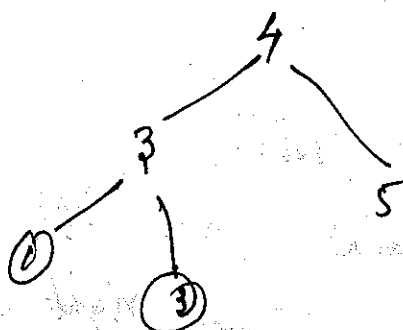


Binary Search Tree

cases - Left
greater - right.



Insert a sequence 60, 25, 75, 15, 50, 66, 33, 44

① Insert 60

60

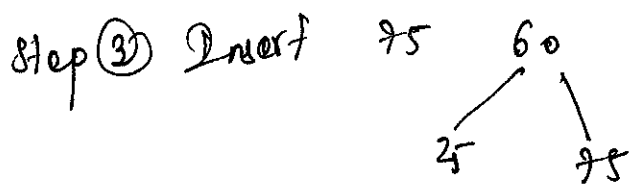
② Insert 25

60

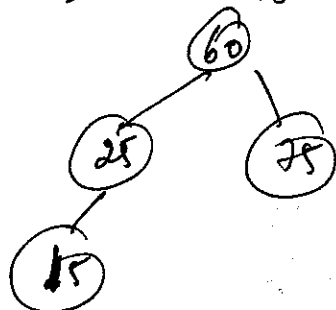
25

$25 < 60$

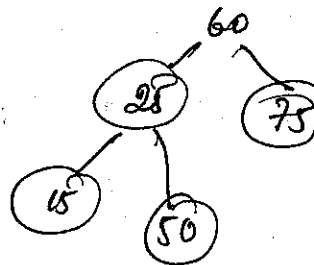
2



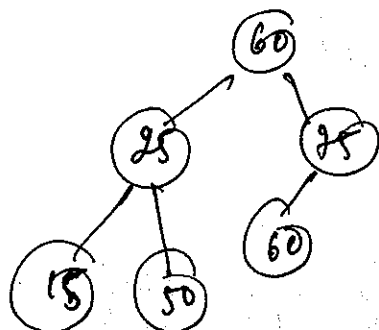
Step 4 Insert 15



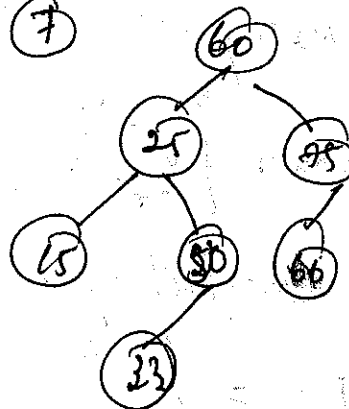
5 Insert 50



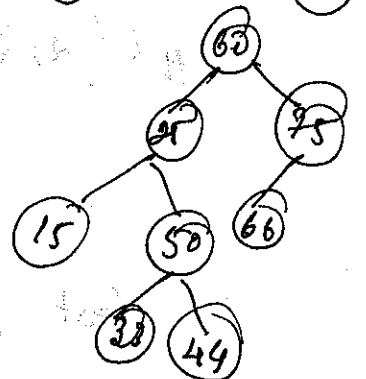
6 Insert 66



7 Insert 33



8 Insert 44



Deletion

1) Deleting a leaf node

2) Deleting a node with one child

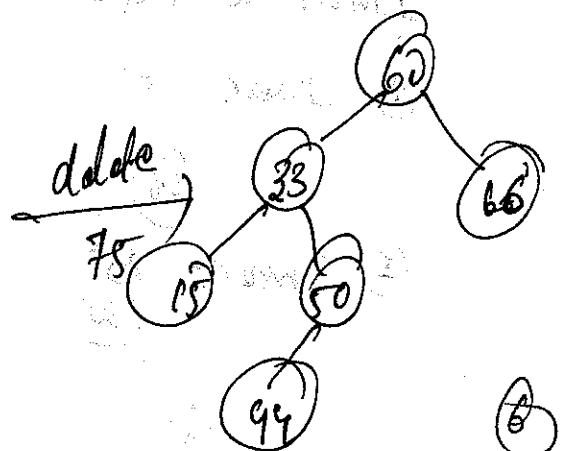
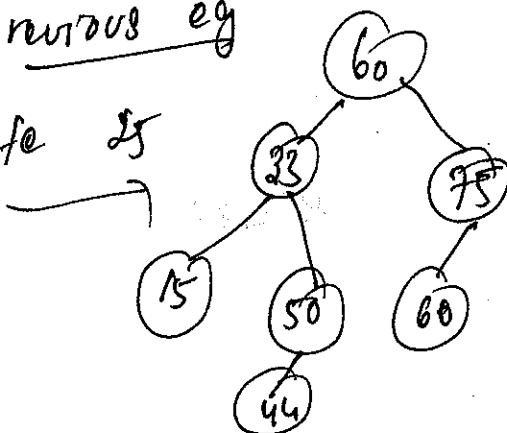
The child will be replaced in the position of the node which is deleted.

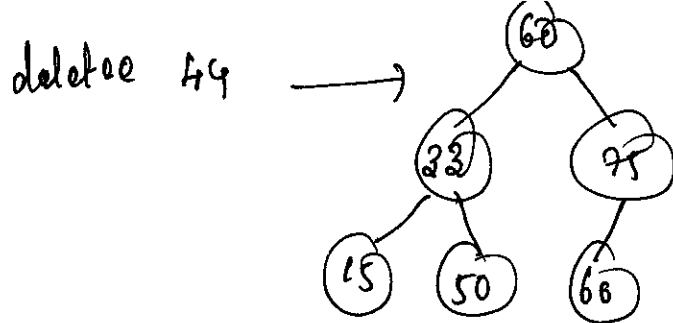
3) Deleting a node with two children

either - place largest element from left sub tree
or - place smallest element from right sub tree

In previous eg

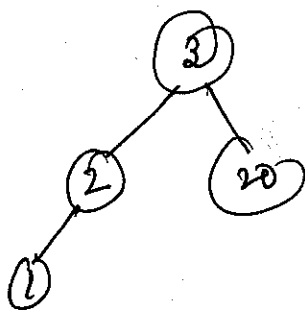
delete 25





AVL Tree - It is a height balanced BST. The balanced factor of each node has to be -1, 0, +1

$(h_L - h_R)$ h_L - height of the left subtree
 h_R - height of the right subtree



Balancing factor of

$$3 = 2 - 1 = 1$$

$$2 = 1 - 0 = 1$$

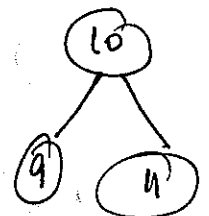
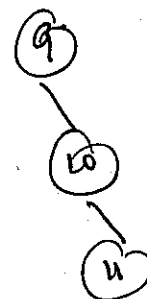
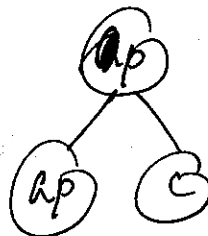
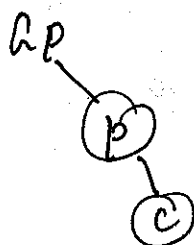
$$20 = 0 - 0$$

Rotation

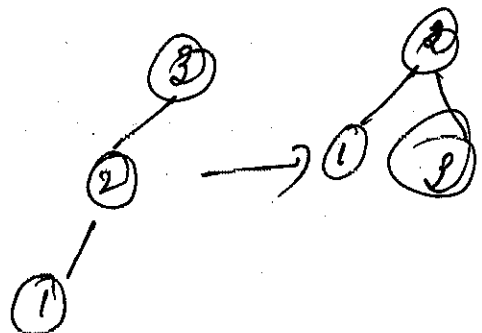
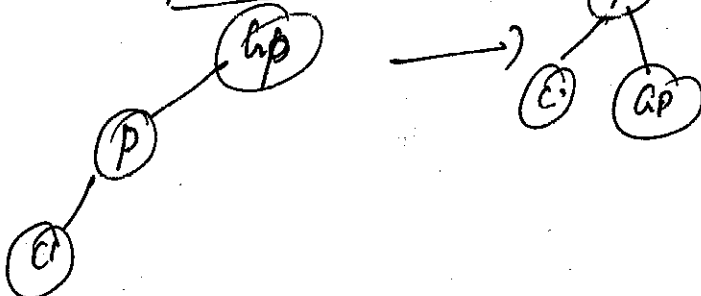
~~L-R~~ $\left. \begin{array}{l} L-L \\ R-R \end{array} \right\}$ Single rotation

$\left. \begin{array}{l} L-R \\ R-L \end{array} \right\}$ Double rotation

Right - Right

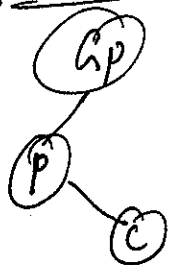


Left - Left

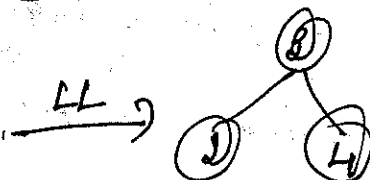
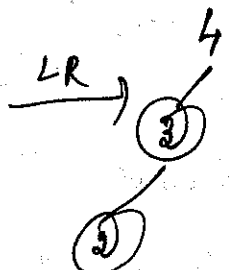
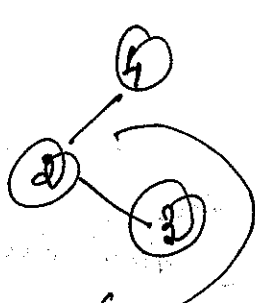
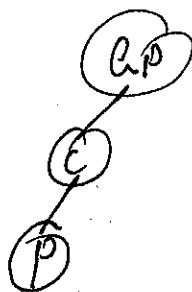


(7)

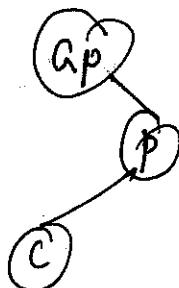
Left - Right



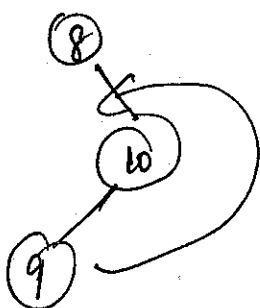
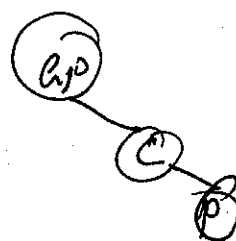
\rightarrow
 p-child
 c-parent



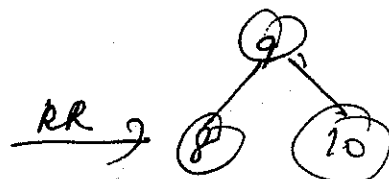
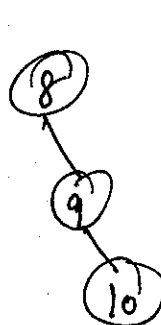
Right - Left



\rightarrow
 p-child
 c-parent



\rightarrow
 RL



Inserting

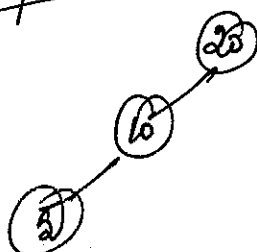
Step 1 Insert 20



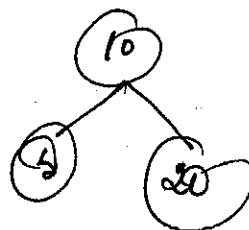
Step 2 Insert 10

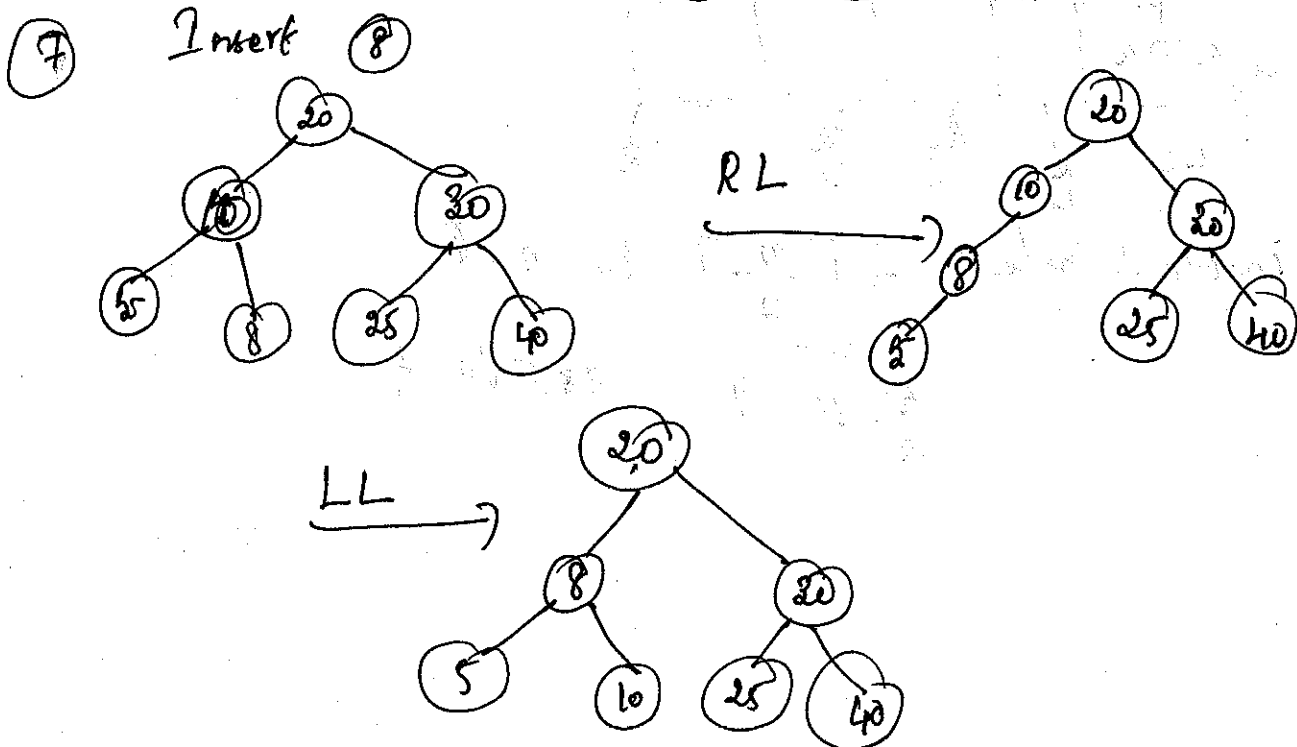
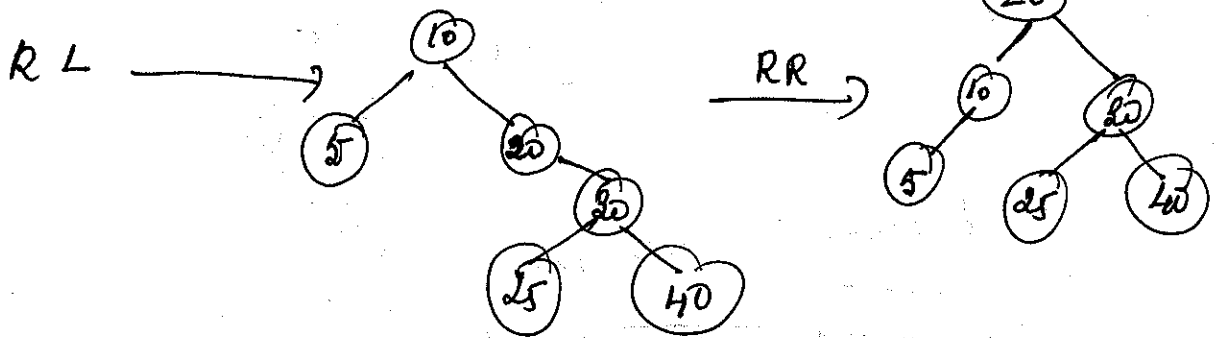
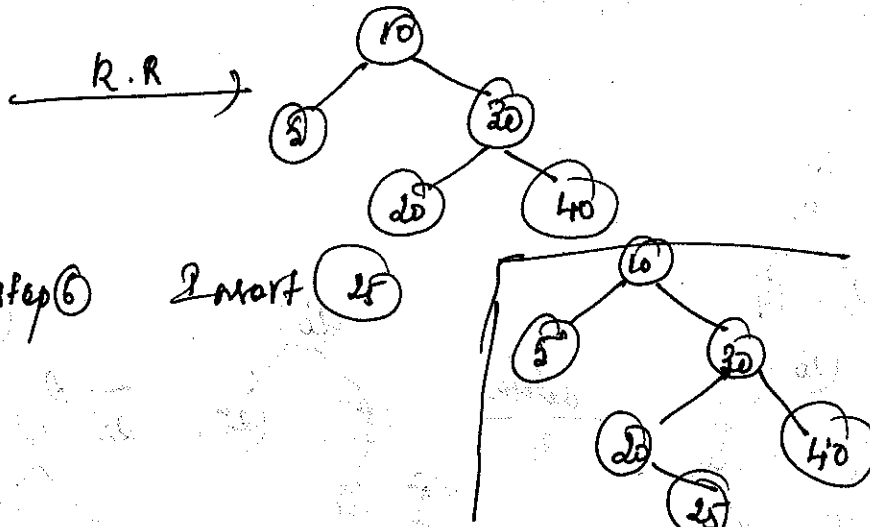
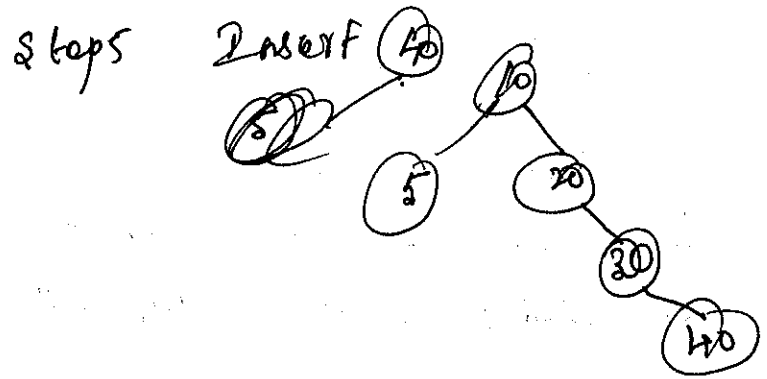
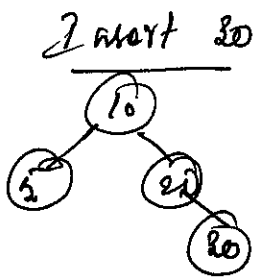


Step 3 Insert 5



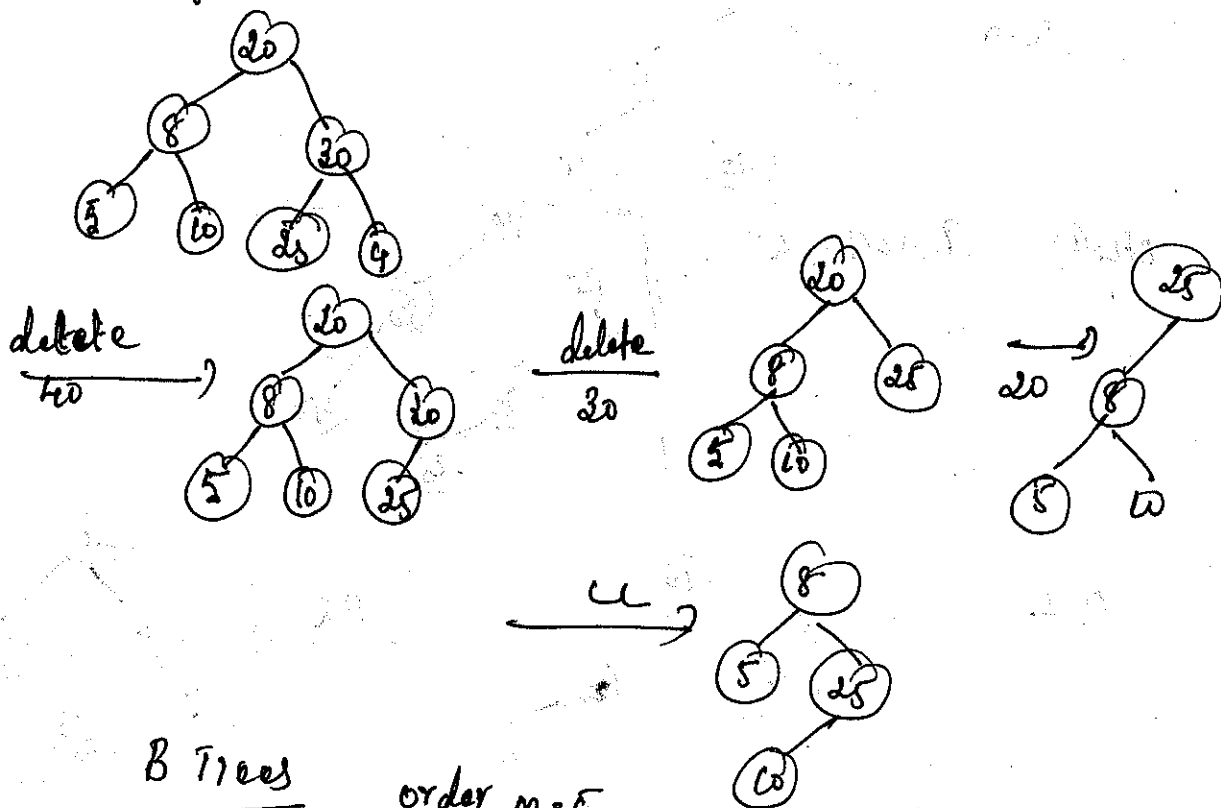
\rightarrow
 LL





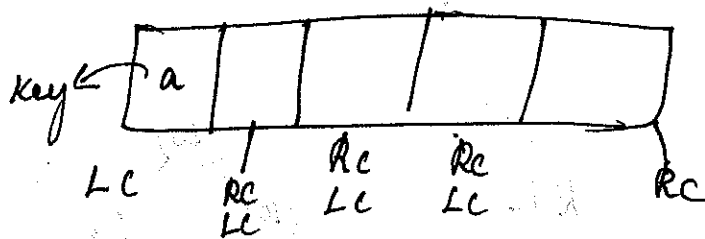
AVL Tree Deletion

- (i) deleting a leaf node
- (ii) deleting a node with one child
- (iii) deleting a node with two children



B Trees

order $m=5$



Internal node = $\left\lceil \frac{n}{2} \right\rceil$ to $n-1$
 $\frac{5}{2}$ to 4 205 to 4

B-Trees order m (edges)

keys $= (m-1)$ root node

For every key there must be a left and right child.

Root node $= m-1$

$\lceil \rceil$ - ceil

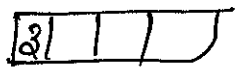
Internal node $= \lceil m/2 \rceil$ to $m-1$

$\lfloor \rfloor$ - floor.

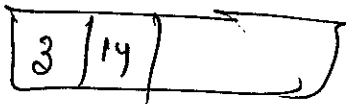
Insert 2, 14, 7, 1, 8, 5, 11, 17, 13, 6, 23, 12, 20, 26, 4, 16, 18, 19, 25, 24 construct a B Tree of order 5

Step 1 Insert 2

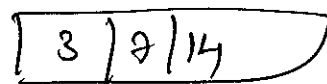
Key $= (m-1) = 5-1 = 4$



Step 2 : Insert 14

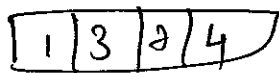


Step 3 Insert 7



The numbers will be inserted / arranged in ascending order

Step 4 : Insert 1



Step 5 : Insert 8

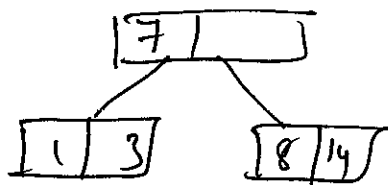
1, 3, 7, 8, 14

$\lfloor \frac{m}{2} \rfloor$ floor $= 5/2 = 2.5 \approx 2$

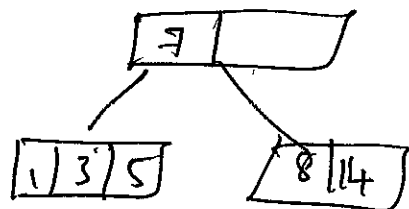
\therefore Break the second node

Since the keys are full and there is no space we are breaking the node.

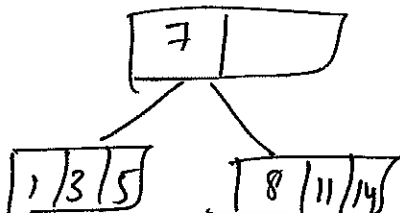
1, 3, 7, 8, 14



Step 6 Insert 5



Step 7 : Insert 11



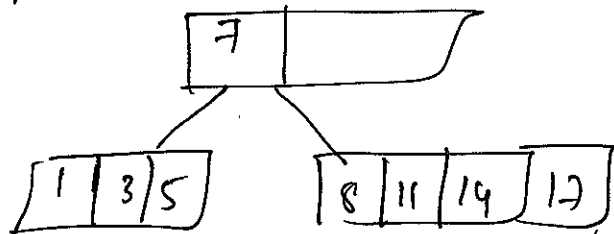
SUBJECT WISE RESULT ANALYSIS – 14.4:**ONE SUBJECT FAILURES:**

S.No.	Register No	Name	Subject Failed
1.	312414104057	LOGESH V R	CS6202/ Programming and Data Structures I
2.	312414104060	MARIYAPPAN S	CS6202/ Programming and Data Structures I
3.	312414104058	MANASVI SRINIVAS V	CS6202/ Programming and Data Structures I
4.	312414104066	NANTHINI S	CS6201/Digital Principles and System Design
5.	312414104067	NAVEEN M	CS6202/ Programming and Data Structures I
6.	312414104069	NEETHU RAVEENDRAN	MA6251/ Mathematics-II

TWO SUBJECT FAILURES:

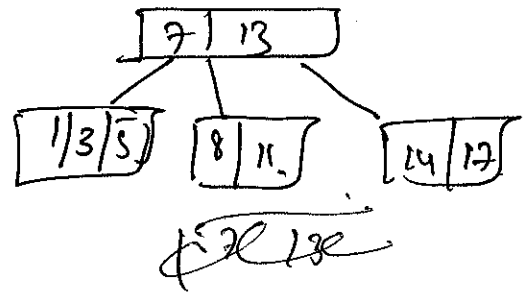
S.No.	Register No	Name	Subject Failed
1.	312414104044	JESSICA MARIA SHAJI	CS6202/ Programming and Data Structures I CS6201/Digital Principles and System Design
2.	312414104045	JOSE MERVIN MARIO V	CS6202/ Programming and Data Structures I CS6201/Digital Principles and System Design
3.	312414104053	KEERTHIKA PRIYADHARSHINI R	CS6201/Digital Principles and System Design MA6251/ Mathematics-II
4.	312414104065	MUTHUKUMAR A	CS6202/ Programming and Data Structures I CS6201/Digital Principles and System Design
5.	312414104079	POORNIMAA N	CS6202/ Programming and Data Structures I CS6201/Digital Principles and System Design
6.	312414104080	PRAKAASH P	CS6202/ Programming and Data Structures I CS6201/Digital Principles and System Design

Step 8 Insert 17

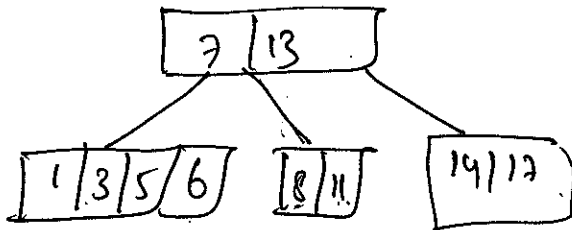


Step 9 Insert 13

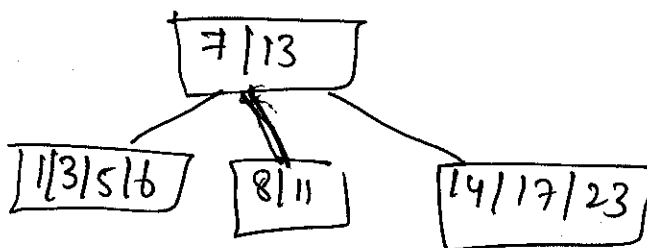
8, 11 | 13 | 14, 17
but 13 becomes root



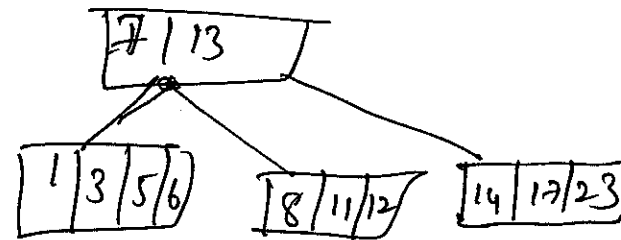
Step 10 Insert 6



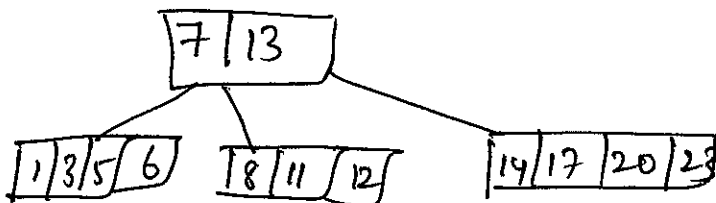
Step 11 Insert 23



Step 12 Insert 12

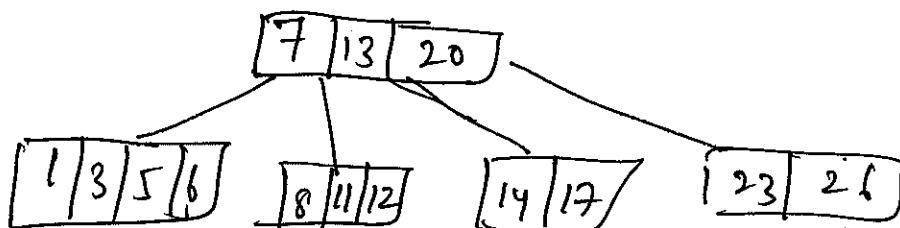


Step 13 : Insert 20



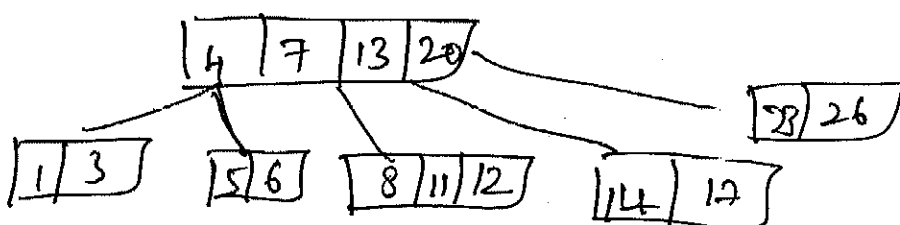
Step 14 Insert 26

14 17 | 20 23, 26



Step 15 Insert 4

1, 3, 4, 5, 6





**ST.JOSEPH'S INSTITUTE OF TECHNOLOGY
CHENNAI -600 119**

Department of Computer Science and Engineering

SUBJECT WISE RESULT ANALYSIS – 14.4:

SUBJECT WISE ARREAR LIST (Including Labs)

SEMESTER I

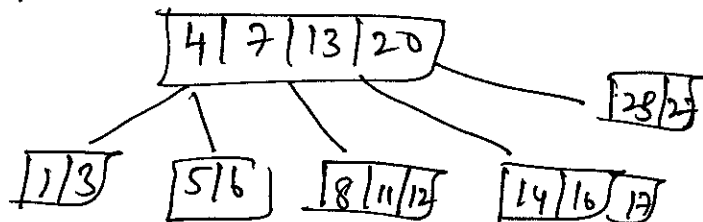
S. No.	Subject Code	Name of the Subject	Register No. of Arrear Students	Total No. of Students
1	CY6151	Engineering Chemistry – I	312414104070	1
2	GE6151	Computer Programming	312414104075,312414104082	2
3	MA6151	MATHEMATICS - I	312414104064,312414104070,312414104075	3
4	PH6151	Engineering Physics – I	312414104064,312414104070,312414104075,312414104081,312414104082	5

SEMESTER II

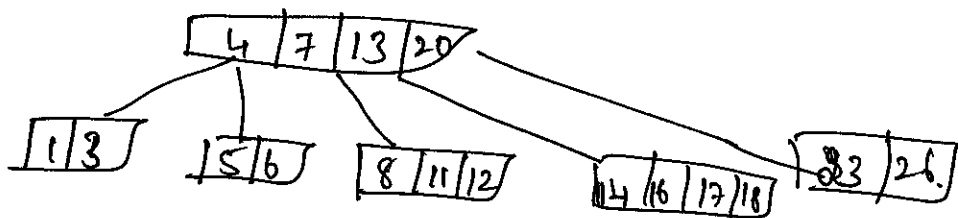
S. No	Subject Code	Name of the Subject	Register No. of Arrear Students	Total No. of Students
1	HS6251	Technical English – II	312414104075	01
1	MA6251	MATHEMATICS - II	312414104046, 4050, 4053, 4056, 4064, 4069, 4070, 4071, 4073, 4075, 4082	11
2	PH6251	ENGINEERING PHYSICS- II	312414104064, 4070, 4075, 4082	04
3	CY6251	ENGINEERING CHEMISTRY- II	312414104046, 4050, 4064, 4070, 4073, 4075, 4081,4082	08
4	CS6201	DIGITAL PRINCIPLES AND SYSTEM DESIGN	312414104044, 4045, 4046,4050, 4056 , 4064, 4065, 4066, 4070, 4071, 4073, 4075, 4079, 4080, 4081,4082	16
5	CS6202	PROGRAMMING AND DATA STRUCTURES I	312414104044, , 4045, , 4046,4050, 4053, 4056, 4057, 4058, 4060,4064, 4065, 4067, 4070, 4071, 4073, 4075, 4079, 4080	18
6	GE6262	Physics and Chemistry Laboratory - II	312414104075	01
7	CS6211	Digital Laboratory	312414104073	01
8	CS6212	Programming and Data Structures Laboratory I	312414104064,312414104073, 312414104075	03

HOD

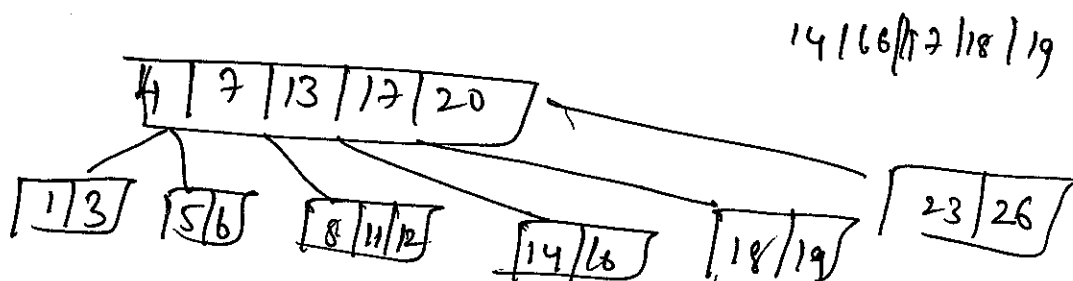
Step 16 Insert 16



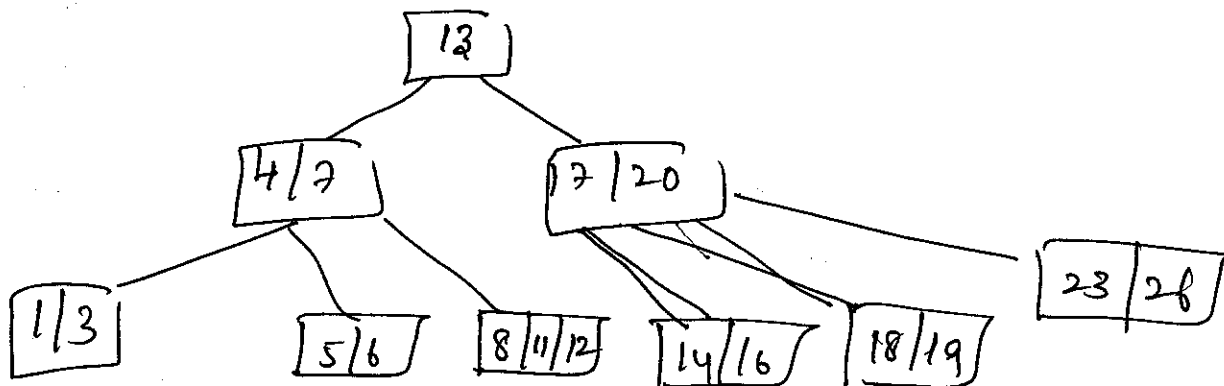
Step 17 Insert 18



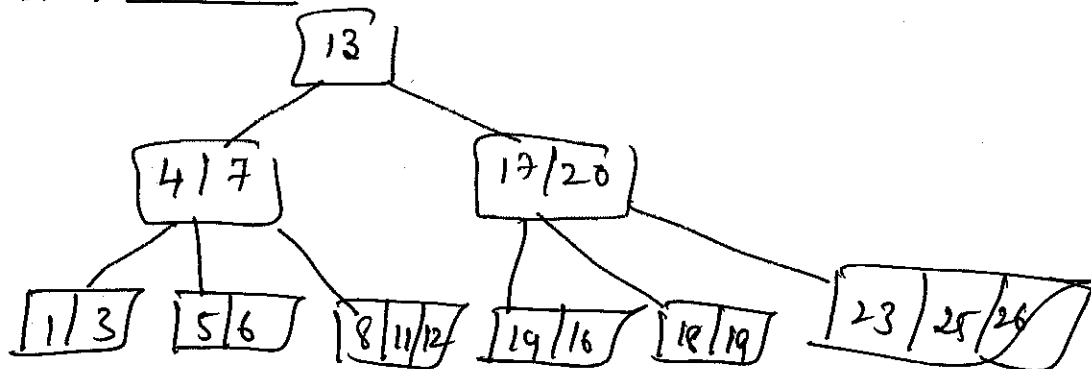
Insert 19



Here 12 becomes root node.



Insert 25





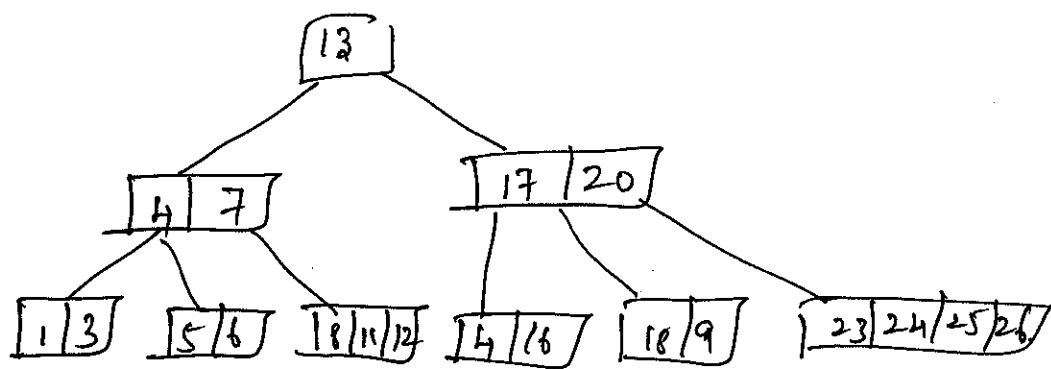
**ST.JOSEPH'S INSTITUTE OF TECHNOLOGY
CHENNAI -600 119**

Department of Computer Science and Engineering

SUBJECT WISE RESULT ANALYSIS:- 14.3

S.NO	REGISTER NO.	NAME	I S E M	II S E M	III SEM	IV SEM	TOTAL
1.	312414104075	PAVANKUMAR S	3	8			11
2.	312414104064	MOHAN RAJ A	2	6			8
3.	312414104070	NIKIL S	3	5			8
4.	312414104073	NITISH SHRIVATSAN N S		6			6
5.	312414104082	PRAVEEN K	2	4			6
6.	312414104046	JOSEPH IMMANUEL KENTENICH D		4			4
7.	312414104050	KAVINKON M		4			4
8.	312414104081	PRAMODH GANESH R	1	2			3
9.	312414104056	LEON VAIBHAV ABRAHAM A		3			3
10.	312414104071	NISHALI KMS		3			3
11.	312414104044	JESSICA MARIA SHAJI		2			2
12.	312414104045	JOSE MERVIN MARIO V		2			2
13.	312414104065	MUTHUKUMAR A		2			2
14.	312414104079	POORNIMAA N		2			2
15.	312414104080	PRAKAASH P		2			2
16.	312414104053	KEERTHIKA PRIYADHARSHINI R		2			2
17.	312414104057	LOGESH V R		1			1
18.	312414104060	MARIYAPPAN S		1			1
19.	312414104058	MANASVI SRINIVAS V		1			1
20.	312414104066	NANTHINI S		1			1
21.	312414104067	NAVEEN M		1			1
22.	312414104069	NEETHU RAVEENDRAN		1			1

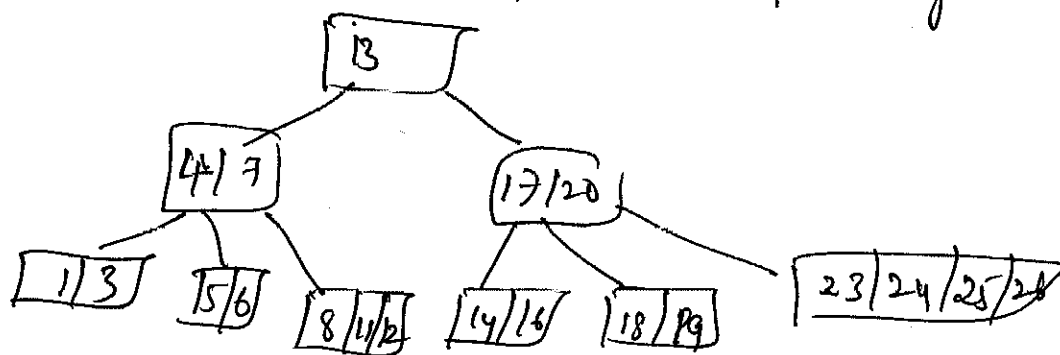
HOD



B Tree Deletion

- (i) If a key to be deleted is present in a leaf node if deleting the key does not violate minimal constraint property, then delete the key and leave the tree.
- (ii) The key to be deleted is present in the leaf node by deleting the key if it violates the minimal constraint property then check for any of its siblings. If sibling is having a extra key then move the extra key to the parent.
- (iii) If the key to be deleted is present in the leaf node check for its sibling if neither of the sibling is having extra key. then combine either one of the sibling with parent and the node in which the deleted key was present.

Delete 8, 20, 18, 5 from the following tree



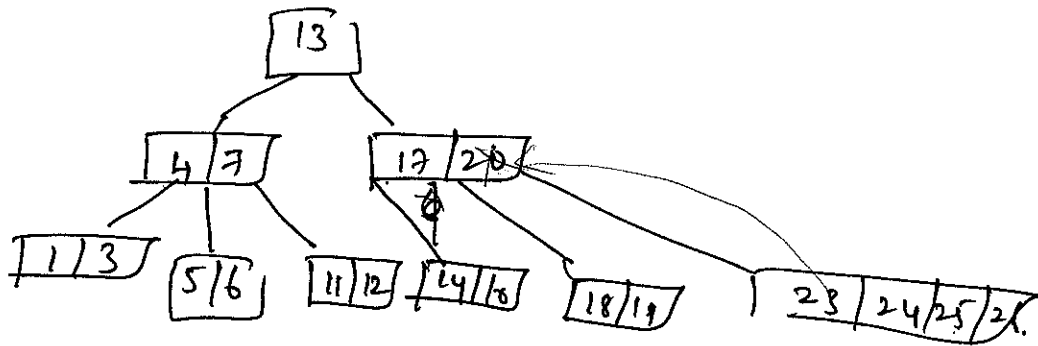
THREE SUBJECTS AND ABOVE FAILURES

S. No	Register No	Name	Subject Failed			
			SEM 1	SEM 2	SEM 3	SEM 4
1.	312414104075	PAVANKUMAR S	GE6151 MA6151 PH6151	HS6251 MA6251 PH6251 CY6251 CS6201 CS6202 GE6262 CS6212		
2.	312414104064	MOHAN RAJ A	MA6151 PH6151	MA6251 PH6251 CY6251 CS6201 CS6202 CS6212		
3.	312414104070	NIKIL S	CY6151 MA6151 PH6151	MA6251 PH6251 CY6251 CS6201 CS6202		
4.	312414104073	NITISH SHRIVATSAN N S		MA6251 CY6251 CS6201 CS6202 CS6211 CS6212		
5.	312414104082	PRAVEEN K	GE6151 PH6151	MA6251 CY6251 CS6201 CS6202		
6.	312414104046	JOSEPH IMMANUEL KENTENICH D		MA6251 CY6251 CS6201 CS6202		
7.	312414104050	KAVINKON M		MA6251 CY6251 CS6201 CS6202		
8.	312414104081	PRAMODH GANESH R	PH6151	CY6251 CS6201		
9.	312414104056	LEON VAIBHAV ABRAHAM A		MA6251 CS6201 CS6202		
10.	312414104071	NISHALI KMS		MA6251 CS6201 CS6202		

HOD

Delete 8

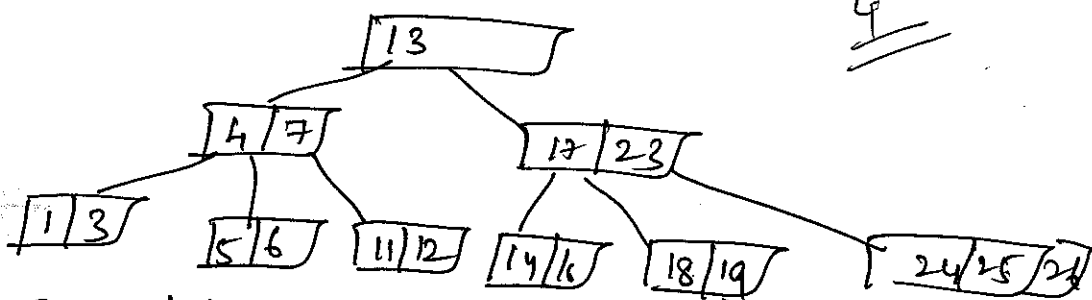
8 is a leaf node and it does not violate



Step 2 Delete 20

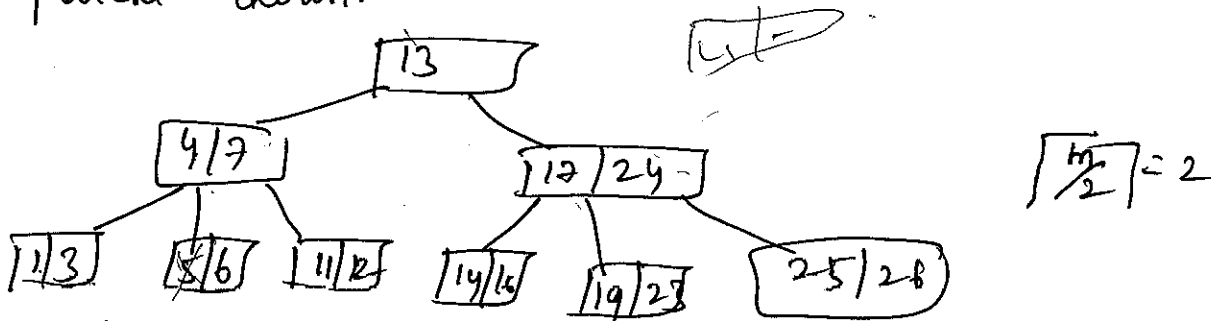
Deleting a key present in Internal node

Here successor of 20 is 23 then move 23 to the 20 position.



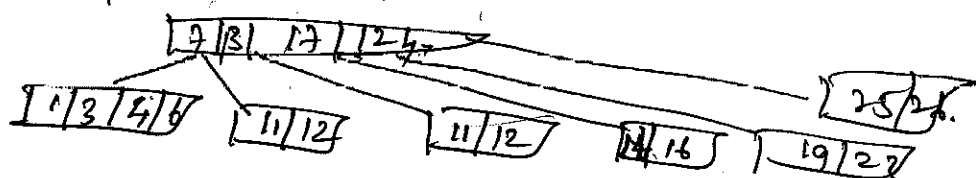
Step 3: Delete 18

Deleting a leaf node when it violates mcp then get the siblings for the internal node position and push the parent down.



Delete 5

Now it violates mcp but here there is no extra key present in the sibling. So we can combine them and form a tree



SUBJECT WISE RESULT ANALYSIS – 14.4:**ONE SUBJECT FAILURES:**

S.No.	Register No	Name	Subject Failed
1.	312414104057	LOGESH V R	CS6202/ Programming and Data Structures I
2.	312414104060	MARIYAPPAN S	CS6202/ Programming and Data Structures I
3.	312414104058	MANASVI SRINIVAS V	CS6202/ Programming and Data Structures I
4.	312414104066	NANTHINI S	CS6201/Digital Principles and System Design
5.	312414104067	NAVEEN M	CS6202/ Programming and Data Structures I
6.	312414104069	NEETHU RAVEENDRAN	MA6251/ Mathematics-II

TWO SUBJECT FAILURES:

S.No.	Register No	Name	Subject Failed
1.	312414104044	JESSICA MARIA SHAJI	CS6202/ Programming and Data Structures I CS6201/Digital Principles and System Design
2.	312414104045	JOSE MERVIN MARIO V	CS6202/ Programming and Data Structures I CS6201/Digital Principles and System Design
3.	312414104053	KEERTHIKA PRIYADHARSHINI R	CS6201/Digital Principles and System Design MA6251/ Mathematics-II
4.	312414104065	MUTHUKUMAR A	CS6202/ Programming and Data Structures I CS6201/Digital Principles and System Design
5.	312414104079	POORNIMAA N	CS6202/ Programming and Data Structures I CS6201/Digital Principles and System Design
6.	312414104080	PRAKAASH P	CS6202/ Programming and Data Structures I CS6201/Digital Principles and System Design

Q. Construct a B tree of order 3

2, 3, 7, 9, 5, 6, 4, 8, 1 and delete the value 4, 6.

Red Black tree

○ — Black colour

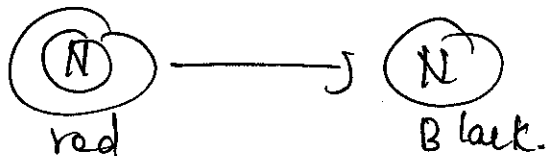
⊙ → Red colour

Root node should be black in colour

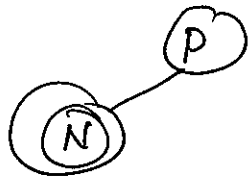
No consecutive red nodes are allowed.

Defn It is a type of self balanced binary search tree where the nodes must be either Black or red in colour.

① Insertion Case 1: If the tree is empty the new node is in red color and then change them to Black color.

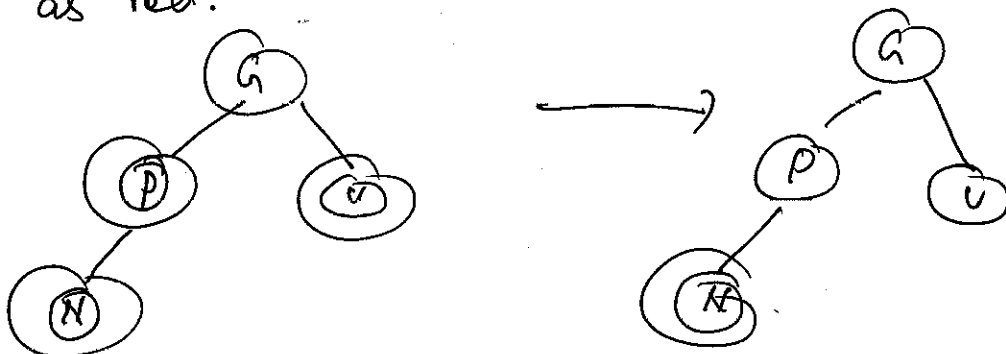


Case 2: If the node be inserted as a parent, which is black in color. then leave the tree as it is.



Case 3: Left-Left red Imbalance

Recolor parent and uncle as Black and Grand parent as red.





**ST.JOSEPH'S INSTITUTE OF TECHNOLOGY
CHENNAI -600 119**

Department of Computer Science and Engineering

SUBJECT WISE RESULT ANALYSIS – 14.4:

SUBJECT WISE ARREAR LIST (Including Labs)

SEMESTER I

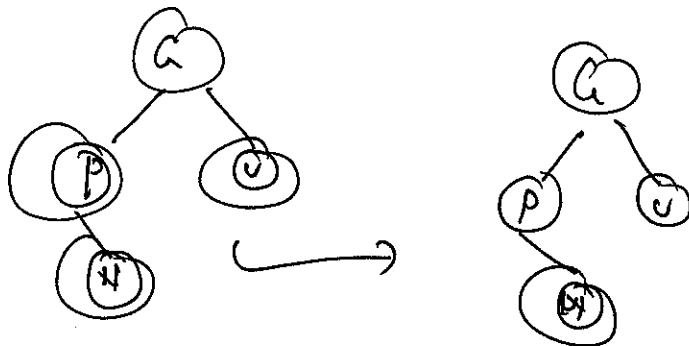
S. No.	Subject Code	Name of the Subject	Register No. of Arrear Students	Total No. of Students
1	CY6151	Engineering Chemistry – I	312414104070	1
2	GE6151	Computer Programming	312414104075,312414104082	2
3	MA6151	MATHEMATICS - I	312414104064,312414104070,312414104075	3
4	PH6151	Engineering Physics – I	312414104064,312414104070,312414104075,312414104081,312414104082	5

SEMESTER II

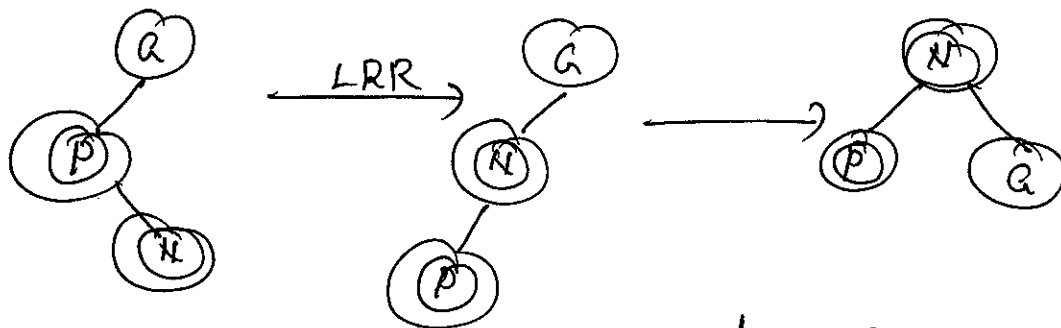
S. No	Subject Code	Name of the Subject	Register No. of Arrear Students	Total No. of Students
1	HS6251	Technical English – II	312414104075	01
1	MA6251	MATHEMATICS - II	312414104046, 4050, 4053, 4056, 4064, 4069, 4070, 4071, 4073, 4075, 4082	11
2	PH6251	ENGINEERING PHYSICS- II	312414104064, 4070, 4075, 4082	04
3	CY6251	ENGINEERING CHEMISTRY- II	312414104046, 4050, 4064, 4070, 4073, 4075, 4081,4082	08
4	CS6201	DIGITAL PRINCIPLES AND SYSTEM DESIGN	312414104044, 4045, 4046,4050, 4056, 4064, 4065, 4066, 4070, 4071, 4073, 4075, 4079, 4080, 4081,4082	16
5	CS6202	PROGRAMMING AND DATA STRUCTURES I	312414104044, , 4045, , 4046,4050, 4053, 4056, 4057, 4058, 4060,4064, 4065, 4067, 4070, 4071, 4073, 4075, 4079, 4080	18
6	GE6262	Physics and Chemistry Laboratory - II	312414104075	01
7	CS6211	Digital Laboratory	312414104073	01
8	CS6212	Programming and Data Structures Laboratory I	312414104064,312414104073, 312414104075	03

HOD

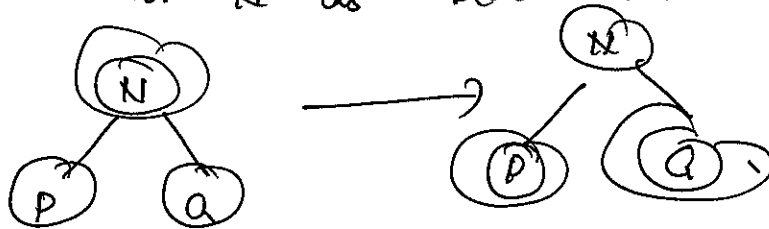
case 4: left - Right Red Imbalance
 Recolor p and v as Black



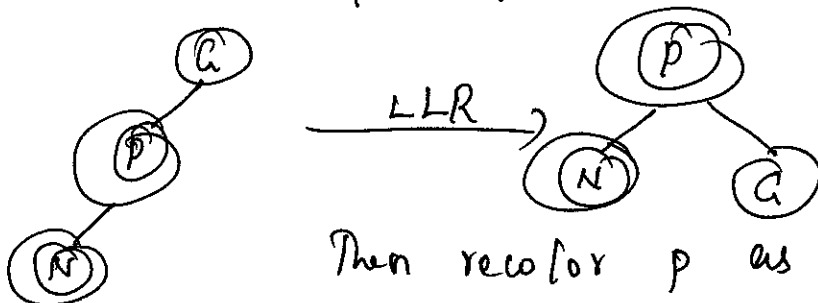
case 5: left - Right Black imbalance



Then recolor N as black and G as red



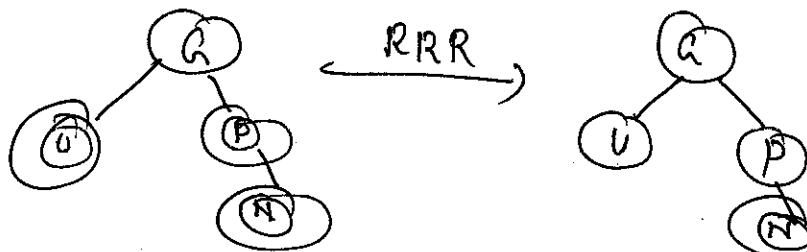
case 6: left left imbalance.



Then recolor p as black and G as red



case 7: Right - Right Red Imbalance (mirror of case 3)



Recolor G as red and v as black





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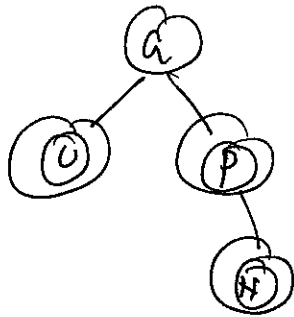
Department of Computer Science and Engineering

SUBJECT WISE RESULT ANALYSIS:- 14.3

S.NO	REGISTER NO.	NAME	I S E M	II S E M	III SEM	IV SEM	TOTAL
1.	312414104075	PAVANKUMAR S	3	8			11
2.	312414104064	MOHAN RAJ A	2	6			8
3.	312414104070	NIKIL S	3	5			8
4.	312414104073	NITISH SHRIVATSAN N S		6			6
5.	312414104082	PRAVEEN K	2	4			6
6.	312414104046	JOSEPH IMMANUEL KENTENICH D		4			4
7.	312414104050	KAVINKON M		4			4
8.	312414104081	PRAMODH GANESH R	1	2			3
9.	312414104056	LEON VAIBHAV ABRAHAM A		3			3
10.	312414104071	NISHALI KMS		3			3
11.	312414104044	JESSICA MARIA SHAJI		2			2
12.	312414104045	JOSE MERVIN MARIO V		2			2
13.	312414104065	MUTHUKUMAR A		2			2
14.	312414104079	POORNIMAA N		2			2
15.	312414104080	PRAKAASH P		2			2
16.	312414104053	KEERTHIKA PRIYADHARSHINI R		2			2
17.	312414104057	LOGESH V R		1			1
18.	312414104060	MARIYAPPAN S		1			1
19.	312414104058	MANASVI SRINIVAS V		1			1
20.	312414104066	NANTHINI S		1			1
21.	312414104067	NAVEEN M		1			1
22.	312414104069	NEETHU RAVEENDRAN		1			1

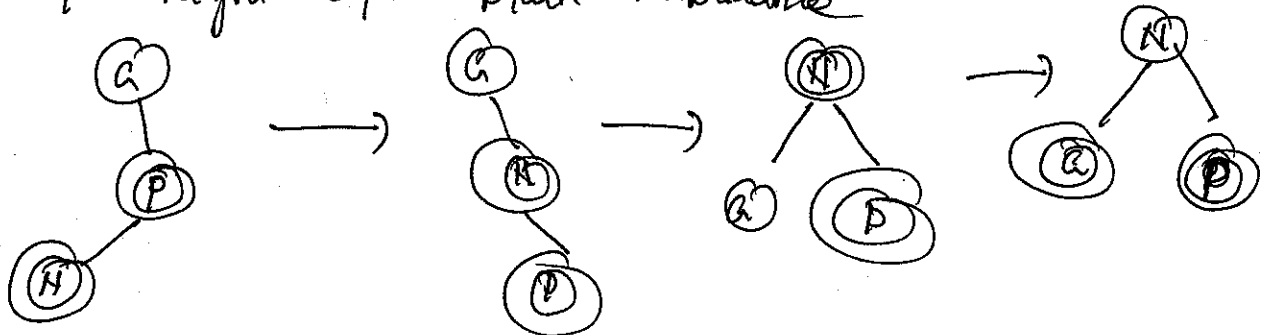
HOD

case 8: Right Left red imbalance. [mirror of case 4]



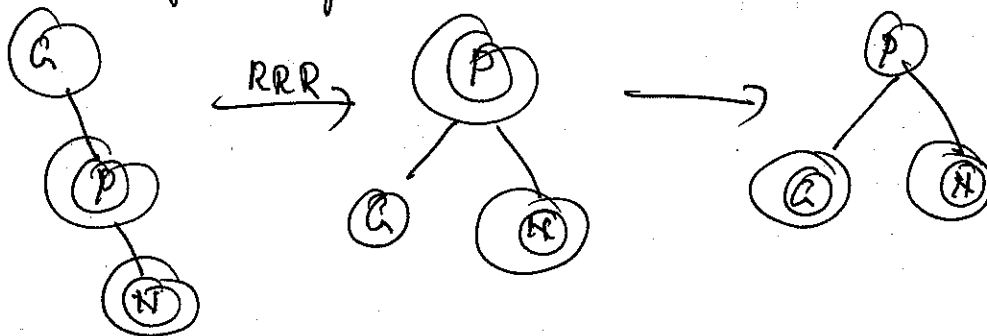
Recolor P and N as black.

case 9: Right Left black imbalance



Recolor N as black and A as red.

case 10: Right Right Red Imbalance



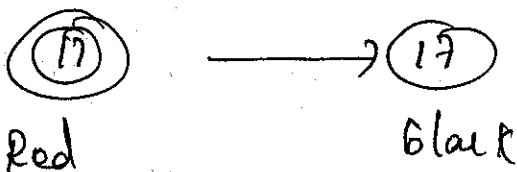
Then recolor P as black and A as red.

Example

Insert 17, 14, 13, 12, 11

Step 1: Insert 17

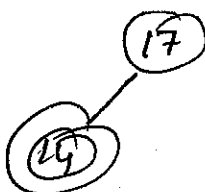
Initial node is red



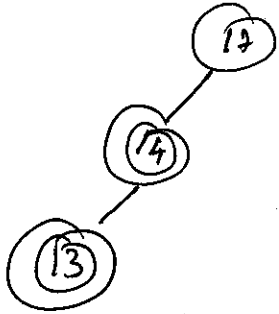
[Eg case 1]

Step 2: Insert 14

14 < 17
left



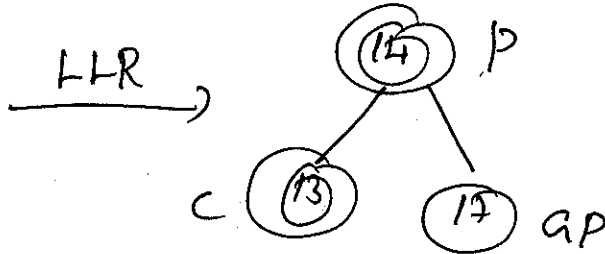
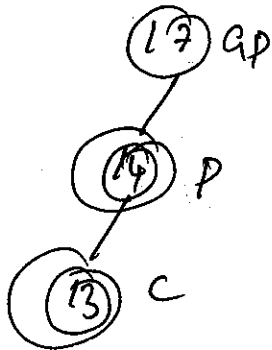
Step 3 : Insert 13



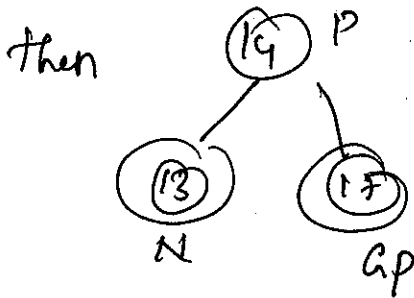
$13 < 14$
left

$13 < 17$
left

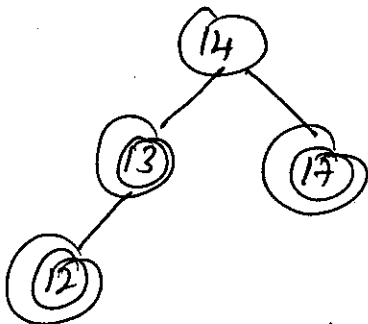
[Left left black Imbalance]



Recolor p as black and ap as red.



Step 4 Insert 12

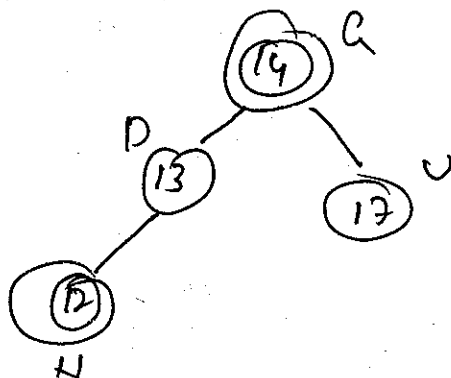


$12 < 14$
left

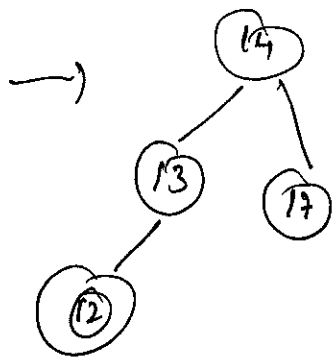
$12 < 13$
left

Left left red imbalance

\therefore Recolor h as red and p & v as black

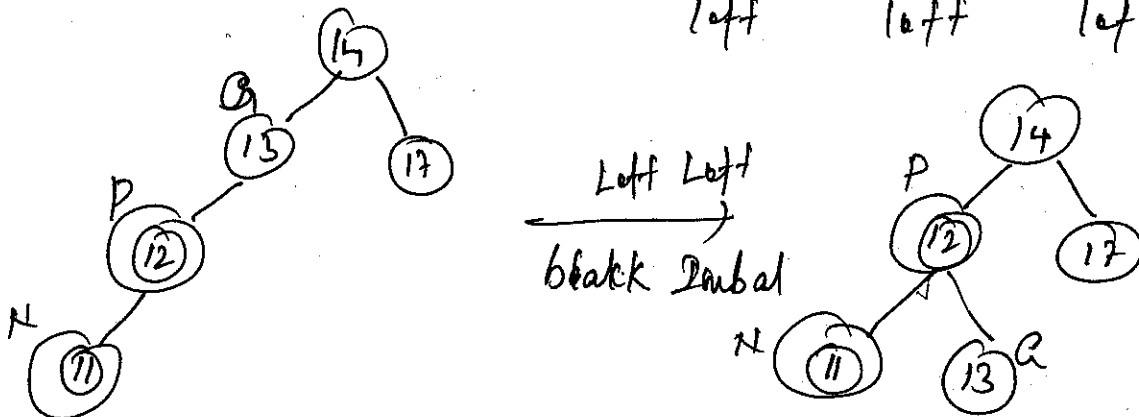


\therefore Root node must be in black color

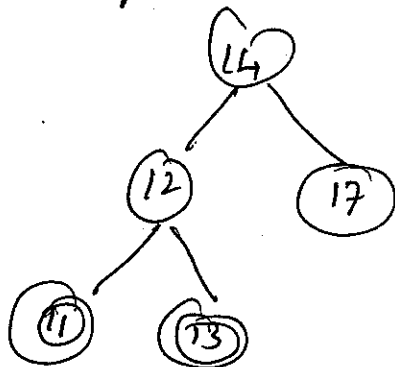


Step 5 : Insert

$11 < 14$ $11 < 13$ $11 < 12$
 left left left



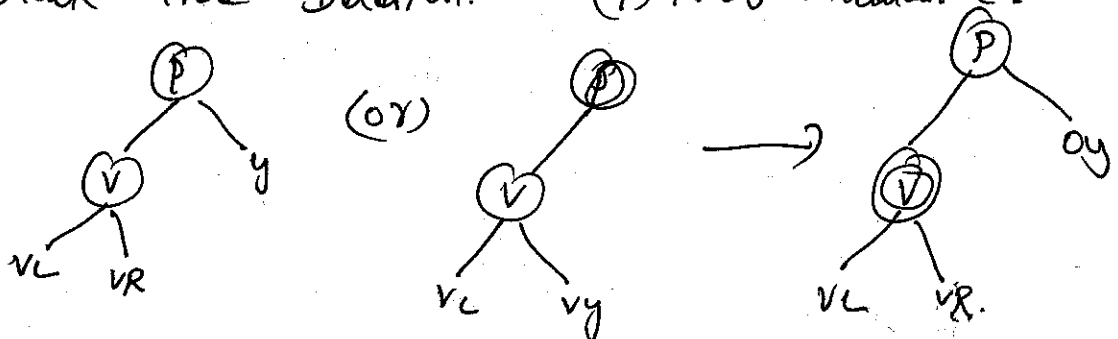
Recolor p as black and Q as red.



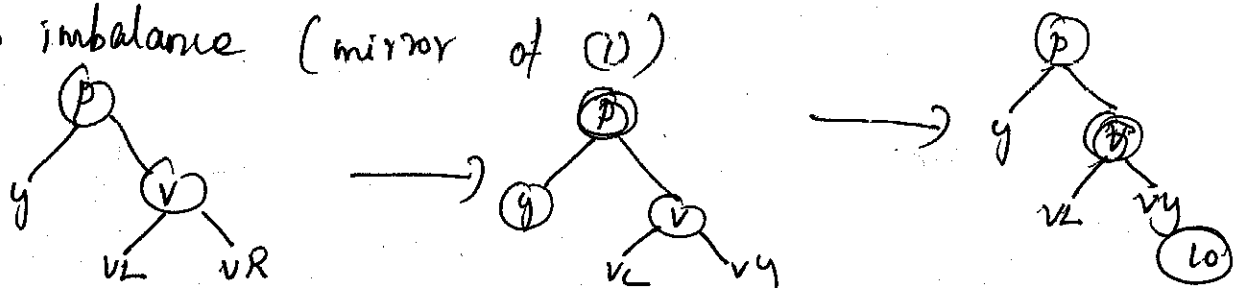
→ output.

Insert 10, 5, 7, 8, 9, 3, 13, 12, 12

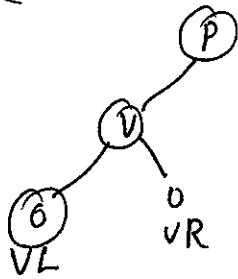
1) Red black tree Deletion. (i) Rbo imbalance.



(ii) Lbo imbalance (mirror of (i))

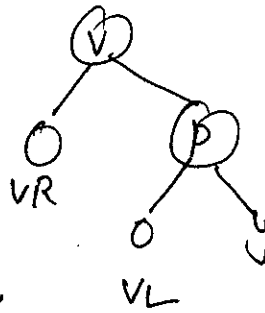


(3) Rb₁(i) imbalance

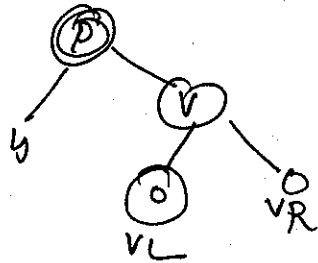


Rotate
and Rebalance

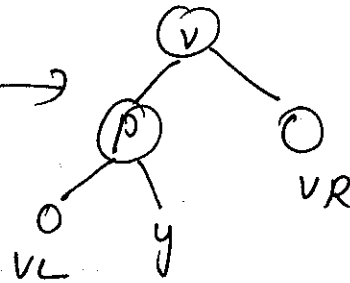
VL as black
K P as black



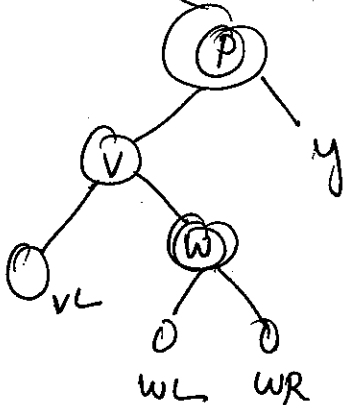
(iv) Lb₁(i) imbalance



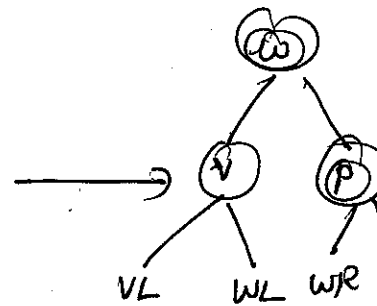
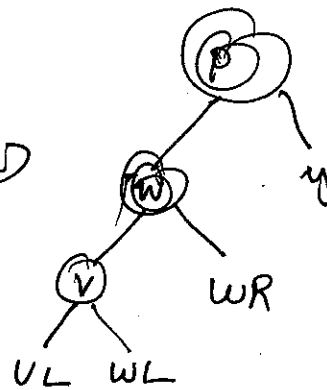
R



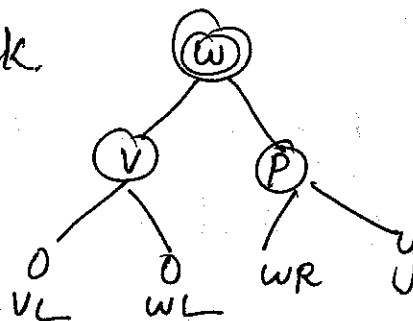
(v) Rb₁(ii) imbalance



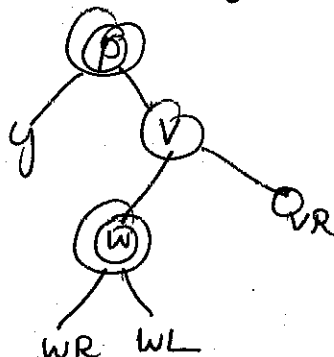
Double
rotation



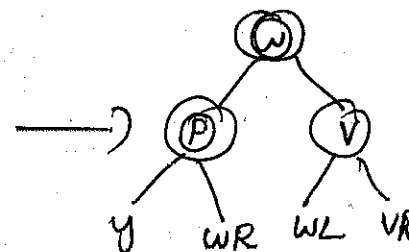
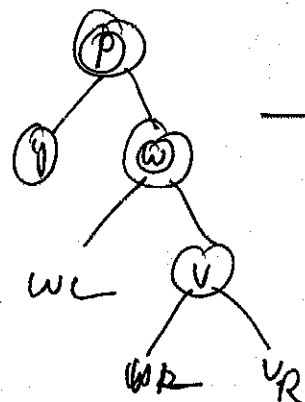
Recolor P as black



(vi) Lb₁(ii) imbalance



Double
rotation



splay trees.

splay trees is self Balancing BST

cases

splaying Left and Right rotation. Zig - zag

Zig - left
zag - Right

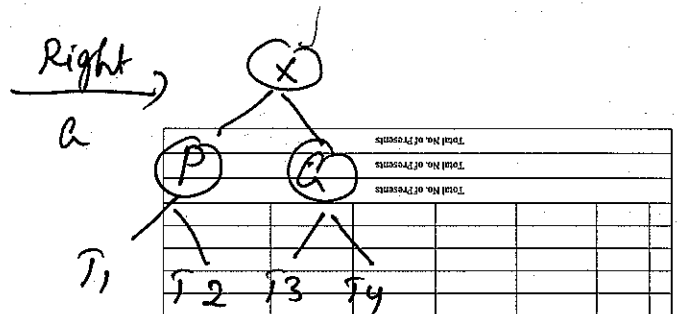
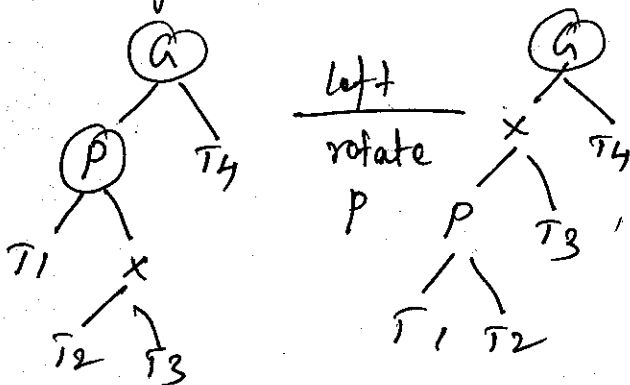
2) Zag zig rotation (Right - left.)

3) Zig - zig

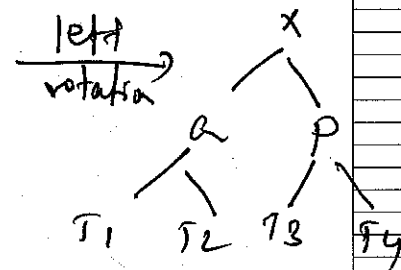
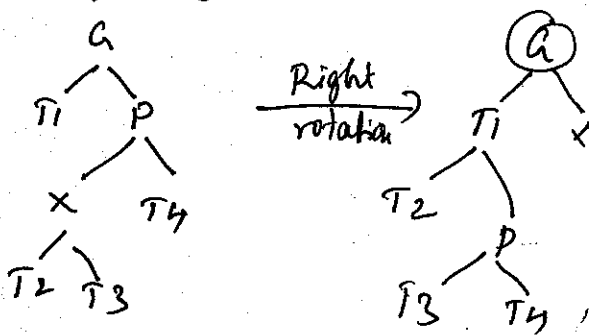
4) zag to zag.

5) Zig

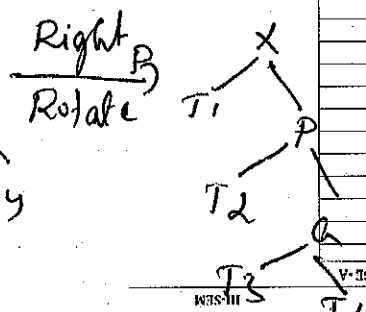
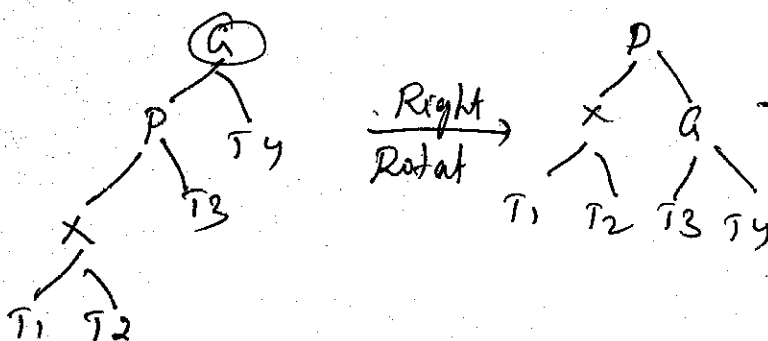
Zig - zag rotation



Zag - zig rotation



3) zig - zig rotation



IN SEM

St Joseph's Institute of Technology, Chennai - 119

II - Year B.E / B.TECH (2014 - 2018 BATCH)

CSE - A

REG No

NAME of the Student

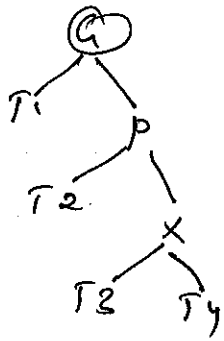
REG No

NAME of the Student

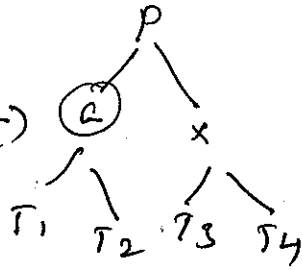
REG No

NAME of the Student

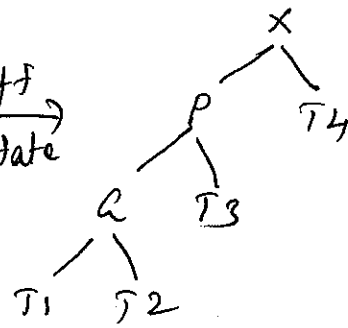
2ag 2ag



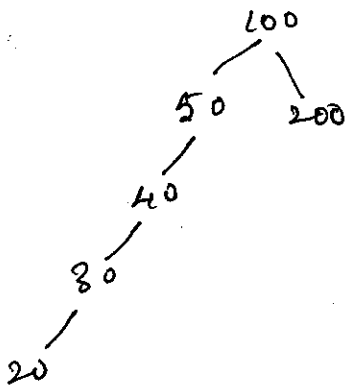
Left
Rotate



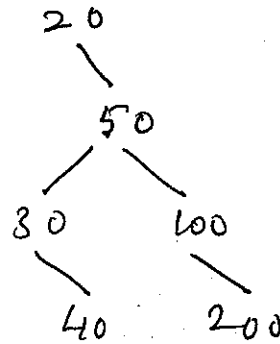
Left
Rotate



Insertion



Insert 25
1) spyay 25



Insert
25

