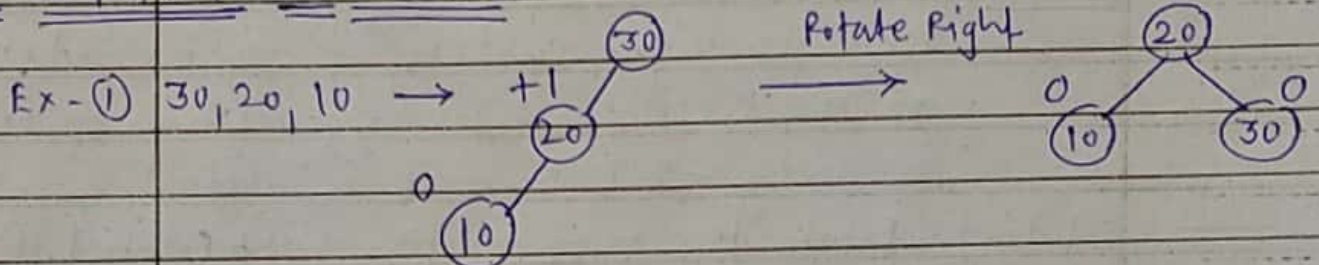


* Subject = Data structures.

* Topic = Height Balanced Trees (AVL Trees)

There are total 4 types of rotations to balance the height of binary search trees.

① R. Rotation (LL Rotation) +2.

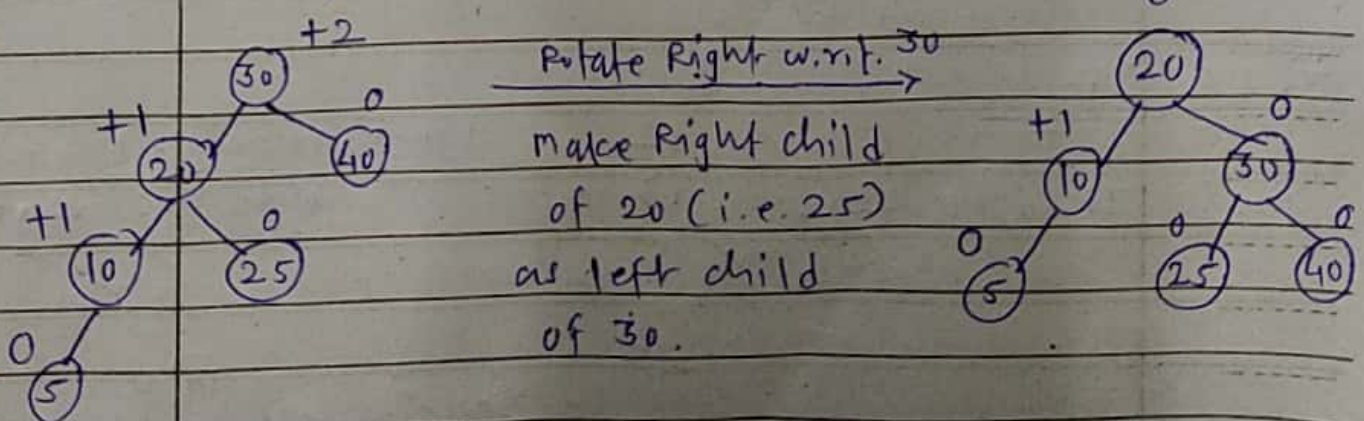


Balance factor = HL - HR

Reason = The newly inserted / added node i.e. node 10 is in the left subtree of the left subtree of the node (root) whose balance factor becomes +2 (Here it is node 30).

Solution = Rotate the tree in the right (clockwise) w.r.t. node whose balance factor becomes +2. (i.e. w.r.t. node 30)

Ex - ② 30, 40, 20, 10, 25, 5

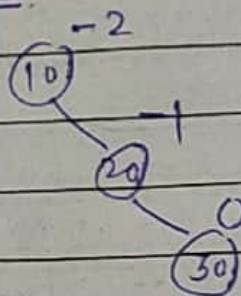


(2) L Rotation (RR Rotation)

Ex-①

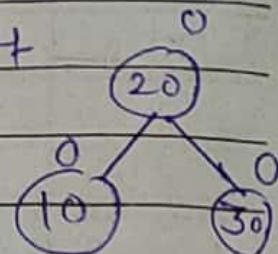
10, 20, 30

→



Rotate Left

→

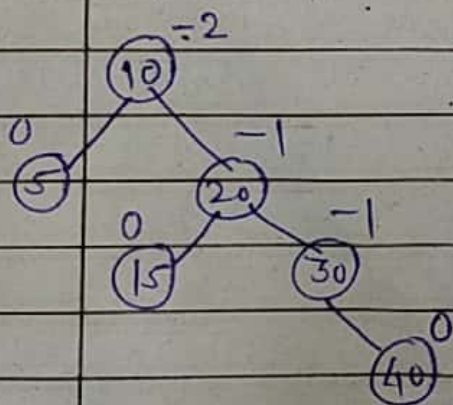


Balance Factor = $H_L - H_R$

Reason = The newly inserted / added node (i.e. node 30) is in the right subtree of right subtree of the node (root) whose balance factor becomes -2 (Here it is node 10).

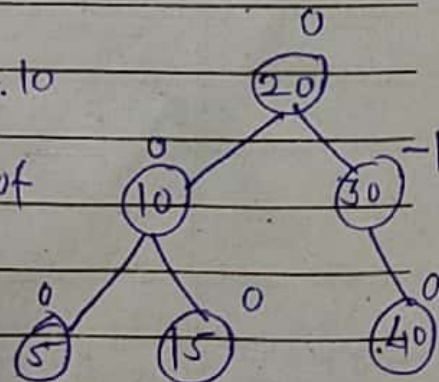
Solution = Rotate the tree in the left (Anticlockwise) w.r.t. node whose balance factor became -2 (i.e. w.r.t. node 10)

Ex-② 10, 5, 20, 30, 15, 40



Rotate Left w.r.t. 10

Make left child of 20 (i.e. 15) as right child of 10.

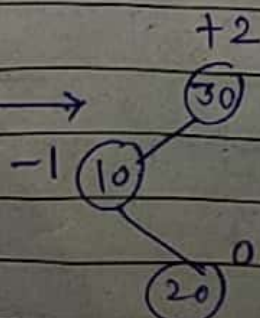


(3) LR Rotation

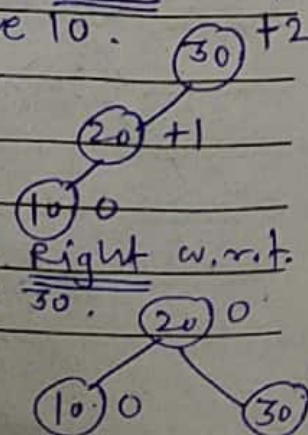
Ex-①

30, 10, 20

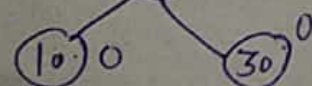
→



step-1) Rotate Left w.r.t. node 10.



step-2) Rotate Right w.r.t. node 30.

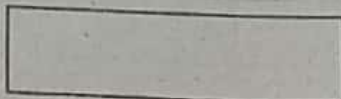




॥ अंतरी पेटवू ज्ञानज्योत ॥

NORTH MAHARASHTRA UNIVERSITY, JALGAON

Signature of the
Junior Supervisor
(with Date)



18/No. : 413102

PRACTICAL EXAMINATION IN
AT THE EXAMINATION
CANDIDATE'S SEAT NO. (in figures) SECTION
CANDIDATE'S SEAT NO. (in words)

INSTRUCTIONS TO CANDIDATES

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- 6) Please, see that your table is in good order before you leave the laboratory.

(Please start writing from here : Write on both sides)

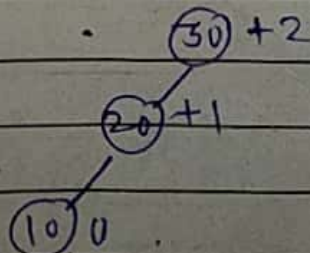
Balance Factor = $HL - HR$

Reason = The newly inserted/added node 20 is in the right subtree of the left subtree of node (root) whose balance factor became +2.
(Here it is node 30).

Solution =

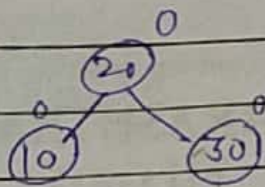
step-1) Rotate the tree in left (anticlockwise) w.r.t the root of the left subtree i.e. node 10 in our example.

Hence

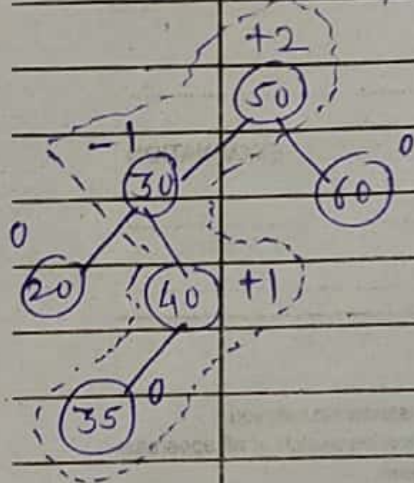


step-2) Now rotate the tree in right (clockwise) w.r.t. the main root i.e. node 30 whose balance factor became +2.

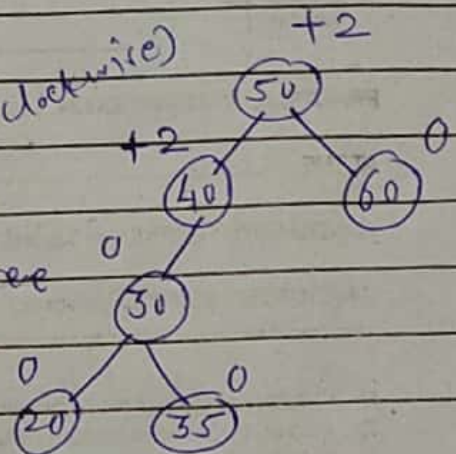
Hence



Ex - ② 50, 30, 60, 20, 40, 35

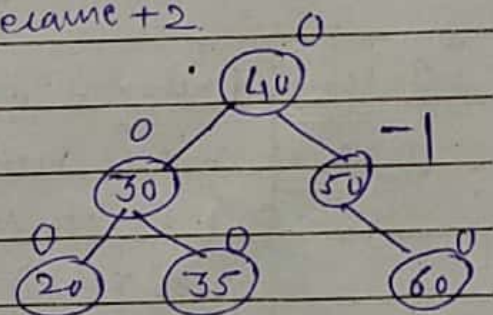


Step-1
 Rotate Left (Anticlockwise)
 w.r.t. Root/Node
 of the left subtree
 i.e. node 30.



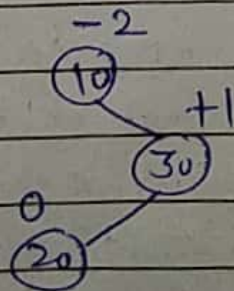
Step-2.

Rotate Right (Clockwise)
 w.r.t. Main Root/Node 50
 whose balance factor became +2.

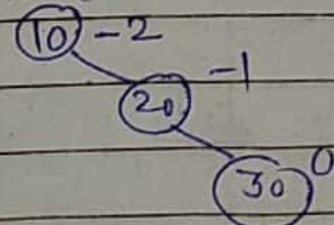


④ RL Rotation

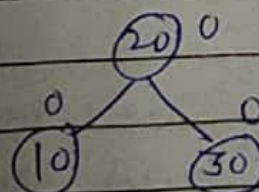
Ex - ① 10, 30, 20



Step-1) Rotate Right w.r.t.
 node 30



Step-2) Rotate left w.r.t. node 10.



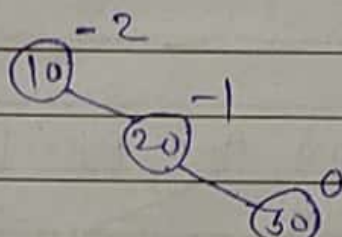
Balance Factor = $H_L - H_R$

Reason: The newly inserted / added node 20 is in the left subtree of the right subtree of node (root) whose balance factor became -2 (Here it is node 10).

Solution =

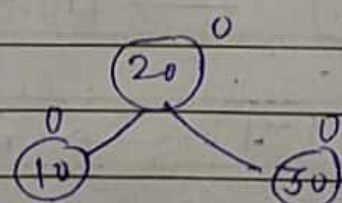
step-1) Rotate the tree in right (Clockwise) w.r.t. the root of the right subtree i.e. node 30 in our example.

Hence.

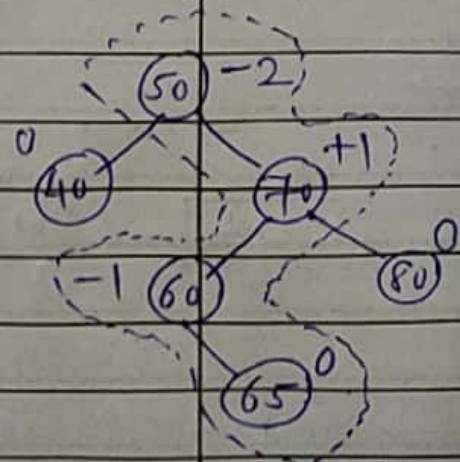


step-2) Now rotate the tree in Left (Anti-clockwise) w.r.t. the main root i.e. node 10 whose balance factor became -2.

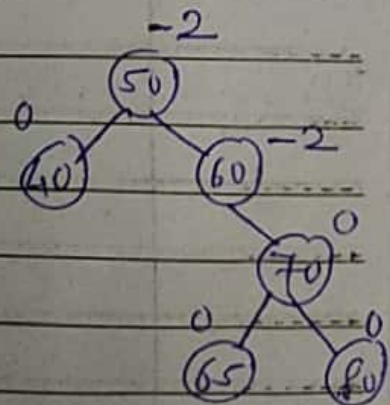
Hence



Ex. ② 50, 40, 70, 60, 80, 65

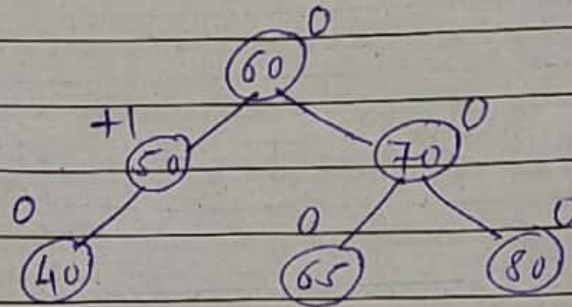


step-1
 Rotate Right (Clockwise)
 w.r.t. root / node
 of the right subtree
 i.e. node 70.



Step-2)

Rotate Left (Anticlockwise)
w.r.t. main Root / Node 50
where balance factor became -2.



Ex-① March, May, Nov, Aug, April, Jan, Dec, July, Feb, June, Oct, Sept.

Solution

New keyword After Insertion After Rebalancing.

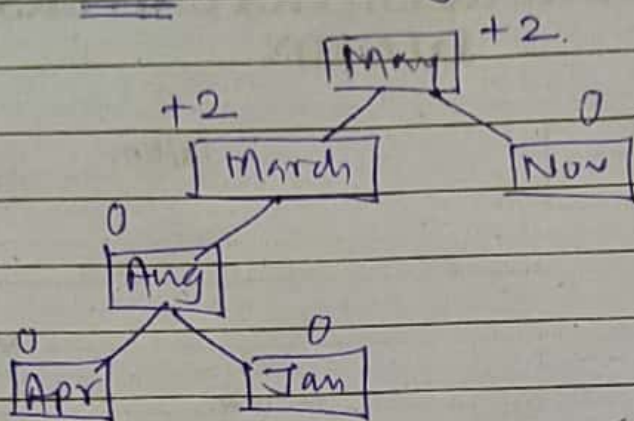
① March (March)⁰ → No Rebalancing Needed.

② May (March)⁻¹ / (May)⁰ → No Rebalancing needed.

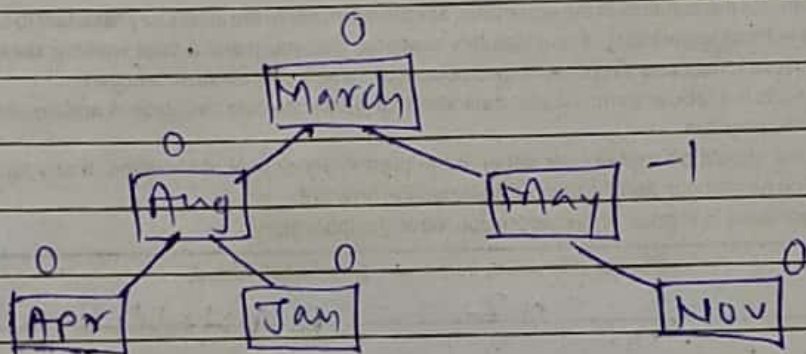
③ Nov (March)⁻² / (May)⁻¹ / (Nov)⁰ → L Rotation. (May)⁰ / (March)⁰ / (Nov)⁰

④ Aug (May)⁺¹ / (March)⁺¹ / (Nov)⁰ / (Aug)⁰ → No Rebalancing needed.

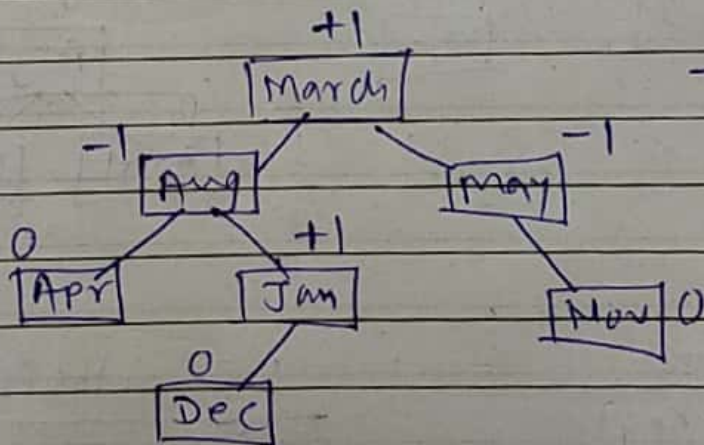
step-1) Rotate left w.r.t. Aug (i.e. Root/Node of left subtree).



step-2) Rotate right w.r.t. May (i.e. Root/Node whose balance factor became +2).

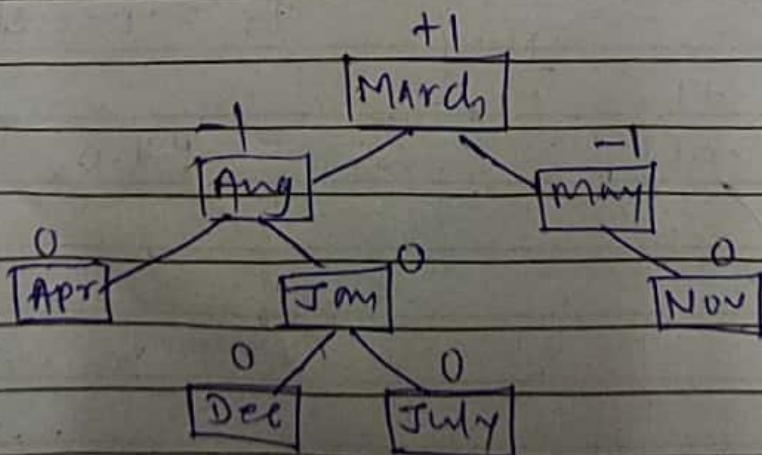


⑦ December



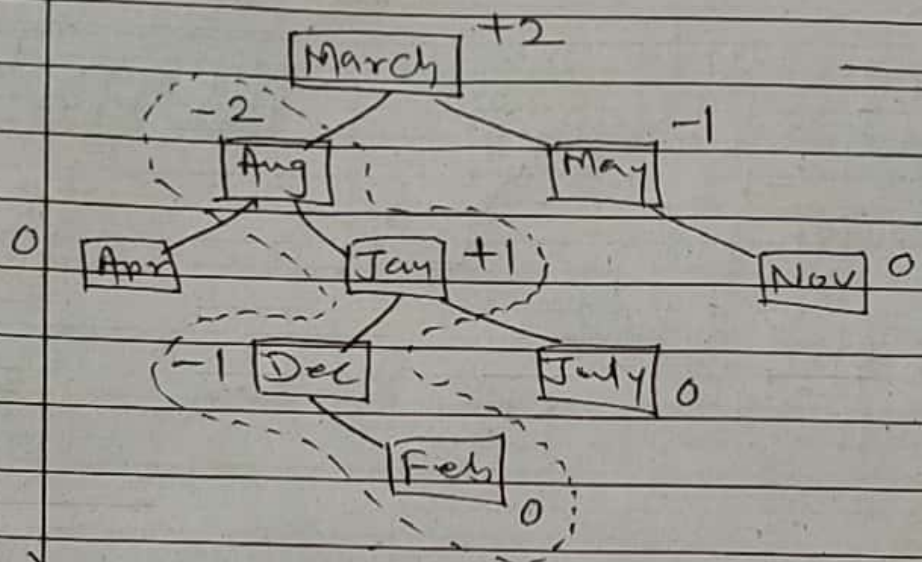
→ No Rebalancing needed.

⑧ July



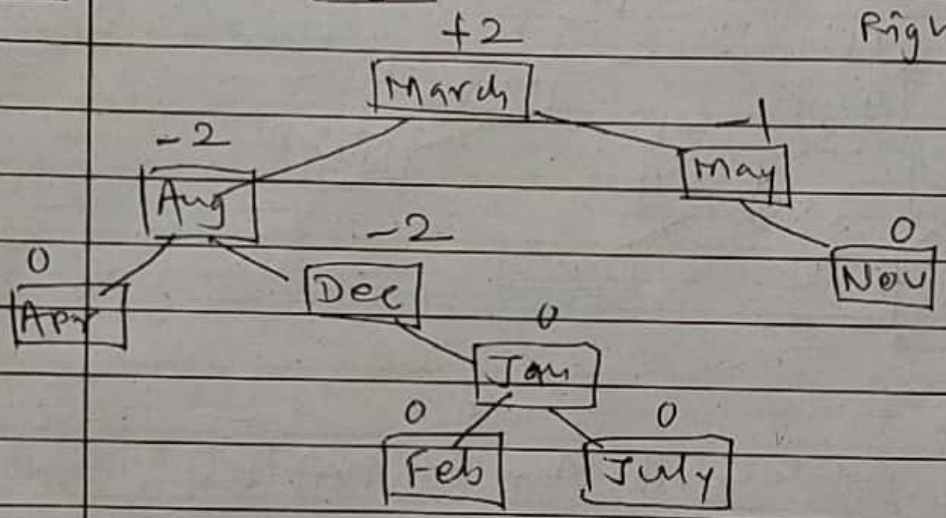
→ No Rebalancing needed.

⑨ Feb

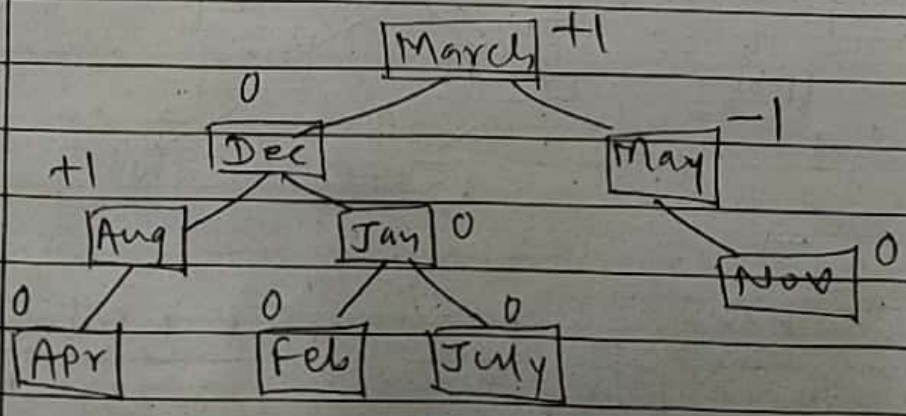


RL Rotation
is expected
here

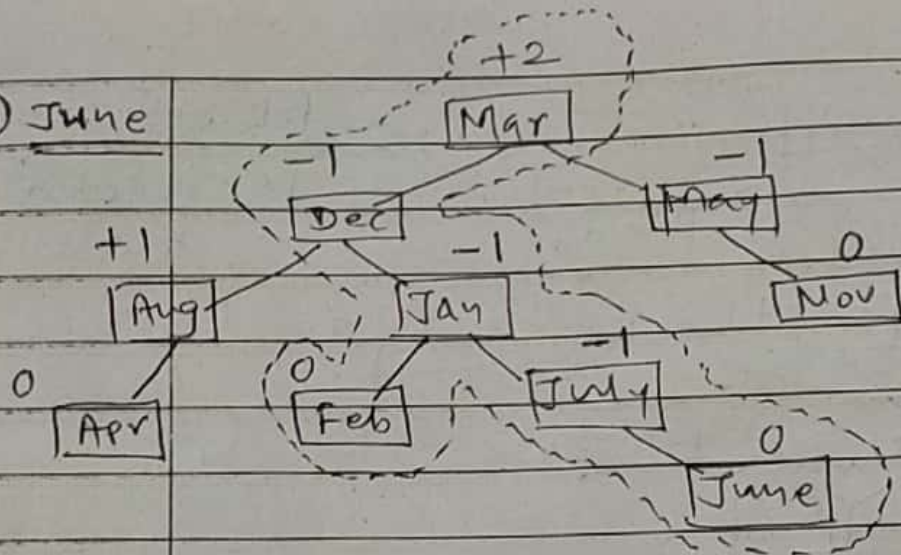
step-1) Rotate Right w.r.t. Jan (i.e. Root/Node of Right subtree)



step-2) Rotate Left w.r.t. Aug. (i.e. Main Root/Node whose balance factor became -2)

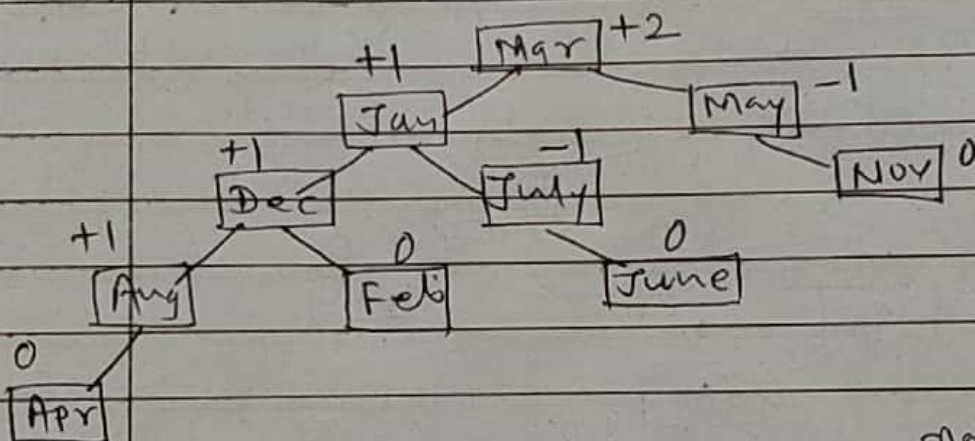


⑩ June

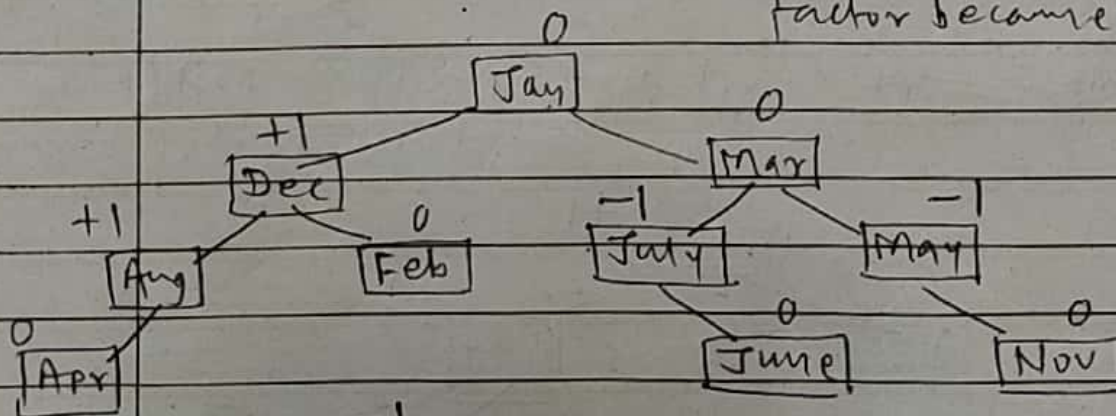


LR Rotation
→
is expected here.

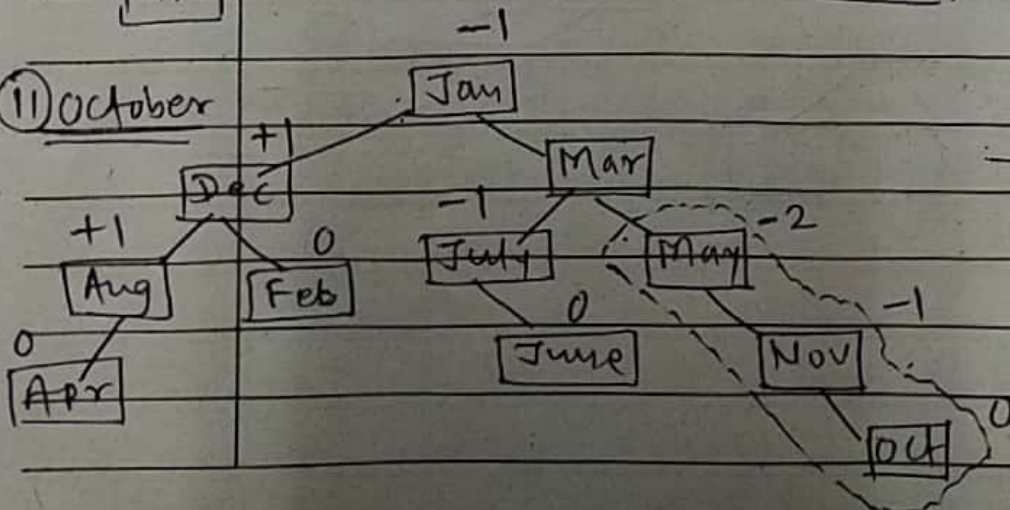
step-1) Rotate left w.r.t. Dec i.e. Root of left subtree.



step-2) Rotate right w.r.t. Mar i.e. Root ^{main} Node whose balance factor became +2.



⑪ October



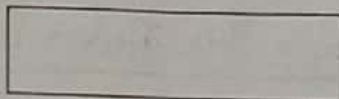
R Rotation
→
is expected here.



॥ अंतरी पेटवू ज्ञानज्योत ॥

NORTH MAHARASHTRA UNIVERSITY, JALGAON

Signature of the
Junior Supervisor
(with Date)



18/No. : 413100

PRACTICAL EXAMINATION IN

AT THE EXAMINATION

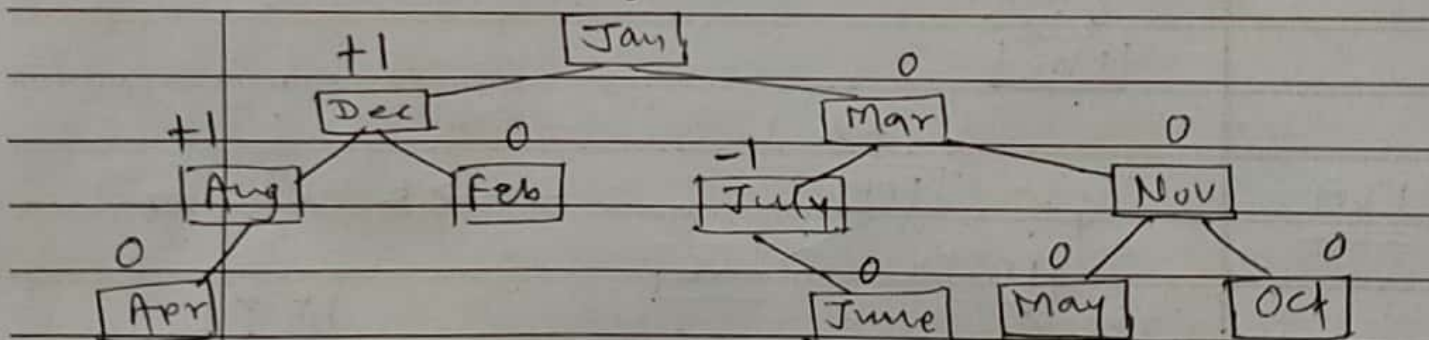
CANDIDATE'S SEAT NO. (in figures) SECTION

CANDIDATE'S SEAT NO. (in words)

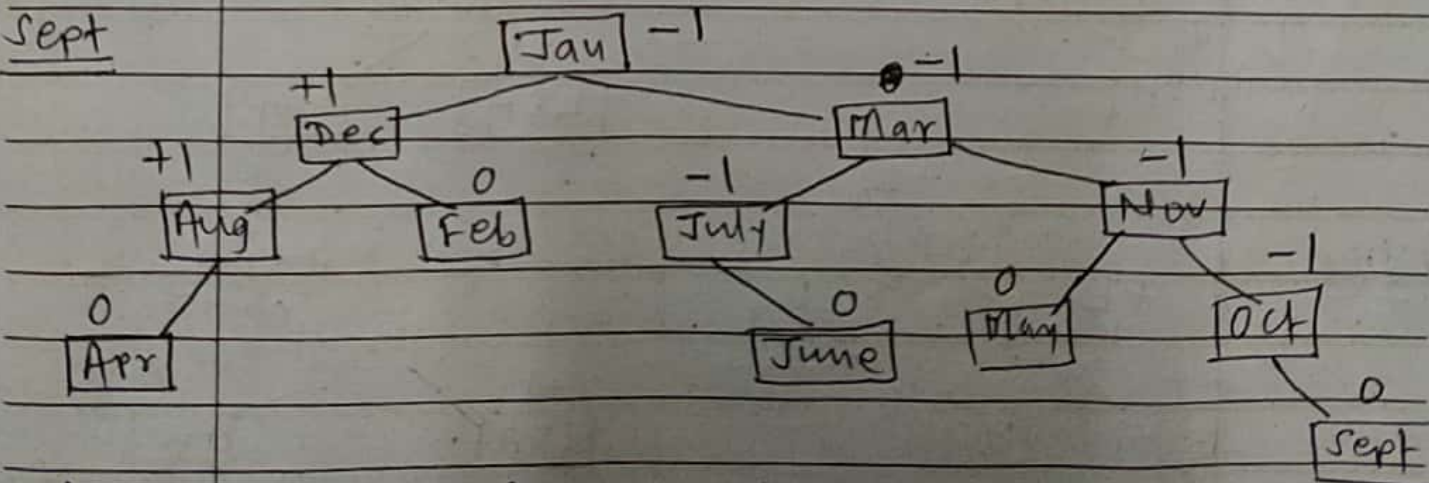
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(Please start writing from here : Write on both sides)



12) Sept

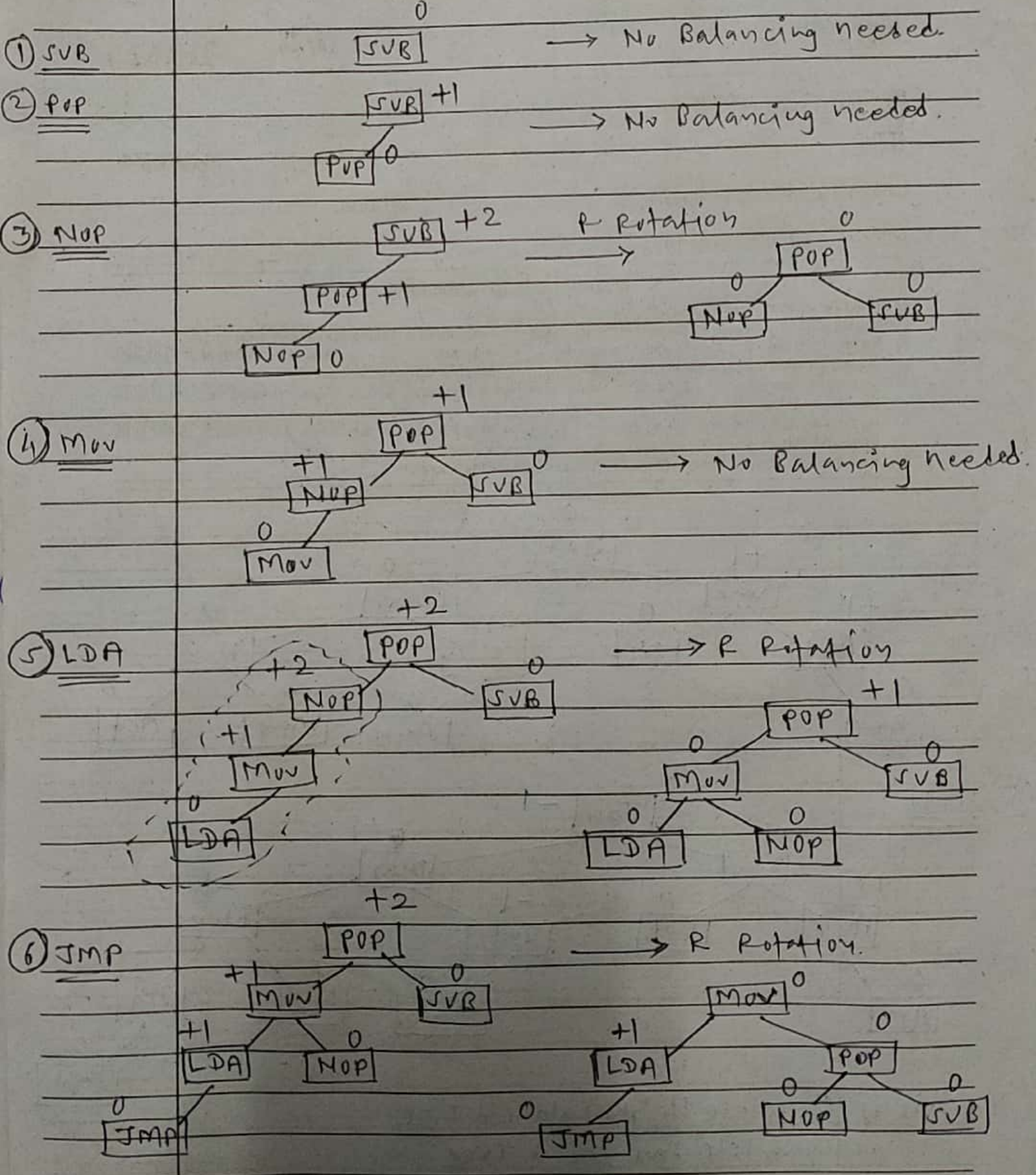


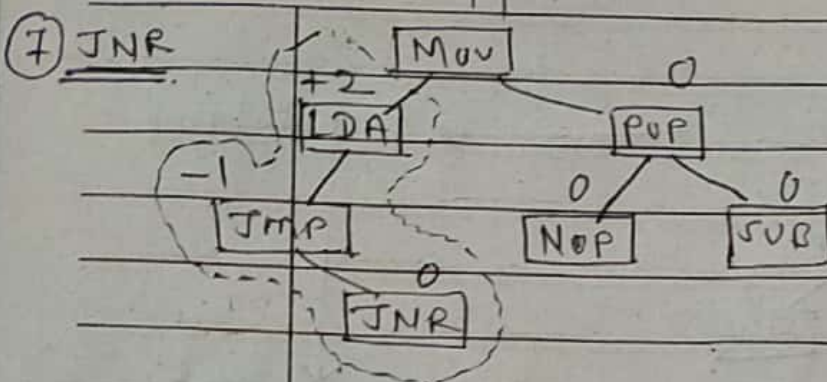
* This is complete Height Balanced Tree
or complete AVL search Tree.

Height Balanced Tree

Ex - (2) Insert following into BST

SUB, POP, NOP, MOV, LDA, JMP, JNR, HLT, DEC, COM, BR, ADD

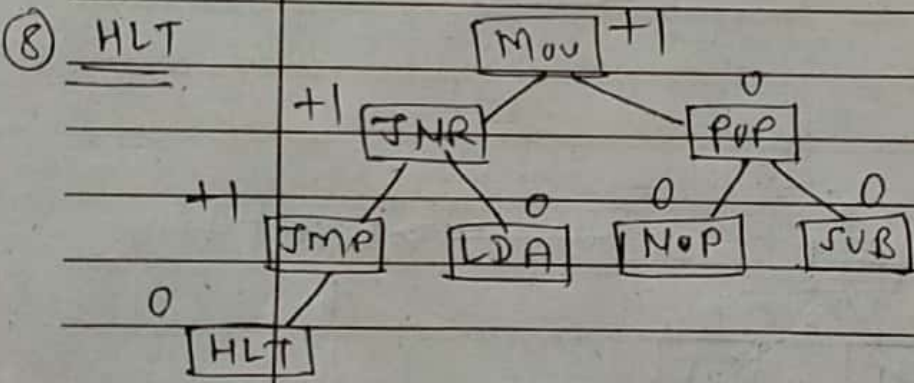
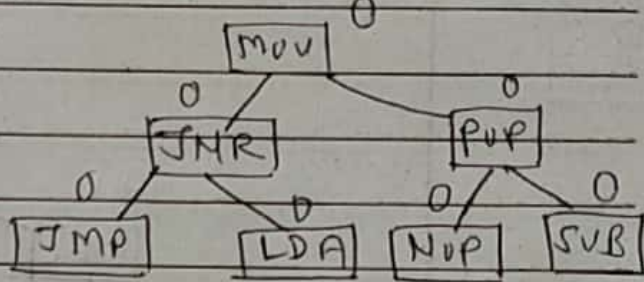
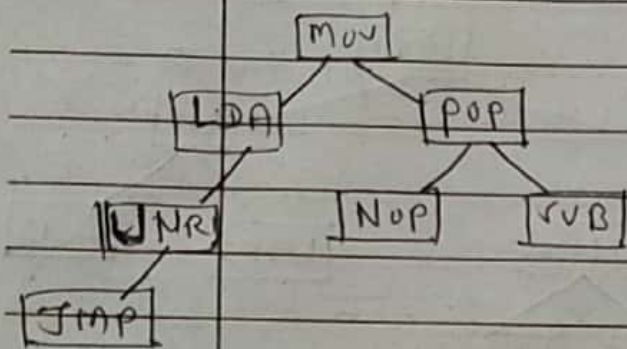




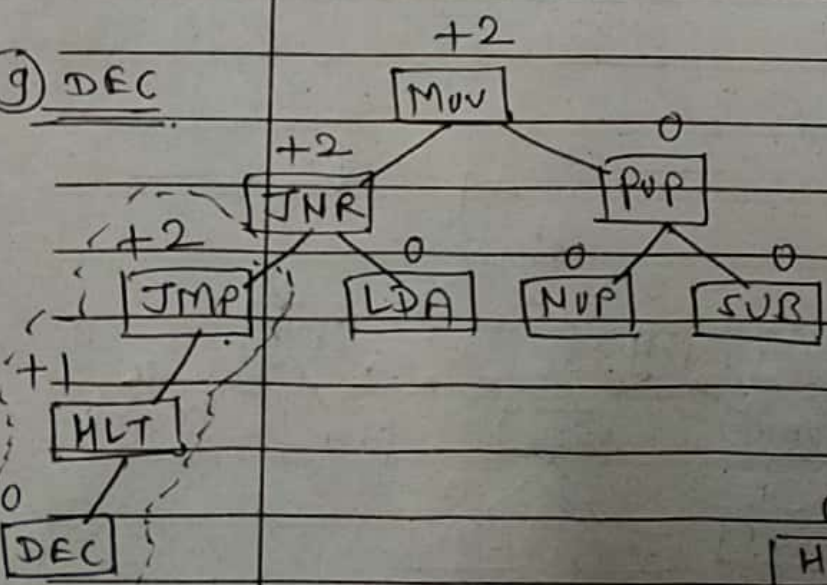
→ LR Rotation.

Step-1) L Rotation

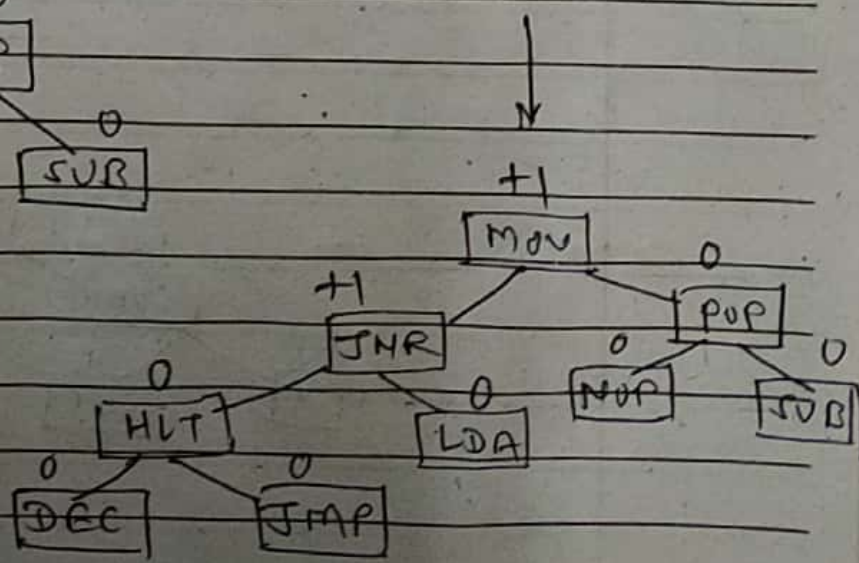
Step-2) R Rotation.



No Balancing needed.



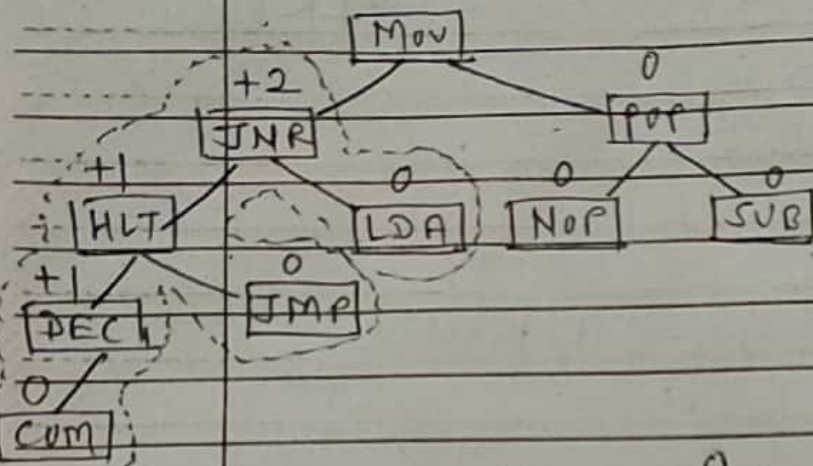
→ R Rotation



⑩ com

+2

→ R Rotation



com

+1

Mov

POP

HLT

DEC

JNR

NOP

SUB

com

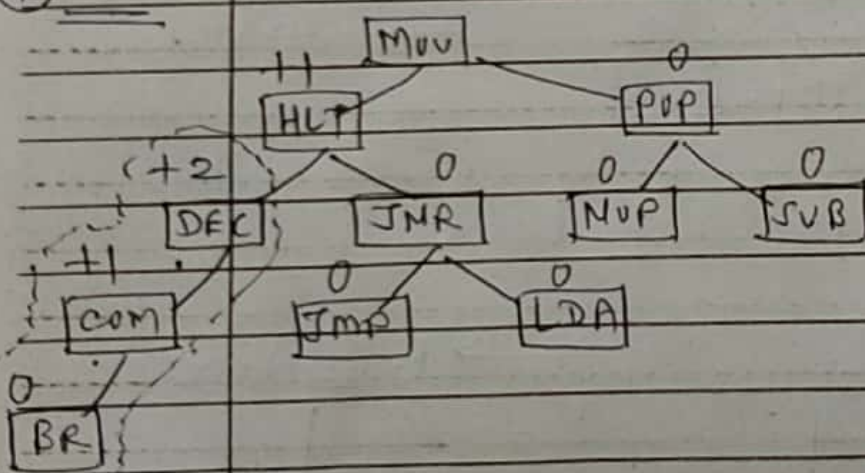
JMP

LDA

⑪ BR

+2

→ R Rotation



BR

Mov

HLT

POP

com

JNR

NOP

SUB

BR

DEC

JMP

LDA



॥ अंतरी पेटवू ज्ञानज्योत ॥

NORTH MAHARASHTRA UNIVERSITY, JALGAON

Signature of the
Junior Supervisor
(with Date)

18/No. : 413099

PRACTICAL EXAMINATION IN

AT THE EXAMINATION

CANDIDATE'S SEAT NO. (in figures) SECTION

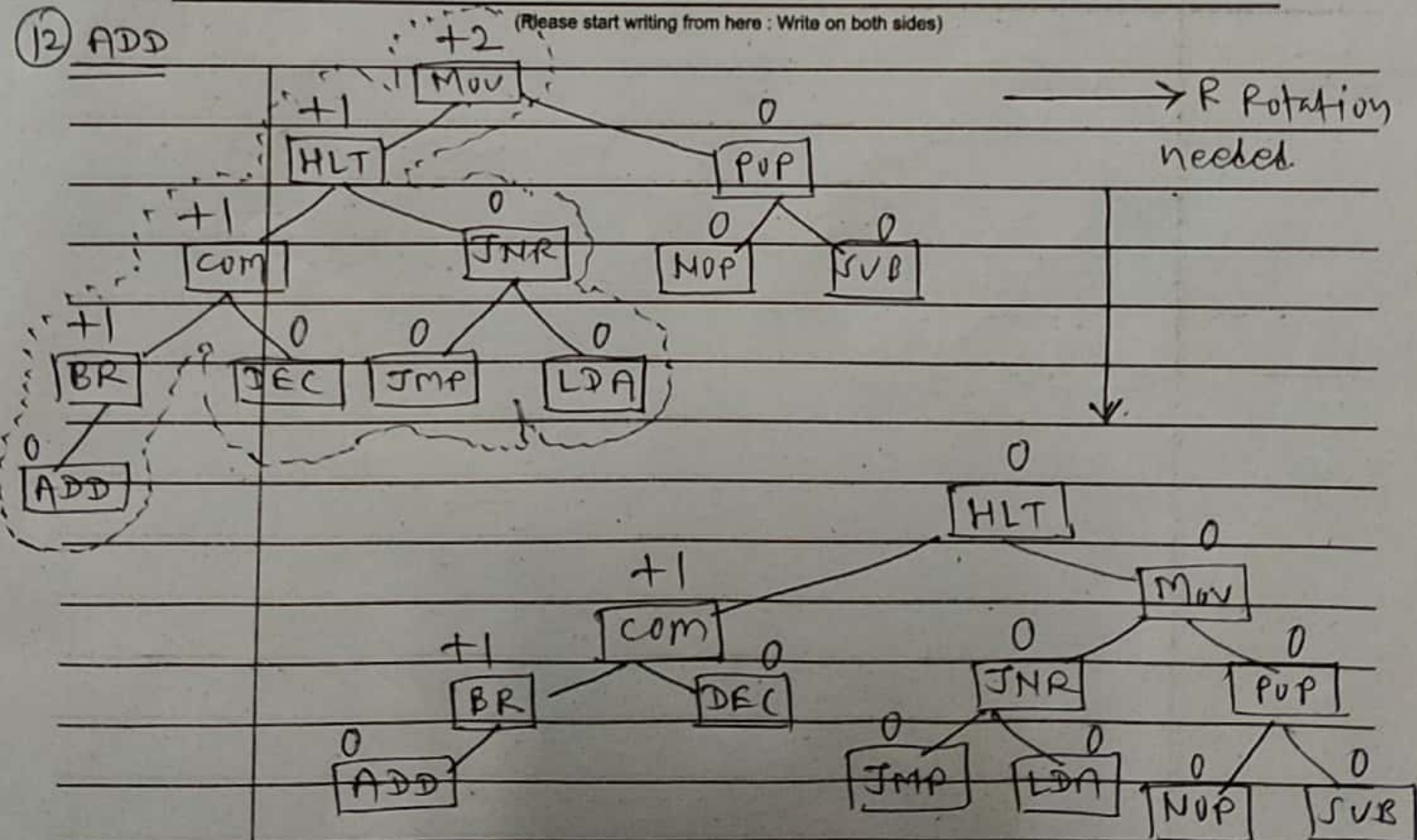
CANDIDATE'S SEAT NO. (in words)

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12) ADD

(Please start writing from here : Write on both sides)



* complete Height Balanced Tree *

* complete AVL search Tree *