

The Open University of Sri Lanka
 Bachelor of Technology Honours in Engineering
 Department of Electrical and Computer Engineering
 ECX 4235 – Data Structures & Algorithms
 Final Examination 2016/2017



Date: 12th November 2017

Time: 0930 - 1230hrs

< INSTRUCTIONS >

1. Answer the **Compulsory Question 1** in **Part A**.
2. Answer **4 questions out of 6** given in **Part B**.
3. This is a closed book exam and no reference books and materials are allowed.

PART A (Compulsory Question)

(40 marks)

- Q1.** Below given are waiting time data in minutes, of ten (10) students at a registration desk. The data are given in a randomized way not according to order the students stand in the queue.

10, 22, 11, 05, 14, 17, 21, 15, 17, 12

- (i) It is required to store these data in a suitable data structure for further processing. Write a pseudo code algorithm for declaring the data structure and for inserting data. (6 marks)
- (ii) The person who has been waiting in the queue for the longest time is the next to be served. Using a simple sorting algorithm sort the above data set according to the order that the students will be served at the registration desk. (8 marks)
- (iii) Write a pseudo code algorithm to find the average time of waiting at the registration queue. (6 marks)
- (iv) It was required to find the student who has been waiting for 14 minutes. Write a pseudo code algorithm for a suitable searching mechanism to find the student who has been waiting for 14 minutes. (6 marks)
- (v) The registration desk members noticed that there is a pregnant student in the queue and they wanted to serve that student first. But the first student in the queue opposed to that telling that he has been waiting for an extra-long time. Luckily the second student in the queue agreed to give his position. Write a pseudo code algorithm to insert the pregnant student to the second position. (8 marks)
- (v) The student standing at the 5th position of the queue decided to go back and come again on another day. Write a pseudo code algorithm to remove the student in the 5th position of the queue. (In general your algorithm should facilitate to remove a student from any given position in the queue) (6 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.

```

function X_search (T[1..n],x)
    {This algorithm assumes that x appears in T}
    i=1; j=n
    while i < j do
        {T[i] ≤ x ≤ T[j]}
        k = (i + j)/2
        case x < T[k]: j= k-1
            x = T[k]: i, j-k {return k}
            x > T[k]: i= k+1
    return i

```

(5 marks)

- (ii) Two of the most common divide-and-conquer sorting algorithms are quicksort and merge sort. In practice quicksort is often used for sorting data in main storage rather than merge sort. Give a reason why quicksort is likely to be the preferred sorting algorithm for this application. (2 marks)
- (iii) Write the pseudo code algorithm for merge sort. (4 marks)
- (iv) Trace by hand how above written merge sort (in iii) will operate on the below data set.

{77, 44, 99, 66, 33, 55, 88, 22}

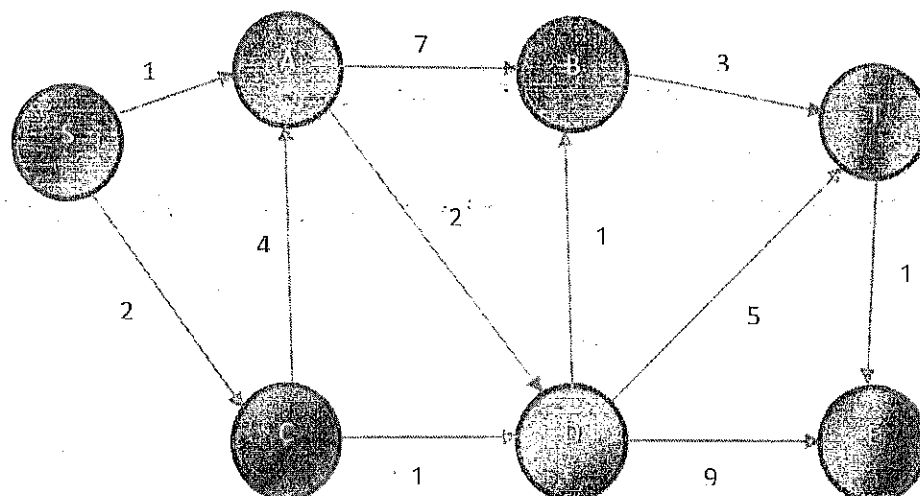
(4 marks)

Q3.

Assume that you are given a set of six letters to form words. For example the letters can be R, E, D, A, W and R. Some possible words that can be formed are *rare*, *ear*, *dear* etc.

- (i) Write a pseudo code algorithm to form all possible three (03) letter words from the above letter set. (5 marks)
- (ii) Assume that you are given a Dictionary of English words and you need to identify whether the words formed in part (i) are meaningful words. Describe a method to perform this task. You need to explain how the English Dictionary is stored and how the matching can be done. (5 marks)
- (iii) Write a pseudo code algorithm to track whether any duplicate words are generated in part (i). (5 marks)

Q4.



A graph is represented by $G = (V, E, w)$, where V is the set of vertices (or nodes), E is the set of edges of the graph and w is the weight. The above graph represent some cities and the edges represent the road network among the cities. The weight associated with each edge is the travelling cost from one city to another. All roads are one directional roads.

- (i) Draw the corresponding adjacency matrix. (4 marks)
- (ii) Run Dijkstra's algorithm on this graph with start vertex city S and target vertex city T and find the shortest path. You have to give the calculations of the intermediate steps as well. (5 marks)
- (iii) Suppose that if the direction between the cities D and B are reversed (can travel from B to D only) then identify the shortest path from city S to city T . (4 mark)
- (v) Briefly describe the impact of having a cycle in a graph. (2 marks)

Q5.

Suppose that you need to design a linked list data structure to store five values.

- (i) Simply describe the steps in adding a node at the beginning of a linked list. (2 marks)
- (ii) Write a pseudo code algorithm to insert values to a linked list. (4 marks)
- (iii) Describe the features of a doubly linked list data structure. (2 marks)
- (iii) Suppose that you are required to delete nodes from list $L1$ whose positions are to be found according to the numbers given in the ordered list $L2$. For instance, if $L1 = (A, B, C, D, E)$ and $L2 = (2, 4, 8)$, then the second and the fourth nodes are to be deleted from list $L1$ (the eighth node does not exist), and after deletion, $L1 = (A, C, E)$. Write a pseudo code algorithm to implement the above action. (7 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.
10, 5, 4, 6, 7, 8, 20, 15, 13, 30
(4 marks)
- (iii) Write a pseudo code algorithm for pre-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. (5 marks)

Q7.

- (i) Assume that you want to find a pattern string within another string or body of text.

For example assume that the given string is

a	a	b	a	b	b	a	a	b
---	---	---	---	---	---	---	---	---

The pattern string you need to find is

a	a	b
---	---	---

- Write a pseudo code algorithm to perform the above task. (5 marks)
- (ii) Insert the objects with key 539, 623, 429, 1055, 155, 866, and 719, respectively, into an initially empty hash table. The hash table has 10 slots and the hash function is $h(k) = k \bmod 10$.
- 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. (2 marks)
 - Use open addressing with linear probing to insert the objects in the given order where the constant c is 1. Show the resulting table. (2 marks)
 - Use open addressing with quadratic probing to insert the objects in the given order. Show the resulting table. (3 marks)
 - 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