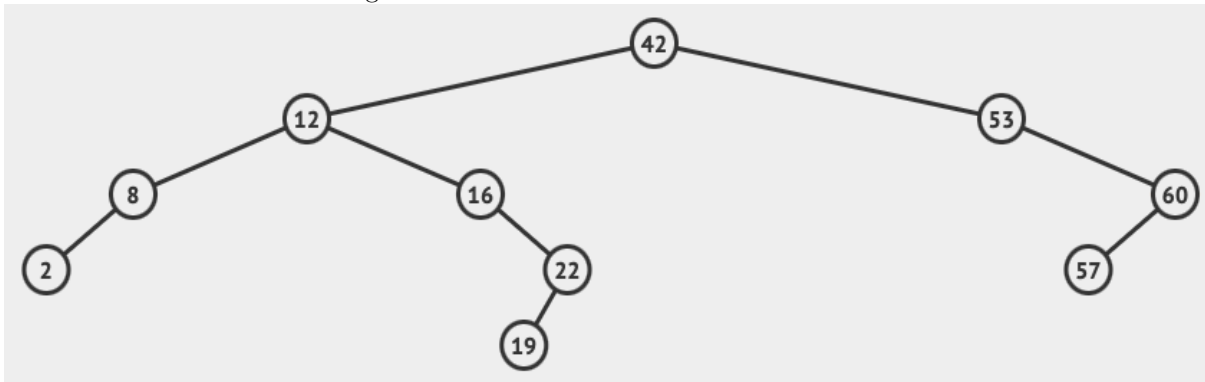# Homework-7

Ali Valiyev

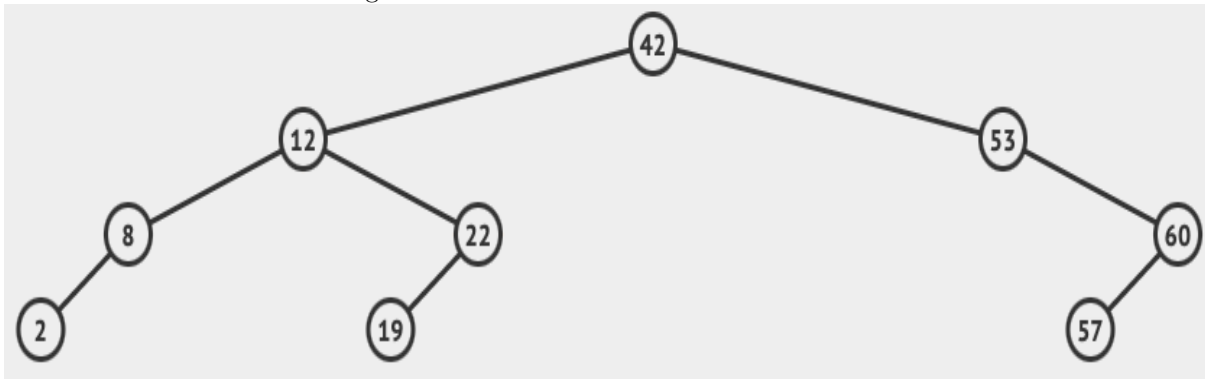December 2021

1   Homework solution

Task 1

Question: For each of the following operation, draw the final state of the binary search tree after the remove operation.
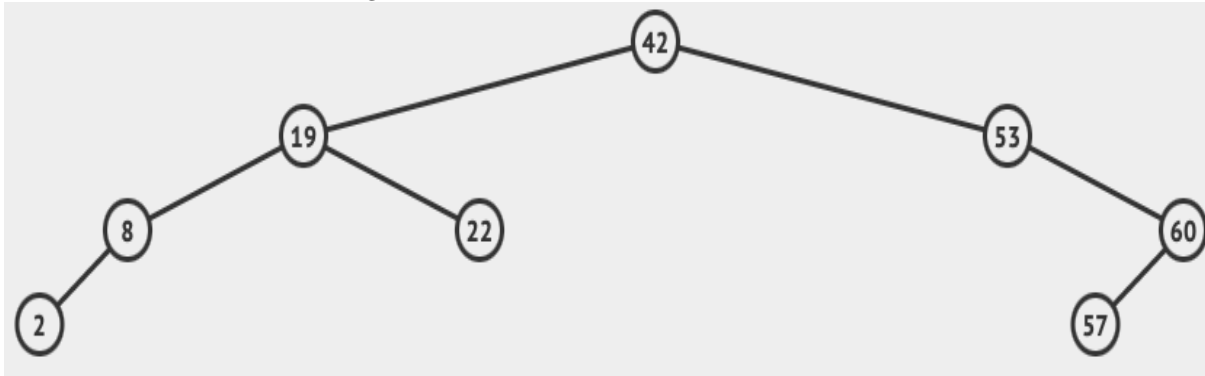
Solution:

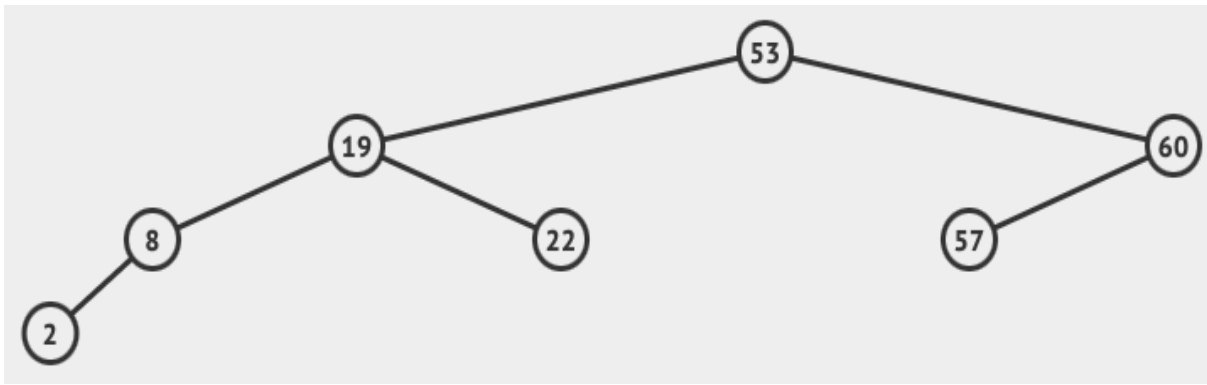- Remove node 65 from the original tree.

- Remove node 16 from the original tree.

- Remove node 12 from the original tree.

- Remove node 42 from the original tree.

Task 2

Question: Write a pseudo code for the before() binary search tree operation.

Solution:

```python
def before(self, p):
    if self.left(p) is not None:
        walk = self.left(p)
        while self.right(walk) is not None:
            walk = self.right(walk)
        return walk
    else:
        walk = p
        ancestor = self.parent(walk)
        while ancestor is not None and walk == self.left(ancestor):
            walk = ancestor
            ancestor = self.parent(walk)
        return ancestor
```
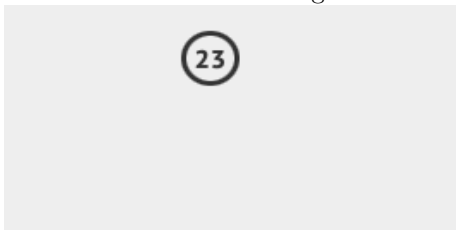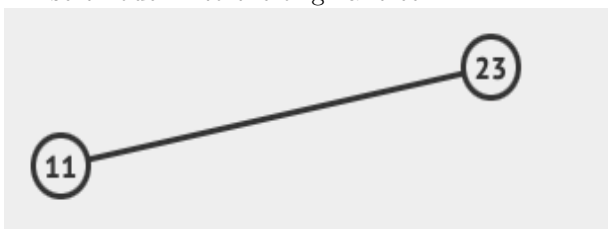
Task 3

Question: Show the results of inserting 23, 11, 48, 57, 90, 34, 69, 72, 78, 82, 81 into an initially empty AVL tree. Show the state of the tree after each insertion.
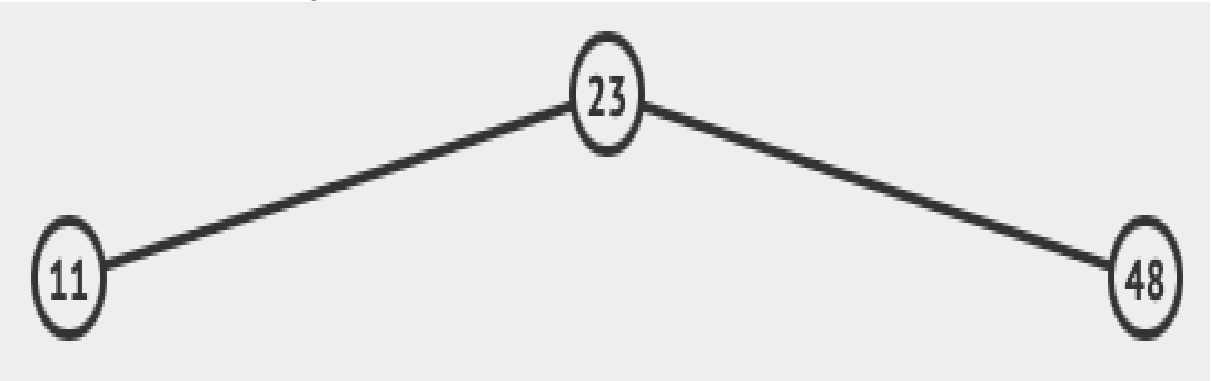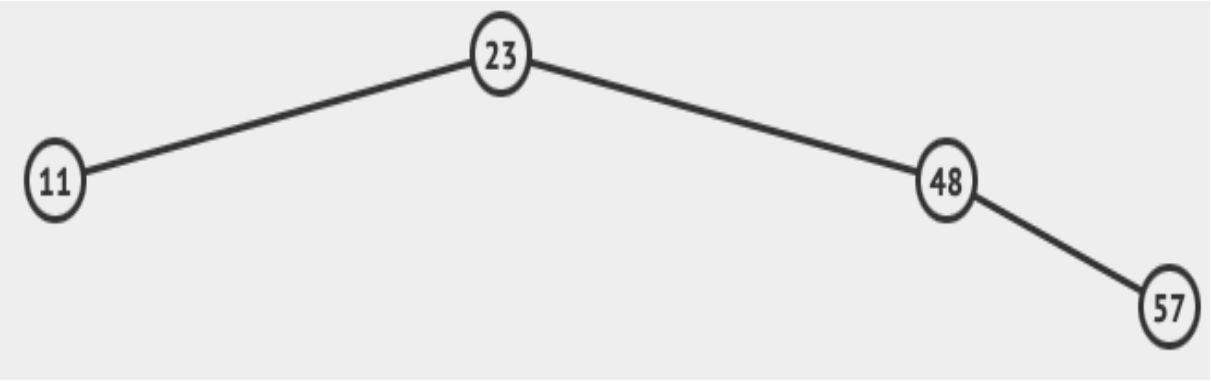
Solution:

• Insert node 23 to the original tree

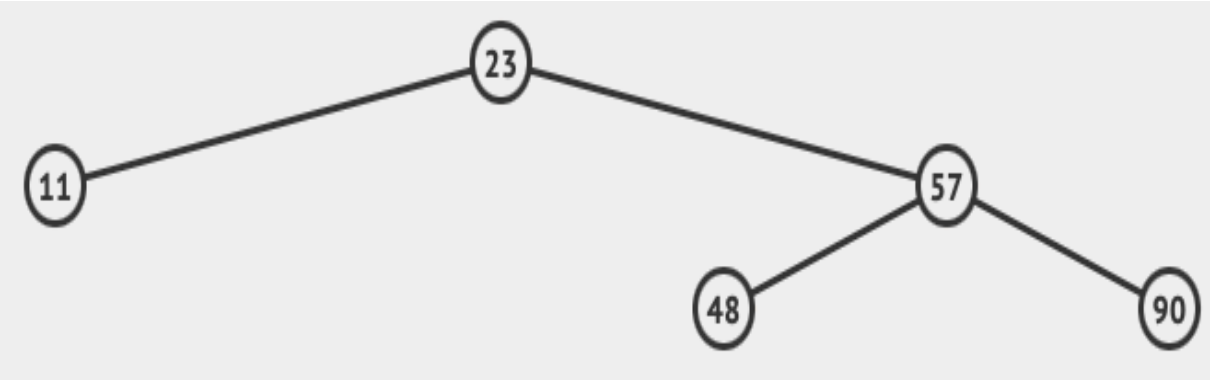• Insert node 11 to the original tree
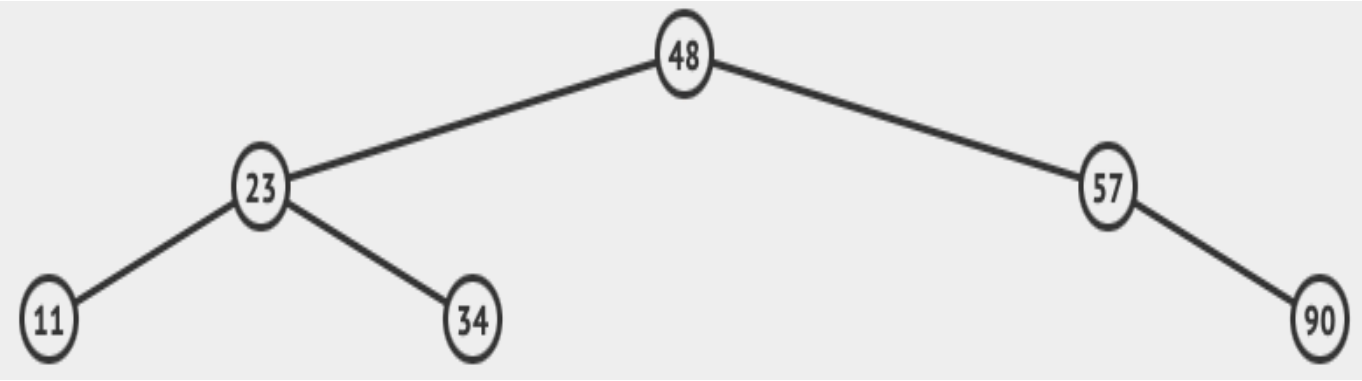
- Insert node 48 to the original tree
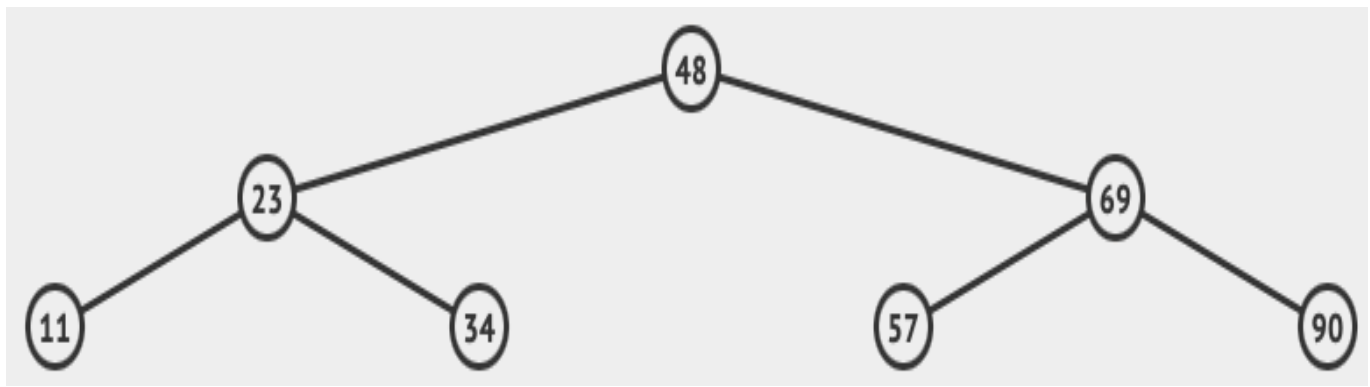

- Insert node 57 to the original tree
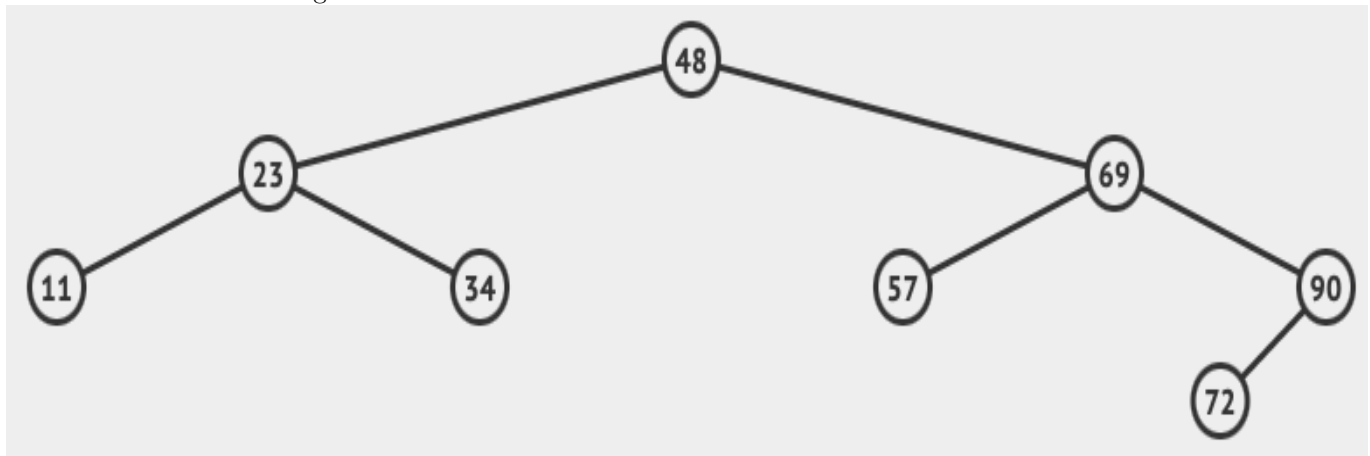

- Insert node 90 to the original tree
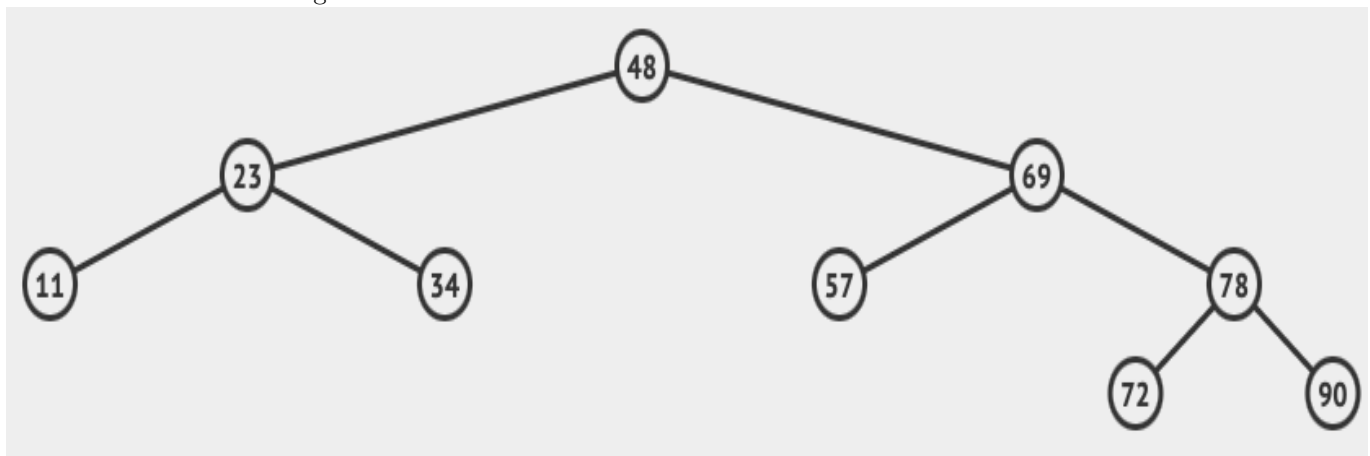

- Insert node 34 to the original tree

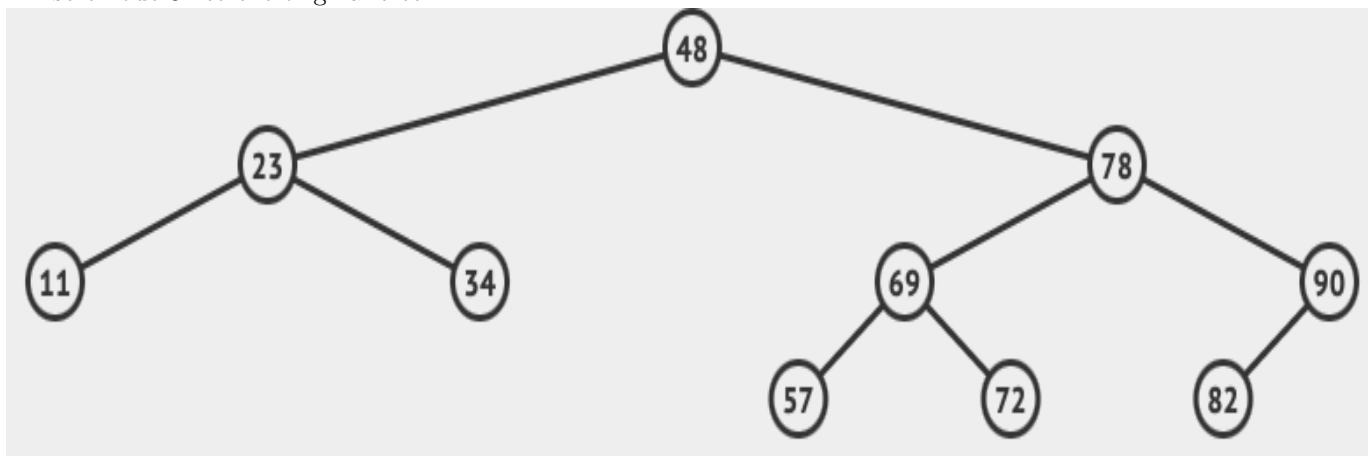- Insert node 69 to the original tree

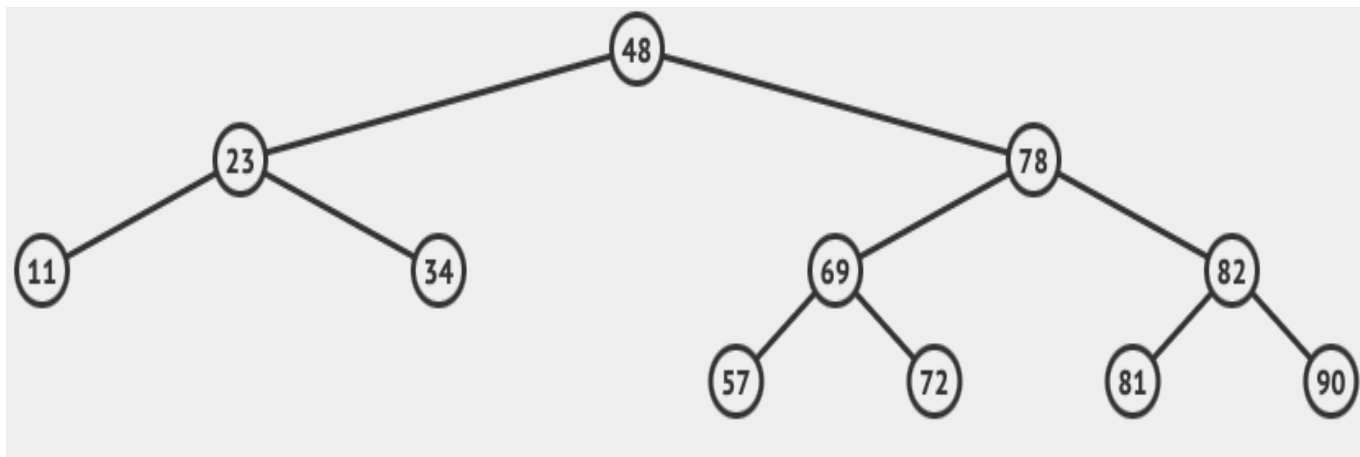- Insert node 72 to the original tree

- Insert node 78 to the original tree

- Insert node 82 to the original tree
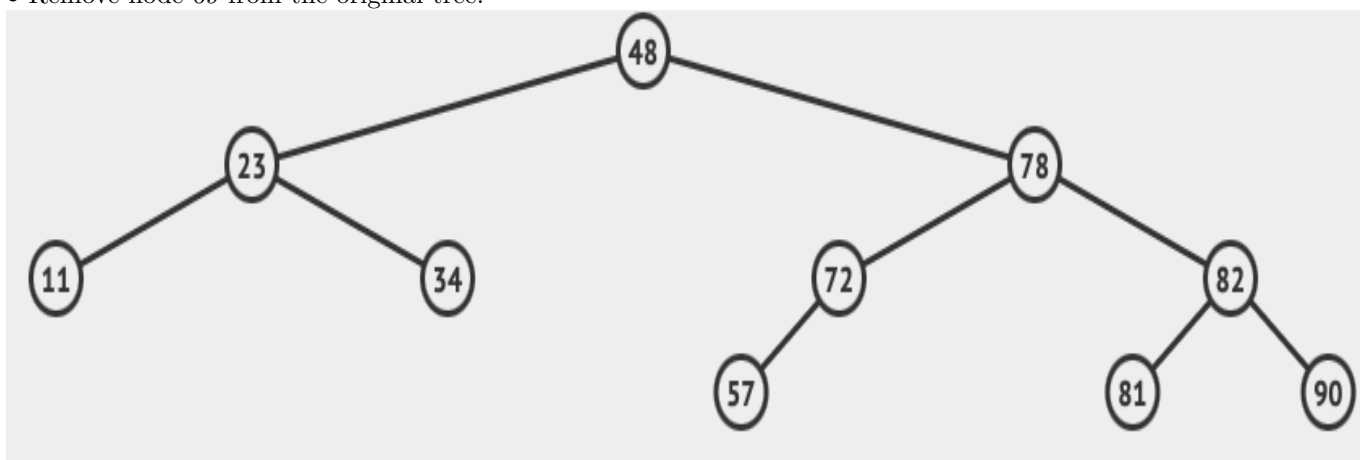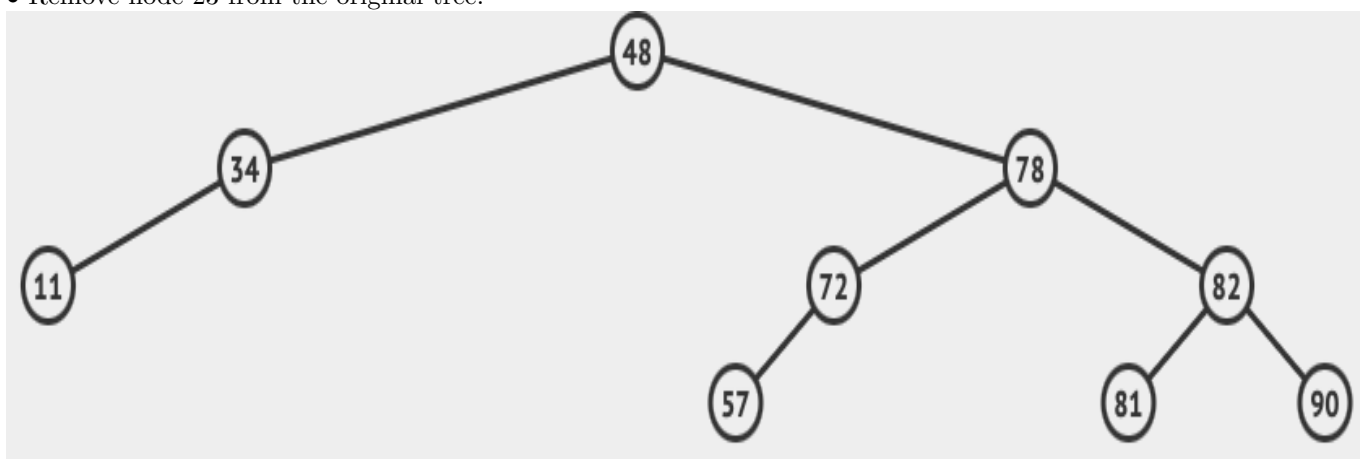

- Insert node 81 to the original tree

Task 4

Question: Show the results of deleting 69, 23, and 11, in this respective order, from the AVL tree that is reached at Task-3. Show the state of the tree after each deletion.
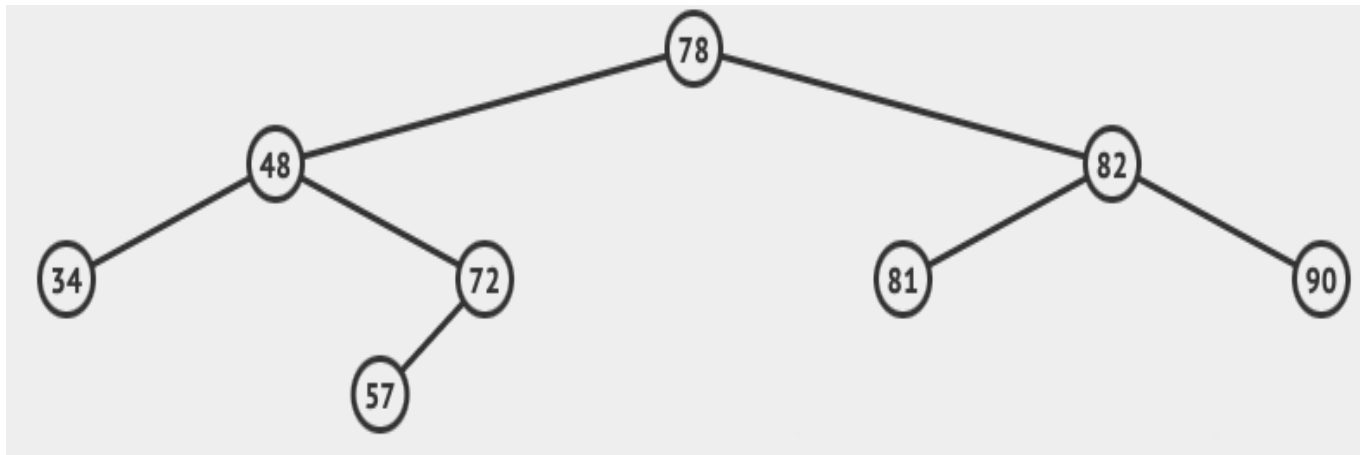
Solution:

• Remove node 69 from the original tree.

• Remove node 23 from the original tree.

• Remove node 11 from the original tree.

Task 5

Question: Show the results of inserting 23, 11, 48, 57, 90, 34, 69, 72, 78, 82, 81, 71, 77, 73, 76, 75, 74 into an initially empty (2,4) tree. Show the state of the tree after each insertion.

Solution:

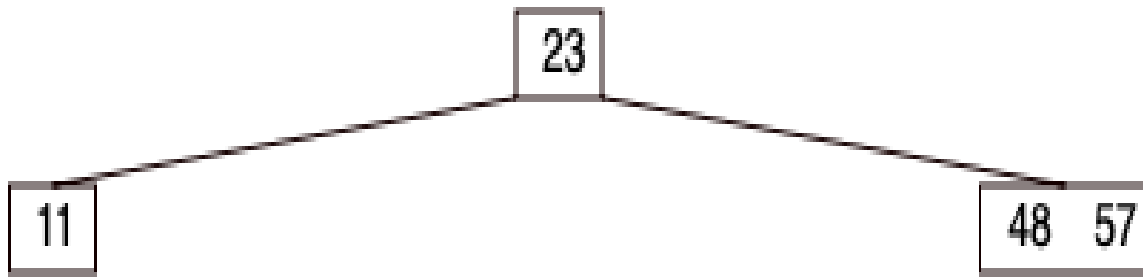• Insert node 23 to the original tree
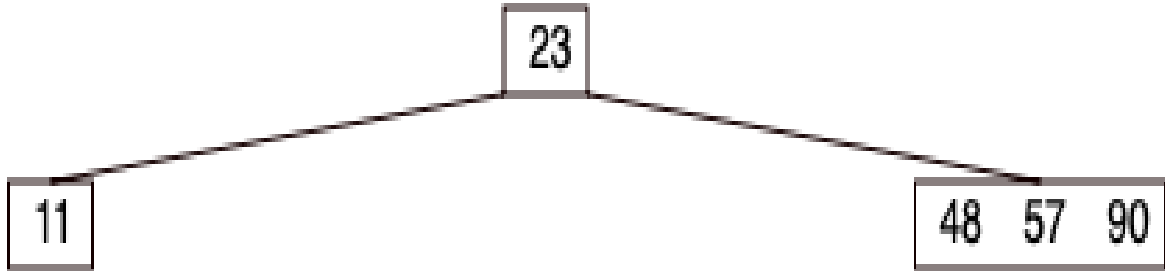

• Insert node 11 to the original tree
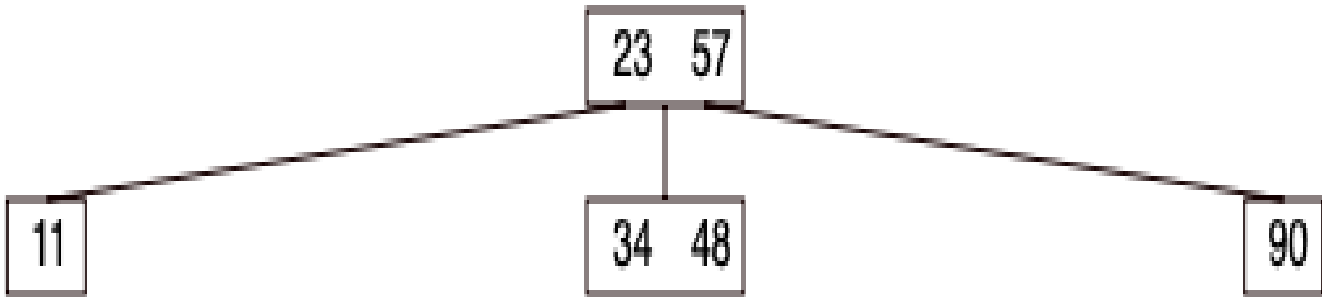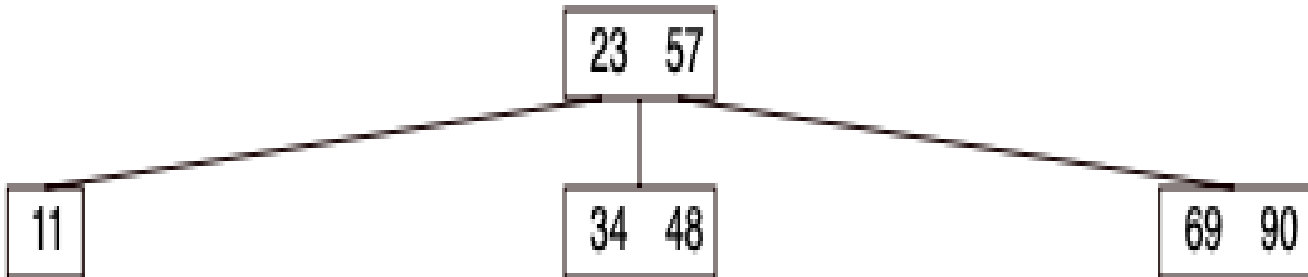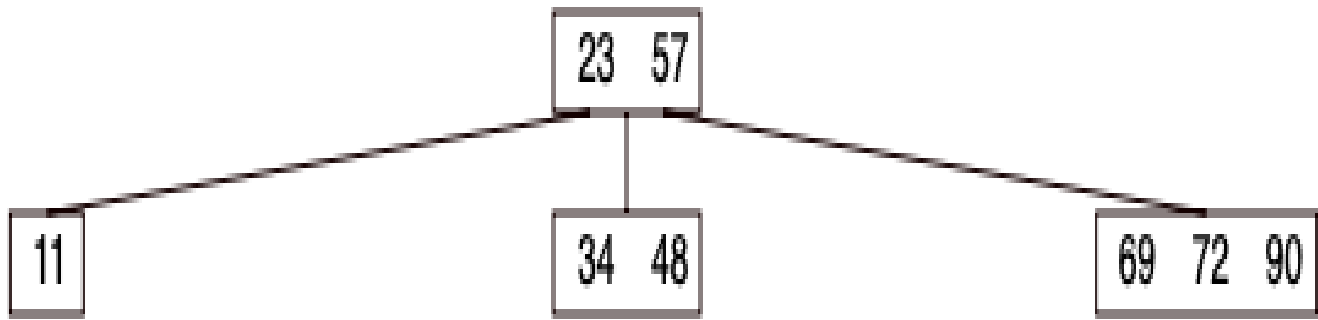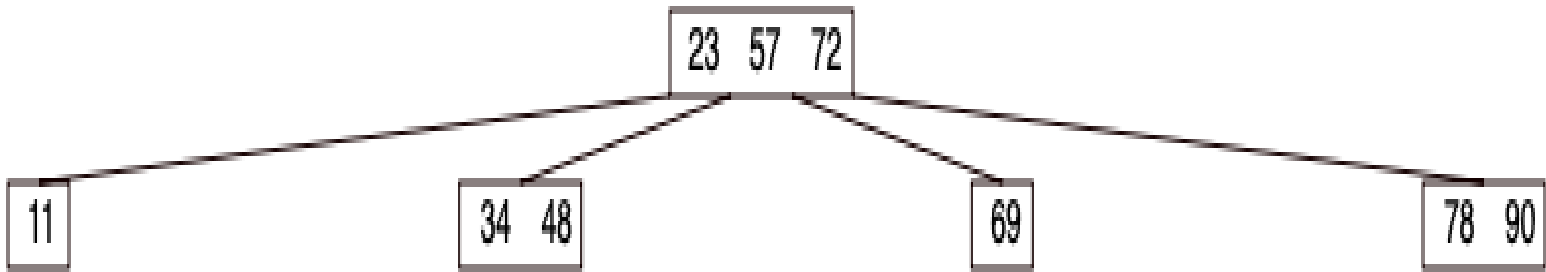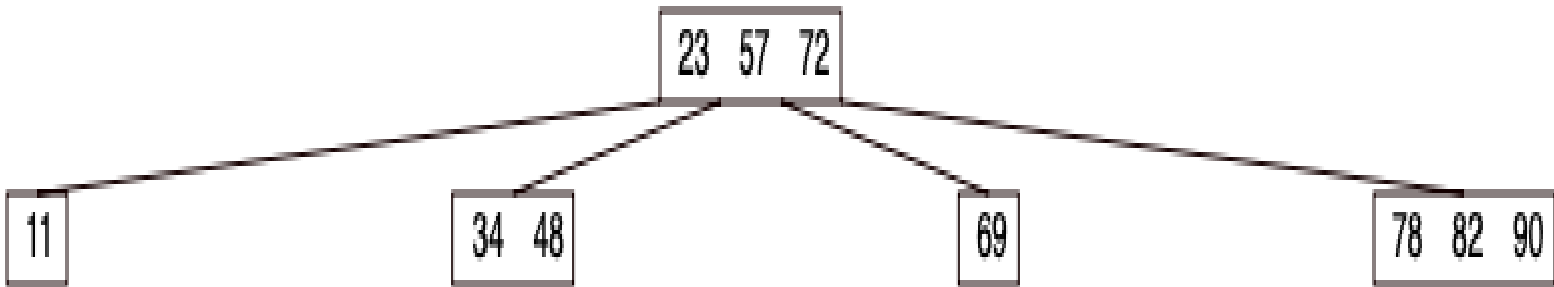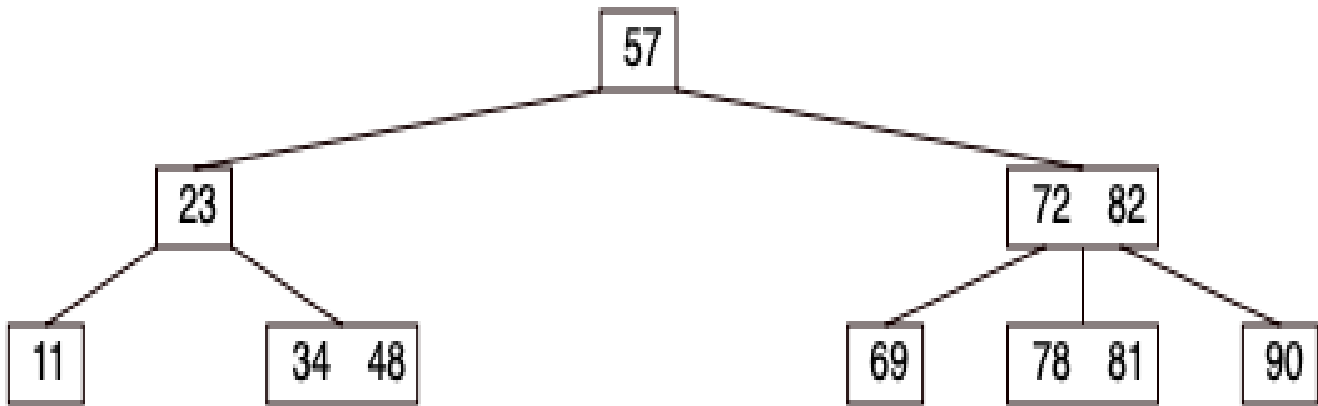

• Insert node 48 to the original tree

• Insert node 57 to the original tree

```
                    ┌────┐
                    │ 23 │
                    └────┘
           ┌────┐          ┌───────┐
           │ 11 │          │ 48  57│
           └────┘          └───────┘
```

• Insert node 90 to the original tree

```
                    ┌────┐
                    │ 23 │
                    └────┘
           ┌────┐          ┌──────────┐
           │ 11 │          │ 48  57  90│
           └────┘          └──────────┘
```

• Insert node 34 to the original tree

```
                    ┌───────┐
                    │ 23  57│
                    └───────┘
       ┌────┐     ┌───────┐      ┌────┐
       │ 11 │     │ 34  48│      │ 90 │
       └────┘     └───────┘      └────┘
```

• Insert node 69 to the original tree

```
                    ┌───────┐
                    │ 23  57│
                    └───────┘
       ┌────┐     ┌───────┐      ┌───────┐
       │ 11 │     │ 34  48│      │ 69  90│
       └────┘     └───────┘      └───────┘
```

• Insert node 72 to the original tree

23 57

11   34 48   69 72 90

• Insert node 78 to the original tree

23 57 72

11   34 48   69   78 90

• Insert node 82 to the original tree

23 57 72

11   34 48   69   78 82 90

• Insert node 81 to the original tree

57

23   72 82

11   34 48   69   78 81   90

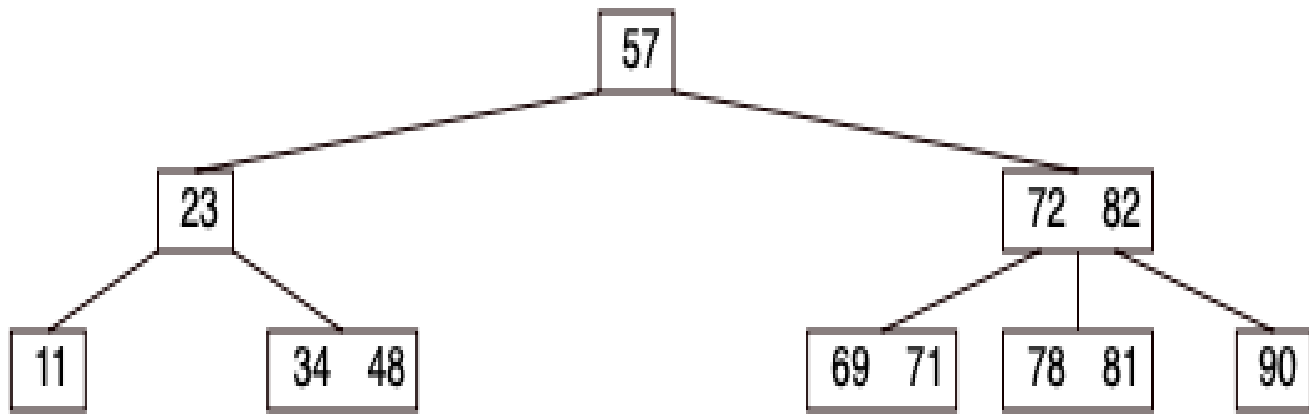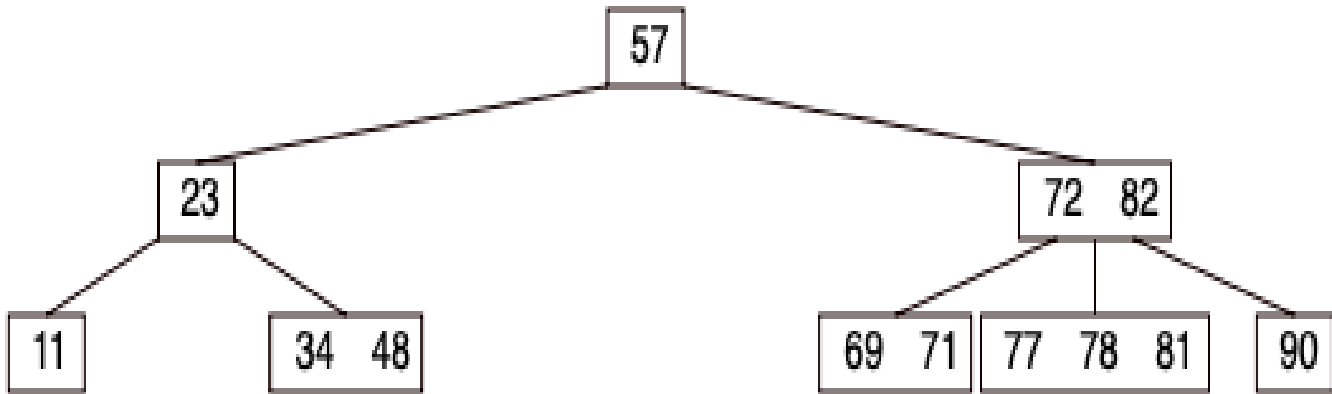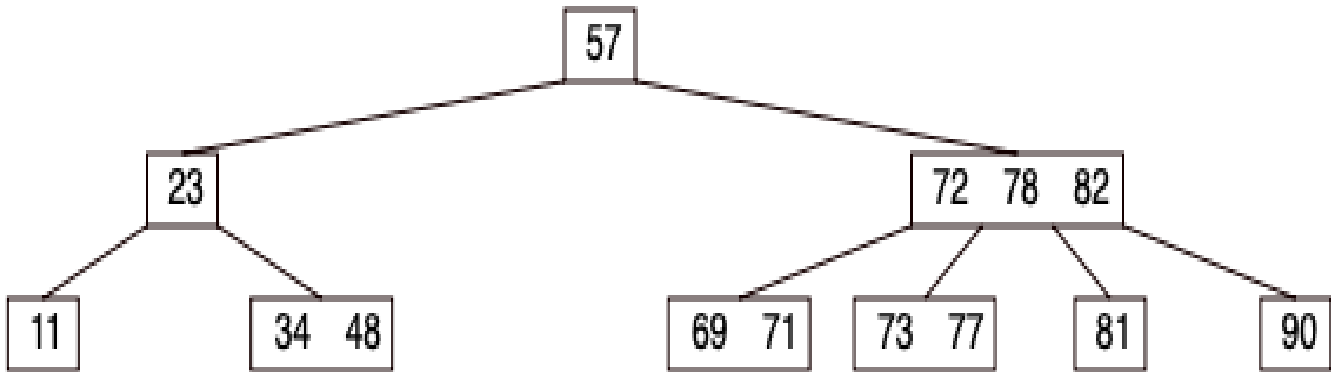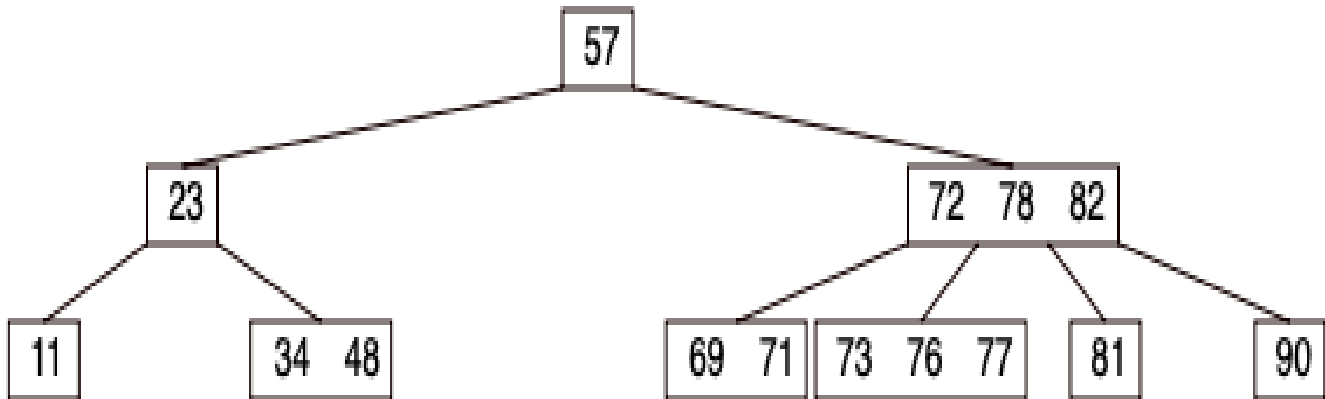• Insert node 71 to the original tree
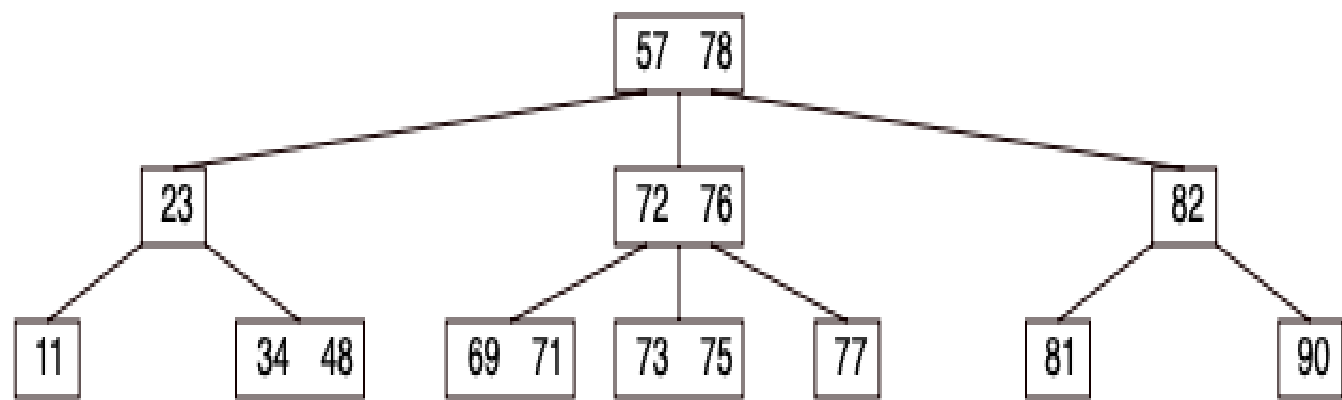
- Insert node 77 to the original tree

- Insert node 73 to the original tree

- Insert node 76 to the original tree

- Insert node 75 to the original tree

- Insert node 74 to the original tree