(Knowledge for Development)

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2019/2020 ACADEMIC YEAR

END OF SEMESTER EXAMINATIONS
YEAR TWO SEMESTER TWO

FOR THE DEGREE OF
COMPUTER SCIENCE

COURSE CODE   :   CSC 225

COURSE TITLE   :   DATA STRUCTURES

DATE: 12/02/2021   TIME: 2.00 P.M – 4.00 P.M

INSTRUCTIONS:

ANSWER QUESTIONS ONE AND ANY OTHER TWO

a) Distinguish between a queue and a stack.   [4 marks]

a) - Queue FIFO
- Stack LIFO

b) Why is sorting necessary?   [1 marks]

- organize data in a specific order, making it easier to search, retrieve, and analyze information

c) Describe briefly

i.   any one sorting algorithm and   [3 marks]

ii.   any one searching algorithm   [3 marks]

"Bubble Sort," which repeatedly steps through the list, compares adjacent elements, and swaps them if they are in the wrong order.

"Binary Search," which works on sorted arrays by repeatedly dividing the search interval in half. It efficiently locates a specific value within the array.

d) Illustrate the operation of the sorting algorithm described in part (c) i above on the following list of integers: [4 marks]

57, 23, 11, 74, 39, 40, 65

```
n = len(arr)
for i in range(n):
  swapped = False
  for j in range(0, n-i-1):
    if arr[j] > arr[j+1]:
      arr[j], arr[j+1] = arr[j+1], arr[j]
      swapped = True
  if not swapped:
    break

return arr
```

e) The diagram below shows an array representation of a binary tree. Draw the tree.   [3 marks]

D	A	T	A	S	T	R	U	C	T	U	R	E

f) Suppose we begin with an empty stack, and perform the following operations: push 7, push 2, push 9, push 6, pop, pop, peek, push 1, push 3, peek, push 8, pop, peek, pop, pop, push 5, push 4, pop, pop, pop, push 8. What is contained on the stack when we are done? Write out the contents from top to bottom.   [4 marks]

g) Given two scenarios: the first in which a problem solution involves a dynamic list (i.e. list in which there are a lot of deletions and insertions) and the second in which a problem involves many accesses to the interior values of a list. State with reasons which data structure will be suitable for each of the two scenarios?   [3 marks]

Linked lists allow for efficient insertions and deletions without the need to shift elements around.
Arrays provide constant-time access to elements based on their index, making it efficient to access interior values.

h) Construct a Huffman code for the following data and hence decode the following message:

01011101100011010101110   [5 marks]

Character	E	B	A	D	R
Probability	0.35	0.2	0.15	0.1	0.2

QUESTION TWO [20 MARKS]

a) The diagram of a linked list below contains nodes with data items of type String that contains the name of a County and type double that contains the poverty index of the County. Define a class to model a generic Node as indicated. Your class should include all the accessor and mutator methods and the default constructor that appropriately initializes the fields. [10 marks]
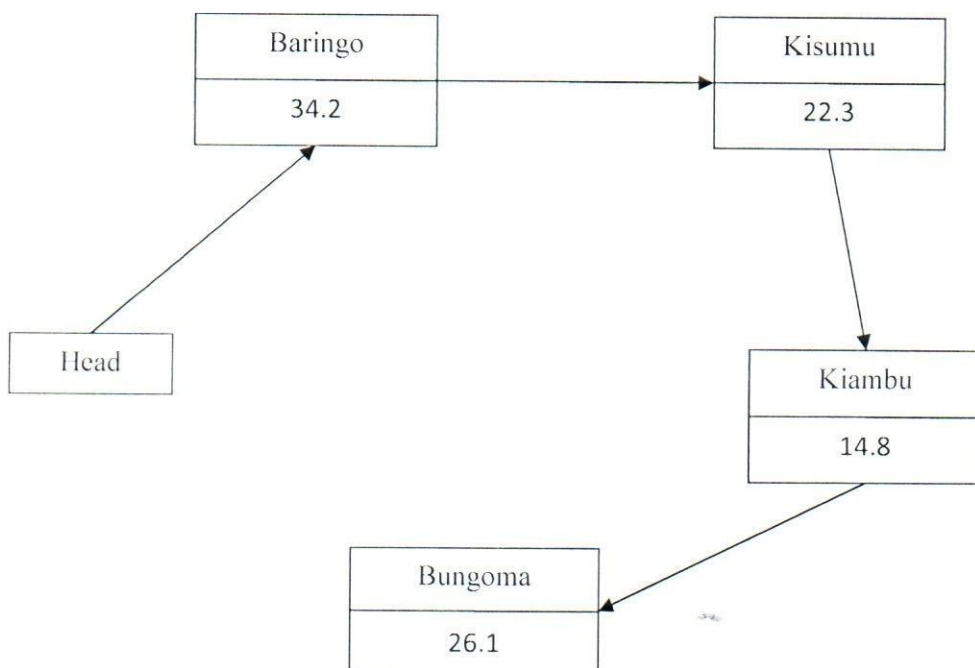
b) Using the Node class in Q. (a) above the following skeleton for a linked list implementation is given:

Provide implementations for the methods insertAtFront, display and insertAtEnd [10 marks]

```
public class LinkedList {
    private Node head;
    public LList ()
    {
```

```
            head=null;
        }

        public void insertAtFront(String t, double p)
        {
        // provide implementation to insert at the head
        }
        public void display()//displays linked list data
        {
        //provide implementation.
        }


        public void insertAtEnd(String t, double p)
        {
        // provide implementation to insert at the end of the
        list
        }
    }
```

Q3.b) In a BST, for each node:
All nodes in the left subtree have values less than the node's value.
All nodes in the right subtree have values greater than the node's value.
- binary tree does not have any specific ordering of elements

QUESTION THREE [20 MARKS]

a) What is a binary tree? a hierarchical data structure in which each node has at most two children, referred to as the left child and the right child. [2 marks]

b) i. How is a binary search tree different from a binary tree?   [3 marks]

    ii. Draw the resulting binary search tree inserting the following values in the given order:

    7, 10, 5, 12, 1, 3, 9.   [5 marks]

    iii. Name the three traversal orders for binary trees and show the result of each of these

    traversals on the above binary search tree.   [6 marks]

c) Describe any two methods for storing binary trees in the computer   [4 marks]

Array Representation:each node at index i has its left child at index 2i+1 and its right child at index 2i+2.
Linked Representation: using a structure that contains data and two pointers (left and right) to its children.

QUESTION FOUR [20 MARKS]

a) Explain how a stack can be used to determine if an infix expression is correctly

    parenthesized.   [5 marks]

b) Describe how a stack can be used to solve postfix expressions.   [3 marks]

c) Evaluate the following postfix expression: [4 marks]

        7 4 5 1 - * 8 / 9 4 - + /

Q4.a)1.Iterate through each character in the infix expression.
2.If the character is an opening parenthesis (e.g., '(', '{', '['), push it onto the stack.
3.If the character is a closing parenthesis (e.g., ')', '}', ']'), check if the stack is empty. If it is, then the expression is not correctly parenthesized. 4.Otherwise, pop the top element from the stack and compare it with the current closing parenthesis. If they do not match (e.g., '(' does not match with ']'), then the expression is not correctly parenthesized. After iterating through the entire expression, if the stack is empty, then the expression is correctly parenthesized. Otherwise, it is not.

Q4.b) If the character is an operand (i.e., a number), push it onto the stack.
If the character is an operator (e.g., +, -, *, /), pop the top two elements from the stack, perform the operation on them using the operator, and then push the result back onto the stack.
After iterating through the entire expression, the final result will be left on the stack.

d)   Describe one implementation strategy for a stack and one for a queue.   [8 marks]

QUESTION FIVE [20 MARKS]

a) What is the difference between a graph and a tree?   [2 marks]

trees are a specific type of graph with certain structural constraints, graphs are more general and versatile data structures that can represent a wide range of relationships and connections between nodes.

b) Draw the directed graph that is represented by the following: [4 marks]

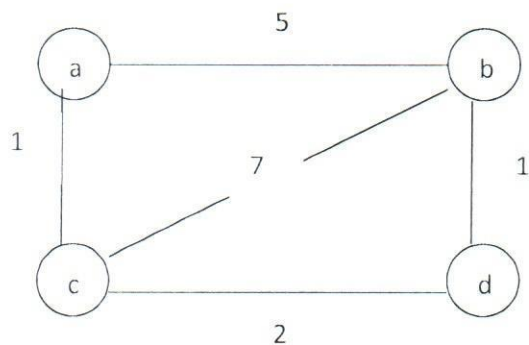**Vertices:** 1, 2, 3, 4, 5, 6, 7

Edges: (1, 2), (1, 4), (2, 3), (2, 4), (3, 7), (4, 7), (4, 6), (5, 6), (5, 7), (6, 7)

c) Describe two principal methods for representing graphs for computer algorithms

[6 marks]

d) If a graph is sparse which representation will you use and why?   [2 marks]

e) Consider the weighted graph given below:

Represent the weighted graph using the two representation methods described in part (c) above.

[6 marks]