given object search method using iteration instead of recursion. (7 marks)

Question 7.

You have been hired to write a 'phonebook' application for a small company. The phonebook stores names of company employees and their phone numbers. Given an employee name it should be possible to retrieve the employee's phone number. It should also be possible to add a name and the associated number when a new employee joins the company; and to delete a name and number when the named employee leaves the company.

(i) Write a pseudocode algorithm to implement the phonebook application using a doubly-linked list, paying attention to the operations for getting the phone number for a given name and adding and deleting employee phone numbers. (6 marks)

(ii) Suppose the company becomes very successful and the employee number increases to thousands. Is the implementation based on a doubly linked list adequate? Give reasons for your answer and propose a suitable method. (2 marks)

(iii) Insert the objects with key values 15, 17, 8, 23, 3, and 5, respectively, into an initially empty hash table of size 7 with the hash function $h(x) = x \bmod 7$.

a. Use hashing with chaining to insert the objects in the given order. Each table slot implements a singly linked list where items are inserted at the head of the list. Show the resulting table. (3 marks)

b. Use open addressing with linear probing to insert the objects in the given order. (3 marks)

c. Use open addressing with quadratic probing to insert the objects in the given order. Show the resulting table. (3 marks)

d. Use open addressing with double hashing to insert the objects in the given order. The hash function h' is defined by $h'(x) = x / 7 + 1$. Show the resulting table. (3 marks)

The End