

The Open University of Sri Lanka
Diploma in Technology
Department of Electrical and Computer Engineering
ECX 4235 – Data Structures & Algorithms
Final Examination 2011



Date: 22nd March 2011

Time: 1400 - 1700hrs

Note: Answer FIVE questions ONLY.

Q1.

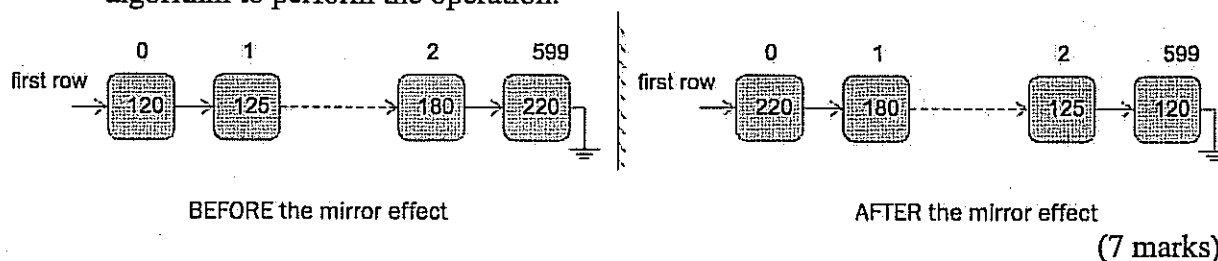
- (a) Describe two methods of designing algorithms by giving an example for each method. (4 marks)
- (b) Describe two instances where algorithm analysis is important. (4 marks)
- (c) Compare and contrast currently available methods for analysing algorithms. (6 marks)
- (d) A common method to prove the incorrectness of an algorithm is to produce a counter example. Briefly explain techniques available to prove incorrectness of an algorithm by giving suitable examples. (6 marks)

Q2.

A linked list is a data structure with a sequence of nodes. Each node holds some information and a reference to another node in the list. Therefore many nodes can be strung together using only one variable to access the entire sequence of nodes.

- (a) Compare and contrast static implementation and dynamic implementation of list data structure. (4 marks)
- (b) Write a pseudo code algorithm to create a linked list with a header and insert four numbers to the list. (4 marks)
- (c) Write a pseudo code algorithm to insert a new element between second and third elements. (5 marks)
- (d) Assume the pixels of the first row of the image are organized in a singly linked list as shown below. An image editor requires applying a mirror effect to the image. Mirror

effect requires the linked list to be arranged in the reversed order. Write a pseudo code algorithm to perform the operation.



Q3.

Following are the weekly records maintained by a football team after each played match.

Name of the opponent team (other team)
 Number of goals scored
 Number of goals received
 Date of the match (assume that DATE is another data type which contains day, month and year)

- (a) Create a new data type FOOTBALL to represent the data structure of such a record. Note that DATE data type must also be created. (8 marks)
- (b) Assume that above created data type is going to be stored in a stack data structure. Create a data type, STACK containing FOOTBALL data structure as its elements. (5 marks)
- (c) Write a function in Java to display the full records of the matches played in January. (7 marks)

Q4.

- (a) Briefly explain the following.
 - (i). What is a binary tree? Mention the properties of a binary tree.
 - (ii). Feature/s of a strictly binary tree.
 - (ii). Difference between terminal nodes and non terminal nodes

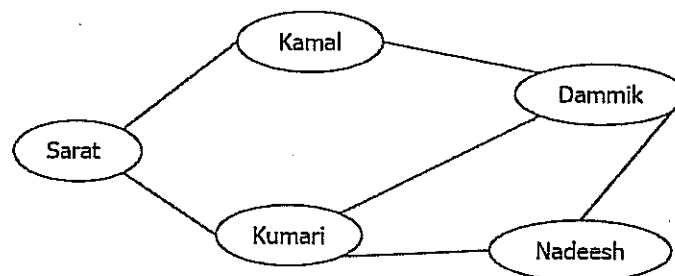
(2 marks each)
- (b) Write a pseudo code algorithm to return the number of leaves in a binary tree. (4 marks)
- (c) Suppose the following list of letters is inserted in the given order into an empty binary search tree.
 S, T, P, Q, M, N, O, R, K, V, A, B
 - (i). Find the final tree. (6 marks)

- (ii). Find the inorder traversal of the final tree.

(4 marks)

Q5.

Assume that you are given the task of creating a social networking site to record connections between the students of a school. One requirement of such a site is the representation of students and the relationships among them. The following figure represents an example view of relationship among a set of students. Each node represents a student and a link between two nodes indicates that the two persons represented by the nodes know each other.



Above information needs to be represented in a "Graph" data structure.

- (a) Identify a suitable data structure to represent a node in the Graph. (4 marks)
- (b) Write the adjacency matrix for the Graph. (6 marks)
- (c) Create a class called friendGraph to represent the persons and their connection. (4 marks)
- (d) Write a pseudo code algorithm to implement the above graph. (6 marks)

Q6.

Quick sort can be described as a recursive in-place sorting algorithm that performs a partition() operation (divide the given data set into two parts) on the given array and then invokes itself twice on two distinct subranges of the array.

- (a) Describe the purpose, I/O parameters and effect of the partition() procedure and explain what the pivot is. Pseudocode is not required. (3 marks)
- (b) Give pseudocode for the quicksort() procedure that would call the partition() procedure you described in (a). Prove that your quicksort() will always terminate. (3 marks)

- (c) Clearly indicate the steps in sorting the following given array using Quick sort along with the pivot chosen.

$$A[] = \{44, 88, 55, 99, 66, 33, 22, 88, 77\}$$

(10 marks)

- (d) Analyse the worst-case behaviour of Quick sort and discuss possible ways of improving it. (4 marks)

Q7.

- (a) Write a pseudo code algorithm or a java program to implement insertion sort. (6 marks)
- (b) Clearly write down the steps involved in sorting the following given array using insertion sort.

$$A[] = \{5, 2, 3, 8, 1\}$$

(4 marks)

- (c) Compare and contrast selection sort with insertion sort. (4 marks)
- (d) Write short answers for the following
- What is the main characteristic of a stable sorting algorithm?
 - Assume that you are given a set of items which are already in sorted order. By giving reasons state what sorting method will be the most efficient to check whether the given set is sorted or not.

(3 for each)

Q8.

- (a) Build a binary search tree by inserting the input sequence 44, 22, 77, 55, 99, 83, 33. You should clearly explain the steps involved. (6 marks)
- (b) Draw the expression tree for $a * (b + c) * (d * e + f)$. (6 marks)
- (c) Take an initially empty hash table with five slots, with hash function $h(x) = x \bmod 5$, and with collisions resolved by chaining. Draw a sketch of what happens when inserting the following sequence of keys into it: 35, 2, 18, 6, 3, 10, 8, 5. [You are not requested to draw the intermediate stages as separate figures, nor to show all the fields of each entry in detail.] (8 marks)

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