EASTERN UNIVERSITY, SRI LANKA
FACULTY OF SCIENCE
SECOND YEAR FIRST SEMESTER EXAMINATION IN SCIENCE - 2021/2022
(Mar./Apr., 2024)
CS 2013 - DATA STRUCTURES AND ALGORITHMS
THEORY

Answer all questions	**Time allowed: Two hours**

Q1)

(a) State what data structures are and explain their importance. [15%]

(b) Differentiate linear data structures from non-linear data structures. [15%]

(c) Write an algorithm to find the maximum occurring of an element in an array A of n elements and analyze the performance of your algorithm. [30%]

(d) Describe the concept of asymptotic analysis in data structures. [10%]

(e) Explain the difference between $O(1)$ and $O(n)$ space complexities. [10%]

(f) Prove the following time complexities can be expressed in terms of Big-Oh notation. [20%]

i. $4n^2 - 3n + 1$ ii. $2^{n+1} + 5n$

Q2)

(a) Provide a comprehensive comparison between *stack* and *queue* data structures. [20%]

(b) Write an algorithm to convert prefix to postfix using stack data structure. [20%]

(c) Convert the given prefix expression `*-E/US-/LDC` into postfix expression using part (b). [10%]

(d) Linked List is a very commonly used linear data structure which consists of group of nodes in a sequence. Answer the following questions based on Linked List data structure:

i. Briefly describe the types of *linked lists* and illustrate how they are represented. [10%]

ii. Write Java code to implement the *LinkedList* and *Node* classes. [10%]

iii. Complete the given incomplete java code to search for an element in a *Linked List*. [10%]

```
public void Traverse()
        LinkedList PTR = ....................;
        while (.........................)
```

iv. Consider the following *Linked List* diagram with integer values:
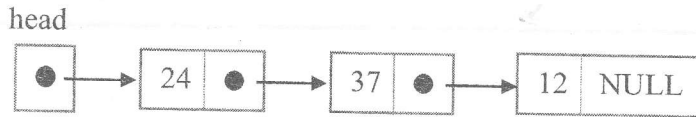
head

Draw a diagram of the above list after the following lines of code have been executed:

```
Link temp=new Link(40, null);
        temp.next=head.next;
    head.next=temp;
```

[10%]

v. What are the data values of *head* and *temp* after the above code has been executed?

[10%]

Q3)
  (a) The Conway's recursive sequence is defined by the following recurrence relation for positive integer n.

$$a(n) = \begin{cases} 1, & \text{if } n\epsilon\{1, 2\} \\ a(a(n-1)) + a(n - a(n-1)), & \text{otherwise} \end{cases} \qquad (1)$$

i. Explain what is recursive method. [10%]

ii. Write a recursive method for the above Conway's sequence. [10%]

iii. Write the steps to find the output value of *a(5)*. [10%]

  (b) You are given the following methods:

```
String str1 (int p) {
if (p > 0)
    return "+" + str1(p-1);
else
```

```
return " ";

}

String str2 (int p, int q) {

if (q > 0)

    return "-" + str2(p,q-1) + "-";

else

    return str1(2*p);

}
```

Write the output for the following statements:

i. System.out.println(str1(3)); [10%]

ii. System.out.println(str2(3,2)); [10%]

(c) Provide the algorithm of Quick sort and analyze its time complexity. [30%]

(d) Sort the following numbers using the above (question 3.c) algorithm. [20%]

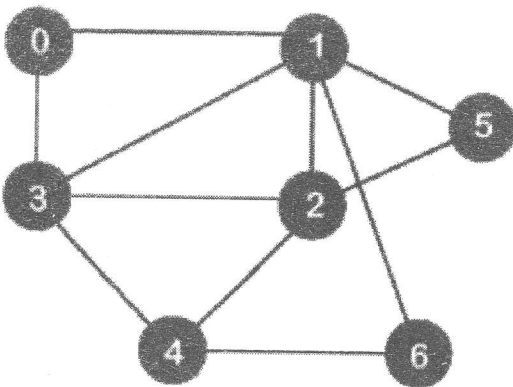   22 9 20 18 29 6 20 14 10 4 83 26 12 82

Q4)

(a) Define the terms: graph, undirected graph, and directed graph. [15%]

(b) Find the Depth First Search and Breadth First Search for the given undirected graph.
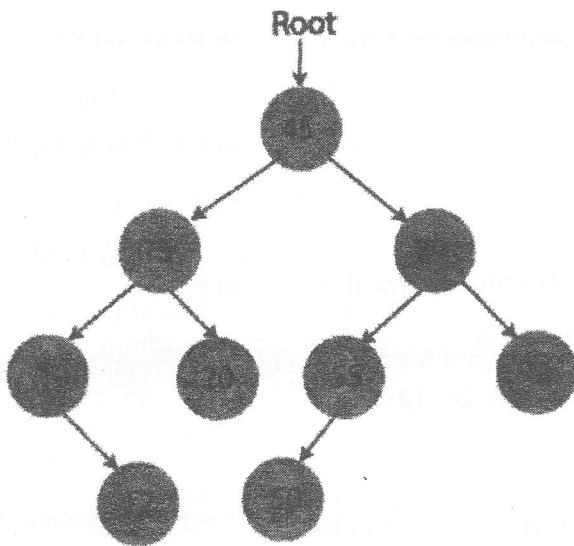   (Start from 6)

[20%]

(c) Describe the *preorder, inorder,* and *postorder* traversal techniques for binary trees.

[15%]

(d) Provide the algorithm or pseudocode for each traversal method in Q4.c and demonstrate their application on following binary tree.

[50%]