THE OPEN UNIVERSITY OF SRI LANKA
B.Sc DEGREE PROGRAMME: LEVEL 03
FINAL EXAMINATION: SEMESTER 2 - 2011/2012
CPU1142: DATA STRUCTURES AND ALGORITHMS

DURATION: **TWO HOURS** (2 HOURS)

Date: **24th November, 2012** Time: **1.30 pm – 3.30 pm**

Answer FOUR Questions ONLY.

Q1.

a) What are the steps which can be followed when selecting a data structure?

b) Explain what you mean by an ADT.

c) Give five unique qualities of an algorithm.

d) Calculate the worst case running time of the following algorithm.

```
for (i=0; i<n-1; i++) {
   for (j=0; j<n-1-i; j++)
      if (a[j+1] < a[j]) {
        tmp = a[j];
        a[j] = a[j+1];
        a[j+1] = tmp;
         }
}
```

e) Briefly explain the following.

i) Rules for Sums

ii) Direct recursion

iii) Factors affecting the running time of a program

Q2.

a) Describe the general features of a list.

b) Compare an array based implementation with a pointer based implementation of lists. Identify two (02) limitations of an array implementation which can be overcome by using a pointer implementation of lists.

c) Taking into consideration the following figure (*Figure 1*) which illustrates a portion of the array implementation of a linked list named *linkArray* that contains four linked lists, answer the questions given below. List 1 starts at *linkArray[4]*, list 2 starts at *linkArray[10]*, list 3 starts at *linkArray[5]* and list 4 starts at *linkArray[1]*.

	info	Next
0	19	8
List 4 = 1	16	22
2		
3	4	-1
List 1 = 4	09	9
List 3 = 5	12	13
6	13	-1
7		
8	26	3
9	5	19
List 2=10	21	15
11	11	21
12		
13	7	18
14		
15	14	11
16		
17		
18	17	-1
19	12	-1
20		
21	15	6
22	20	0

Figure 1: Array of nodes containing four linked lists

i) How many elements are there in each list?
ii) Starting from the first node, write the integers included in each linked list separately.

d)

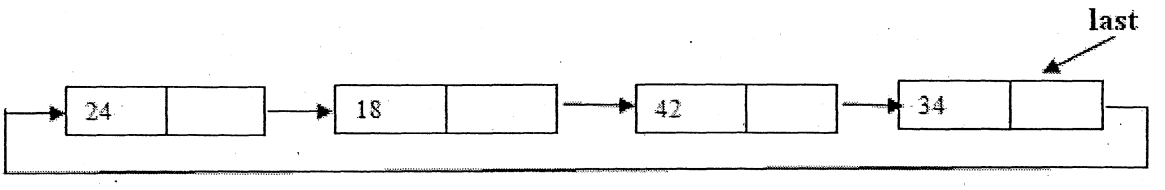

Figure 2: A Circular Linked List

Figure 2 shows a *circular linked list.*

i) Draw the resultant diagram of the linked list after deleting the first node.
ii) State the steps which have to be considered when deleting a node from the beginning of the circular linked list.

e) Give one advantage and one disadvantage of a doubly linked list.

Q3.

a) State why a stack is called *'a push down list'*.

b) How does a LIFO Data structure differ from a FIFO Data structure?

c) A Stack has two basic operations.

POP(S) – remove the top element of the stack S.

PUSH(X,S) – insert element x at the top of the stack.

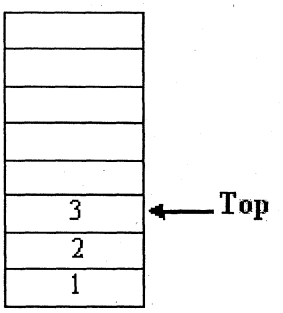

Figure 3: Current state of the stack

i) *Figure 3* shows the current state of the Stack. Graphically show the following operations that can be performed on the above Stack. Indicate the `top` pointer in each state of the Stack.

```
PUSH(4, S);
PUSH(5, S);
POP(S);
PUSH(6, S);
POP(S);
POP(S);
```

ii) Write the code to perform the `PUSH` and `POP` operations in C language.

Q4.

a) *"Graphs are non-linear and non-hierarchical data structures."*

Differentiate graphs from linear data structures and hierarchical data structures.

b) The adjacency matrix of a directed graph is given below.

	A	B	C	D	E	F
A	0	1	0	0	0	0
B	0	0	1	0	1	0
C	0	0	0	1	0	0
D	1	1	0	0	0	0
E	0	0	0	0	0	1
F	0	1	0	0	0	0

Figure 4: Adjacency matrix of a directed graph

i) Draw a directed graph that corresponds to the above given adjacency matrix(*Figure 4*)
ii) Write down the edges in the graph.
iii) State, giving reasons, whether the graph you have drawn is a strongly connected graph or a weakly connected graph.

c)

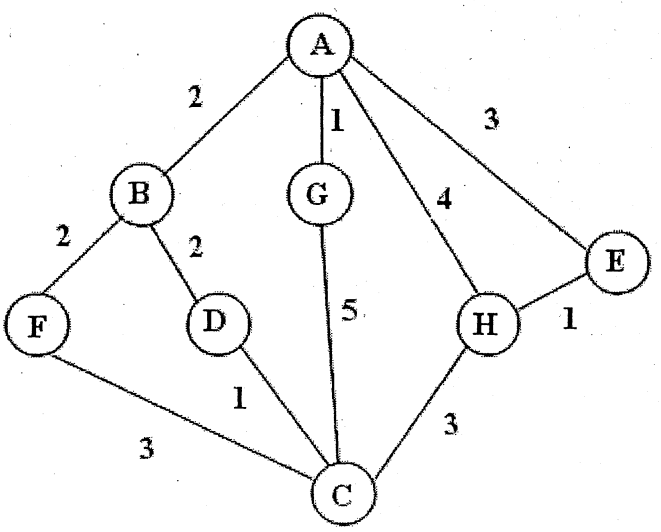

Figure 5: A graph

i) Write the breadth first traversal of the graph given above, starting from A.
ii) Give all possible paths from vertex A to vertex C and identify the shortest path.
iii) Draw a minimum spanning tree for the graph given above.

Q5.

a) Construct a binary tree by considering the following traversal of a tree.

Preorder = {7, 10, 4, 3, 1, 2, 8, 11}

Inorder = {4, 10, 3, 1, 7, 11, 8, 2}

b) Answer the following questions from (i) to (iv) by using the constructed binary tree in part (a).

i) Write the *Postorder* traversal of the tree.
ii) How many levels are there in the tree?
iii) What is the height of the tree?
iv) How many leaf nodes are there?

c) Construct a binary tree for the following mathematical expressions and write down the preorder, inorder and postorder forms of each expression.

i) 2 * 5 / (3-1) + 5 * (5-1)
ii) (A + B * C) + ((D * E+ F) * G)

d) What is an AVL tree?

e) Taking into consideration the following AVL tree, draw and show the balance factor of each node and indicate it within the node.

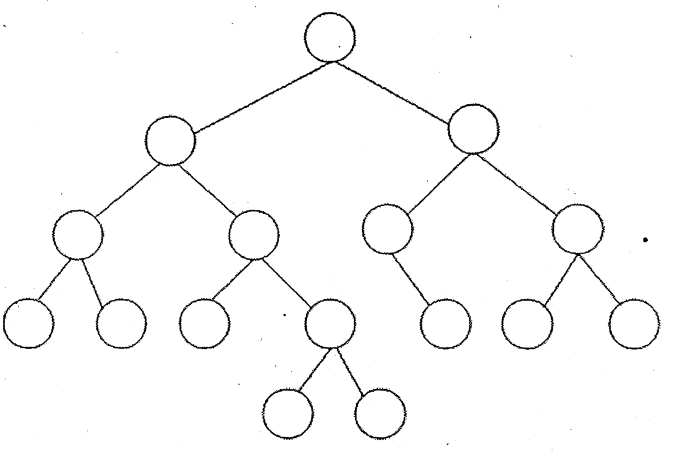

Figure 6: AVL tree

Q6.

a) Give one advantage and one limitation of the following sorting algorithms
   i) Bubble sort
   ii) Shell sort
   iii) Merge sort
   iv) Straight selection sort

b) Show the steps of the quick sort on the following list of unsorted integers. In each step, assuming that the pivot node is always the one on the left hand side of the list, circle all pivots and underline all numbers that have been placed in their correct respective positions.

25	57	48	22	62	98	53	12

c) Write a C language code to sort a set of integers using the insertion sort.

d) State how binary search can be applied for the following array, to search the element with the value '36'. Clearly state the steps that are involved.

4	7	10	18	20	23	29	32	36	40	55

e) Give an instance of the usage of the method called *rehashing*. Explain it with the help of a hash table.