



## MASENO UNIVERSITY UNIVERSITY EXAMINATIONS 2024/2025

SECOND YEAR FIRST SEMESTER EXAMINATION FOR THE  
DEGREE OF BACHELOR OF SCIENCE IN MATHEMATICS  
& COMPUTER SCIENCE

### MAIN CAMPUS

### CIR 203: DATA STRUCTURES AND ALGORITHMS

Date: 16<sup>th</sup> January, 2025

Time: 12.00 - 3.00pm

#### INSTRUCTIONS:

- Do not write anywhere on this Question paper
- Answer Question ONE and any other TWO.

ISO 9001:2015 CERTIFIED

## CIR 203: Data structures and algorithms

### Question 1 (30 marks)

1. Explain the difference between linear and nonlinear data structures. Explain two examples of each (4 marks)
2. Explain the below concepts as used in Graphs
  - a. Vertex → ~~nodes~~
  - b. Edge →
  - c. Path
3. Convert the following infix expressions  $(A + B) \cdot (C + D) \cdot (E + F)$  to prefix (use full parentheses) (2 marks)
4. Explain the difference in the following types of graphs
  - a. Digraph
  - ~~b.~~ Weighted graph
  - c. Cyclic graphs
5. A company wishes to have a representation of their local area network. Give the data structure that is most appropriate for this purpose, stating the reasons for your choice (3 marks)
6. What is hashing? Explain with example. (2 marks)
7. Define an algorithm and hence explain the following algorithm strategies with appropriate examples, explain the following algorithm design paradigms (4 Marks)
  - a. Divide and conquer
  - b. Dynamic programming
8. Write a program pseudo code to remove last node of the linked list. (2 marks)
9. Using the O-notation, explain the running time of the following equations (3 Marks)
  - a.  $f(n) = 100n^3 - 7n^3 + 14n^2$
  - b.  $f(n) = 5 \log \log n + 4 \log^2(n)$
  - c.  $f(n) = 100n^3 - 100n^3 + 7n^2$
10. Derive the running time of the following section of an algorithm; clearly show how you arrived at your solution. (4 Marks)

```

int f4(int n) {
    if (n < 10) {
        System.out.println("!");
        return n+3;
    } else {
        return f4(n-1) + f4(n-1);
    }
}

a. }

b. float sum(float age[],int n)

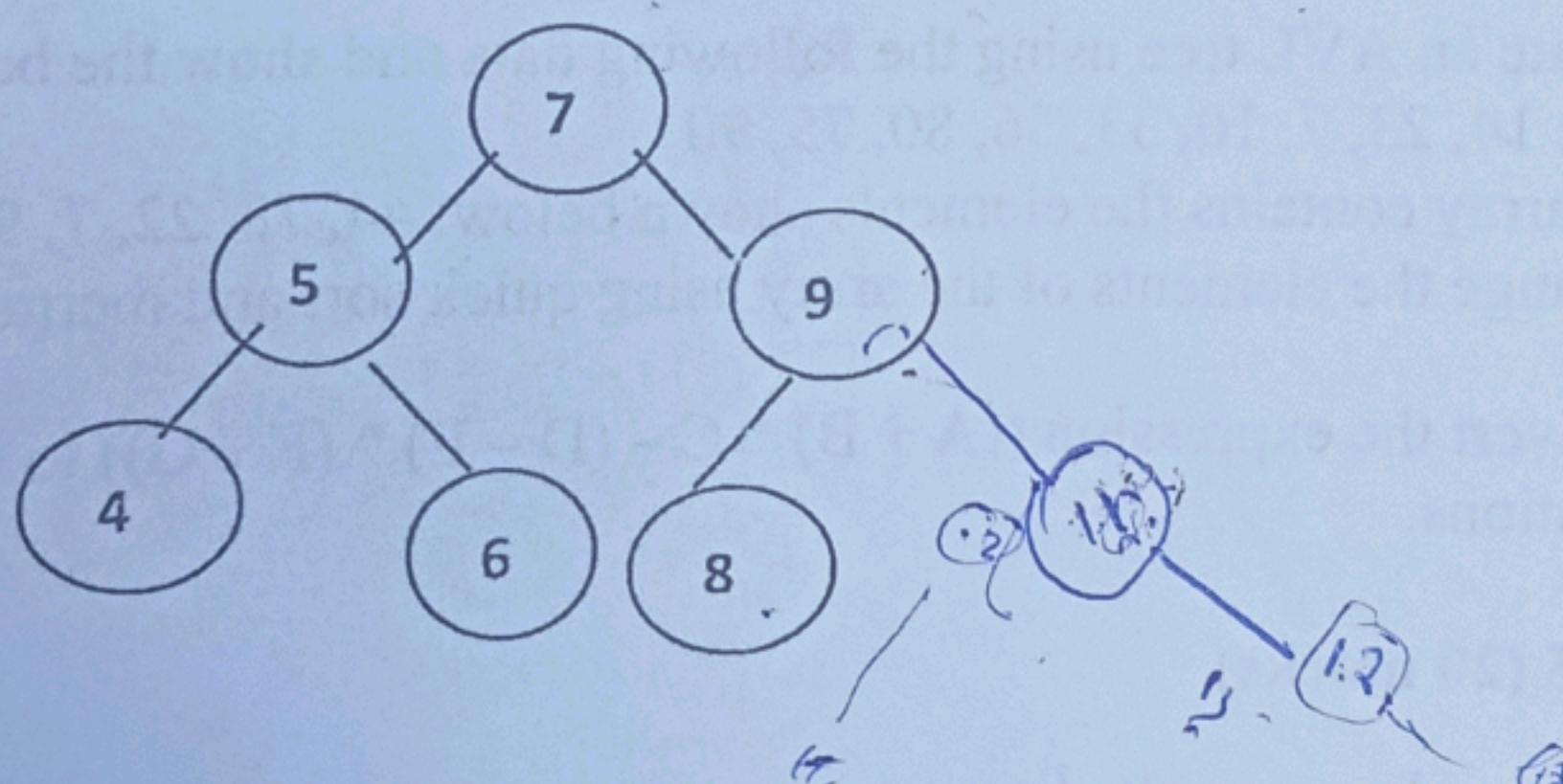
{
    float temp=0; 1
    int i; 2
    for(i =0 3 ; i<n 4 ; i++ 5)
        temp +=7 age[i]6 ;
    return temp; 8
}

```

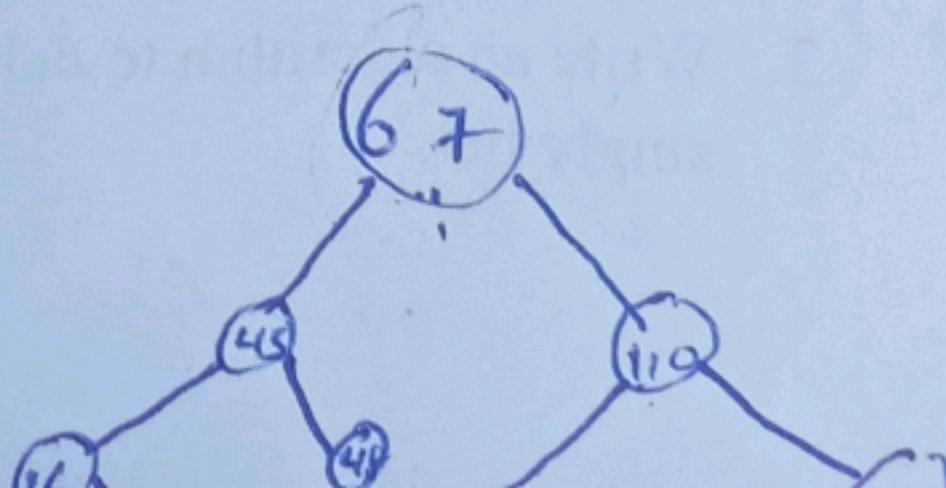
## Questions 2 (20 marks)

1. Explain how one would insert the value 11 in the BST below

(2 marks)

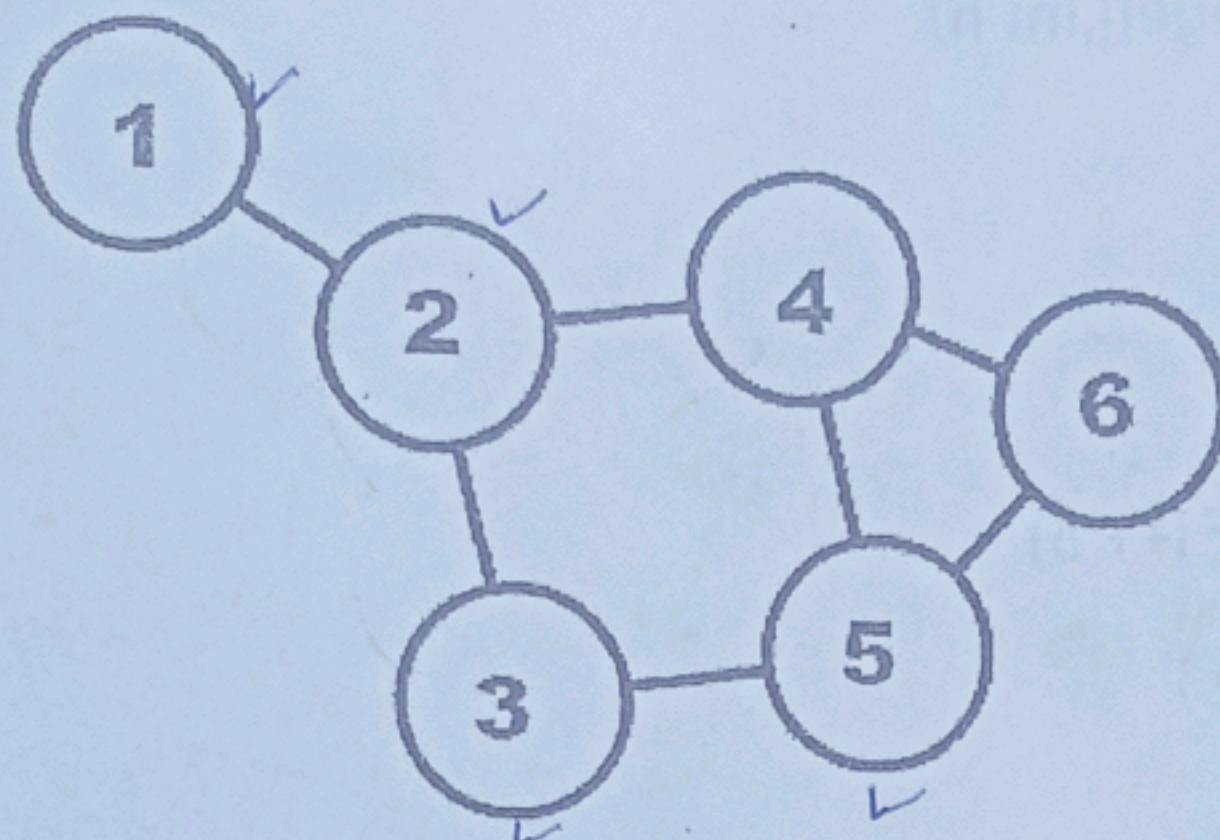


2. Evaluate the below postfix expression  $-2\ 3\ \cdot\ 4\ +$  Show the stack as each operand and operator is processed. (2 marks)
3. Create a BST using the following set of values. ~~67, 45, 110, 26, 12, 80, 33, 115, 230, 412, 48, 71, 10, 98, 5, 139, 21~~ (6 marks)
4. Traverse the above tree using Inorder traversal (4 marks)
5. Outline the basic idea of selection sort algorithm, and use it to sort the following elements: 6, 4, 15, 12, 2, 1 (6 marks)



### Question 3 (20 marks).

- Using an example, explain the spanning tree and minimum spanning tree and list some properties of spanning trees (6 marks)
- Draw an adjacency matrix for the graph shown below. (2 marks)



	1	2	3	4	5	6
1	0	1	0	0	0	0
2	1	0	1	1	0	0
3	0	1	0	0	1	0
4	0	1	0	0	0	1
5	0	0	1	0	1	0
6	0	0	0	1	0	1

- Use the depth first search algorithm to traverse the above graph. Show the state of the stack at every step of the traversal. (6 marks)
- Use the breath first search algorithm to traverse the above graph. Show the state of the queue at every step of the traversal (6 marks)

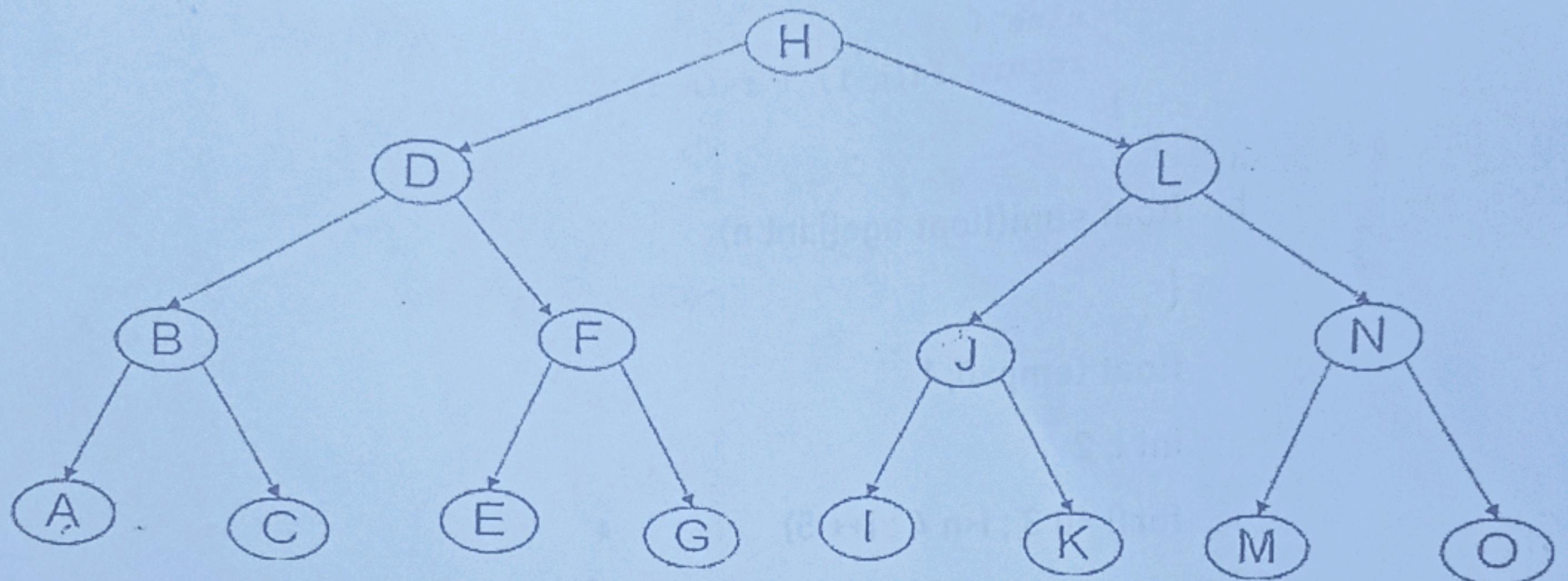
### Question 4 (20 marks)

- Draft of height & RTree*
- Create an AVL tree using the following data and show the balance factor in the resulting tree: 14, 23, 7, 10, 33, 56, 80, 75, 90 (8 marks)
  - An array contains the elements shown below: 44, 78, 22, 7, 98, 56, 34, 2, 38, 35, 45. Arrange the elements of the array using quick sort and merge-sort (8 marks)
  - Convert the expression  $((A + B) * C - (D - E)^F + G)$  to equivalent Prefix and Postfix notations. (4 marks)

### Question 5 (20 marks)

- queue*
- A friend has consulted you on coming up with a software for his fresh product shop. He wishes to ensure that all products take the shortest time possible, by selling the products in the order they came. What data type, and data structures would you recommend for this implementation? Give reasons for your answer (2 marks)
  - The study of efficiency of algorithms is the amount of resources they used in terms of space and time. Explain the two ways of measuring these qualities. (3 marks)
  - Write an algorithm to delete (a) First node (b) Last node (c) Any desired node from a singly list. (9 marks)
- Time & Space*

4. Traverse the given tree in Pre-order and post-order, in each case show the output.  
LTR      RLT  
(6 Marks)



Pre-order - H D B A C F E G L J I K M N O  
Post-order - H D B A C F E G L J I K M N O

```

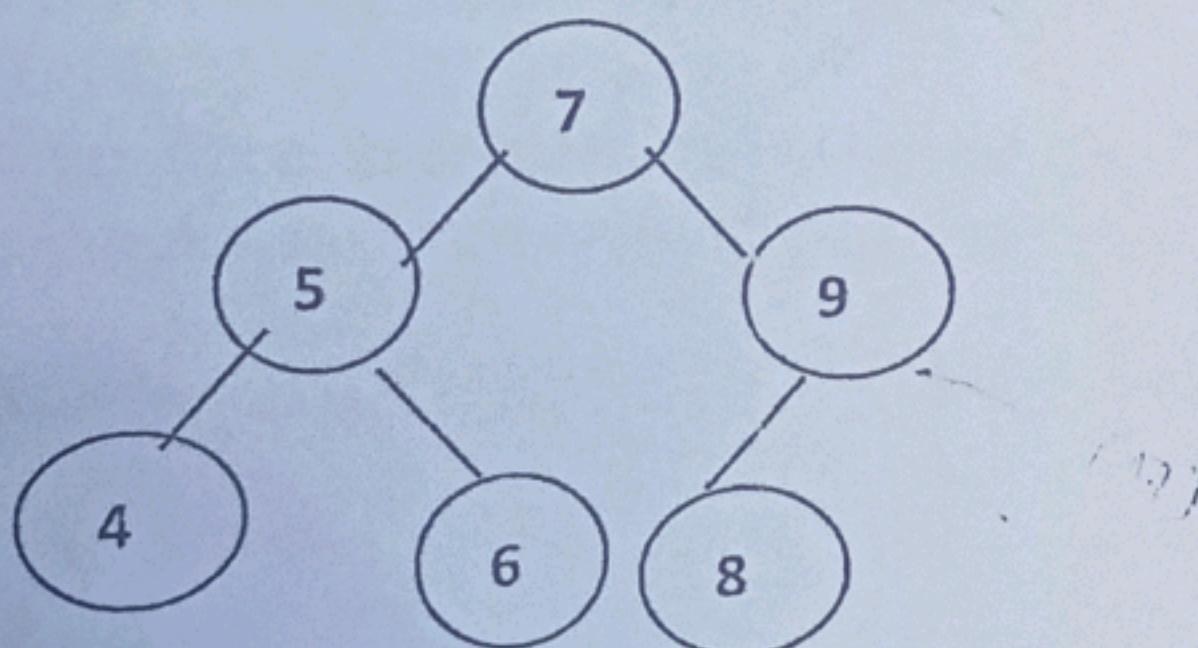
int f4(int n) {
    if (n < 10) {
        System.out.println("!");
        return n+3;
    } else {
        return f4(n-1) + f4(n-1);
    }
}

b. float sum(float age[],int n)
{
    float temp=0; 1
    int i; 2
    for(i =0 3 ; i<n 4 ; i++ 5)
        temp += age[i]6 ;
    return temp; 8
}

```

## Questions 2 (20 marks)

1. Explain how one would insert the value 11 in the BST below (2 marks)



2. Evaluate the below postfix expression - 2 3 · 4 + Show the stack as each operand and operator is processed. (2 marks)
3. Create a BST using the following set of values. 67, 45, 110, 26, 12, 89, 38, 115, 230, 442, 48, 71, 10, 98, 5, 139, 21. (6 marks)
4. Traverse the above tree using Inorder traversal (4 marks)
5. Outline the basic idea of selection sort algorithm, and use it to sort the following elements: 6, 4, 15, 12, 2, 1 (6 marks)