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	: **EEX4535/ECX4235 Data Structures and Algorithm**
Academic Year	: 2017/2018
Date	: 29th January 2019
Time	: 0930-1230hrs
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.

2. This question paper consists of **Seven (7)** questions in **Five (5)** pages.

3. Answer **compulsory question(Q1)** in **PART A** and any **Four (4)** questions out of **Six(6)** given in **PART B**. All questions given in **PART B** carry equal marks.

4. Answer for each question should commence from a new page.

5. This is a Closed Book Test (CBT).

6. Answers should be in clear handwriting.

7. Do not use Red colour pen.

PART A (Compulsory Question)   **(40 marks)**

Q1. The ABC phone company maintains a very efficient service centre and many customers daily visit this centre to get various services. There are several service counters and the customers are allocated to these counters considering the queue at each counter. The customers allocated to each counter is displayed and if there is an undue delay in any of the counters then the customers are reshuffled based on their waiting time. Given below are the waiting times of 10 customers in minutes at 11a.m. on last Friday.

<p align="center">8, 12, 21, 13, 7, 17, 9, 11, 5, 16</p>

(i) Assume that at a particular time point there are a limited number of customers only. Write a pseudo code algorithm to store these data in a suitable data structure for further processing.   (6 marks)

(ii) It was required to find out the customers who have been waiting for more than 15 minutes from the above given waiting times data set. Write a pseudo code algorithm to identify the customers who have been waiting for more than 15 minutes.

            (6 marks)

(iii) In every half an hour (1/2hour) the system randomly picks a customer and is been served immediately. At the given time slot 11 a.m. on last Friday customer who has been waiting for 13 minutes was been identified as the customer to be served immediately. Write a pseudo code algorithm to find the customer who has been waiting for 13 minutes.   .   (8 marks)

(iv) At the time point where the above waiting times are indicated it was required to arrange the waiting time data set in ascending order by selecting the lowest waiting time at each run. Write a suitable pseudo code algorithm to get this work done.

            (8 marks)

(iii) Write a pseudo code algorithm to find the average waiting time per customer.

            (5 marks)

(vi) The customer who has been waiting for 17 minutes has got really frustrated about the service and decides to leave. Write a pseudo code algorithm to remove this customer from the sorted list obtained in above part (iv).   (7   marks)

PART B
Answer any Four (04) questions

Q2.

(i) Calculate the running time of the below given algorithm with respect to Big Oh notation.

```
repeat the following for items i from 1 to N for array1
  repeat the following for items j from 1 to M for array2
      repeat the following for items k from 1 to L for array3
          do something
      end repeat
  end repeat
end repeat
```
(4 marks)

(ii) Assume that you want to create a grade book for the students in year 6A and the grading scheme is as per given below. Write a pseudo code algorithm to print the grading for each subject when the mark is given for a particular course for each student

        Marks>= 75 –A   Marks>= 40 – C

        Marks >=60 –B   Else Marks – D   (7 marks)

(iii) Explain the features of a good algorithm with respect to the algorithm you wrote in part(ii)   (4marks)

Q3.

There are many situations where we need to check whether the parentheses in a mathematical expression are nested correctly. In doing so the rules to follow are,

1. There is an equal number of right and left parentheses.
2. Every right parenthesis is preceded by a matching left parenthesis.

(i) Write a pseudo code algorithm to test whether the parentheses are nested correctly according to the above rules in a given mathematical expression.   (6 marks)

(ii) Hand trace how the above written algorithm will work on the below expression

$$((((3 + 1)*3)/((9\text{-}5) + 2)) - ((3* (7\text{-}4))+6))$$
(3 marks)

(iii) Draw the arithmetic expression tree for the above given expression in part (ii).
(6 marks)

Q4.
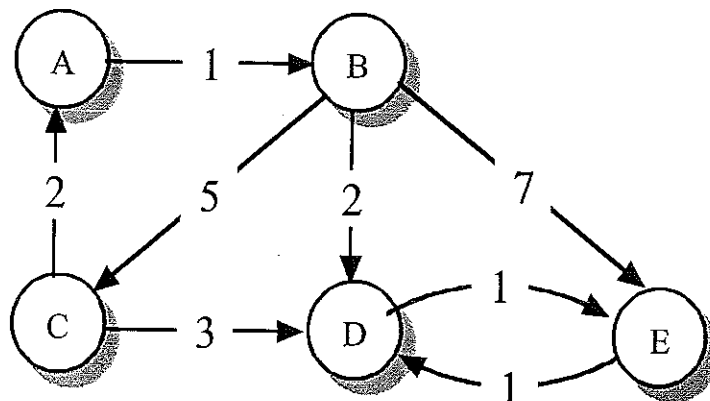
A graph is represented by G = (V, E), where V is the set of vertices (or nodes), E is the set of edges of the graph. The above graph represents locations of warehouses of a company with the distance between them.

(i) Draw the corresponding adjacency matrix for the above graph. (4 marks)

(ii) Run Dijkstra's algorithm on this graph with start vertex *A* and target vertex *E* and find the shortest path. You have to give the calculations of the intermediate steps as well.
(6 marks)

(iii) Suppose that direction of travelling between warehouses B and D are reversed due to road construction and now it only allows to go from D to B only. Modify the shortest path identified in part (ii) with the changed situation. (3mark)

(v) Briefly describe the impact of having a cycle in a graph. (2 marks)

Q5.

(i) Assume that you are given three numbers to check whether they satisfy the Pythagorean Theorem $p^2+q^2=r^2$. Write a pseudo code algorithm to check whether any given three numbers satisfy the Pythagorean theorem. (6 marks)

(ii) Prove the correctness of your algorithm using the sample numbers 3, 4, 5. You need to give step by step illustrations of how the algorithm written in part (i) work.

(4 marks)

(iii) Write a pseudo code algorithm for insertion sort and hand trace how your written algorithm will work on the data set 15, 22, 3, 5, 12. (5 marks)

Q6.

(i)   Describe the features of a Binary Search tree.   (2 marks)

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

30,50,60,25,65,47,32   (4 marks)

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

(iv)   Write a recursive pseudo code algorithm to insert a given value in to a binary search tree and modify the binary search tree drawn in part(ii) to insert value 48.

(5 marks)

Q7.

(i)   Describe the importance of hashing using a real world example.   (3 marks)

(ii)   Insert the objects with key values 525, 172, 212, 48, 681, 231, and 719, respectively, into an initially empty hash table. The hash table has 5 slots and the hash function is $h(k) = k \bmod 5$.

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 $h'(k) = \lfloor k / 1000 \rfloor$. Show the resulting table.   (3 marks)

The End