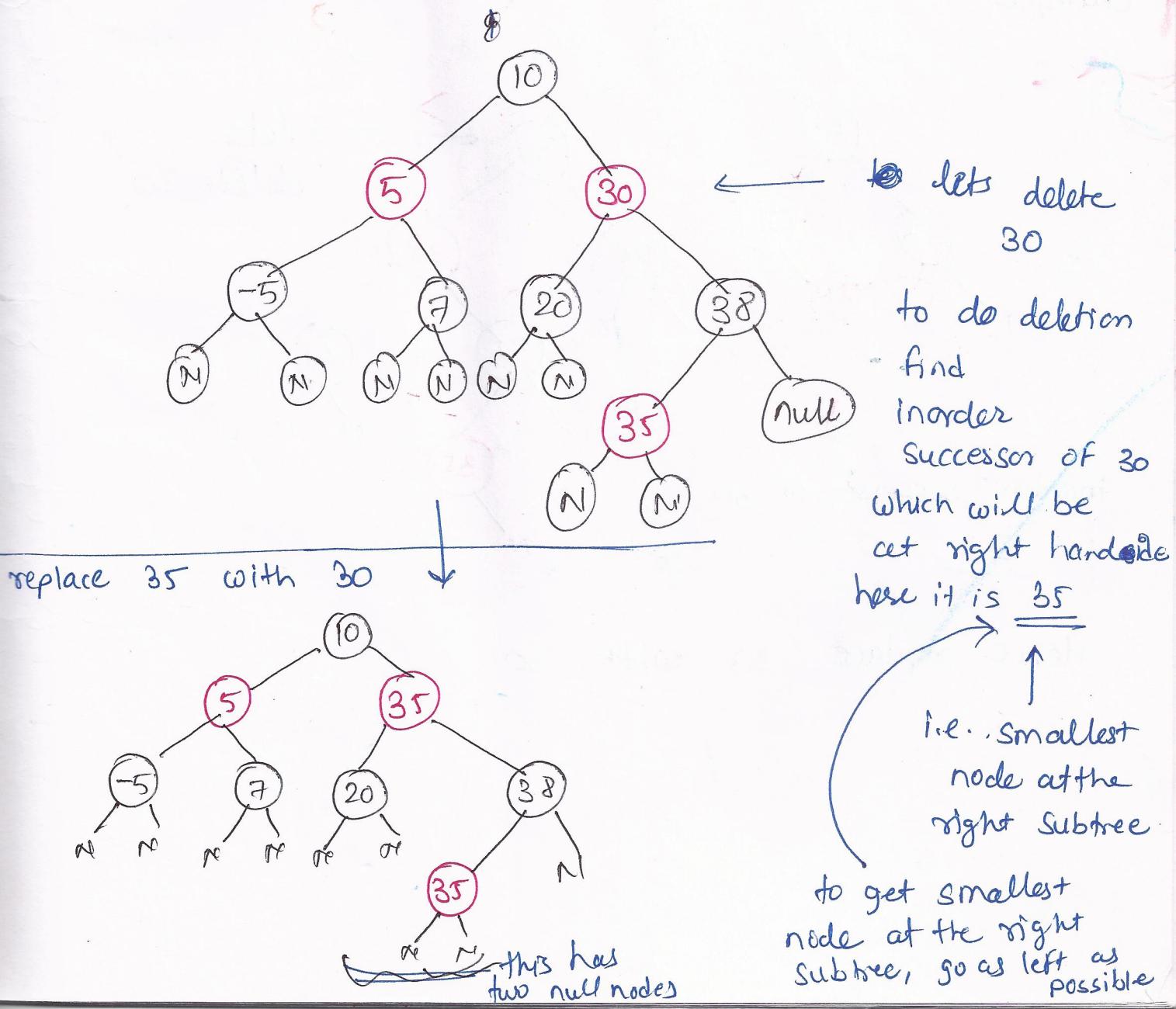


Red Black tree deletion

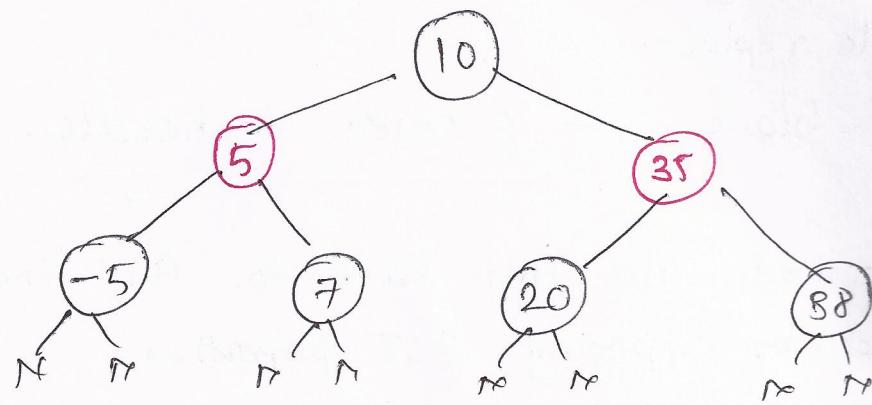
- ① Convert to 0 or 1 child case
- ② if node to be deleted is red or child is red
then do replace
- ③ Double black :- 6 cases to handle

} to delete a node we first have to find the node to be deleted by applying BST properties
if node to be deleted is having two not Null childs
then convert to 0 or 1 child case

Examples

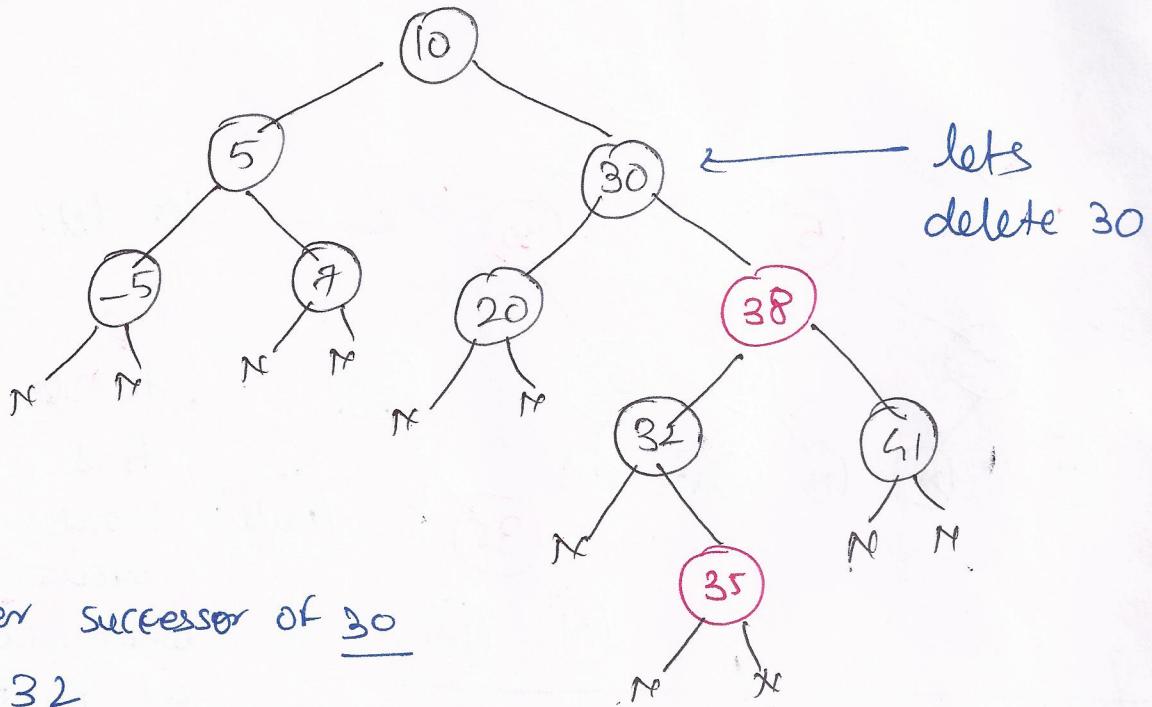


Since is above example 35 has two null nodes and it is red in color simply delete ~~it~~ it.

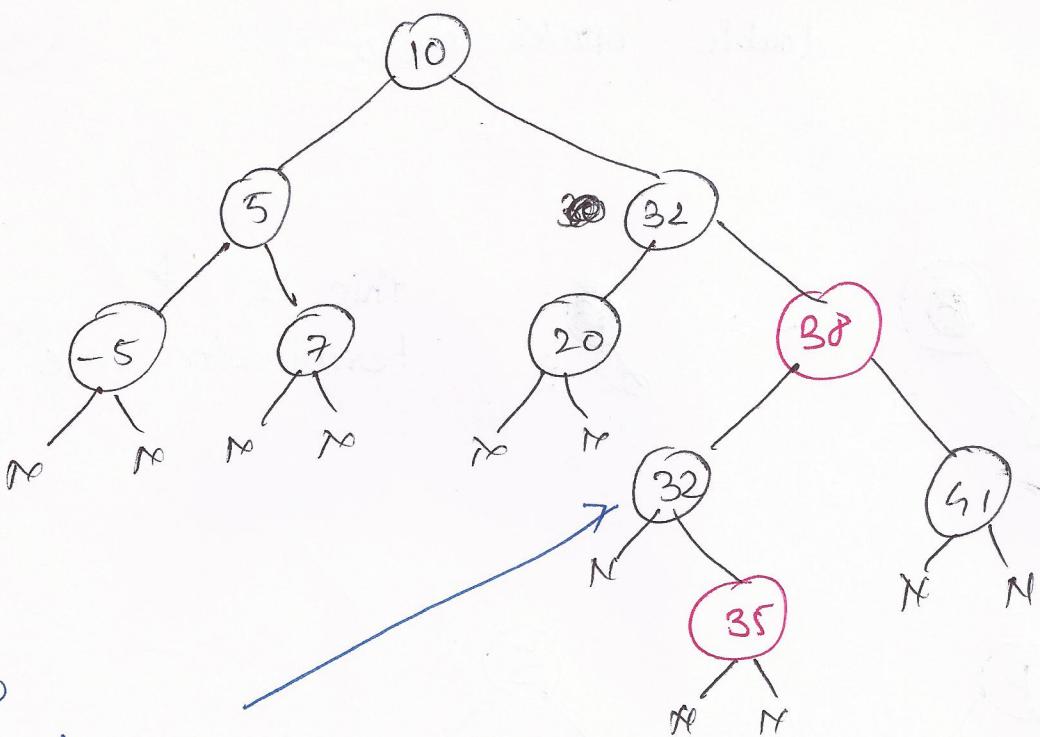


- ③ if black node with red child then delete black & turn red into black node

example



Hence replace 32 with 30

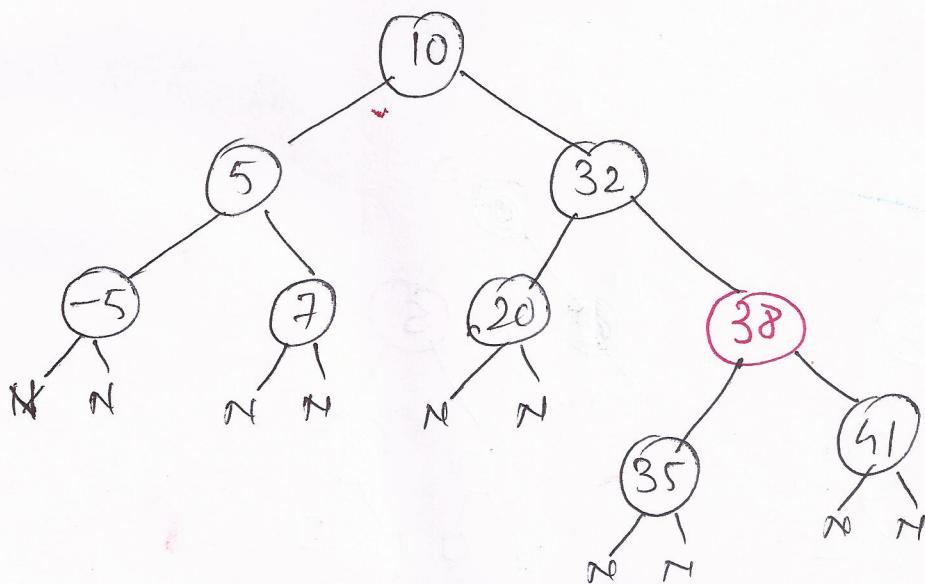


Now

we need to remove
this node

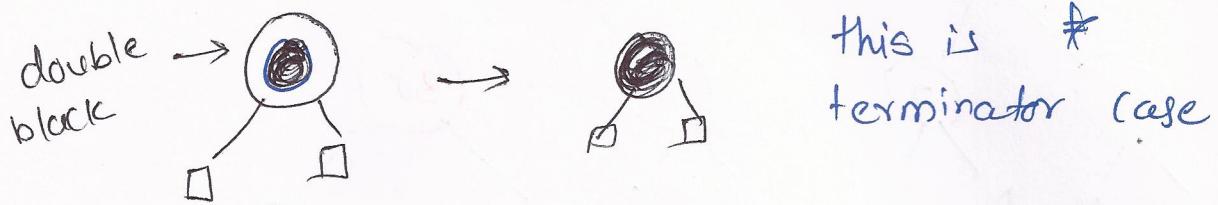
it is black & has one red child 35

∴ replace the 35 ~~to~~ with 32 & change its color

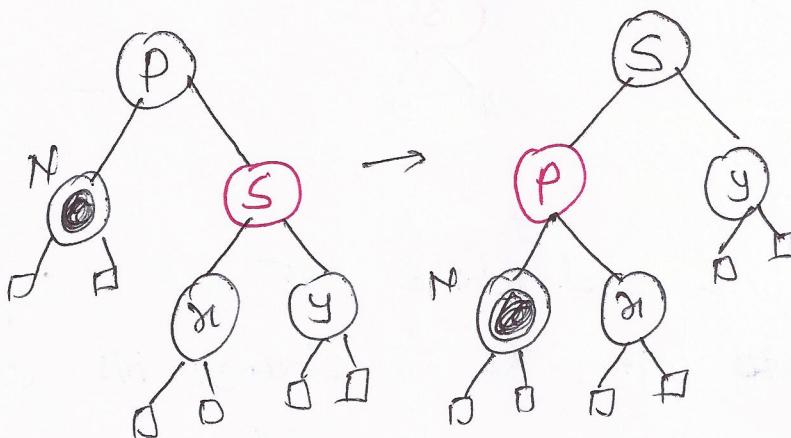


double black cases

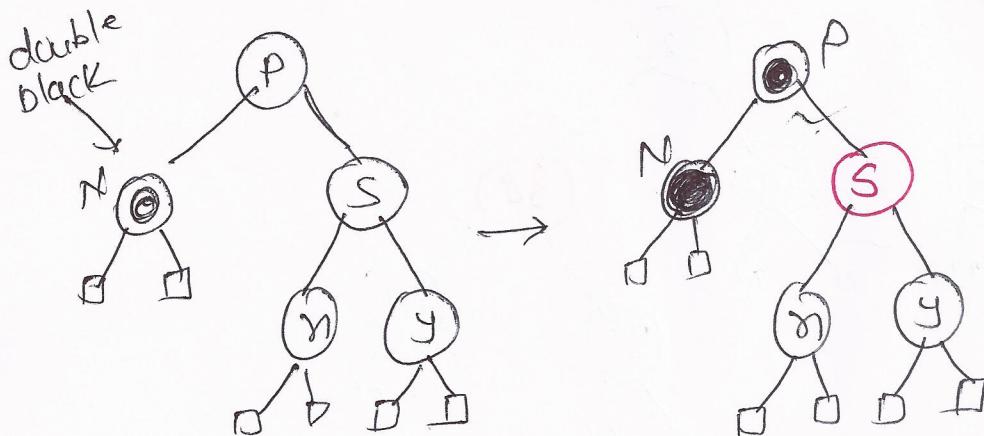
Case 1



Case 2



Case 3



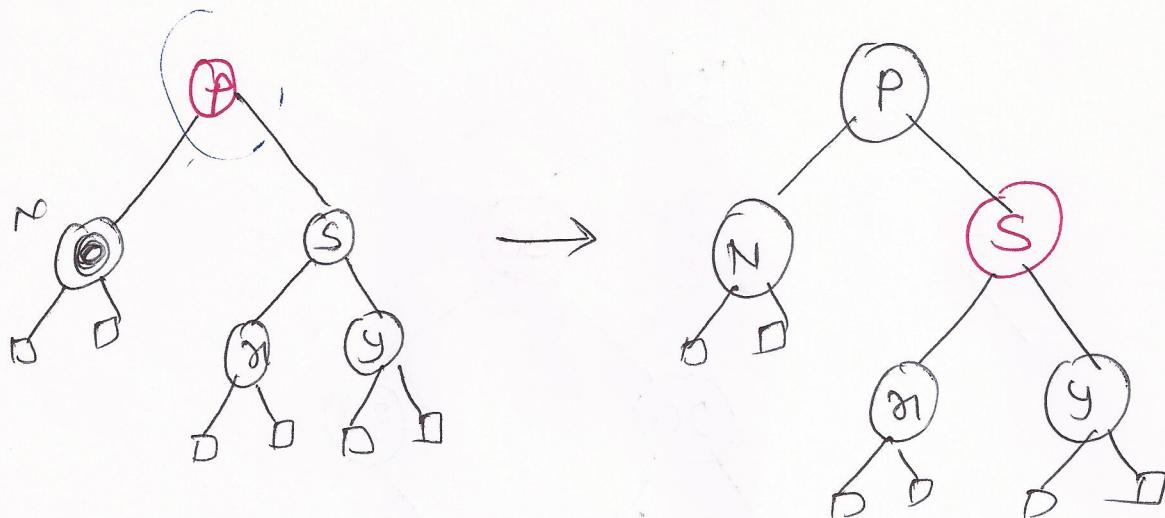
Note :-

case 2, 3, 4 and 5, 6 also has the
minor cases

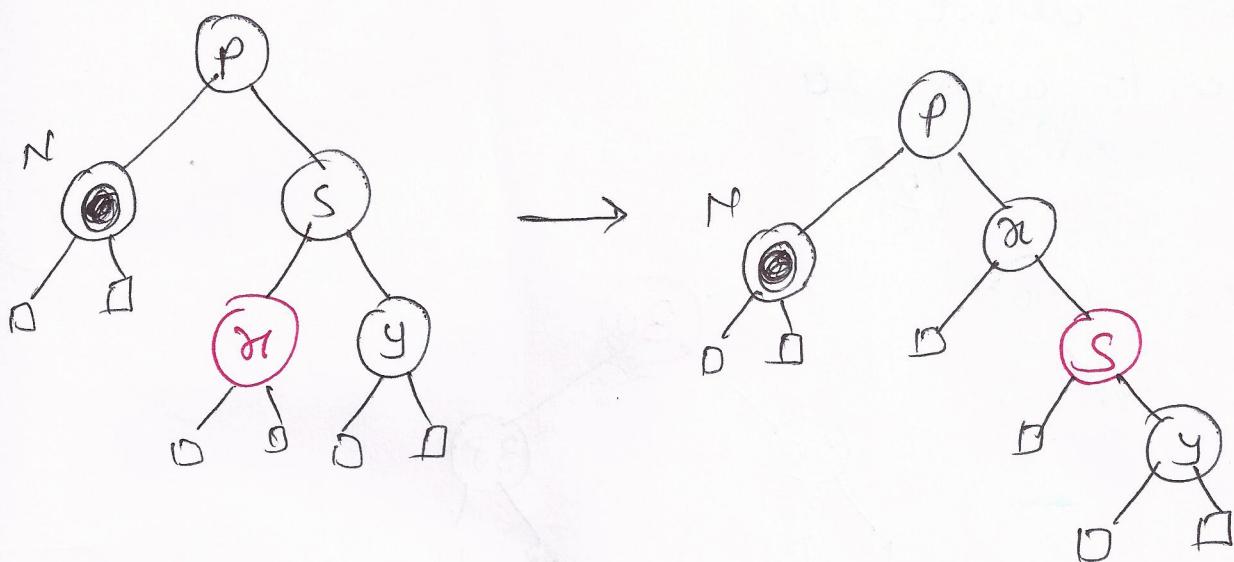
case ④

this is terminator case

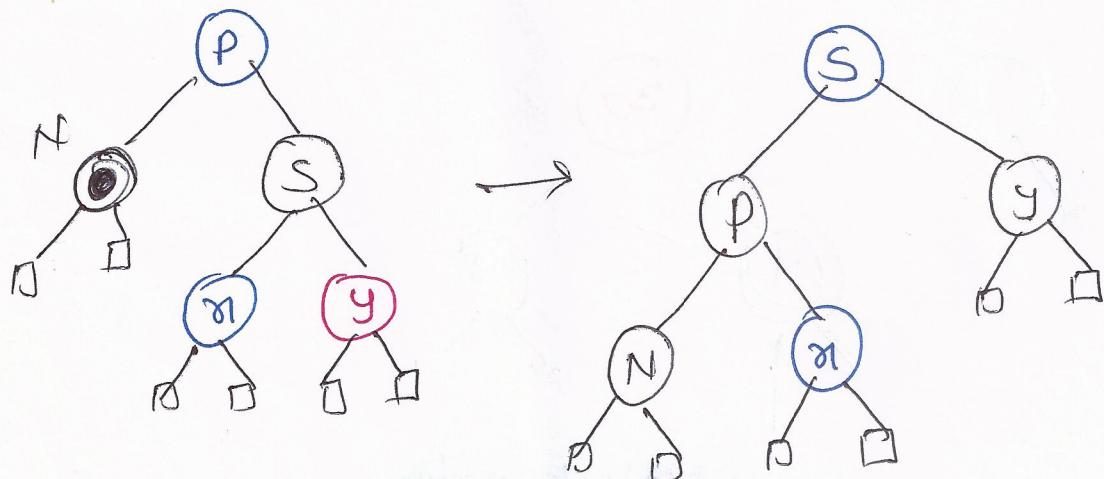
*



case ⑤

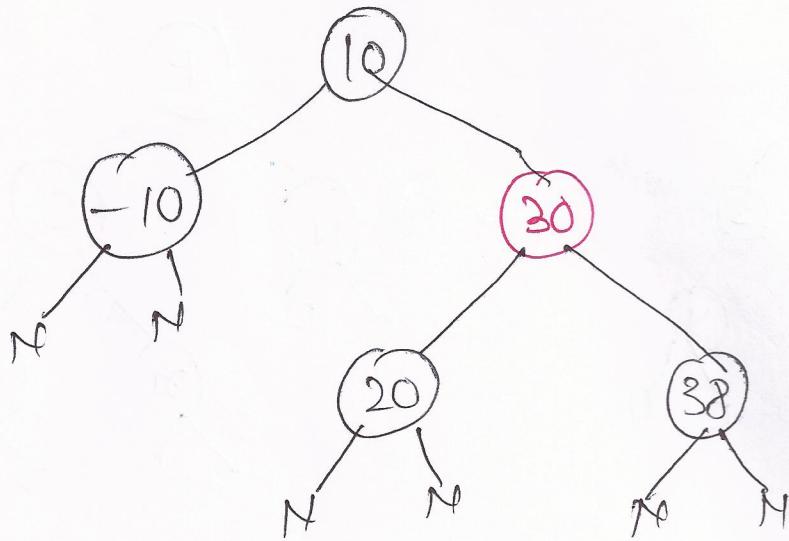


case ⑥ this is terminator case *

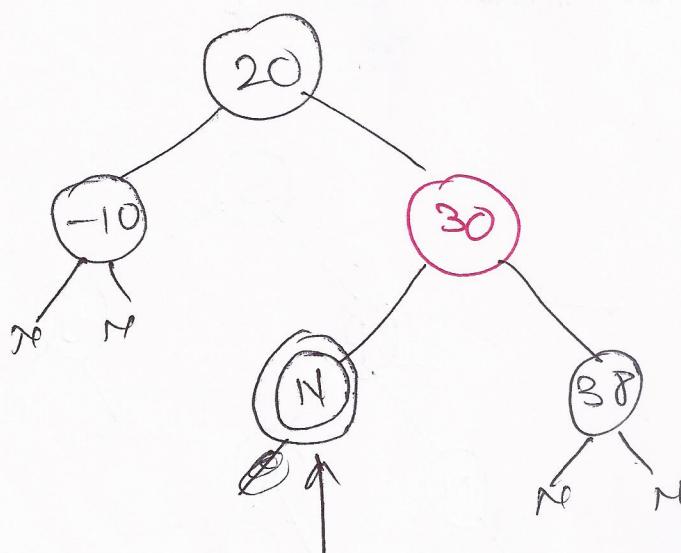
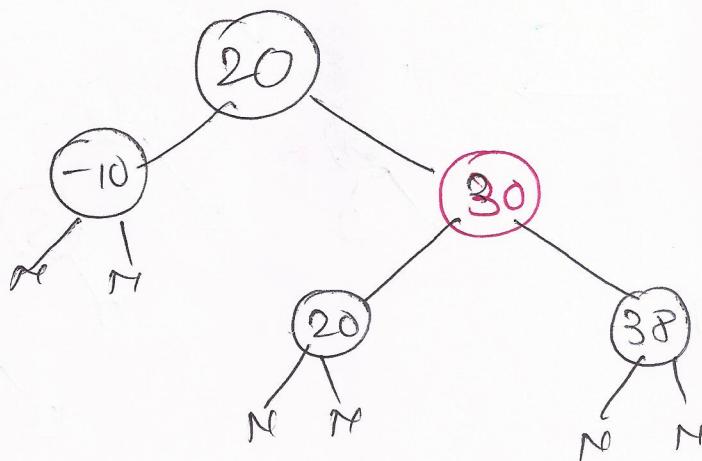


∴ Blue color indicates that node is either red or black it does not makes any difference.

what is double black

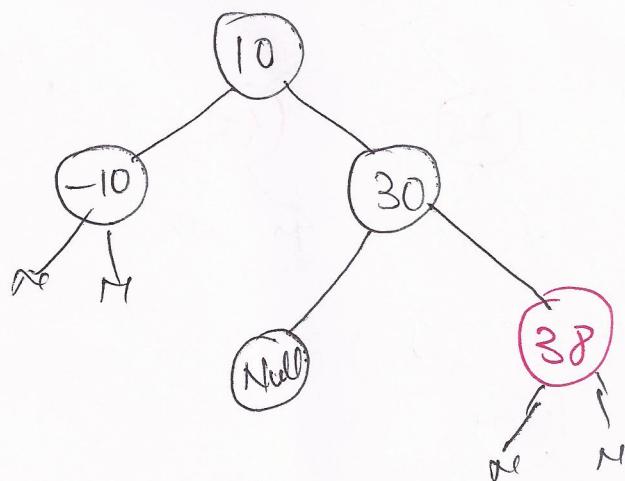
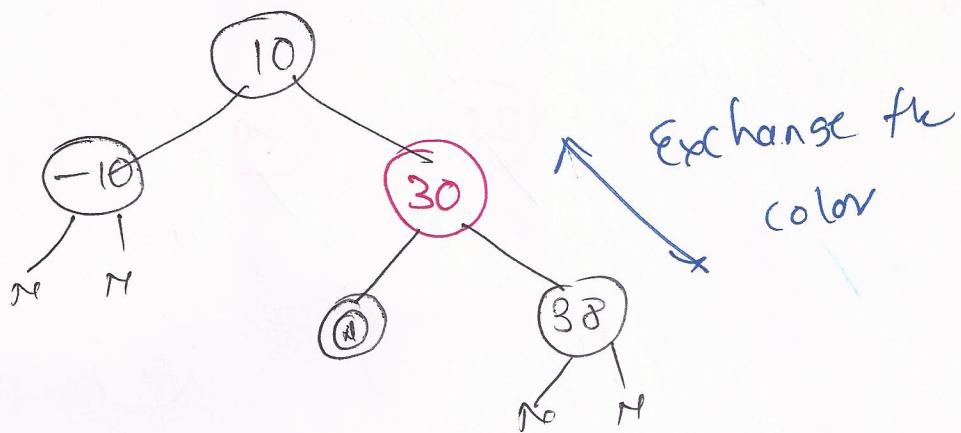
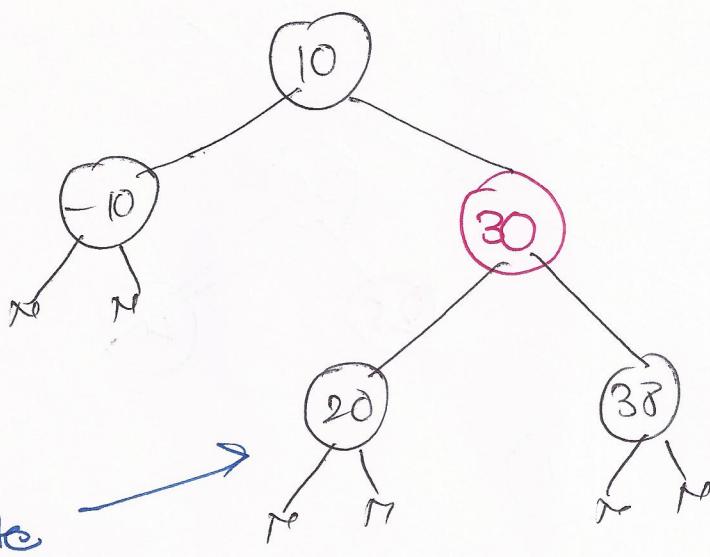


lets delete 10
replace 10 with 20

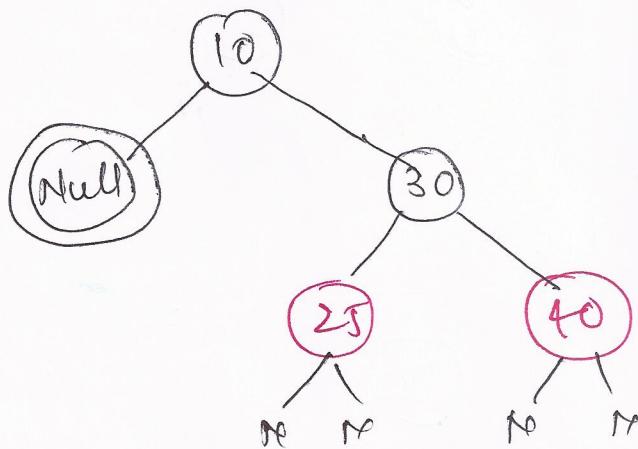
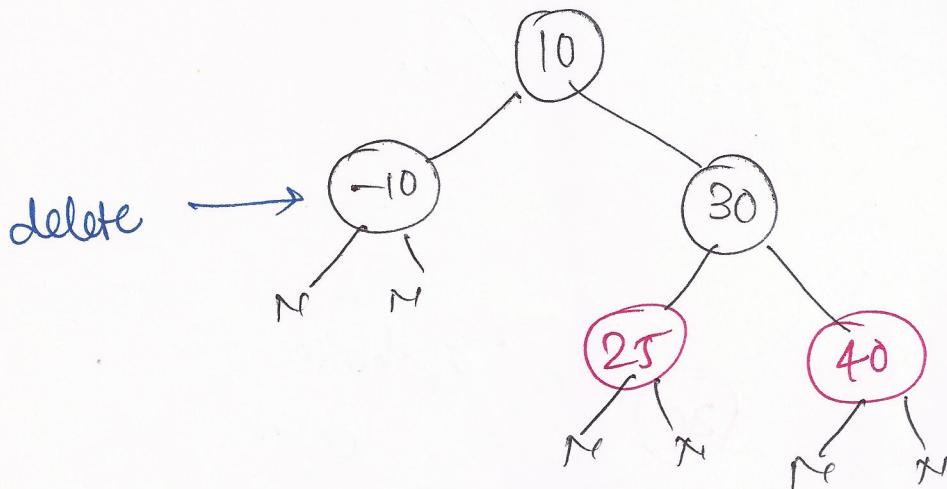
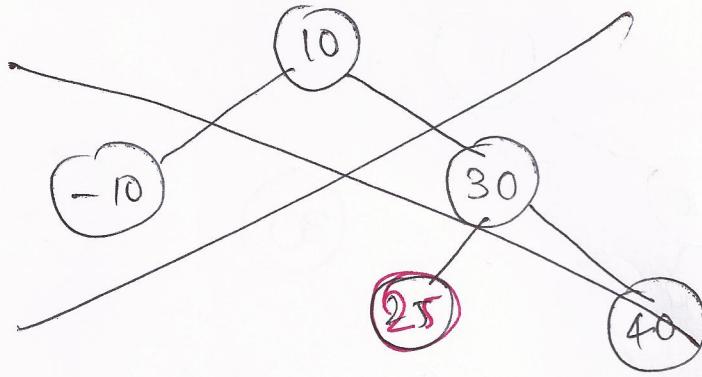


this / double black node

Case 5

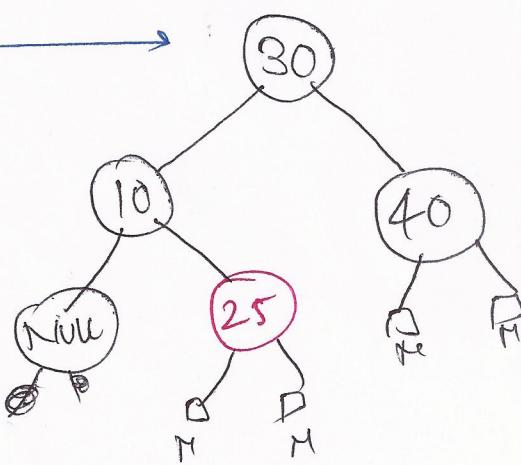


case 6

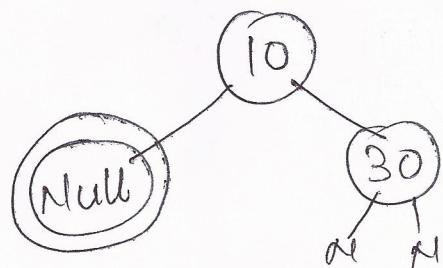
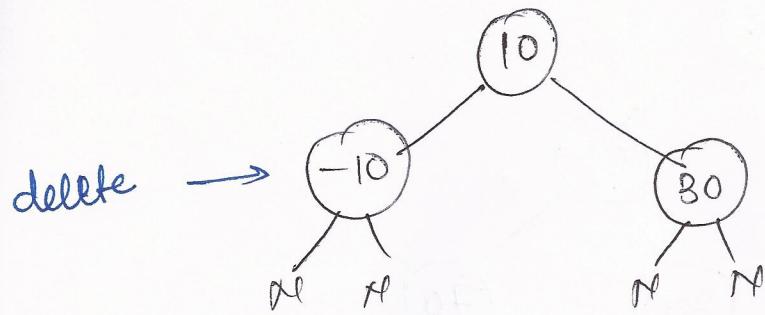


left rotation and recoloring

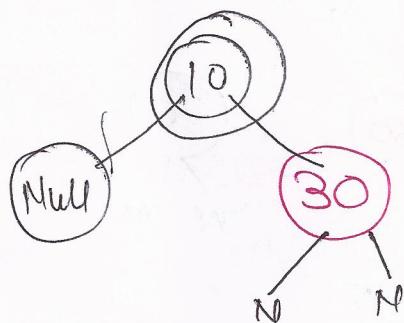
30 will take the color of 10
10 will become black



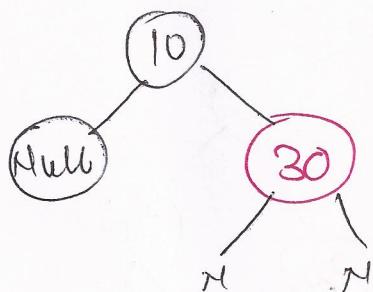
Case 3



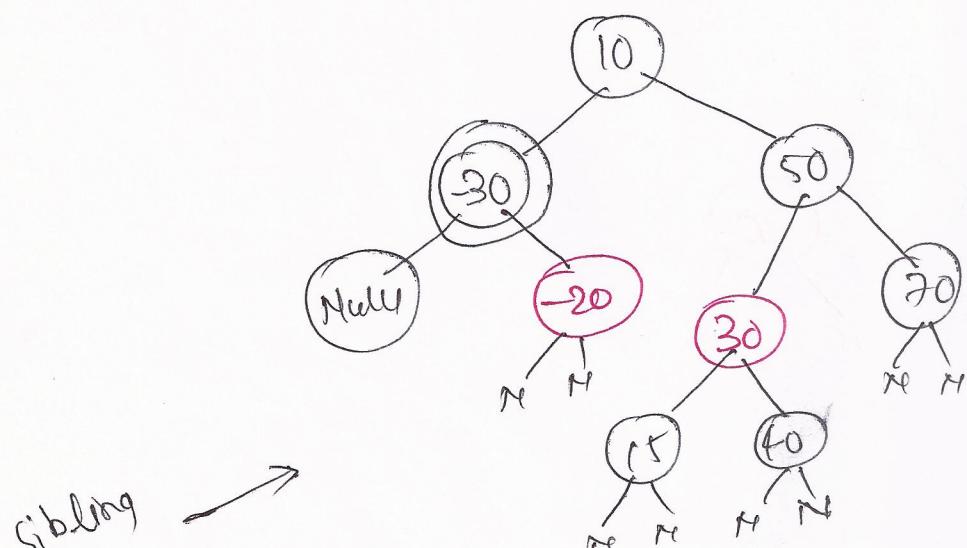
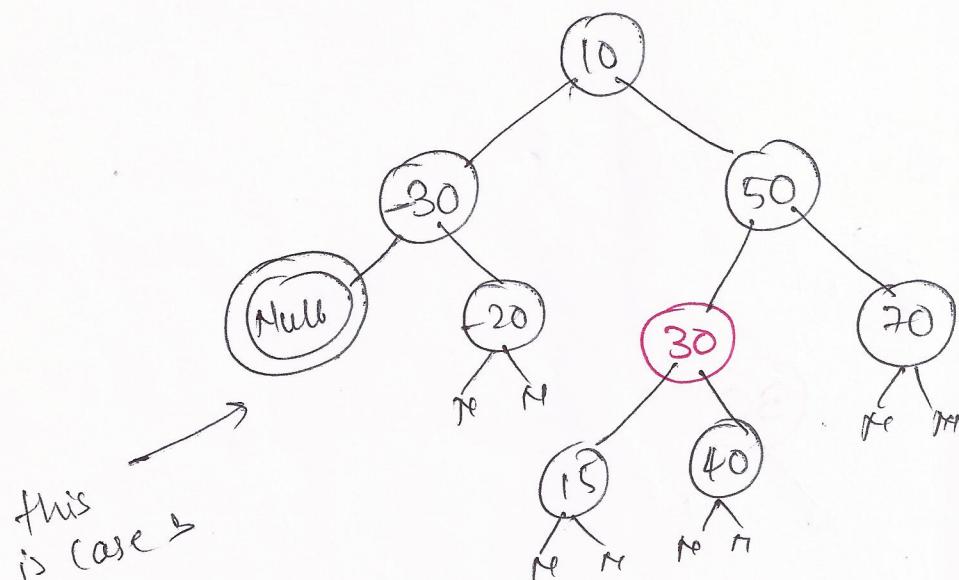
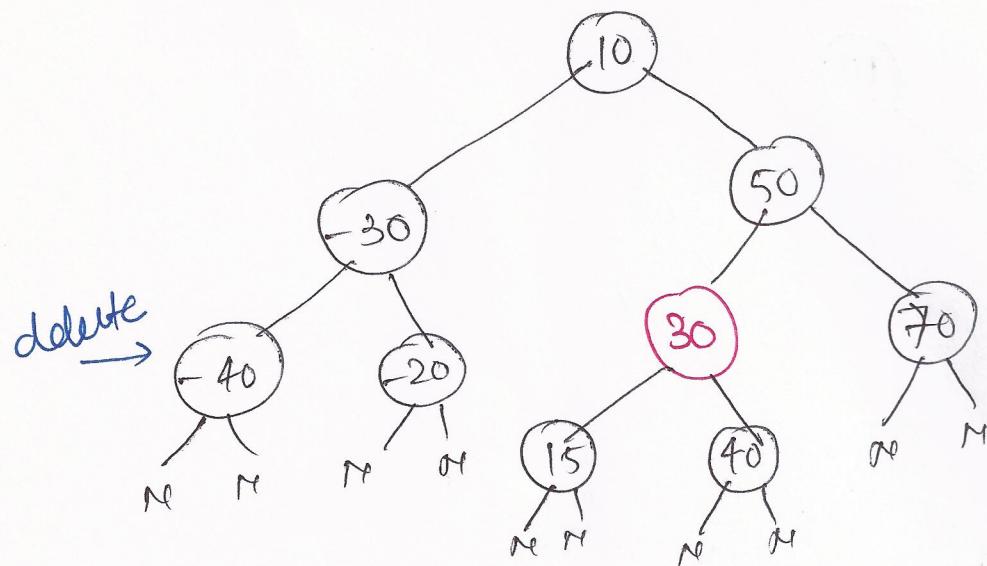
Change the color



Now this is case 1



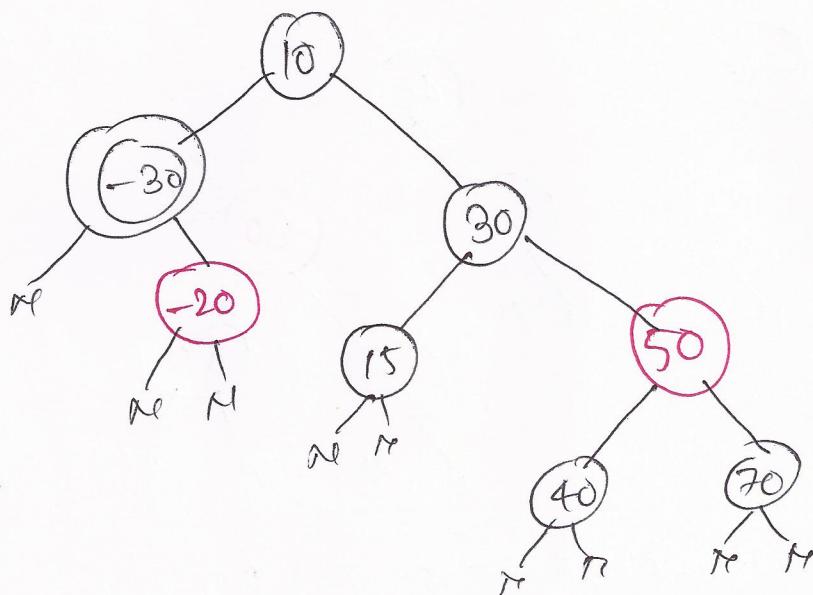
case 3 which results in case 5



is
black
hence it is
case 5

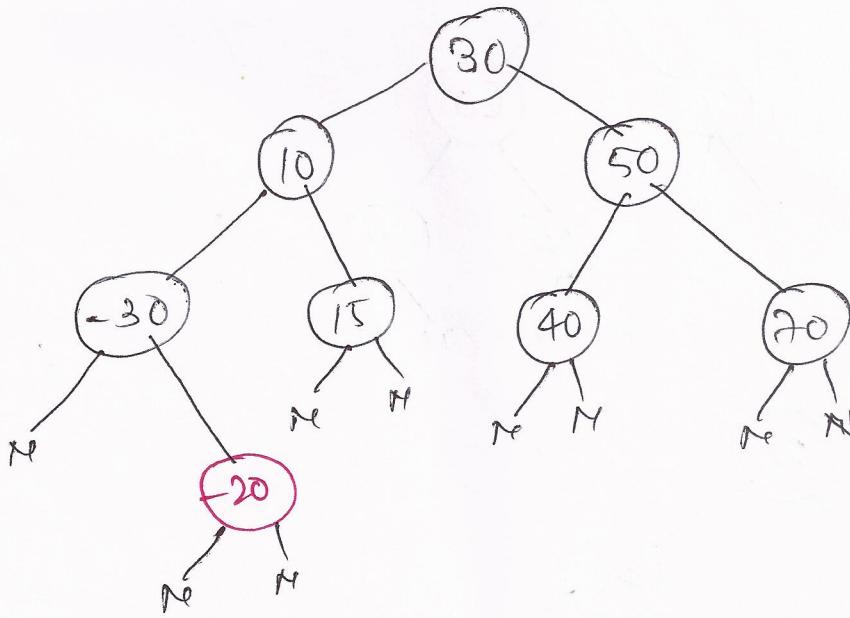
do rotation and convert to case 6
with color change

here we do right rotation.

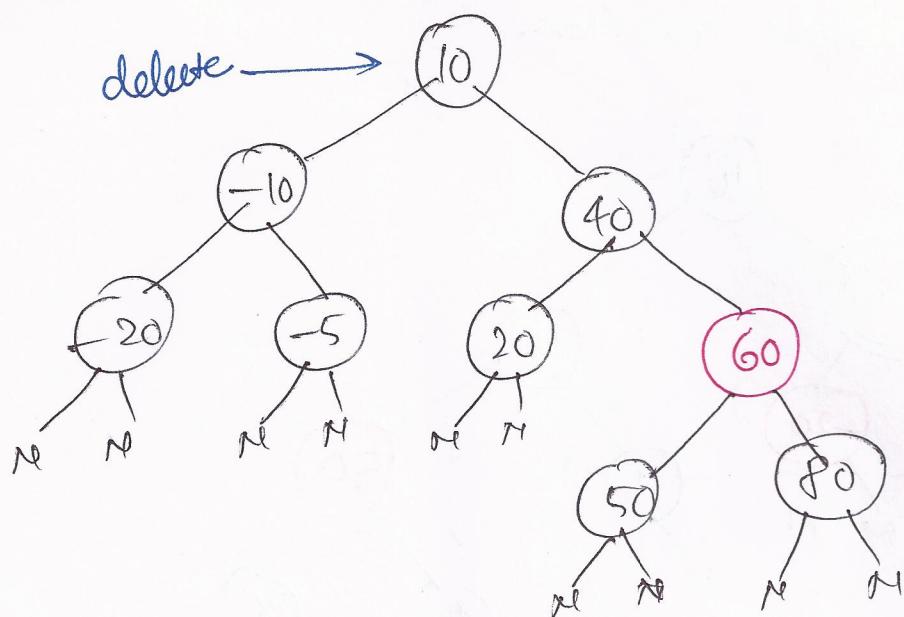


this
is
case 6

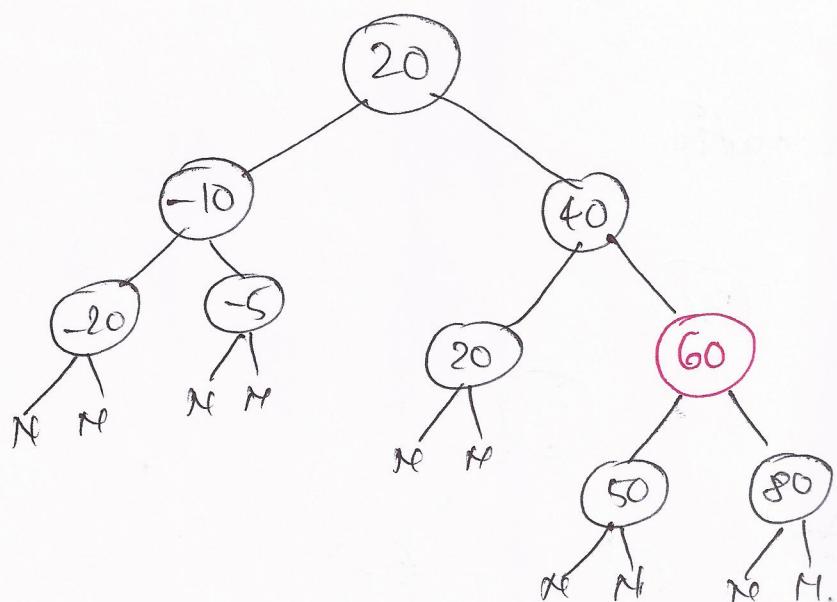
do rotation



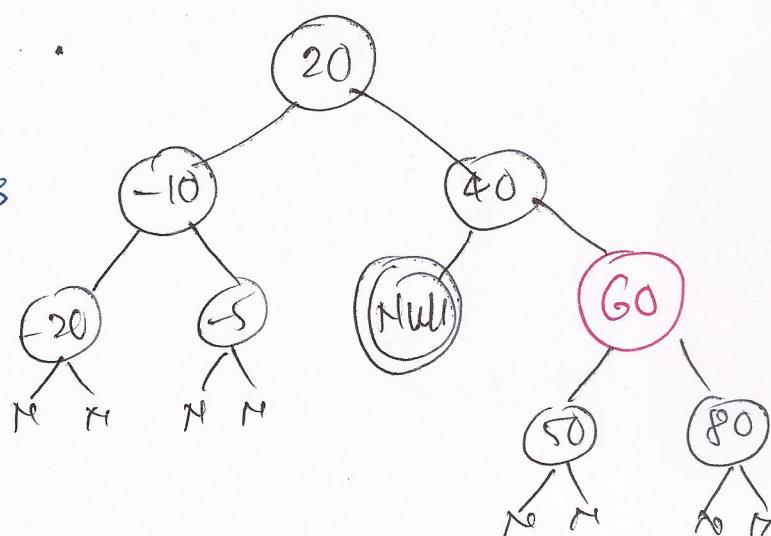
case 2



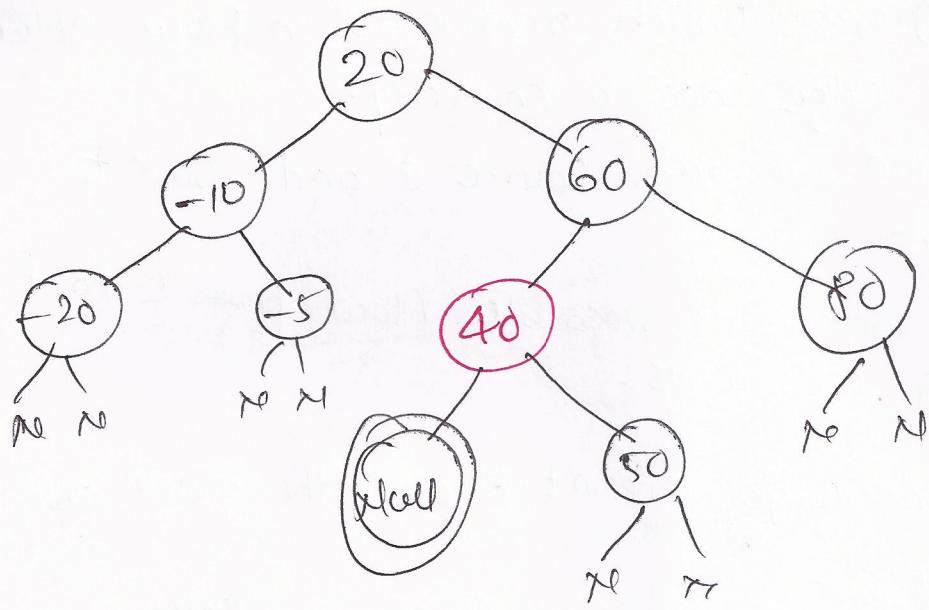
Smallest in-order Successor is 20



Ans
is
case



do rotation & color



this case 4