THE OPEN UNIVERSITY OF SRI LANKA
B.Sc DEGREE PROGRAMME: LEVEL 04
FINAL EXAMINATION: SEMESTER 2- 2010/2011
CSU2279: DATA STRUCTURES AND ALGORITHMS

DURATION: THREE HOURS (3 HOURS)

Date: 29th June, 2011 — Time: 1.30 pm – 4.30 pm

Answer FOUR Questions ONLY.

1.

a)

   i. What is an ADT? Explain the two properties of it.

   ii. Design an ADT to store the radius and height of a cone.

   iii. Write a procedure to add values to the ADT created above (part (ii)) and calculate the volume of the cone.
   (*Note: Radius=r, Height=h, Volume=1/3πr²h*)

b)

   i. Write a recursive function to find the nth Fibonacci number. The definition of the Fibonacci number is as follows,

$$fib(n) = \begin{cases} 0 & if\ n = 0 \\ 1 & if\ n = 1 \\ fib(n-1) + fib(n-2) & if\ n >= 2 \end{cases}$$

   i. Calculate the running time of the written function in part (i).

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

c)

   ii. Perform the Big-Oh notation analysis on the following function.

$$\frac{20\ (X-1)\ (X+1)}{5(X-1)}$$

   iii. Let P and Q be two algorithms for a task with time complexities $O(n^3)$ and $O(n^4)$ respectively. Identify, which one is the better algorithm to perform the task. Assume that, for a particular compiler machine combination, P and Q takes $400n^3$ and $20n^4$ milliseconds respectively for successful completion.

   iv. Calculate the running time of the procedure below given.

```
Procedure BubbleSort (var A: array [1..n] of Integer; n:
                      Integer);
Var i, j, temp: Integer;
Begin
    For i: = n-1 Down To 1 do
```

```
For j: = 2 to i do
If (A [j-1] > A[j]) then
Begin
        temp: = A [j-1];
        A [j-1]:= A[j];
        A [j]:= temp;
    End;
End.
```

Q2.

a)

i. What are the time complexities of *worst case* and *average case* in three simple internal sorting algorithms and in advanced internal sorting algorithms?

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

iii. What are the domain factors of internal and external sorting?

b)

i. Write a procedure for the Binary Search algorithm.

ii. What is block accessing?

iii. Explain graphically, how the Quick sort algorithm works on the following array of integers.

| 75 | 12 | 45 | 32 | 120 | 95 | 67 | 43 | 80 | 111 | 65 | 37 |

c)

i. Write a sorting algorithm which sorts by selection. Give the name of the written sorting algorithm.

ii. The goals scored by 12 countries in the FIFA football world cup in 2010 are given below.

Country	Goals
Brazil	09
Italy	04
Spain	08
Portugal	07
Argentina	10
Uruguay	15
England	03
Chile	03
Mexico	04
Ghana	07
France	01
Japan	07

Sort the countries into alphabetic order (of the country name). Use the above mentioned sorting algorithm (part (i)) for sorting. (Write all the steps clearly)

iii. Use the *bubble sort algorithm* to sort the countries into the descending order of the number of goals. What is the modification you have done to the algorithm for this purpose?

Q3.

a)

i. Construct a binary tree by considering the following traversals.

Postorder: F D E C B H J K I G A

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

ii. Represent the above constructed tree (part (i)) in an array.

iii. What are the advantages and disadvantages of the two representations of the tree structure?

b)

i. State all the steps which are used for finding duplicates in a list using a binary search tree.

ii. What are the two conditions which have to be satisfied in a binary tree to become an almost complete tree? Explain those by using an appropriate diagram.

iii. Explain what a strictly binary tree is. (Use a diagram)

c) Write Pascal procedures/functions to implement the following operations of a binary tree.

i. Finding the father of a node.

ii. Finding the left child.

iii. Find information.

Q4.

a)

i. What are the advantages and disadvantages of a doubly linked list and a singly linked list?

ii. Compare and contrast the *array based implementation* and *pointer based implementation* of the list data structure.

iii. Using appropriate diagrams show how to insert and delete a node in a pointer based linked list.

b)

i. Write a Pascal procedure/function to insert a node in to an array implementation of a list.

ii. Write a Pascal procedure/function to search a node (return the position of a given node on the list) in a pointer based implementation.

iii. Write a Pascal procedure/function to delete a node in an array implementation of a list.

c)

i. Write the type definition of a singly linked data structure to store the index number and grades for three subjects (Astronomy, Herbology and Arithmancy) of a student.

ii. Write a complete Pascal program to display the data stored in the above list (part (i)). (Assume that, there are 30 students in the class)

iii. Convert the following pointer based definition in to its array based definition.

```
Type
    Celltype=record
            Element: elementtype;
            Next: ^celltype
    End;
List = ^celltype;
```

Q5.

a)

i. Explain the following three string operations using your own examples. Assume S1, S2 and S3 are strings.

```
LENGTH (S1)
POS (S1, S2)
COPY (S1, start, extent, S2)
```

ii. Write a Pascal procedure/function to CONCAT two given strings (S1, S2) in to one string (S3).

iii. Write a Pascal procedure/function to return the starting position of string S1 in string S2.

b)

i. Using appropriate diagrams describe the differences between *Stack* and *Queue*.

ii. Write an array based type definition of a stack data structure. (Assume that, the stack may consist of 25 characters.)

iii. Explain the disadvantages of an array based stack and how they can be overcome by using a pointer based stack.

c)

i. Write a Pascal procedure/function to add a character in to an array based stack.

ii. Write a Pascal procedure/function to delete a character from a array based stack.

iii. Write a Pascal procedure/function to count the number of elements in an array based stack without changing the order of the elements.

26.

a)

i. What is a set? Explain two types of set representations.

ii. Write a Pascal procedure/function to find the set union using any set representation.

iii. Write a Pascal procedure/function to find the set intersect using any set representation.

b)

i. What is the advantage of a *circular queue data structure* over a *linear queue data structure*?

ii. Write a pointer based definition of a queue data structure to store marks of 50 students.

iii. Explain the concept of the circular array implementation of a queue.

c)

i. Write a procedure/function to insert a total value of a bill into a pointer based queue.

ii. Write a procedure/function to delete the total value of a bill into a pointer based queue.

iii. Write a procedure/function to display the content (total value of a bill of a customer) in a pointer based queue.