UNIVERSITY OF BIRMINGHAM | DUBAI دبي

LM Data Structures, Algorithms, and Databases (34140, 34141, 34139, 36989)

Exercise Sheet

Week 02

Q1.

a. If the height of a binary tree is given as 10, what is the total number of nodes that could be present in this tree?

b. What is the height of a binary tree with a total of 1 trillion nodes?

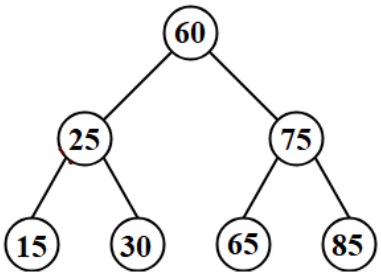
Q2. Construct a Binary Search Tree (BST) by sequentially **inserting** the values

Part A: 15, 20, 25, 18, and 16.

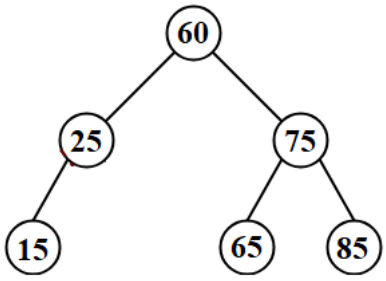
Part B: 15, 20, 25, 18, 16, 14, 26, 27, 13, 23.

Q3. Show the effect of **delete** operation on the following Binary Search Tree (BST).

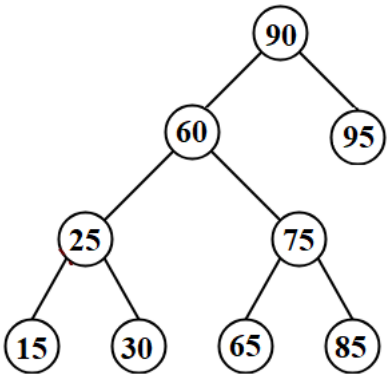
Part A: Delete 30



Part B: Delete 25



Part C: Delete 60



Q4. Describe the results of three types of tree traversal (in-order, pre-order, and post-order) on the following binary tree:

Provide the sequence of nodes visited for each traversal method: in-order, pre-order, and post-order.

Q5. Provide pseudocode to calculate the height of a binary tree.

Q6. Provide pseudocode to count the total number of nodes in a binary tree.

Q7. Provide pseudocode for counting the number of leaf nodes in a binary tree.

Q8. Given below are the equations for the Insertion algorithm of binary search trees. Fill in the blank.

```
insert(x, NIL) = Fork(x, NIL, NIL)

insert(x, Fork(x, l, r)) = Fork(x, l, r)

insert(x, Fork(y, l, r)) = Fork(y, insert(x, l), r), if x < y

insert(x, Fork(y, l, r)) = _____________________, if x > y
```

Q9. For deleting the value at the root of a tree that has two nonempty subtrees, the following equation was used in the lecture:

```
delete(x, Fork(x, l, r)) = Fork(smallest(r), l, removeSmallest(r))
```

This replaces the value at the root by the smallest value of the right subtree.

One can also replace the value at the root by the largest value of the left. Write the formula for this alternative.

Q10. Consider modifying the algorithms for binary search trees so that multiple copies of values can be inserted. How should the equation for insert be modified?

```
insert(x, Fork(x, l, r) = _______________
```