THE OPEN UNIVERSITY OF SRI LANKA
B.Sc DEGREE PROGRAMME: LEVEL 04
FINAL EXAMINATION: 2009/2010
CSU2279: DATA STRUCTURES AND ALGORITHMS – PAPER I
DURATION: **TWO AND HALF HOURS** (2 ½ HOURS)

Date: 20ᵗʰ July, 2010   Time: 9.30 am – 12.00 noon

Answer FOUR Questions ONLY.

Q1.

a)
  i.   What is an *ADT*?
  ii. What are the characteristics of an ADT?

b) Design an ADT to store the radius and the height of a cylinder.

c) Write a procedure to add values for the ADT created in part (b) and calculate the volume of the cylinder.
(*Note: Radius = r, Height = h, Volume = $\pi r^2 h$*)

d) Why do you need an ADT to solve the above problem?

Q2.

a) What is a *Linked list*?

b) What are the advantages of the *Doubly linked list* compared to the *Singly linked list*?

c) Define a singly linked list data structure that uses a pointer implementation, for storing a set of integers.

d) Describe the steps to insert data into a singly linked list.

e) Write a Pascal function/procedure to compute the sum of all the values in the nodes of a singly linked list.

Q3.

a) What are the factors you should consider when selecting a sorting algorithm?

b) Discuss instances where you can apply internal sorting methods.

c) Write a Pascal function/procedure to sort a set of integers using linear insertion sort method.

d) Explain how your program works on the following set of characters.

A L G O R I T H M S

e) Calculate the time complexity of the best case and the worst case situations.

Q4.

a) Explain the relevance of the Big-Oh notation, in specifying the complexity of algorithms.

b) Simplify the following function using the Big-Oh notation to describe its growth rate.

$$f(x) = 6x^4 - 2x^3 + 5$$

c)

    i.   Calculate the running time of the Pascal function/procedure given below.

```
function sum(i: integer):integer;
  var
    count, total: integer;
  begin
    total := 0;
     for count := 1 to i do
      total := total + count;
    sum := total;
  end;
```

    ii.   Write a recursive function to perform the operation in part (i).

Q5.

a) Describe the *Queue* data structure using appropriate diagrams.

b) What is the advantage of a *circular queue* over a *linear queue* in the queue data structure?

c) Write Pascal functions/procedures for the following operations of a queue, represented in linked form.

    ENQUEUE (x, Q) - Insert an element x at the end of the Q.
    DEQUEUE (Q)   - Deletes the first elements of the Q.
    EMPTY (Q)   - Returns true if and only if Q is an empty queue.
    FRONT (Q)   - Return the first element of the Q, without deleting it.

d) If the characters 'D', 'C', 'B', 'A' are placed in a queue (in that order), and then removed one at a time, in what order will they be removed?

Q6.

a) Briefly explain the following terms with respect to a binary tree structure.

    i.   Strictly binary
    ii.   Almost complete binary
    iii. Complete binary

b) Construct a binary tree by considering the following traversals of a tree.

          Preorder :   A B C E D F G H J I
          Inorder :   E C D B F G A J H I

c) Answer the following questions by using the constructed binary tree in part (a).

    i.   What is the depth of the tree?
    ii.   What are the leaf nodes and the non leaf nodes?
    iii. Is the constructed tree an almost complete binary tree? If not state the rule that has been violated.
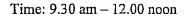
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THE OPEN UNIVERSITY OF SRI LANKA
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FINAL EXAMINATION: 2009/2010
CSU2279: DATA STRUCTURES AND ALGORITHMS – PAPER II
DURATION: **TWO AND HALF HOURS** (2 ½ HOURS)

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Date: 21st July, 2010   Time: 9.30 am – 12.00 noon

Answer FOUR Questions ONLY.

Q1.

a) Distinguish between the *straight selection sort algorithm* and the *quick sort algorithm*.

b) "Quick sort is a fast sorting algorithm than straight selection sort". Do you agree with the statement? Justify your answer.

c) Write a Pascal function/procedure to implement the quick sort algorithm.

d) Explain how your function/procedure works on the following set of data.

    45 66 12 32 7 9 62 24 15

Q2.

a) What are the factors that the running time of a program depends on?

b) Using examples, explain the following terms briefly.

    i.   Best - case running time
    ii.   Average - case running time
    iii. Worst - case running time

c) Perform the Big-Oh notation analysis on the following functions.

    i. $T(n) = (n + 1)^2$
    ii. $T(n) = 2n^2 + n - 6$

d) Write a program to find the largest element in an array of length n. What is the time complexity of your program?

Q3.

a) Give an array based type definition of a *Stack* data structure. The stack should have a maximum of 50 elements.

b) Write Pascal functions/procedures for the following stack operations.

    PUSH (x,S)   – Insert an element x into the stack S

POP(S)   – Deletes an element from the stack S
STACKTOP(S)   – Return the top element of the stack S without removing it.

c) Assume that it is necessary to determine whether the parenthesis in a mathematical expression are balanced and nested correctly. For example, the parenthesis in the mathematical expression given below are balanced and nested correctly.

{x + (y - [a + b]) * c - [(d + e)]}

Describe the data structure that is most appropriate to represent the above scenario and write a suitable algorithm for that purpose.

Q4.

A Binary tree is to be implemented in Pascal using three pointers namely, a pointer to the left child, a pointer to the right child and a pointer to the parent and is defined as follows.

```
Type
    treeptr = ^treenode;
    infotype = char;
    treenode = record
                info: infotype;
                left: treeptr;
                right: treeptr;
                father: treeptr;
    end;
```

Write Pascal functions/procedures to implement the following operations. Let p be a pointer to a node N of a binary tree.

a) getnode   - A function which returns a pointer to a new node.

b) nodeinfo (p) - A function which returns the contents of N.

c) isright (p)   - A function which returns true if N is a right son, of some other node in the tree, and false otherwise.

d) brothernode (p) - A function which returns the pointer to the sibling of N.

Q5.

a) Discuss the importance of the external sorting algorithms.

b) Write a Pascal function/procedure to sort a set of integers using the shell sorting method.

c) Explain how your algorithm works on the following data set.

44 55 12 42 94 32 06 67 44 42

d) Write a recursion function to print the square values of numbers from a given positive number down to 1. The output should be as follows, if the given number is 5.

```
square value of 5 = 25
square value of 4 = 16
square value of 3 = 9
square value of 2 = 4
square value of 1 = 1
```

Q6.

a) Assume that there is no simple data type in your Pascal compiler to represent character strings. Give a suitable data structure to implement character strings in this Pascal version and write Pascal functions/procedures to implement the following string operations.

    i.   LENGTH (S)   - Return the length of the string

    ii.   CONCAT (S1, S2, S3) - Concatenates S1 and S2 and the result will be in S3.

    iii.   COPY (S1, start, extent, S2) - Copies a sub string S1 into S2. *start* gives the starting position and *extent* gives the number of characters to be copied.

b)

    i.   Distinguish between the *straight sequential search* and the *binary search.*

    ii.   Write a procedure using the straight sequential search to find students who have scored greater than 50 marks for a subject. Clearly state the assumptions you make.