The Open University of Sri Lanka
Department of Electrical and Computer Engineering

ECX 4265 – Data Structures & Algorithms
Final Examination 2009/2010

Date: 29th May 2010	**Time: 9.30 – 12.30hrs**

Note: Answer ONLY Five questions.
Write the coding in pseudo code or in JAVA language.

Q1.

a). Describe what is an Abstract Data Type by defining a suitable ADT. (4 marks)

b). Describe how to calculate the worst case time complexity (Big O value) for a given function $f(n)$. (4 marks)

c). Analyze the following algorithm and calculate the time complexity using O notation. (6 marks)

```
for i=1 to n
     for j= 1 to i
          K[i][j]= i*j
     end for
end for
```

d). Assume that Tx(n) and Ty(n) are two algorithms doing the same task with the following running times. Where, n is the input size. (3 marks each)

$$Tx(n) = 4n^3 + n^2$$
$$Ty(n) = 9n^2$$

(i) Find the value for input size where both algorithms will take same running time.
(ii) Find the range for input size where X is faster than Y.

Q2.

a). Compare and contrast static implementation and dynamic implementation of data structures. (5 marks)

b). Write a program to create a linked list with a header and insert four numbers to the list. For example, insert 40, 90, 30, 110 (8 marks)

c). Write a program to delete a given number in the middle of a list. For example, delete number 30 from the list given in part b. (7 marks)

Q3.

The following array contains the number of pages found in some novels in a book shop.

```
int pages[] = {140, 78, 230, 167, 172, 290}
```

You can assume that the above array has been already defined and can be accessed by the functions described below.

a). Illustrate how the above array can be sorted using bubble sort (No need to include any coding). (4 marks)

b). Write a function that sorts the above data using the bubble sort algorithm. (6 marks)

c). Implement a method called `largebooks()` which returns the number of books having more than 170 pages. (7 marks)

d). Is the below statement true or false? Justify your answer in terms of time and space complexity.

"Selection sort is faster than Bubble sort" (3 marks)

Q4.

a). Write a pseudo code for binary search. (8 marks)

b). Explain how you can search number 59 in the following set of numbers using binary search. You should clearly state each and every step in your searching.

23, 28, 31, 48, 53, 59, 72 (7 marks)

c). Compare and contrast Sequential search with binary search mechanism with the help of the set of numbers given in part b. (5 marks)

Q5.

a). Briefly describe a real world example operating as a stack. (2 marks)

b). Using an appropriate data structure write a pseudo code algorithm to check whether the parenthesis are properly placed in a given string.

Hint: The opening parenthesis can be of the type (, [or {and you have to check whether they have been closed properly in the string. (08 marks)

c). Assume that Q is a circular queue, having 5 elements as follows.
Front = 2, Rear =4, Q: _, P, Q, _, _.

```
              F .        R
    0    1    2    3    4
  +----+----+----+----+----+
  |    | P  | Q  |    |    |
  +----+----+----+----+----+
```

Illustrate the following operations. In each operation you have to clearly state the positions of Front, Rear and the order of elements in the queue.

(i) Add R to the Queue.
(ii) Delete two letters from the queue.
(iii) Add S, T and U to the queue.   (2 marks each)

d). Write a pseudo code algorithm for inserting an element to a non empty queue. (4 marks)

Q6.

Consider that you want to store the following data in a binary tree (key is StudentId).

StudentId	Name
1200	Imesha
1174	Chathura
1145	Manel
1250	Nishantha
1160	Prabath
1240	Nuwan
1320	Kanchana
1210	Gamini

a). Write the definition of the **Node class** and the **Tree class** to store above data.   (6 marks)

b). Draw the Binary tree after you have inserted the above data.   (4 marks)

c). Write the sequence of the Names you get if you traversed the above tree using
(i) pre order traversing
(ii) post order traversing   (2 marks each)

d). Write a pseudo code algorithm for the post order traversing and output the name of the student.   (6 marks)

Q7. Use the following graph to answer a, b and c parts of the question.
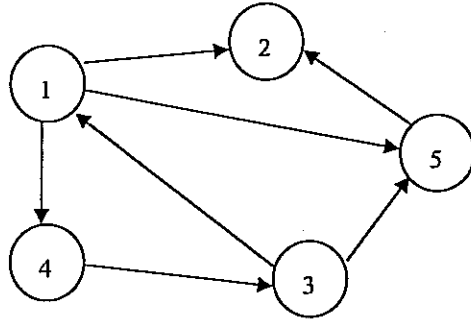
a). Represent the above graph in an adjacency matrix. (5 marks)

b). Find the degree of the vertex 1 of the above graph. (2 marks)

c). Write the pseudo code for Breadth First Traversal for the above graph and write the outcome. (8 marks)

d). Briefly describe Dijkstra's algorithm using an example. You need to clearly state any essential requirements (You are not expected to write any codes). (5 marks)

Q8.

a). The towers of Hanoi consist of 3 pegs A, B and C, and n disks of different sizes. Initially all discs are on peg A and in order of decreasing size as shown in figure 1. The objective is to move all discs in peg A to peg C as in figure 2.
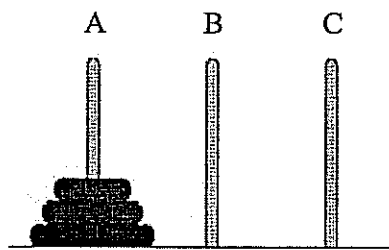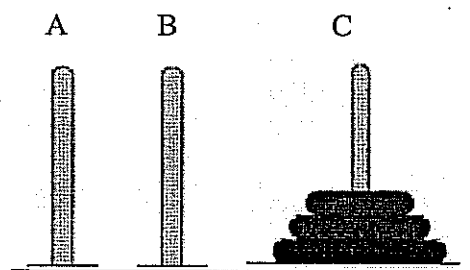

Figure 1   Figure 2

In moving the discs only the top most disc can be moved to another disc and a larger disc cannot be kept on a smaller disc. Write a recursive program using a suitable data structure, in Java, to print a sequence of moves to solve the towers of Hanoi problem.

(10 marks)

b). (i) Briefly explain what is hashing by describing two hashing methods. (4 marks)

(ii) With an example, explain how you can resolve a hash collision. (6 marks)