NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

**FACULTY OF COMPUTING AND INFORMATICS**
DEPARTMENT OF SOFTWARE ENGINEERING

| | |
|---|---|
| **QUALIFICATION:** BACHELOR OF COMPUTER SCIENCE, BACHELOR OF INFORMATICS | |
| **QUALIFICATION CODE:** 07BCMS, 07BAIT | **LEVEL:** 5 |
| **COURSE:** DATA STRUCTURES AND ALGORITHMS 1 | **COURSE CODE:** DSA521S |
| **DATE:** NOVEMBER 2023 | **PAPER:** THEORY |
| **DURATION:** 3 HOURS | **MARKS:** 100 |

| **FIRST OPPORTUNITY EXAMINATION QUESTION PAPER** | |
|---|---|
| **EXAMINER(S)** | **MR S. TJIRASO** |
| **MODERATOR:** | **MRS S. CHIVUNO-KURIA** |

**INSTRUCTIONS**

1. Answer ALL the questions.
2. **Answer All the questions in the answer booklet provided.**
3. Read all the questions carefully before answering.
4. Number the answers clearly in your answer booklet.
5. All things that should not be marked, e.g., any “rough work”, should be crossed out unambiguously.

**THIS QUESTION PAPER CONSISTS OF 7 PAGES**
(Including this front page)

**PERMISSIBLE MATERIALS**
NON-PRGRAMMABLE CALCULATOR

**SECTION A:** Multiple Choice Questions **[20 Marks]**

- Answer all the questions in the provided answer booklet.
- The section consists of 10 problems.

**Problem A1**

Which one of the below mentioned data structures is a linear data structure? [2 Marks]

A. Binary tree

B. Binary search tree

C. Graph

D. Stack

**Problem A2**

Which of the following statement(s) is true? [2 Marks]

**Statement A:** A binary tree is always a binary search tree.

**Statement B:** A binary search tree is a graph.

A. Statement A is true, and statement B is false.

B. Statement A is false, and statement B is true.

C. Both statement A and statement B are true.

D. Both statement A and statement B are false.

**Problem A3**

Which of the following statement(s) is true? [2 Marks]

**Statement A:** All trees are graphs.

**Statement B:** Not all graphs are trees.

A. Statement A is true, and statement B is false.

B. Statement A is false, and statement B is true.

C. Both statement A and statement B are true.

D. Both statement A and statement B are false.

**Problem A4**

Which one of the following operations can be performed on a Binary Search Tree (BST)? [2 Marks]

A. Insertion-adding a node into the BST

B. Deletion-removing a node from the graph

C. Traversal-visiting all nodes in a BST

D. All of the above

**Problem A5**

Which one of the following is a time complexity of a recurrence relation for computing the $n^{th}$ Fibonacci number? [2 Marks]

A. T(n)= T(n-2) +c
B. T(n)= T(n-1) + T(n-2) +c
C. T(n)= T(n/2) +c
D. none of the above

**Problem A6**

What is the minimum number of edges a graph with 2 vertices can have? [2 Marks]
A. 6
B. 9
C. 0
D. none of the above

**Problem A7**

What is the maximum number of edges a graph with 5 vertices can have? [2 Marks]
A. 6
B. 9
C. 4
D. none of the above

**Problem A8**

In ..., searching starts at the beginning of the list and checks every element in the list. [2 Marks]
A. Binary Search
B. Linear Search
C. Jump Search
D. none of the above

**Problem A9**

.....is the term used to delete an element from stack? [2 Marks]
A. Pop
B. Insert
C. sort
D. none of the above

**Problem A10**

...........are a series of instructions that are followed, step by step, to do something useful or solve a problem. [2 Marks]
A. Graph
B. Algorithm
C. Queue
D. Stack

**SECTION B:** True and False Questions **[10 Marks]**

- Answer all the questions in the provided booklet.
- The section consists of 5 problems.

**Problem B1**

Deletion in a queue is performed from the rear. [2 Marks]

**Problem B2**

The Pop() operation is used to insert an element in a queue. [2 marks]

**Problem B3**

A Stack follows a LIFO (last-in-first-out) rule. [2 marks]

**Problem B4**

Enqueue and Dequeue operations are associated with stack data structure. [2 marks]

**Problem B5**

Big-O is an asymptotic notation. [2 marks]

**SECTION C:** Structured questions **[70 Marks]**

- Answer all the questions in the provided booklet.
- The section consists of 17 problems.

**Problem C1**

What is a data structure? [2 Marks]

**Problem C2**

What are the two types or categories of non-primitive data structures? [2 Marks]

**Problem C3**

What is a linked-list? [2 Marks]

**Problem C4**

Singly linked-list and doubly linked-list are data structures

Provide a graphical representation of **singly linked-list** and the **doubly linked-list** using the elements below in that order. [8 Marks]

**Data = 3, 1, 7**

**Problem C5**

The following are statements to insert an integer element / data into a **static stack.** [5 Marks]

a. Check if the stack is full
   i. If the stack is full, display an appropriate message
b. If the stack is not full
   i. Move **top** to the next index
   ii. Insert the element / data in the stack

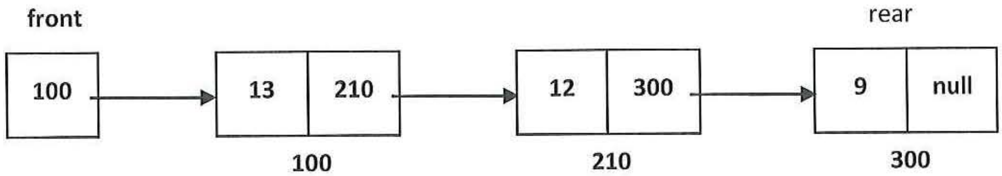
Taking **num** as the variable containing the data and **n** as the **size** of the stack, write a simple pseudocode close to a programming language to satisfy all the statements in (a, a.i) and (b, b.i, b.ii) above.

**Problem C6**

Write a pseudocode to display() the elements of a static stack in problem C5. [3 Marks]

**Problem C7**

Consider the queue below and write a function display() to print all values in the queue. [6 Marks]



**Problem C8**

Discuss the difference between merge and Insertion sort algorithms. [4 Marks]

**Problem C9**

Consider an array data structure below and answer the questions that follow. [8 marks]

| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 4 | 1 | 10 | 11 | 78 | 12 | 0 | 6 | 9 | 15 | 19 | 7 | 3 | 23 | 33 | 14 | 13 | -1 | 5 | 8 | 16 | -7 |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |

(a). How many elements must be checked to try to find the value 33 in the above array using linear search?

(b). How many elements must be checked to try to find the value 2 in the above array using linear search?

(c). How many elements must be checked to try to find the value -7 in the above array using linear search?

(d). How many elements must be checked to try to find the value 22 in the above array using linear search?

**Problem C10**

Given that a list has **n** elements, what would be the best case that could occur when linear searching for an element? [2 marks]

**Problem C11**

Given that a list has **n** elements, what would be the worst case that could occur when linear searching for an element? [2 marks]

**Problem C12**

What would be the complexity of the best case for linear search? [2 marks]

**Problem C13**

What would be the complexity of the worst case for linear search? [2 marks]

**Problem C14**

Given the following array: **12, 18, 10, 14, 17, 8, 5, 11, 7**

Provide a logical representation of the Quick sort partition. Use first element as **pivot.** [5 marks]

**Problem C15**

Discuss the difference between the linear search and binary search algorithms. [4 Marks]

**Problem C16**

Given the following operations of a stack which are performed in that order,

**Push(5), push(3), push(1), pop(), pop(), push(7)**

(a). Draw a logical representation of a **static stack** after all the above operations are performed. You must include the **top** pointer. [3 marks]

(b). What will be the output of the pseudocode when the display() function is called? [2 Marks]

**Problem 17**

If you want to create a binary tree whose nodes contain integer values, we can represent the nodes using the following blue print.

```
Node
{
  integer data;    // value contained in this node
  Node leftChild; // left subtree; null if empty
  Node rightChild; // right subtree; null if empty
}
```

Complete the definition of the following method so that it returns the sum of the data values contained in all of the nodes of the binary tree with root; **rootNode**. Rewrite the complete method in the provided booklet by filling the missing code lines. **Hint**: use Recursion. [8 Marks]

```
public int sum(Node rootNode)
{
 IF(__________________)
    return 0

 ELSE
return rootNode.________ + sum(____________.leftChild) + sum(_______________)

ENDIF
```

************************************ End of Exam*****************************************