

ELECTRONICS AND COMPUTER SCIENCE

2010-2011

Code: ECSE502

Title: Algorithms and Data Structures

Date: 12 May 2011

Time: 10:00

Duration: 2 Hours

INSTRUCTIONS TO CANDIDATES

Attempt ALL QUESTIONS.

SECTION 1

[3 marks each correct answer]

1. What does the **Big O** notation stand for?
2. For which operation do **ordered arrays** perform better than **unordered arrays**?
3. How many times would you need to traverse a **singly linked list** to delete the item with the largest key? Justify your answer.
4. When are **iterators** not useful in a Linked List?
5. What is the key feature of the nodes of a **binary tree** acting as a **search tree**?
6. Give the definition of a **sub-tree** of a binary tree.
7. What is the main feature of a **balanced tree**?
8. What is the definition of a **red-black tree** as a balanced tree?
9. What is the definition of a **minimum spanning tree** is a **graph**?
10. Under which condition must an **undirected graph** have a **cycle**?

SECTION 2

11. If a graph with vertices {A, B, C, D} is represented by an adjacency matrix, which has rows {0,1,0,0}, {1,0,1,1}, {0,1,0,0}, and {0,1,0,0}, what are the corresponding adjacency lists of the vertices? Each list should be given by following the notation:

`{vertex}:{set of adjacent vertices}`

[3 marks]

12. Let us assume, you are applying an in-order traversal on a binary tree, which has been constructed by the consecutive insertion, from left to right, of the following key values:

50, 25, 75, 12, 37, 43, 30, 33, 87, 93, 97

a) Construct the binary tree.

[3 marks]

b) **In-order traverse** the tree and list the key values in the sequence of order they are displayed.

[4 marks]

13. Given the following graph with edges {A, B} {B, C} {A, D} {D, E} and vertices {A, B, C, D, E}, which is the corresponding adjacency matrix in terms of {0,1} entries?

[4 marks]

14. Given the following directed graph {A, B, C, D, E} with their corresponding **weights** on edges as follows:

AB 50, AD 80, BC 60, BD 90, CE 40, DC 20, DE 70, EB 50

construct the graph and give the shortest path from vertex A to vertex E.

[9 marks]

15. Construct an undirected graph of three vertices connected with three edges, i.e., forming a triangle, give the maximum number of different spanning trees.

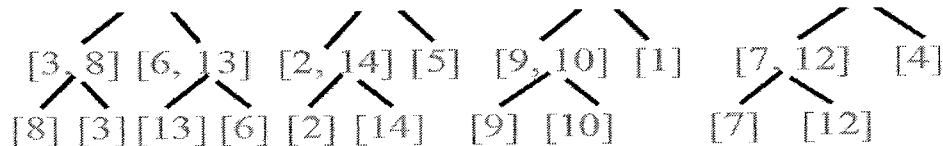
[7 marks]

SECTION 3

16. Assume that you are given an unsorted list [8, 3, 13, 6, 2, 14, 5, 9, 10, 1, 7, 12, 4], which needs to be sorted into the list [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14]. There are two ways to resolve this problem: a) **recursively** and b) **non-recursively**. In both case, a tree can be used to represent the way to the sorted list.

a) Describe in pseudo-code the recursive solution. *In order to do so, you may consult the figures in (b) below.* [7 marks]

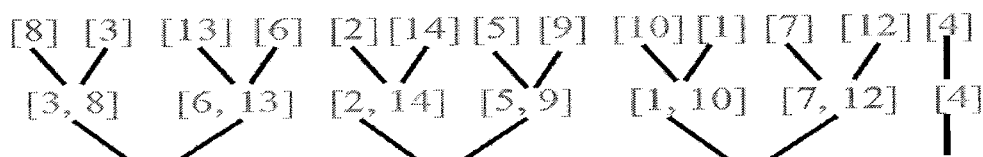
b) Complete **upwards and towards the root** the corresponding tree below for the recursive solution. [8 marks]



c) Give the time complexity in big-O notation of the upward pass of the tree and justify your answer [2 marks]
[3 marks]

d) Describe in pseudo-code the non-recursive solution. *In order to do so, you may consult the figures in (e) below.* [7 marks]

e) Complete **downwards and towards the root** the corresponding tree below for the non-recursive solution. [8 marks]



f) Give the time complexity in Big-O notation of the non-recursive algorithm and justify your answer. [2 marks]
[3 marks]