NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF COMPUTING AND INFORMATICS

DEPARTMENT OF SOFTWARE ENGINEERING

QUALIFICATION: BACHELOR OF COMPUTER SCIENCE, BACHELOR OF COMPUTER SCIENCE IN CYBER SECURITY AND BACHELOR OF INFORMATICS	
QUALIFICATION CODE: 07BCMS, 07BCCY, 07BAIT	**LEVEL**: 5
COURSE: DATA STRUCTURES AND ALGORITHMS 1	**COURSE CODE:** DSA521S
DATE: JANUARY 2025	**PAPER:** THEORY
DURATION: 2 HOURS	**MARKS:** 100

SUPPLEMENTARY / SECOND OPPORTUNITY EXAMINATION QUESTION PAPER	
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INSTRUCTIONS

1. Answer ALL the questions.
2. Read all the questions carefully before answering.
3. Number the answers clearly.

THIS QUESTION PAPER CONSISTS OF 10 PAGES
(Including this front page)

PERMISSIBLE MATERIALS

1. NON-PRGRAMMABLE CALCULATOR

SECTION A: Multiple Choice Questions [20 Marks]

Answer all the questions in the booklet provided.

The section consists of 10 problems (A1-A10).

Problem A1

Which of the following cannot be used for searching in an unordered array? [2 marks]

A. Linear Search

B. Binary Search

C. Quick Search

D. Merge Sort

Problem A2

Which of the following is the best-case time complexity for a Binary Search algorithm? [2 marks]

A. O(n)

B. $O(n^2)$

C. O(log n)

D. O(1)

Problem A3

What are the applications of queue? [2 marks]

A. parentheses matching check

B. Breadth First Search (BFS) Algorithms

C. Evaluation of arithmetic expressions

D. None of the above

Problem A4

In Quick Sort, the pivot element is used to: [2 marks]

A. Sort the array immediately.

B. Partition the array into two sub-arrays.

C. Merge the sub-arrays into one sorted array.

D. Compare elements to find the maximum.

Problem A5

Which of the following is true about the Linear Search algorithm? [2 marks]

A. It works only on sorted arrays.

B. It uses a divide-and-conquer technique.

C. It checks each element sequentially.

D. It always has a time complexity of O(1).

Problem A6

What is the maximum number of edges a graph with 4 vertices can have? [2 marks]

A. 3

B. 6

C. 4

D. 16

Problem A7

Which of the following is the average time complexity of searching for an element in a sorted array using binary search [2 marks]

A. O(n)

B. O(log n)

C. O(n log n)

D. O(1)

Problem A8

Which data structure is used to represent a graph in an adjacency list? [2 marks]

A. Array

B. Linked List

C. Hash Map

D. Stack

Problem A9

In a circular linked list, the last node points to which of the following? [2 marks]

A. Itself

B. The first node

C. Null

D. A random node

Problem A10

Which of the following is NOT a valid operation on a stack? [2 marks]

A. Push()

B. Pop()

C. Peek()

D. Random()

SECTION B: True and False Questions [20 Marks]

Answer all the questions in the booklet provided.

The section consists of 10 problems(B1-B10).

Problem B1

In Merge Sort, the merge step always combines two sorted arrays into one sorted array. [2 marks]

A. True

B. False

Problem B2

In Quick Sort, elements larger than the pivot element are placed to the left of the pivot. [2 marks]

A. True

B. False

Problem B3

Binary Search can be performed on both sorted and unsorted arrays. [2 marks]

A. True

B. False

Problem B4

The best-case time complexity of linear Search is O(1). [2 marks]

A. True

B. False

Problem B5

Merge Sort is a divide-and-conquer algorithm that splits an array in half until subarrays contain only one element. [2 marks]

A. True

B. False

Problem B6

A subtree is any connected structure below the root. [2 marks]

A. True

B. False

Problem B7

Time and space are not the two main measures of the efficiency of algorithms. [2 marks]

A. True

B. False

Problem B8

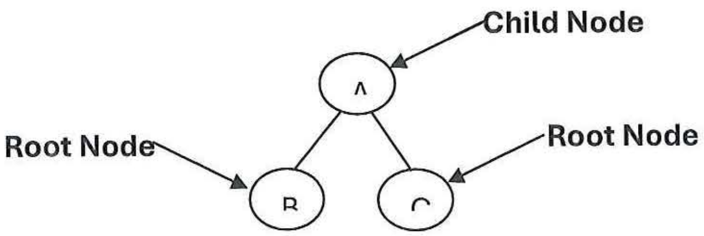
The first thing to consider when using binary search to search for an element in an array is whether the array can be recursively divided into sub-arrays. [2 marks]

A. True

B. False

Problem B9

Given the tree below, A is a child node and B and C are root nodes. [2 marks]



A. True

B. False

Problem B10

The bottom of a stack can be accessed directly for insertion and removal of elements. [2 marks]

A. True

B. False

SECTION C: Structured Questions [60 Marks]

Answer all the questions in the booklet provided.

The section consists of 7 problems(C1-C7).

Problem C1

Define the following terms: [8 marks]

a) Algorithm

b) Data structure

c) Stack

d) Parent node

Problem C2

Use selection sort algorithm to sort the array below: Show content for each step/pass. [6 marks]

15	28	17	12	18	9	6

Problem C3

Consider an array {20, 57, 6, 37, 73, 89, 23} with the starting position start and its ending position end. Sort the array using the quick sort algorithm in ascending order by selecting the mid element as a pivot. [6 Marks]

Problem C4

Study the code fragment below and answer the questions that follows.

```
FOR (i = 1; i < n; i++)
    temp =35
    temp = array[i]
    j = i - 1
    WHILE (j >= 0 AND array[j] > temp)
```

```
            array[j + 1] = array[j]
            j = j – 1
        ENDWHILE
        array [j + 1] = temp
ENDFOR
```

(a). How many times does the inner loop(WHILE loop) iterate after complete execution of the program for the array below; [4 Marks]

array = {12,5,17,4,70,3}?

(b). What is the value of temp when i=3? [2 Marks]

(c). What is the output of the program if the code fragment highlighted in ***bold*** is added to the algorithm? [8 Marks]

```
FOR (i = 1; i < n; i++)
         temp =35
        temp = array[i]
        j = i - 1
        WHILE (j >= 0 AND array[j] > temp)
                array[j + 1] = array[j]
                j = j – 1
        ENDWHILE
        array[j + 1] = temp
        FOR(count=0;count < n ; count++)
            DISPLAY array[count]
        ENDFOR


ENDFOR
```

Problem C5

Consider the function below and fill in the missing code fragments to display the content of a dynamic queue if; **data** is the variable name that holds the actual value.

```
mergeSort(array[], lowerIndex, upperIndex)
        {
        IF(.....................................)THEN                    [1 Mark]
                mid = (lowerIndex + upperIndex)/2
                    ....................................                [1 Mark]
                    ....................................                [1 Mark]
                    ....................................                [1 Mark]
                ENDIF
        }
```

Problem C6

MTC Namibia hires you to implement a call center management system. The system should be able to put the incoming calls on hold until an agent is available to attend to the customer call. The data structure should expand and shrink based on the number of calls waiting to be served.

(a). What data structure is the most suitable for the implementation of the call management system scenario described above? Justify your answer. [3 Marks]

(b). Provide a diagrammatic representation of the data structure you chose in **Problem C6(a)** above, if three customers; **cus1**, **cus2** and **cus3** are waiting to be served in that order respectively. [3 Marks]

(c). Write a pseudocode to display the customers on hold. [8 Marks]

Problem C7

Consider the function below and fill in the missing code fragments to display the content of a dynamic queue if; **data** is the variable name that holds the actual value. [8 Marks]

```
display()
{
   IF(front == null AND rear == ..............................THEN          [2 marks]
     DISPLAY "empty"
ELSE
   temp = [...................]                                             [2 marks]
   WHILE(temp != null)
     DISPALY temp ->[................................................]      [2 marks]
   [..........................]                                             [2 marks]
 ENDWHILE
ENDIF
}
```

***************************** **End of the Paper** *************************************