Each leaf node's height is 0
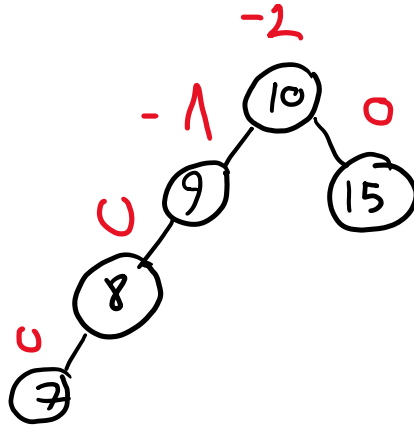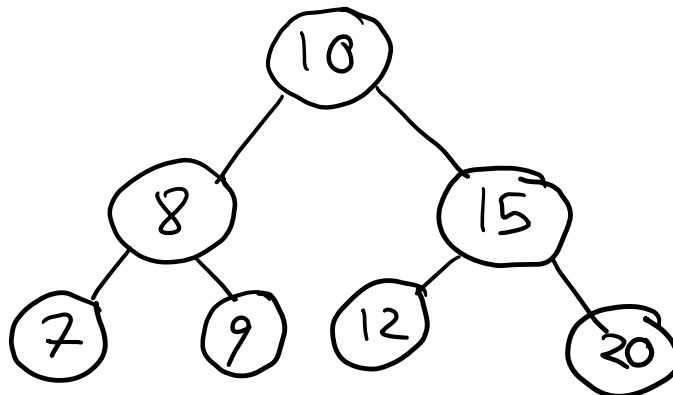*Balance factor calculation formula: rightSubTree's height – leftSubTree's height*

      i. Write the balance factors of each node in the tree shown below.

-2

-1 (10) 0

∪ (9)   (15)

(8)

∪

(7)
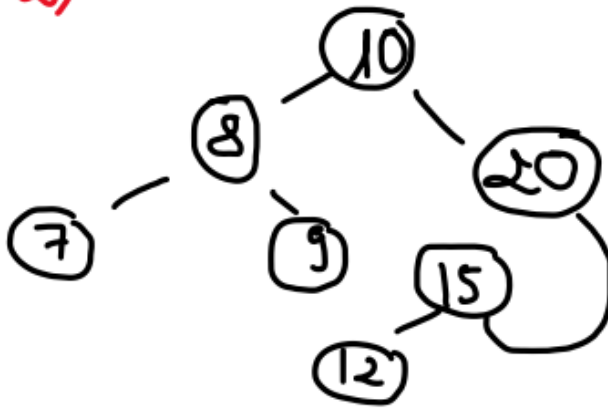
     ii. Rotate the sub-tree rooted at node containing 15 to the left by 1 in the tree shown below. Draw trees to show intermediate steps.

1)

(10)

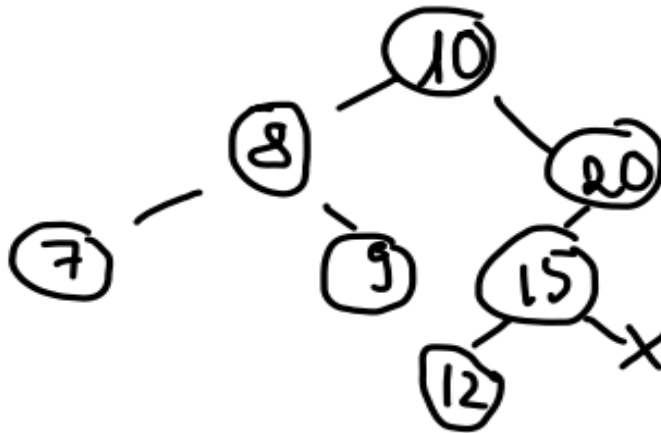(8)   (15)
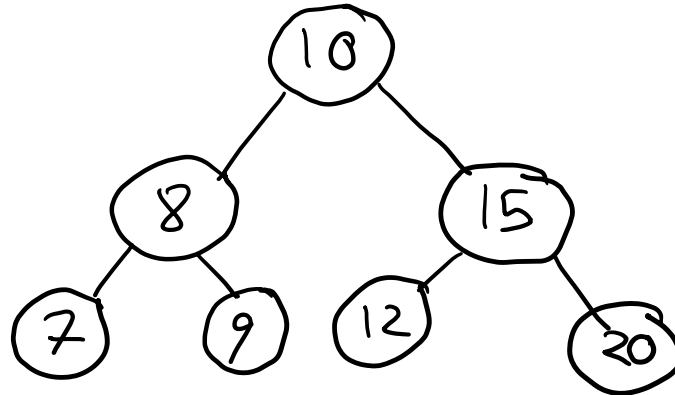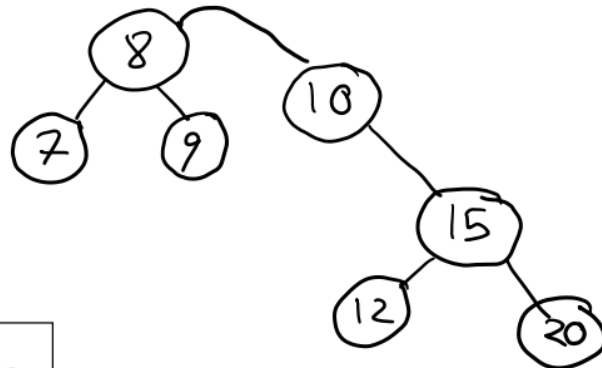
(7) (9) (12)   (20)

2)

15->right is still 20.

3)

iii. Rotate the sub-tree rooted at node containing 10 to the right by 1 in the tree shown below. Draw trees to show intermediate steps.
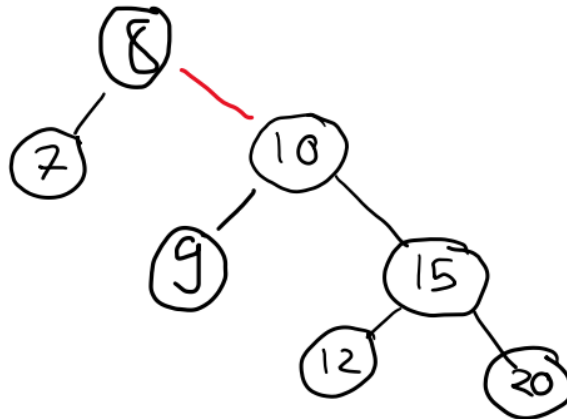
1)

```
              10
            /    \
           8      15
          / \    /  \
         7   9  12   20
```

2)

```
        8          
       / \    10
      7   9     \
               15
              /  \
            12    20
```

Node 8 is the root now.
Node 10-left at the moment is still 8

3)

```
        8
       / \
      7   10
         /  \
        9    15
            /  \
          12    20
```
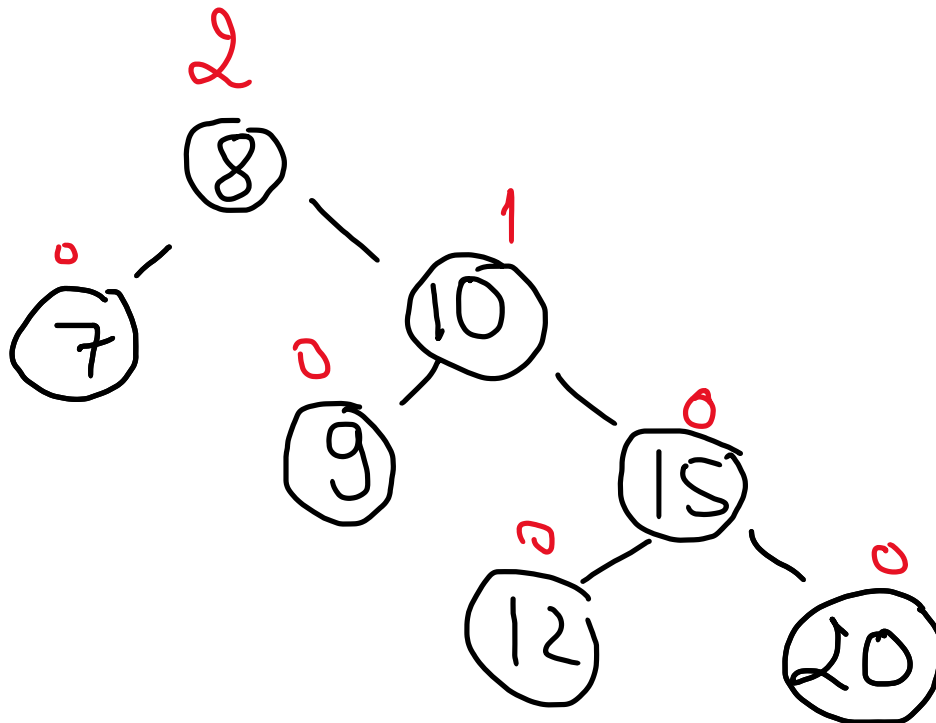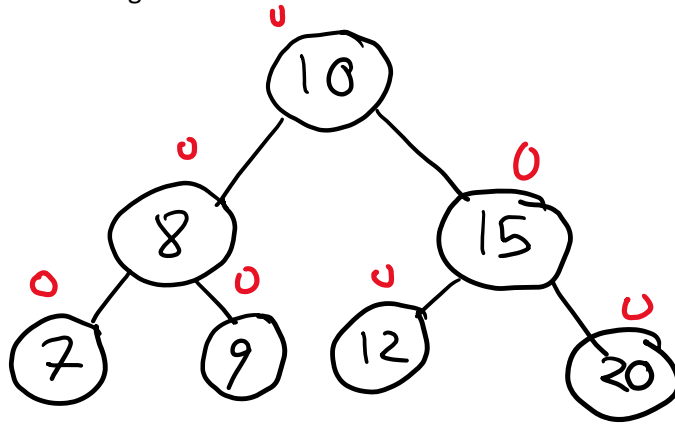
Node 10-left links to node8-right.
node8-right now links to 10.

2. AVL Tree analysis
   a. Convert the following bst into one that has an RR imbalance.
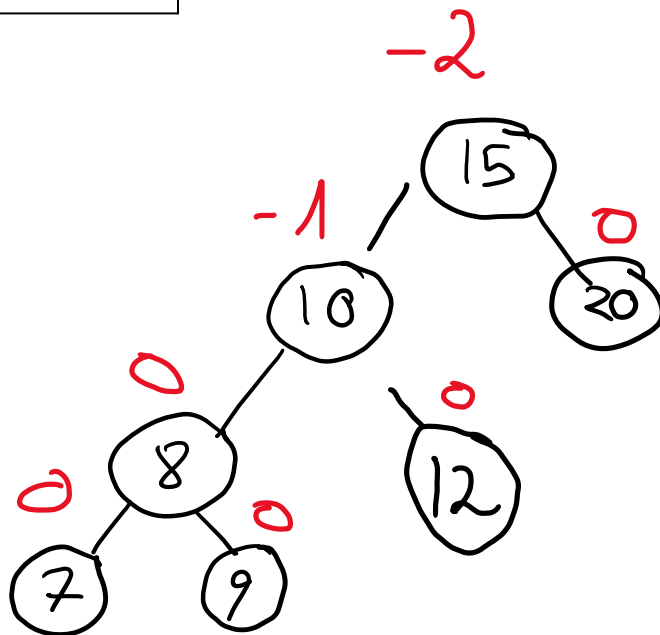
10
8   15
7 9 12 20

2
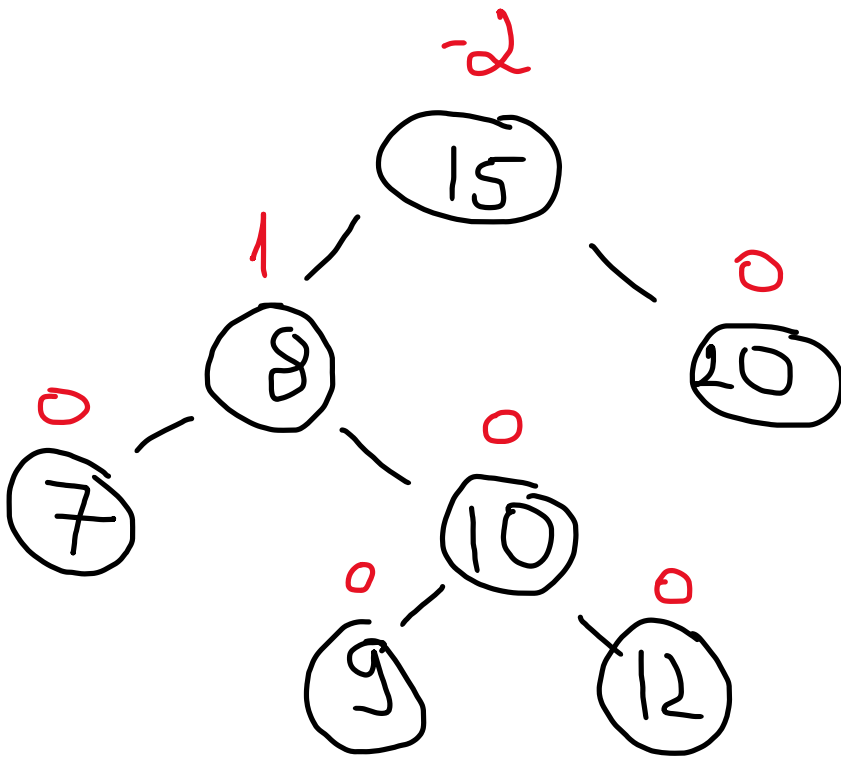8
7
10
9
15
12 20

Right rotate node 10

→ RR imbalance at 8

b. Convert the following bst into one that has an LR imbalance.
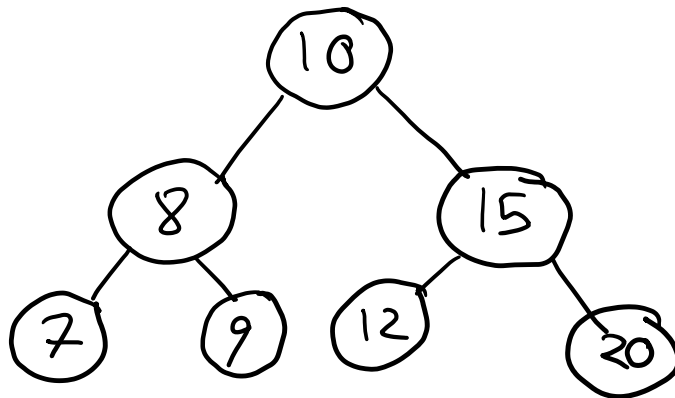
Left rotate at 10, then a right rotate at 10
→ LR imbalance at 15

$\Rightarrow$

=>

-2
15

1
8

0
20

0
7

0
10

0
9

0
12

c. What type of imbalance does the bst shown below have at node containing 15? Give reasoning using balance factors.
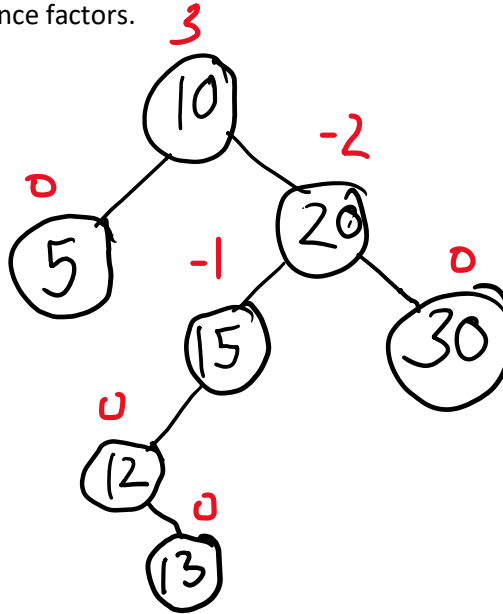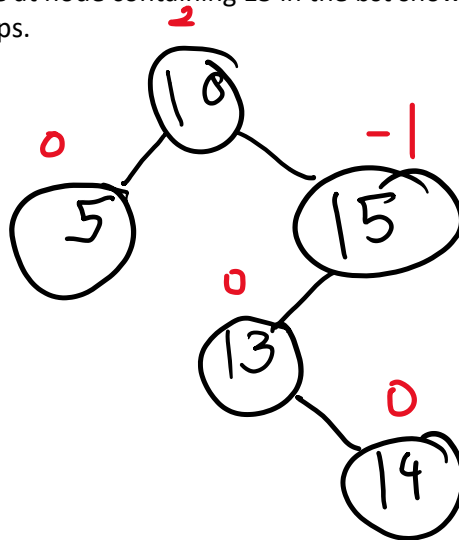

At 15, it's LR imbalance since:
BF(15) == -2
BF(15->left) = BF(12) = 1

d. Fix the imbalance at node containing 15 in the bst shown below. Draw trees to show intermediate steps.

At 15 → LR imbalance.
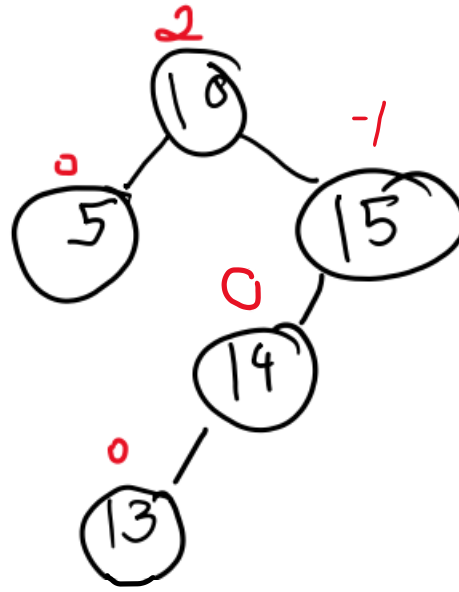
→ 1 left rotation at 13
→ 1 right rotation at 15

1)

Left rotation at 13:
15->left to 13->right which is 14
13->right to 14->left which is nullptr
14->left to 13

Right rotation at 15:
10->right now links to 14
15->left links to 14->right (nullptr)
14->right links to 15

2)