THE OPEN UNIVERSITY OF SRI LANKA
DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE
B.Sc. DEGREE PROGRAMME : LEVEL 03
FINAL EXAMINATION: SEMESTER II - 2013/2014
CPU1142: DATA STRUCTURES AND ALGORITHMS
Duration: Two Hours (2 Hours)

Date: 22 - 11 - 2014 Time: 01.30 p.m - 03.30 p.m

Answer FOUR(4) Questions Only.

QUESTION 01

1. Explain two basic requirements you should consider, when you select a data structure.
2. STACK is an Abstract Data Type which we can implement using Arrays or Pointers. Consider the following segment of code in C which is written to implement Stacks using Arrays.

```
#define STACKSIZE 100
struct stackApp
{
        int top;
        int items[STACKSIZE];
}
```

   (a) Declare a stack with the name 'MyST'

   (b) Write functions in C language to perform the following tasks.

      i. Insert an element to the STACK you declared in section (a) above. Use ***void pushStack(int x)*** as the function header. (When you insert an element, you should check whether the stack is full)

      ii. Display the TOP element of the STACK. Use ***void topStack( )*** as the function header. (First you should check whether the stack is empty)

3. Using Big O notation, determine the running time of the following C code segment. State any assumptions you made.

```
for (i = 0; i<n; i++)
{
        x = x + i;
}
```

4. State two disadvantages of using Singly Linked Lists to implement a list.
5. Binary search is a popular divide and conquer searching technique. Tō employ binary search, what is the requirement that should be fulfilled by the data set(Data Array)?

QUESTION 02

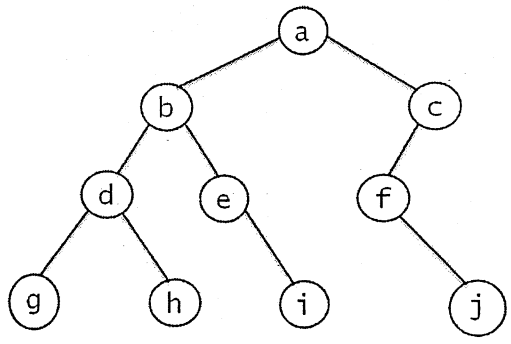
1. Define a Binary Tree. Is a tree with a single node (only the root) a binary tree? Give reasons.

2. What is the depth of a complete binary tree with 8 nodes?

3. Tree traversal refers to the process of visiting each node in a tree data structure, exactly once, in a systematic way.

   - Pre-order
   - In-order
   - Post-order

   are three depth first tree traversals that you have learned. Employ these three traversals to the following binary tree and write the outputs.



4. Describe the following terms with respect to GRAPH data structure.

   (a) Adjacent Vertices

   (b) Path

   (c) Cycle

5. What is the *'Binary Search Tree Property'*?

QUESTION 03

1. Write a C function to implement the bubble sort. Use *void bubbleSort(int data[ ], int n)*, where '**data**[ ]' array has the elements to be sorted and 'n' gives the number of elements.

2. What is the running time of the bubble sort [Use Big O notation] in the worst case scenario?

3. What will be the output of the following function if we pass '7' as the value for 'num'?

```
int testF(int num)
{
   if (num==0)
      return 0;
   else if (num==1)
      return 1;
   else
      return testF(num-1) + testF(num-2);
}
```

4. State two disadvantages in the array implementation of Lists.

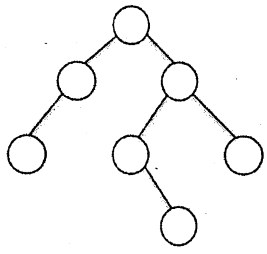
5. Define the following terms in Tree terminology

   (a) Degree of a Node

   (b) Leaf Node

   (c) Siblings

6. Draw the extended binary tree of the following binary tree.

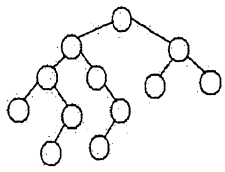


QUESTION 04

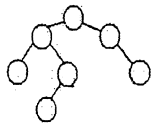
1. State two disadvantages in the array implementation of a Linear Queue.

2. What is a height balanced or AVL tree. Clearly showing the steps, check whether the following binary trees are height balanced trees or not.

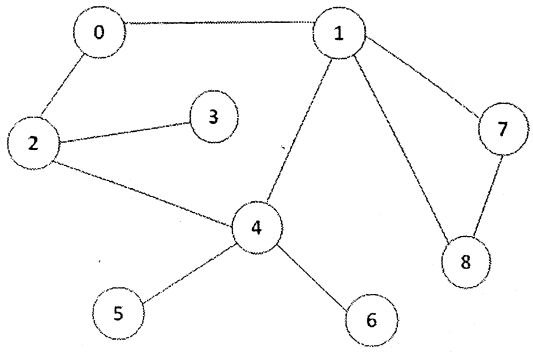
   (a) Binary Tree 1



   (b) Binary Tree 2



3. In what order are the vertices visited in "Depth First" and "Breadth First" traversals in the following Graph. Select '0' as the starting node.



4. What are the two basic operations associated with a Queue?

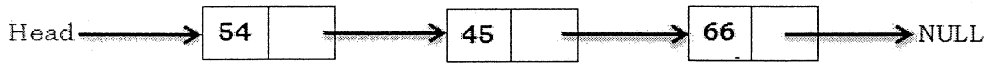
5. Implement a structure using C language to create queues. Your structure should have two integer variables to store front and rear positions, and an integer array to hold 10 data elements in the queue.

   (a) Using the structure you have created, declare a queue with the name 'MyQ'

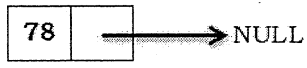
   (b) Write a function in C, to insert data items to 'MyQ'. You can use ***void enqueue(int x)*** as the function header. (Check queue overflow condition before you insert)

QUESTION 05

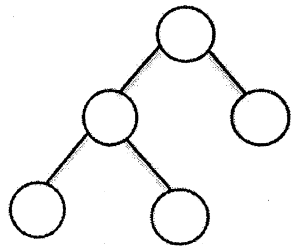
1. Following diagram shows a singly linked list with 3 nodes.



   Describing the steps clearly, state how you insert the following node to the beginning of the singly linked list, given above.



2. Define a 'Complete Binary Tree'. Is the following tree a complete binary tree? Give reasons.



3. State one application (where you can use) of Binary search trees.

4. Show the following mathematical expression using a strictly binary tree.
   {(A + B) * (C+D)} / E

5. Graphically showing the steps, sort the following data set using merge sort algorithm.

2	4	1	6	8	5	3	7

QUESTION 06

1. Explain how the shell sort differs from the insertion sort. How does the shell sort improve the performance of the insertion sort.

2. What is external sorting and why we need external sorting algorithms? Give an example for an external sorting algorithm.

3. Assume we have been given the following data set.

34	52	45	40	12	120	98	39

   (a) Create the heap by inserting elements correctly.

   (b) What are the two main characteristics of a heap?

4. Write a program in C to implement the sequential / linear search algorithm.
   Your program should return the position of the element if it matches to the key, otherwise return (-1). You can use ***int sequentialSearch(int array[], int key, int n)*** as the function header. 'n' gives the number of elements in your array.

5. What is the running time of the sequential search in the worst case scenario? (Use Big O notation)

6. What is a hash collision or a hash clash in Hashing?

7. Using 'Division method', create the hash values for the following data set. Assume we have 100 records in the table.

Records
324
105
223
657
873
432

   (a) Do these hash values produce hash collision? Explain your answer.