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	**NQF LEVEL**: 5
COURSE: DATA STRUCTURES & ALGORITHMS 1	**COURSE CODE:** DSA521S
DATE: DECEMBER 2025	**SESSION:** THEORY
DURATION: 3 HOURS	**MARKS:** 100

SUPPLEMENTARY EXAMINATION QUESTION PAPER	
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INSTRUCTIONS
1. Answer **ALL** the questions 2. Read all the questions carefully before answering 3. Write your answer in the space provided on the question paper 4. Number the answers clearly

THIS QUESTION PAPER CONSISTS OF 11 PAGES
(Including this front page)

PERMISSIBLE MATERIALS
1. NON-PROGRAMMABLE CALCULATOR

SECTION A: 10 MARKS
MULTIPLE CHOICE (Select the letter that corresponds to the correct answer.)

1. Given a list of elements, 3,12,6,16,9 inserted into a data structure in that order. An element is deleted using a basic data structure operation. If the deleted element is 3, the data structure can be a _____?
   A. Queue
   B. Tree
   C. Graph
   D. None of the above

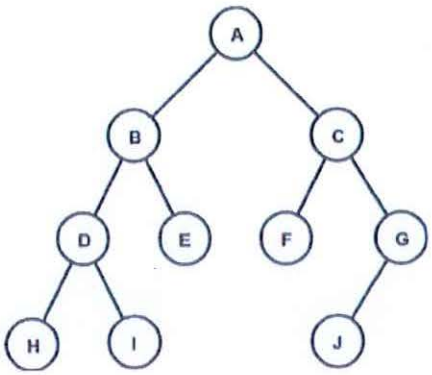
2. Which of the following operations cannot be performed on a singly-linked list, a doubly-linked list, and a circular list?
   A. Insertion- adding an element to the list.
   B. Deletion – removing an element from the list
   C. Search – seek for an element in a given list
   D. None of the above

3. How many rows does the two-dimensional array or matrix have if it is created as follows: int[][]twoDimenArray = {{14, 19, 9, 17},{12,15,0,15},{12,15,0,15},{22,1,0,18}}?
   A. 4 rows
   B. 3
   C. 16
   D. 2D

4. The formula used to calculate the middle index in Binary Search is:
   A. (low + high) / 2
   B. (low × high) / 2
   C. (low - high) / 2
   D. (low ÷ high) / 2

5. Which element is chosen in Quick Sort to partition the array?
   A. Always the middle element
   B. The minimum element
   C. The maximum element
   D. The pivot element

6. Given the following tree. Give its **inorder traversal** algorithm output.



A. ABDHIECGFS
B. HDIBEAFCJG
C. HIDEBFJGCA
D. ABDHIECFGS

7. Which of the following is the best time complexity for a Binary Search algorithm?
   A. O(n)
   B. $O(n^2)$
   C. O(log n)
   D. O(1)
8. What are the applications of a stack?
   A. Queues in routers/switches
   B. Check parentheses matching in an expression
   C. Process scheduling
   D. Shared resource

9. If the node to be deleted has _____, we replace it with its inorder successor (or predecessor) and then delete that successor (or predecessor) node..
   A. Only a left subtree
   B. Only a right subtree
   C. two children
   D. Has one child

10. Which of the following is an approach to traversing a graph?
    A. Binary search
    B. Sequential search
    C. Both A and B are approaches to traversing a graph.
    D. None of A or B is an approach to traversing a graph

SECTION B: 10 MARKS

TRUE/FALSE (Determine whether the following statements are True or False)

1. In a stack, the push() operation inserts elements at the bottom of the stack.
   A. True
   B. False
2. A doubly linked list allows traversal in both directions, forward and backwards.
   A. True
   B. False

3. In a linked list, insertion can be done at the End, Middle, but not at the beginning.
   A. True
   B. False

4. In a queue, both front and rear pointers must be updated during **enqueue** operations.
   A. True
   B. False

5. Merge Sort is a divide-and-conquer algorithm that splits an array in half until subarrays contain only one element.
   A. True
   B. False

6. Binary Search can be used on linked lists without modification.
   A. True
   B. False

7. Binary search can be performed on both sorted and unsorted arrays.
   A. True
   B. False

8. In a binary tree, each node can have at most three children.
   A. True
   B. False

9. The inorder traversal of a binary search tree produces elements in ascending order.
   A. True
   B. False

10. In Breadth First Search (BFS), a stack data structure is used..
    A. True
    B. False

SECTION C: 80 MARKS
STRUCTURED QUESTIONS

- *Answer all the questions in the space provided.*
- *This section consists of 4 questions.*

1. Linear Data Structures **[25 Marks]**

1.1. Discuss the difference between a Stack and a Queue. (4)

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1.2. Six (6) DSA521S students took a test and scored the following marks: **23, 37, 63, 13, 70, 33** in that order, starting with 23. By way of a diagram, illustrate how the above test marks will be stored in a Stack using a linked list implementation (6)

1.3. Study the code fragment below and answer the following question.

```
mystery (marks[], size)
 FOR (outerCounter=0  to size-1)
        lowestIndiex= outerCounter

        FOR (innerCounter= outerCounter +1 to size-1)
              IF(marks[innerCounter] < marks[lowestIndiex]  )THEN
               lowestIndiex= innerCounter

              ENDIF
            ENDFOR
              marks[outerCounter]= marks[lowestIndiex]
ENDFOR

ENDmystery()
```

i. What is the final output of the algorithm if an array, **marks= {45, 75, 62, 18}** is passed to the function mystery()? (5)

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ii. If the two (2) highlighted lines are added, what will be the output for the same array, **marks = {45,75, 62,18}**? Show the state or content of the array after each iteration of the outer loop. (6)

```
mystery (marks[], size)
 FOR (outerCounter=0  to size-1)
        lowestIndiex= outerCounter

        FOR (innerCounter= outerCounter +1 to size-1)
              IF(marks[innerCounter] < marks[lowestIndiex]  )THEN
                lowestIndiex= innerCounter

              ENDIF
            ENDFOR
             temp= marks[outerCounter]
             marks[outerCounter]= marks[lowestIndiex]
            marks[lowestIndiex]= temp
```

1.4. Consider the function below and fill in the missing code fragments to display the content of a dynamic queue, where 'data' is the variable name that holds the actual value.

```
display()
      {
      IF(front == ..... AND rear == .....)THEN   (2)
            DISPLAY "Queue is empty"
      ELSE
            FOR(i = .....; i < rear + 1; i++).      (1)
            DISPLAY .....                           (1)
      ENDFOR
      ENDIF
}
```

2. Sorting Algorithms [15 Marks]

2.1. Discuss the differences between selection and insertion sort algorithms. (5)

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2.2. Here is an array of ten integers:

5 3 8 9 1 7 0 2 6 4

Draw this array after the TWO recursive calls of merge sort are completed, and before the final merge step has occurred. (5)

2.3. Use the Quick Sort algorithm to sort the array below: 4,3,2,10,12,1,5,6. Show content for each step. (5)

3. Searching Algorithms **[15 Marks]**

3.1. What is the difference between Linear Search and Binary and explain in which situations Linear Search is preferred over Binary Search (4)

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3.2. Given the array {6, 8, 17, 20, 23, 27, 37, 51, 57, 73, 89},

i. Write the pseudocode for the Linear Search algorithm to find the key 57. (8)

ii. How many elements will Binary Search need to check to find the key=27?
..... (3)

iii. How many elements will Linear Search need to check to find the key 27?
..... (3)

iv. Discuss what will happen if you linear search the key=38 in the array {20, 57, 6, 37, 73, 89, 23, 51,17,8,27,73} (2)

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4. Non-Linear Data Structures [30 Marks]

4.1. Define the following terms:

4.1.1. Child node (1)

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4.1.2. Parent node (1)

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4.1.3. Edge (1)

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4.1.4. Path (1)

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4.1.5. Depth of node (1)

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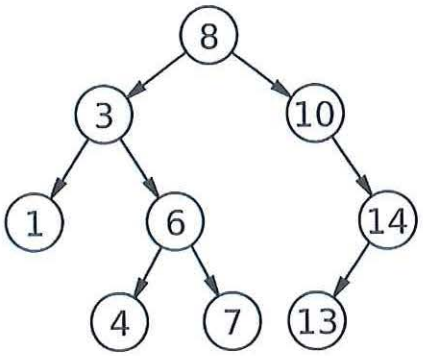
4.2. Given the following array {20, 30, 60, 100, 90, 50, 130, 210, 160, 110}. Construct a Binary Search Tree (BST) using a **Preorder** traversal. (5)

4.3. Study the BST below:



4.3.1. Delete the following nodes: 8, 3, and 7, and draw the new BST (5)

4.3.2. What is the maximum height/level of the BST after the operations in 4.2.1?(2)

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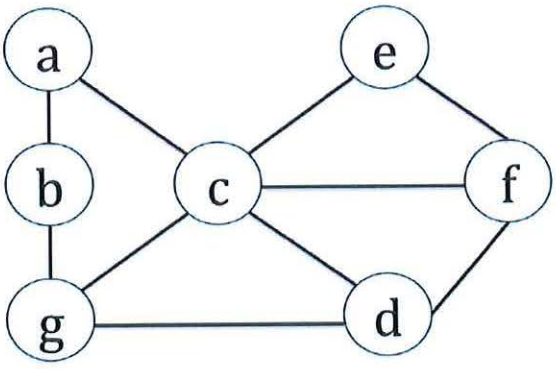
4.4. Consider the graph below, and answer the following questions: (5)



4.4.1. Represent the graph as an adjacency list. (5)

4.4.2. Use Breadth-First Search to traverse the graph using a queue data structure, beginning with vertex a, and record the queue and visited vertices at each stage of the traversal. (8)

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