



**NAMIBIA UNIVERSITY  
OF SCIENCE AND TECHNOLOGY**

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

<b>QUALIFICATION:</b> BACHELOR OF COMPUTER SCIENCE, BACHELOR OF COMPUTER SCIENCE IN CYBER SECURITY AND BACHELOR OF INFORMATICS	
<b>QUALIFICATION CODE:</b> 07BCMS, 07BCCY, 07BAIT	<b>LEVEL:</b> 5
<b>COURSE:</b> DATA STRUCTURES AND ALGORITHMS 1	<b>COURSE CODE:</b> DSA521S
<b>DATE:</b> NOVEMBER 2024	<b>PAPER:</b> THEORY
<b>DURATION:</b> 2 HOURS	<b>MARKS:</b> 100

<b>FIRST OPPORTUNITY EXAMINATION QUESTION PAPER</b>	
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<b>INSTRUCTIONS</b>
1. Answer ALL the questions. 2. Read all the questions carefully before answering. 3. Number the answers clearly.

THIS QUESTION PAPER CONSISTS OF 12 PAGES  
(Including this front page)

**PERMISSIBLE MATERIALS**

1. NON-PROGRAMMABLE 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

Given a list of elements; 8,12,6,16,30 inserted into a data structure in that order. An element is deleted using a basic data structure operation. If the deleted element is 30, the data structure cannot be a?

[4 Marks]

- A. Tree
- B. Queue
- C. Graph
- D. None of the above

#### Problem A2

Study the code fragment below and answer the question 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
```

Which of the following statement(s) is true about the code fragment?

[2 Marks]

**Statement A:** Code fragment has the worst-case time complexity of  $O(n)$ .

**Statement B:** Code fragment is a pseudocode for a searching algorithm.

- 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 one of the following cannot be used for sorting?

[2 Marks]

- A. Selection Sort
- B. Merge sort
- C. Insertion Sort
- D. Binary Sort

**Problem A4**

A binary search tree is constructed by inserting the following elements in order: 60, 25, 72, 15, 30, 68, 100, 13, 18, 47, 70. How many number of right subtree nodes does the tree have?

[2 Marks]

- A. 3
- B. 5
- C. 7
- D. 6
- E. 4
- F. None of the above

**Problem A5**

Which one of the following is the worst-case time complexity of selection sort algorithm?

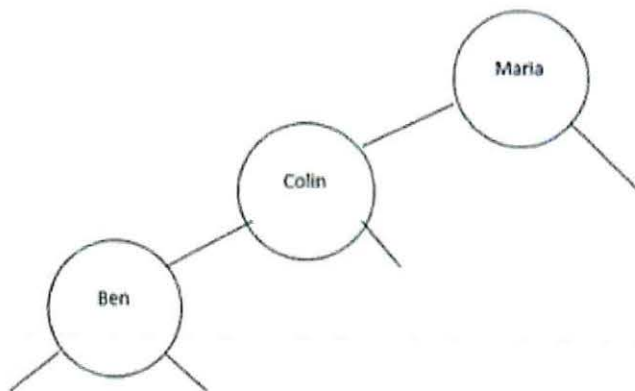
[2 Marks]

- A.  $O(1)$

- B.  $O(n)$
- C.  $O(n^2)$
- D.  $O(\log n)$
- E.  $O(n \log n)$
- F.  $O(n^3)$
- G. None of the above

**Problem A6**

Study the BST below and answer the question that follows.



If we compute;  $2^h - 1$ : where  $h$  is "height", what are we computing or trying to find out?

[2 Marks]

- A. 3
- B. Minimum number of nodes in tree
- C. 2
- D. Minimum number of internal nodes in tree
- E. Maximum number of nodes in tree
- F. 4
- G. Minimum height
- H. Invalid computation
- I. Maximum number of leaf nodes in tree

- J. Maximum number of internal nodes in tree
- K. Maximum height
- L. Minimum number of leaf nodes in tree

**Problem A7**

The operation for visiting each node in a tree data structure is known as.....

[2 Marks]

- A. inserting
- B. Merging
- C. Sorting
- D. Traversal
- E. none of the above

**Problem A8**

Which traversal algorithm is satisfying the following order?

[2 Marks]

- 1 - Go left and perform x
- 2 - Perform an action on current node
- 3 - Go right and perform x

**HINT:** x is the name of the traversal being performed

- A. PostOrder
- B. PreOrder
- C. InOrder
- D. None of the above

**Problem A9**

Which of the following statement(s) is true?

[2 Marks]

**Statement A:** Enqueue operation is concerned with adding an element to a queue data structure.

**Statement B:** Dequeue operation is concerned with searching for an element in a queue data structure.

- 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 A10**

Which of the following statement(s) is true?

[2 Marks]

**Statement A:** Selection sort algorithm has a worst-case time complexity of  $O(n^2)$ .

**Statement B:** Selection sort algorithm has a best-case time complexity of  $O(n^2)$ .

- 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.

**SECTION B: True and False Questions [20 Marks]**

Answer all the questions in the booklet provided.

The section consists of 7 problems (B1-B7).

**Problem B1**

Stack is an abstract data type where data are inserted from both ends provided that the isEmpty() function is declared first and checked. [2 Marks]

- A. True
- B. False

**Problem B2**

Selection sort algorithm has best and worst-case time complexity of  $O(n^2)$ . [2 Marks]

- A. True
- B. False

**Problem B3**

In a linked list, insertion can be done at the End, Middle but not at the beginning of the list. [2 Marks]

- A. True
- B. False

**Problem B4**

When we insert data into a queue with data already in it, the only pointer that needs to be updated is the rear pointer, which is set to point to the new node. [2 Marks]

- A. True
- B. False

**Problem B5**

The inorder traversal processes the left subtree first, then the root, and finally the right subtree. [2 Marks]

- A. True
- B. False



### Problem B6

The postorder traversal processes the left subtree first, then the root, and finally the right subtree.

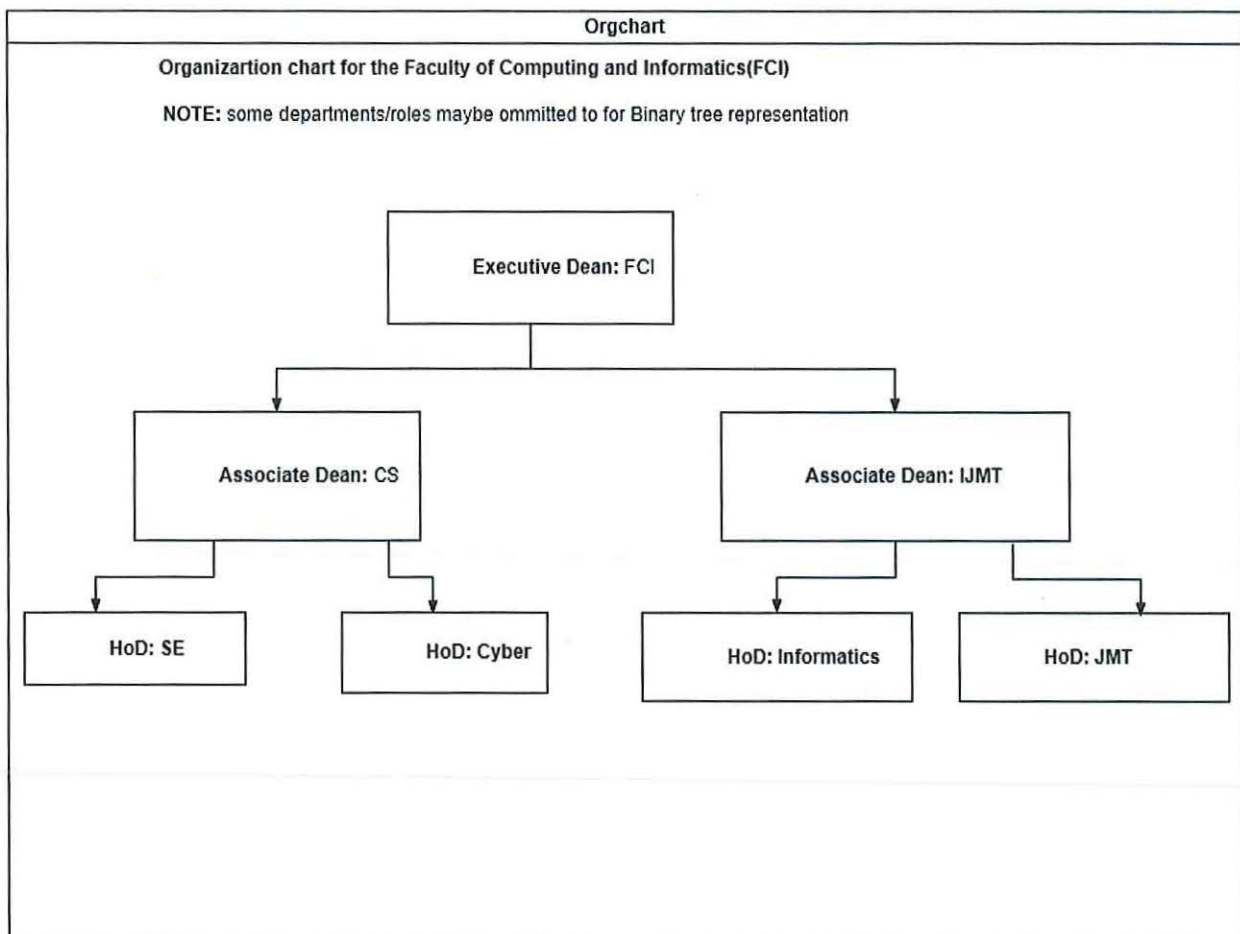
A. True

[2 Marks]

B. False

### Problem B7

Consider the structure below and answer the question(s) that follows.



(a) The preorder predecessor of **HoD: SE** in this binary tree is **Executive Dean: FCI**.

[2 Marks]

A. True

B. False

(b) The Inorder successor of **HoD: Informatics** is **Associate Dean: IJMT**.

[2 Marks]



A. True

B. False

(c) The height of the node; **HoD: JMT** is two(2).

[2 Marks]

A. True

B. False

(d) The height of the this binary tree is two(2).

[2 Marks]

A. True

B. False

### SECTION C: Structured Questions [60 Marks]

Answer all the questions in the booklet provided.

The section consists of 9 problems (C1-C9).

#### Problem C1

- (a) Given the array {6, 8, 17, 20, 23, 27, 37, 51, 57, 73, 89} Write the pseudocode for the binary search algorithm to search for the **key=51**. [8 Marks]
- (b) How many elements will Binary Search need to check to find the **key=27**? [4 Marks]
- (c) How many elements will Linear Search need to check to find the **key 27**? [3 Marks]
- (d) Discuss what will happen if you binary search the **key=51** in the array {20, 57, 6, 37, 73, 89, 23, 51, 17, 8, 27, 73} [4 Marks]

#### Problem C2

Suppose that a selection sort of 500 items has completed 100 iterations/passes of the main(outer) loop. How many items are now guaranteed to be in their final spot (never to be moved again)? [2 Marks]

#### Problem C3

Here is an array of ten integers: 5, 3, 8, 9, 1, 7, 0, 2, 6, 4

- (a) Draw this array after the **FIRST** iteration of the main(outer) loop in a selection sort (**sorting from smallest to largest**). [3 Marks]
- (b) Draw this array after the **FIRST** iteration of the main(outer) loop in an insertion sort (**sorting from smallest to largest**). This iteration has shifted at least one item in the array! [3 Marks]

#### Problem C4

Describe a case where insertion sort algorithm will exhibit linear time  $O(n)$  in the best-case scenario.

**Hint:** when the inner loop never executes or may execute once for example. [2 Marks]

### Problem C5

Here is an array which has just been partitioned by the first step of quicksort:

[4 Marks]

3, 0, 2, 4, 5, 8, 7, 6, 9

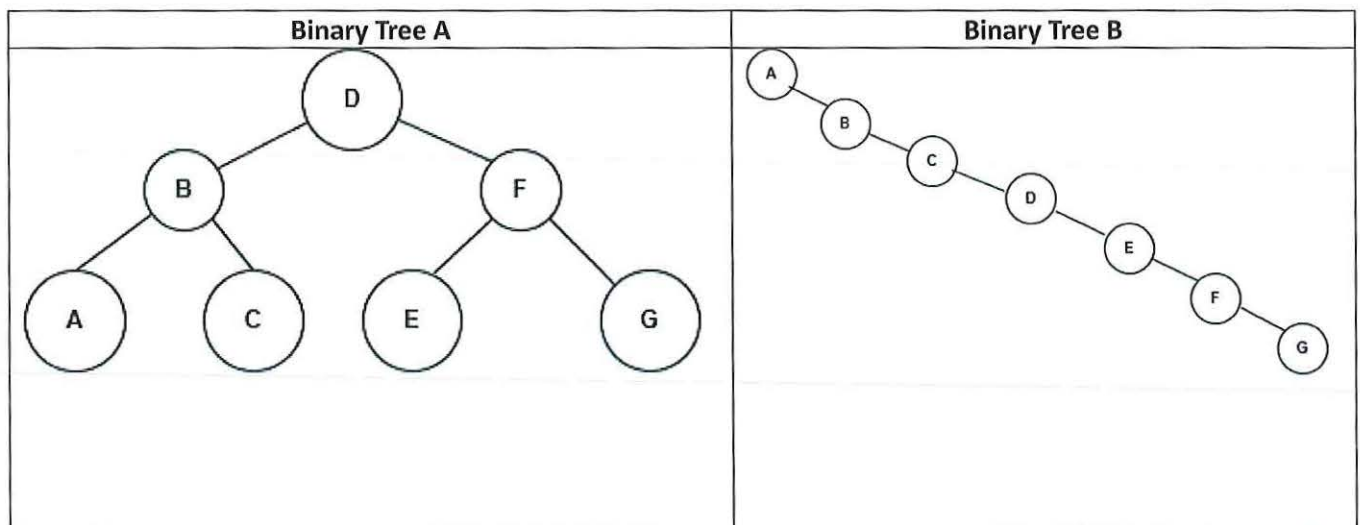
Which of these elements could be the pivot? (There may be more than one possibility!)

### Problem C6

Briefly describe binary and linear search algorithms with respect to how they work given the following array and searchKey; **array={2,3,7,11,14,18,23,27}** and **searchKey=90**. One of the key descriptions should be about their respective worst-case time complexity or their asymptotic behavior. [10 marks]

### Problem C7

Study the tree data structure below and answer the following questions.



(a) Briefly discuss the height of each of the two (2) structures and how it affects a search operation. [4 Marks]

(b) What will be the preorder, inorder and postorder traversal output for **Binary Tree A**? [6 Marks]

(c) Which node is an inorder successor of node **D** in **Binary Tree A**? [2 Marks]

### Problem C8

A binary search tree is constructed by inserting the following elements in order: 60, 25, 72, 15, 30, 68, 100, 13, 18, 47, 70. How many numbers of left subtree nodes will the resulting tree have? [2 Marks]

### Problem C9

Consider the function below and fill in the missing code fragments.

[3 Marks]

```
quickSort(array, start, end) {  
    IF (start < end) {  
        pivot = start  
        i = start  
        j = end  
        WHILE(i < j){  
            WHILE (array[i] <= array[pivot] && i < end)  
                i = i + 1  
            WHILE (array[j] > .....)  
                j = j - 1  
            IF (i < j) {  
                temp = .....  
                array[i] = array[j]  
                array[j] = temp }  
            }  
            temp = array[pivot]  
            array[pivot] = array[j]  
            array[j] = temp  
            quickSort(array, start, j+1)  
            quickSort(array, ....., end) }  
    }
```

\*\*\*\*\* End Of Paper \*\*\*\*\*

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

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- A. Tree
- B. Queue
- C. Graph
- D. None of the above

### Problem A2

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

```
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    temp = 35
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    temp = array[i]
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```
        array[j + 1] = array[j]
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```
        j = j - 1
```

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

```
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```