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: JANUARY 2024	**PAPER:** THEORY
DURATION: 3 HOURS	**MARKS:** 100

SECOND OPPORTUNITY / SUPPLEMENTARY EXAMINATION QUESTION PAPER	
EXAMINER(S)	**MR S. TJIRASO**
MODERATOR:	**MRS S. CHIVUNO-KURIA**

INSTRUCTIONS
1. Answer ALL the questions. 2. Read all the questions carefully before answering. 3. Number the answers clearly 4. All things that should not be marked, e.g., any "rough work", have to 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 booklet.
- The section consists of 10 problems.

Problem A1

Which data structure can be used to implement a static queue? [2 Marks]

A. Binary tree

B. Array

C. Linked List

D. Stack

Problem A2

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

Statement A: A tree is a linear structure.

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: Preorder traversal algorithm visits parent, Left child then right child.

Statement B: Postorder traversal algorithm visits right child, Left child then, parent.

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 are true about merge sort? [2 Marks]

A. It is quadratic sorting algorithm

B. It uses divide and conquer technique

C. it uses pivot to divide the list

D. None of the above

Problem A5

Which one of the following is a worst case time complexity for linear search? [2 Marks]

A. O(n)

B. O(1)

C. $T(n)= T(n/2) +c$

D. $O(\log_2 n)$

Problem A6

Which linked list does not have a null value in the address part? [2 Marks]

A. Doubly linked list

B. Circular linked list

C. Singly linked list

D. none of the above

Problem A7

What is the minimum number of edges a graph with 2 vertices can have? [2 Marks]

A. 6

B.0

C. 4

D. none of the above

Problem A8

A node in a binary tree has at most ____________children. [2 Marks]

A. Two

B. Three

C. four

D. none of the above

Problem A9

.....is the term used to insert an element onto stack? [2 Marks]

A. Sort

B. Pop

C. Push

D. none of the above

Problem A10

The following numbers; 5, 8,2,9,3 are inserted into a stack in that order. If a pop () operation is called four (4) time. What is the correct order of removal? [2 Marks]

A. 5,8,2,9

B. 3, 9, 2, 8

C. 3,9,8,2

D. None of the above

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

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

Problem B1

A binary search algorithm has a worst case time complexity of O(n). [2 Marks]

Problem B2

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

Problem B3

A Stack is a linear data structure. [2 marks]

Problem B4

A queue data structure is useful for resources allocation and /or scheduling in operating systems. [2 marks]

Problem B5

A tree data cannot have more than two(2) children. [2 marks]

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

- Answer all the questions in the provided booklet.
- The section consists of 15 problems.

Problem C1

What is an algorithm? [2 Marks]

Problem C2

Which data Structure uses Last-In First-out (LIFO) principle? [1 Mark]

Problem C3

Consider the following two lists given below:

A = { 7, 9, 0, 11, 5, 3, 2, 1, 8}

B = {0, 1, 2, 3, 5, 7, 8, 9, 11}

Which one would you say is a better way of storing data? Justify your answer [3 Marks]

Problem C4

Analyse the fragment of a program given below:

```
mysteryFunction(array,n)
FOR (i = 0; i < n - 1; i++)
  min = i
  FOR(j = i + 1; j < n; j++)
   IF(array[j] < array[min])THEN
     min = j
   ENDIF
  ENDFOR
   temp = array[i]
   array[i] = array[min]
   array[min] = temp
ENDFOR
```

If the calling part of the program passes the following array {13, 2, 10, 15, 20, 17, 1} to mysteryFunction*(*array,n*)*

a) What is the general task performed by the function given above? [1 Mark]
b) How many times does the inner loop iterate? [2 Marks]
c) Write down the state of the array on each pass of the outer loop, from the initial array given above to the final array. [6 Marks]

Problem C5

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

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

Taking **num** as the variable containing the data and **n** as the **size** of the queue, 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 queue in problem C5. [3 Marks]

Problem C7

There have been several security incidents at NUST. It is time to improve security at NUST. Management wants to develop an App that can be used by security personnel to check the credentials of everyone coming through the security gate. The App will accept as input a person's student/staff number, and output "registered student", "staff member", "unknown person" depending on whether the person is recognised as a registered student/staff member or not.

Task:

a) What searching algorithm will be the most appropriate for this scenario? [1 Mark]
b) Explain one disadvantage/weakness of your solution in (a) [2 Marks]

Problem C8

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

Problem C9

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 C10

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 C11

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

Problem C12

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

Problem C13

Consider a sorted array below and answer the questions that follow.

-7	-1	0	1	2	3	4	5	6		7	8	9	10	11	12	13	14	15	16	19	23	33	78
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 sorted array using binary search? [2 marks]

(b). State which elements (give values not indices) must be checked to try to find the value 33 in the above sorted array using binary search? [2 marks]

(c). State which elements (give values not indices) must be checked to try to find the value -7 in the above sorted array using binary search? [2 marks]

(d). How many elements must be checked to try to find the value 22 in the above sorted array using binary search? [2 marks]

(e). State which elements (give values not indices) must be checked to try to find the value 22 in the above sorted array using binary search? [2 marks]

Problem C14

Given the binary search algorithm below,

a. Write a complete binary search algorithm by filling the missing code in **provided booklet**. [7 marks]
   Note: n is the size of the array.

```
binarySearch (a[ ], n, target){
    lowerBound = _______
    upperBound = _________

    WHILE(______________________________)
        middle = _____________________ __________
        IF (target == a[middle]) THEN
            return ___________
            ELSE IF (________________________) THEN
                upperBound = middle – 1
            ELSE
                ____________________________
            ENDIF
    ENDWHILE
    return -1
    }
```

b. When searching for a target in an array using a binary search algorithm, which are the two main conditions that determines when the searching stops. [2 marks]

c. Given the array below

   A[] = {1, 5, 6, 8, 10, 22, 30, 42}
   target = 10

Provide a logical representation of a binary search algorithm when searching for the **element 10** in the array: **A[]**. [5 marks]

Problem C15

(a). Draw the binary search tree that is created if the following values are inserted in the tree in the given order; 10, 13, 1, 21, 27, 12 [6 marks]

(b). What will be the output of the pre-order and post order traversal algorithms for the tree in C15 (a)? [2 marks]

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