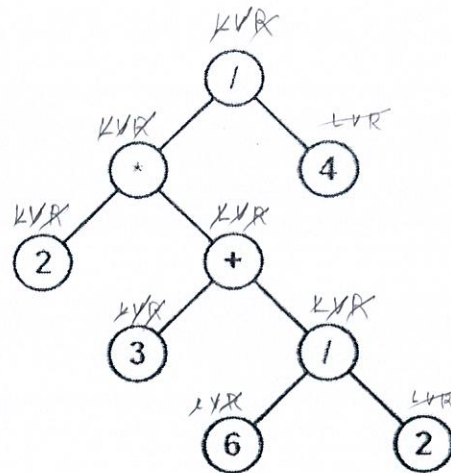


M2 Solution

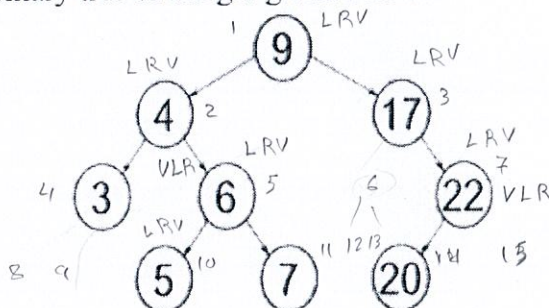
Question 1 | u/4 marks]

Part a: [1 point] Give the **expression** corresponding to the binary tree given on the right. *in order*

2 * [3 + (6 / 2)] / 4



Part b: [2 points] Consider the binary tree of integer given below:



- [1.00] Give the array representation of the tree.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
X	9	4	17	3	6		22			5	7			20					

- [0.25] what node is visited in post order traversal after node 6? 4
- [0.25] what node is visited in post order traversal after node 22? 17
- [0.25] what node is visited in pre order traversal after node 6? 5
- [0.25] what node is visited in pre order traversal after node 22? 20

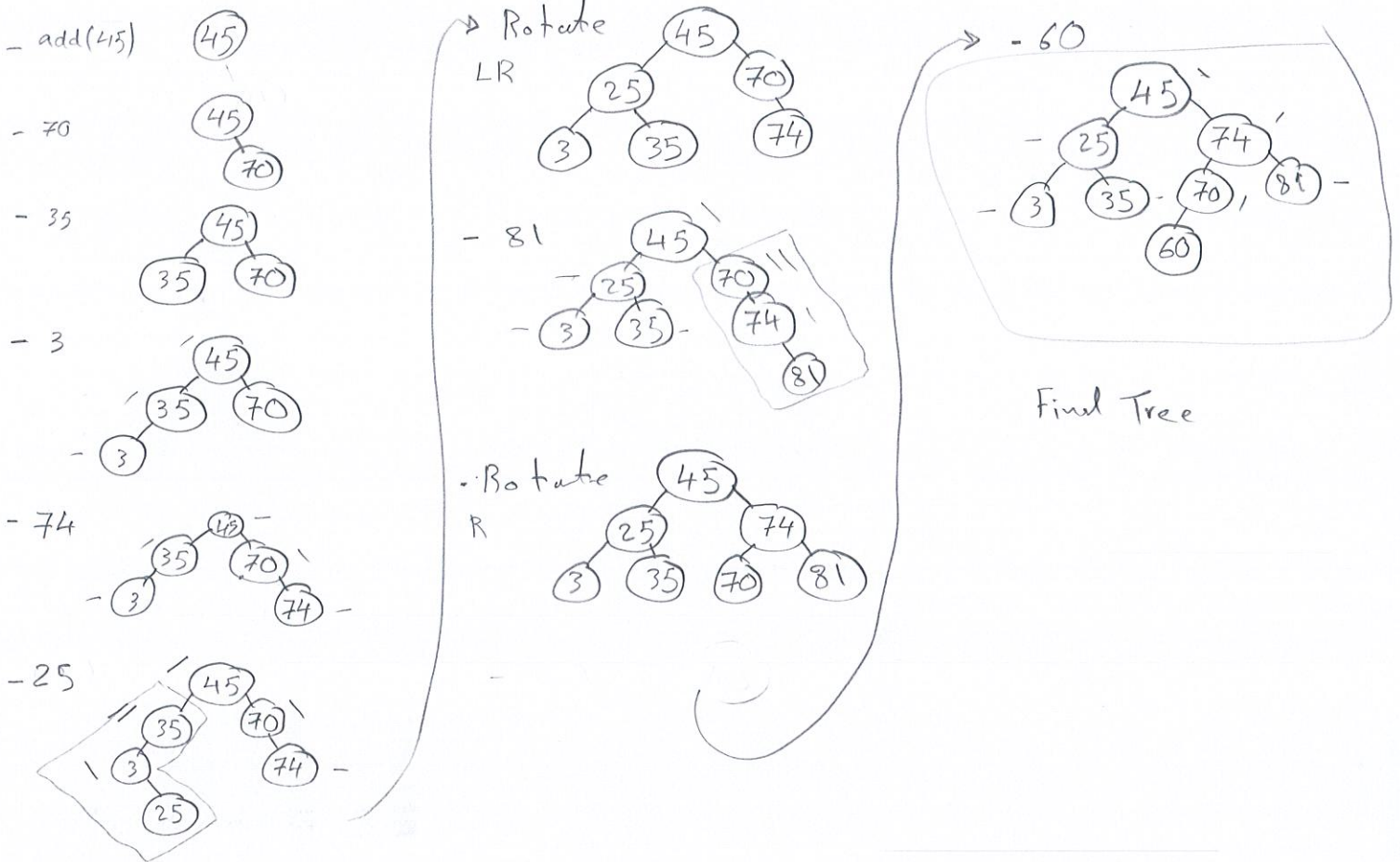
Part c: [1 point] Give the Big Oh run-time for the following operations (0.25 pts for each):

- Inserting an element in a BST: $O(n)$
- Removing an element from a AVL tree $O(\log n)$
- Pre-order traversal for all elements in a BST: $O(n)$
- Removing an element from an empty Binary Tree: $O(1)$

Question 2 - [3 marks]

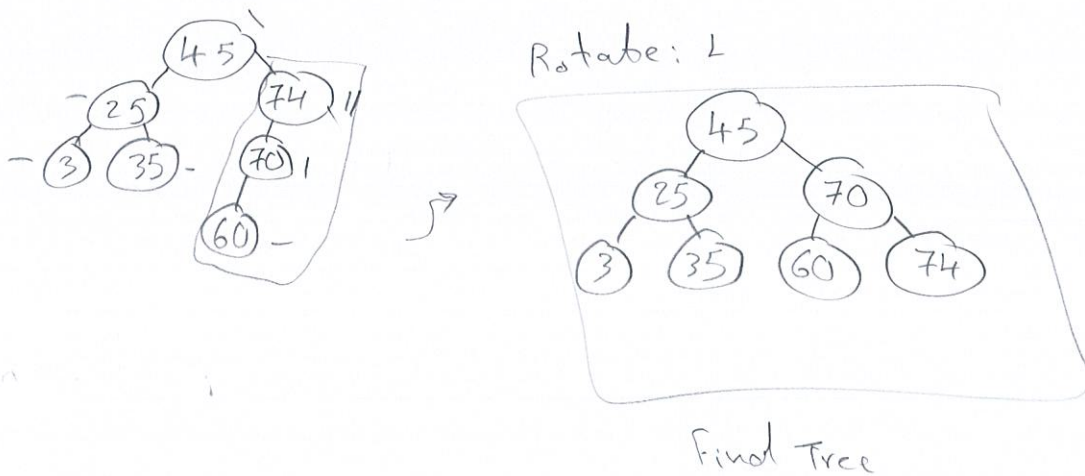
Part a: [2 points]

Create an AVL tree by inserting the following values: Re-draw the tree balancing after each insertion and identify each rotation (if necessary): 45, 70, 35, 3, 74, 25, 81, 60



Part b: [1 point] From the resulting tree, remove node 81. Which deletion case applies, re-draw the AVL tree and identify appropriate rotations (if necessary).

Case 0: No children



Question 3 | 4 /4 marks]

Consider a hash table of size 11 with hash function $h(i) = (2i+5) \bmod 11$. Show the table that results after inserting, in the given order, the following values: 12, 44, 13, 88, 23, 94, 11, 39, 20, 16 and 5. Assume that collisions are handled using Linear Probing and then separate chaining.

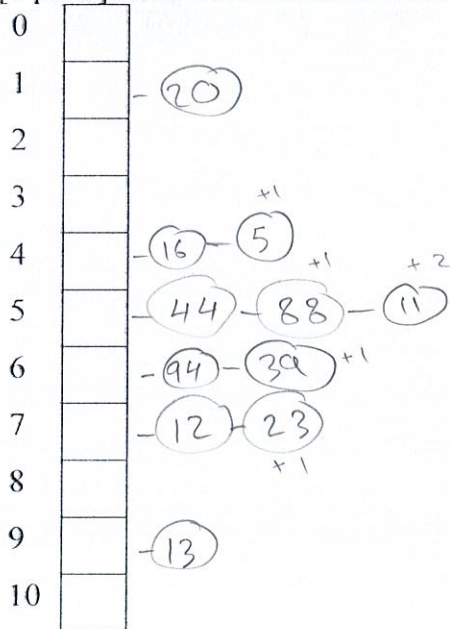
[1 point] Hash table with linear probing. Show all displacements.

0	11	+6	
1	39	+6	
2	20	+1	
3	5	+10	
4	16	0	
5	44	0	
6	88	+1	
7	12	0	
8	23	+1	
9	13	0	
10	94	+4	

[1 point] Compute Hash codes:

k	h(i)
12	7
44	5
13	9
88	5
23	7
94	6
11	5
39	6
20	1
16	4
5	4

[1 point] Draw the Hash table with separate chaining

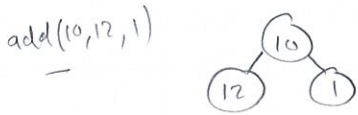


[1 point] How many collisions/displacements are observed for each method?

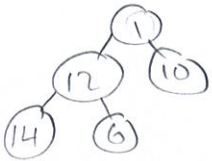
6 disp. for separate chaining
 29 disp. for linear probing

Question 4 - [/4 marks]

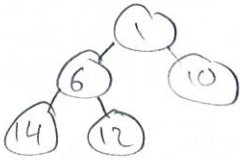
Part a [2 points]: Given the following sequence of elements stored in an array, $S = [10, 12, 1, 14, 6, 5, 8, 15]$ Insert the elements of the array S in a min-heap. Ensure to restore the heap order after every insertion.



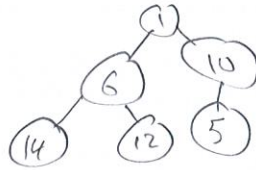
- add(14, 6)



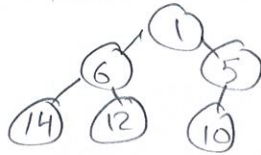
~~Rotate~~ swap



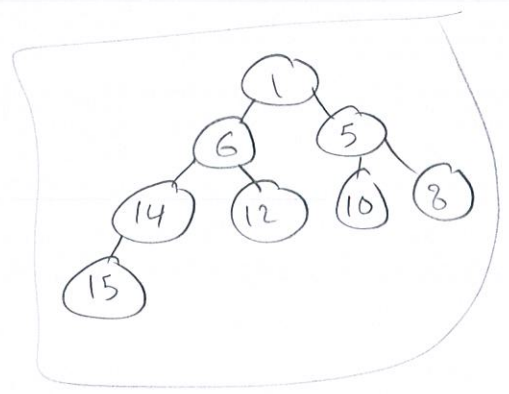
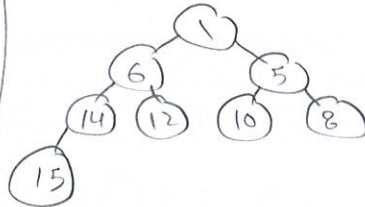
add(5)



~~Rotate~~ Swap



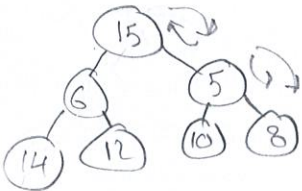
- add(8, 15)



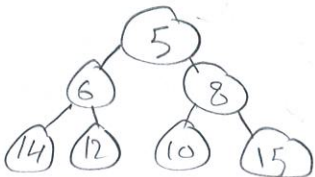
Part b [2 points]: From the resulting tree (heap), remove **two** values. Show all sink/swim (heap up and heap down) operations.

* remove(1)

- swap(1, 15) & remove(1)

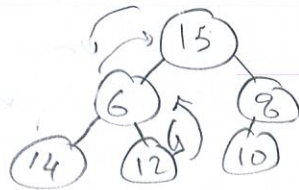


- sink(15) twice



* Remove(5)

- swap(5, 15) & remove(5)



- sink(15) twice

