LAIKIPIA UNIVERSITY

UNIVERSITY EXAMINATIONS

SECOND SEMESTER 2023/2024 ACADEMIC YEAR

SECOND YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE (ICT) AND BACHELOR OF COMPUTER SCIENCE

COMP 225/BICT 225: DATA STRUCTURES AND ALGORITHS

STREAM: R ***TIME: 2 HRS***

DAY: WEDNESDAY[8.30 – 10.30 A.M] ***DATE: 10/04/2024***

THIS QUESTION PAPER CONSISTS OF FIVE (5) PAGES

PLEASE DO NOT OPEN UNTIL THE INVIGILATOR SAYS SO.

Instructions: Answer question one and any other two

Use illustrations where necessary

QUESTION ONE (30 MARKS)

a) Explain how insertion sort and selection sorts are different. **[6 Marks]**

b) You are given a list of intervals representing the start and end times of meetings. How would you determine the minimum number of meeting rooms required to schedule all the meetings? **[2 Marks]**

c) Here is an array with exactly 15 elements:

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

i) Suppose that we are doing a serial search for an element. Identify any elements that will be found by examining two or fewer numbers from the array. **[2 Marks]**

ii) Suppose that we are doing a binary search for an element. Identify any elements that will be found by examining two or fewer numbers from the array. **[2 Marks]**

d) You are required to develop a university management system. You have a one-dimensional array containing "n" number of students' names. How will you reference all of the elements in the array? **[2 Marks]**

e) Draw a complete binary tree with exactly six nodes. **[5 Marks]**

f) Using an illustration, show how we reverse a linked list? **[2 Marks]**

g) State what the operations for adding and removing an entry from a stack are traditionally called. **[2 Marks]**

h) How does the divide and conquer algorithm work? **[2 Marks]**

i) What is dynamic memory allocation and how does it help in managing data? **[2 Marks]**

j) Given an array of integers, write an algorithm to find the maximum subarray sum efficiently. **[3 Marks]**

QUESTION TWO [20 MARKS]

a) Draw a full binary tree with at least 6 nodes. [**4 Marks]**

b) Differentiate between priori analysis and posterior analysis stages in checking the efficiency of an algorithm [**4 Marks]**

c) A palindrome is a word, phrase, or sequence that reads the same backwards as forwards, e.g. madam or nurses run. Write an algorithm to determine if a given string, is a palindrome. Discuss its time complexity and potential optimizations. **[6 Marks]**

d) State **THREE** characteristics of a Data Structure. **[3 Marks]**

e) Using a diagram illustrate the following items in a tree data structure. **[3 Marks]**
Node, Root, Leaf, Child, Parent, Siblings

QUESTION THREE [20 MARKS]

a) What operations can be performed on stacks? [**3 Marks]**

b) Explain what the following algorithm does **[4 Marks]**

```
S = new empty set
A = new empty dynamic array
for every element x in input array
    if not S.member(x) then
    S.insert(x)
    A.append(x)
return
```

c) What are Homogeneous Data Structures? Give an example. **[3 Marks]**

d) Explain the difference between best-case, average-case, and worst-case time complexities. Provide examples of algorithms for each case. [**6 Marks]**

e) What is the difference between a stack and a queue? **[4 Marks]**

QUESTION FOUR [20 MARKS]

a) Explain the following types of linked lists
   i) Simple Linked Lists **[2 Marks]**
   ii) Doubly Linked Lists **[2 Marks]**
   iii) Circular Linked Lists **[2 Marks]**

b) What is a stack overflow and what is the name of the stack operation could result in a stack overflow? **[2 Marks]**

c) Differentiate between adaptive and non-adaptive sorting of algorithms **[2 Marks]**

d) What is algorithm complexity, explain the two factors that determines an algorithm's complexity **[6 Marks]**

e) Explain why inserting an element at the beginning of an array is not as efficient as inserting at the end of an array. **[4 Marks]**

QUESTION FIVE [20 MARKS]

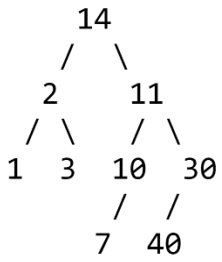
a) Consider the following pseudocode:

```
declare a stack of characters

while (there are more characters in the word to read)

{

   read a character

   push the character on the stack

}

while (the stack is not empty)

{

   pop a character off the stack

   write the character to the screen

}
```

What is written to the screen for the input "carpets"? **[4 Marks]**

b) What is a hash table in data structures? **[2 Marks]**

c) Here is a small binary tree:



Write the order of the nodes visited in:

i) An in-order traversal **[2 Marks]**

ii) A pre-order traversal **[2 Marks]**

iii) A post-order traversal **[2 Marks]**

d) Entries in a stack are "ordered". What is the meaning of this statement? **[2 Marks]**

e) Explain **THREE** common problems that applications face now-a-days that necessitate the need for data structures **[6 Marks]**