University of Swaziland
Supplementary Examination

JULY 2013

Title of paper : Data structures

Course number : CS342

Time Allowed : Three(3) hours

Instructions :

- *Each question is worth 20 marks*
- *Answer any five(5) of the seven (7) questions*

This paper may not be opened until permission has been granted by the invigilator

Question 1

(a) List and describe the operations of the queue ADT. [5]

(b) Give a linked-list based implementation of the queue ADT, including definitions of relevant data types. [15]

Question 2

(a) List and describe the operations of the stack ADT [5]

(b) Define the meaning of big-O notation and hence show that $N(N+1)$ is $O(N^2)$. [6]

(c) Using C++ STL or Java Collection, write an algorithm that finds and returns the greatest value in a given stack of numbers. [6]

(d) Analyse the big-O time complexity of the algorithm given in (c). [3]

Question 3

Using C++/Java notation, write an array based class that implements the list ADT, including definitions of relevant data and member functions. [20]

Question 4

(a) Draw a binary tree of size 10 and depth 4. Label the nodes 1, 2, ..., 10 according to the *postorder* traversal sequence. [6]

(b) What is meant by the term *binary search tree?* [2]

(c) Draw the binary search tree that results from insertion of the following values in sequence: 2, -10, 3, 15,0,9. [3]

(d) Write an algorithm that searches for a given key in a given binary search tree. It should return the subtree whose root contains the given key, if found. Otherwise it should return the empty tree. [9]

Question 5

(a) Write an algorithm that takes a list of numbers and repeatedly deletes the largest remaining item until the list becomes empty. [14]

(b) Analyse the big-O time complexity of the algorithm given in (a), assuming that the given list is array based. [6]

Question 6

(a) Draw a sample directed graph with 9 nodes and 15 edges.

(b) With the aid of the graph obtained in (a) above, explain the main ideas behind *adjacency matrix* and an *adjacency list* representation of graphs. [10]

(c) Write the algorithm for depth-first traversal of a given graph commencing at a given vertex. [5]

(d) Using the graph obtained in (a), show a trace of the depth-first search algorithm. [5]

Question 7

(a) Explain the meaning of the following terms:

(i) Left shell of a node [2]

(ii) Height of a tree [2]

(iii) (a,b)-tree [2]

(iv) B+ tree [2]

(b) Assuming the values are inserted in the given order, construct a 2-3 tree containing following values:

Gule, Khan, Zulu, Oyoko, Mamba, Banda, Dube, Cele, Langa, Nkomo, , Xaba, Musi, Sambo, Zulu, Odumbe, Jele, Gama, Mumba, Hlubi, Hlophe, [12]