SHIV NADAR
INSTITUTION OF EMINENCE DEEMED TO BE UNIVERSITY
DELHI NCR

Programme: **B. Tech** Discipline: **Computer Science and Engineering**
Exam: **End Semester** Year: **2024-2025**
Course Code: **CSD102** Course Title: **Data Structures**
Date: **May 06, 2025** Time: **2:00 PM – 4:00 PM** Max. Marks: **60**

Instructions: Ques.1 and Ques. 2 to be done in the Question Paper itself.

Ques.1 Multiple Choice Questions (Single Correct): (19 Marks)

1. In Binary Tree construction, which is the suitable efficient data structure?
(a) Array **(b)** Linked List **(c)** Stack **(d)** Queue

2. Which of the following is useful in traversing a given graph by Breadth First Search?
(a) Queue **(b)** Array **(c)** Stack **(d)** List

3. In a min heap, inserting which element would lead to the worst case time complexity?
(a) An element smaller than all elements in the heap **(c)** An element larger than all elements in the heap
(b) An element which is smaller than just the largest element in the heap **(d)** Cannot be determined

4. Consider 2 sorted lists of size 50 and 60 respectively. Find the number of comparisons needed in the worst case by merge sort algorithm?
(a) 109 **(b)** 50 **(c)** 60 **(d)** 3000

5. The tree traversal in which the node is processed before the recursive call to the child nodes complete?
(a) Postorder **(b)** Preorder **(c)** Inorder **(d)** Level Order

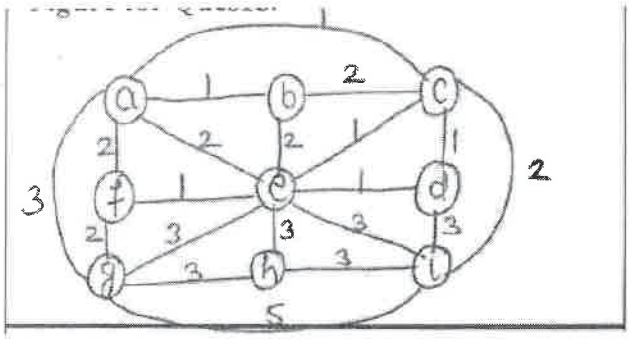
6. Which of the following sequence of array elements form a valid binary max heap?
(a) 35, 21, 10, 14, 15, 9, 6 **(c)** 40, 20, 14, 15, 21, 4, 11
(b) 50, 18, 14, 15, 17, 16, 12 **(d)** 9, 6, 4, 2, 1, 5, 3

7. The number of leaf nodes in a rooted tree of 10 nodes with each node having 0 or 3 children is:
(a) 4 **(b)** 5 **(c)** 6 **(d)** 7

8. Consider a hash table of size 7, with starting index zero, and a hash function *(3K + 4)mod7*. Assuming the hash table is initially empty, and the sequence 1, 3, 8, 10 is inserted into the table using double hashing. What will be the index values of 8 and 10 in the resultant table?
(a) 2 & 6 **(b)** 2 & 4 **(c)** 4 & 6 **(d)** 4 & 2

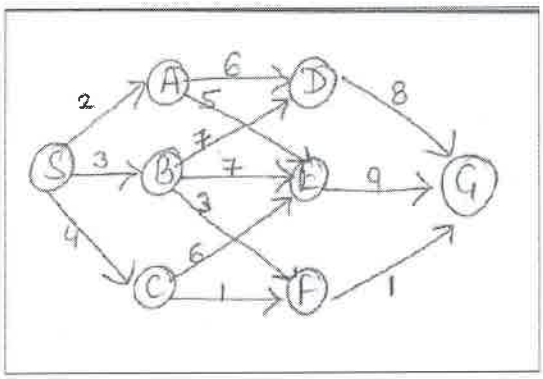
9. The Bellman Ford Algorithm solves the single-source shortest path problem in the case in which edge weights may be negative, what is the time complexity of running Bellman Ford Algorithm?
(a) $O(V^2)$ **(b)** $O(V * E)$ **(c)** $O(V + E)$ **(d)** $O(E \log V)$

10. Find the length of the Minimum Spanning Tree for the following graph using Kruskal's Algorithm:



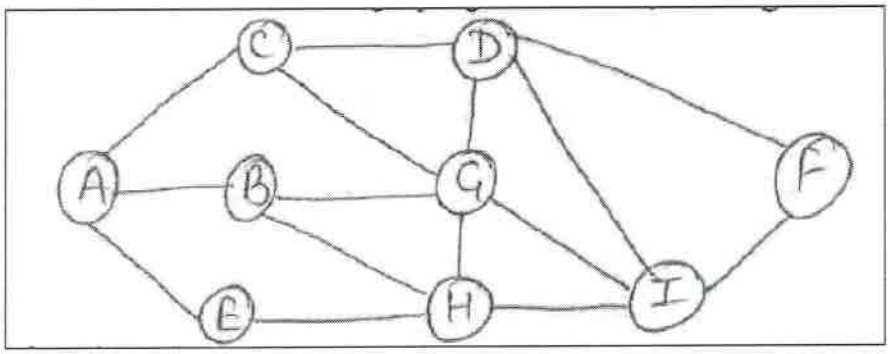
(a) 10
(b) 11
(c) 12
(d) 13

11. Consider the given multi stage graph. What is the shortest path from node 'S' to node 'G' using Dijkstra's approach?



(a) S -> B -> F -> G
(b) S -> A -> D -> G
(c) S -> C -> F -> G
(d) S -> B -> E -> G

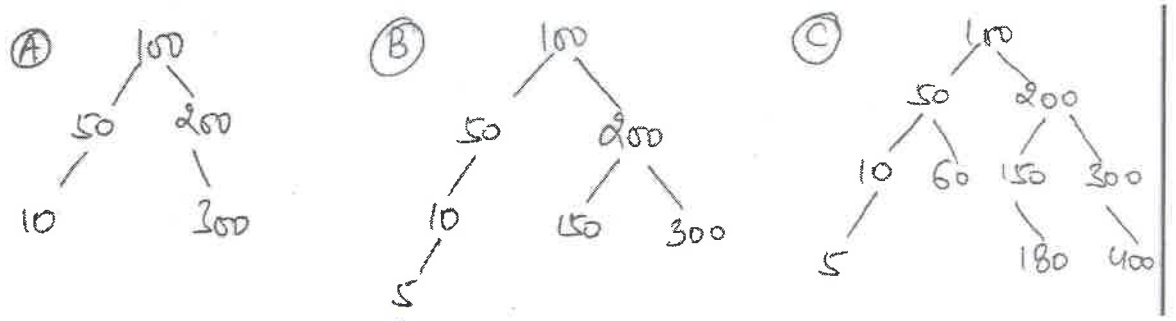
12. Write the BFS sequence on the graph given below, starting at vertex A.



Assume that the adjacency lists are in sorted order. For Example, when exploring vertex E, the algorithm considers the edge E-B, before E-C, E-F, E-G, or E-H. Which of the following is the order of vertices that are enqueued on the FIFO queue?

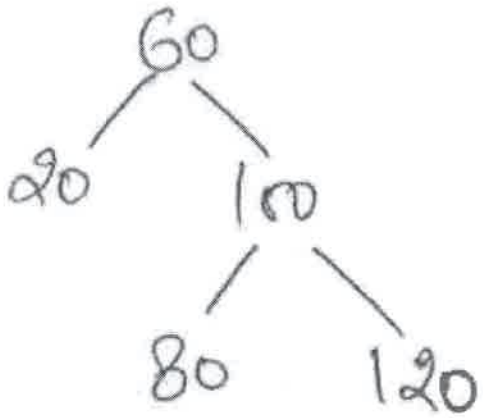
(a) A, B, C, E, G, H, I, D, F
(b) A, B, C, D, E, G, H, I, F
(c) A, B, C, E, H, G, D, I, F
(d) A, B, C, E, G, H, D, I, F

13. Which of the following is AVL Tree?

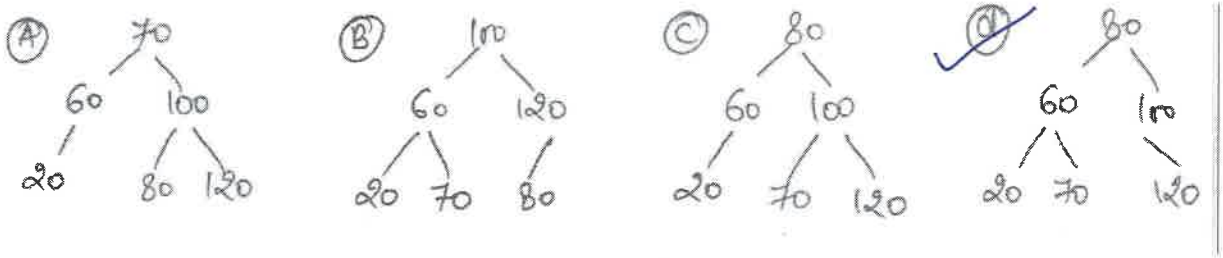


(a) Only A **(b)** A and C **(c)** A, B and C **(d)** Only B

14. Consider the following AVL Tree



Which of the following is updated AVL tree after insertion of 70. Also mention which rotation will be applicable after insertion of 70.



RL Rotation

15. A hash table of length 10 uses open addressing with hash function h(k)=k mod 10, and linear probing. After inserting 6 values into an empty hash table, the table is as shown below.

0	
1	
2	42
3	23
4	34
5	52
6	46
7	33
8	
9	

Which one of the following choices gives a possible order in which the key values could have been inserted in the table?

(a) 46, 42, 34, 52, 23, 33
(b) 46, 34, 42, 23, 52, 33
(c) 34, 42, 23, 52, 33, 46
(d) 42, 46, 33, 23, 34, 52

16. In delete operation of BST, we need inorder successor (or predecessor) of a node when the node to be deleted has both left and right child as non-empty. Which of the following is true about inorder successor needed in delete operation?

(a) Inorder Successor is always a leaf node
(b) Inorder successor is always either a leaf node or a node with empty left child
(c) Inorder successor may be an ancestor of the node
(d) Inorder successor is always either a leaf node or a node with empty right child

17. Create a max-heap starting from the following elements 2, 1, 4, 6, 5, 3, 7 in this particular order, and identify the final order of the elements in an array representation of the heap.

(a) 7, 5, 6, 1, 4, 3, 2
(b) 7, 6, 5, 1, 4, 3, 2
(c) 7, 6, 4, 1, 5, 3, 2
(d) 7, 6, 5, 4, 3, 2, 1
(e) None of the above

18. The following C function takes a single-linked list of integers as a parameter and rearranges the elements of the list. The function is called with the list containing the integers 1, 2, 3, 4, 5, 6, 7 in the given order. What will be the contents of the list after the function completes execution?

```
struct node
{
        int value;
        struct node *next;
};
void rearrange(struct node *list)
{       struct node *p, * q;
        int temp;
        if (( ! list) || ! (list->next))
        return;
        p = list;
        q = list->next;
        while(q)
        {       temp = p -> value;
                p -> value = q -> value;
                q -> value = temp;
                p = q -> next;
                q = p? p -> next : 0;       } }
```

(a) 1, 2, 3, 4, 5, 6, 7
(b) 2, 1, 4, 3, 6, 5, 7
(c) 1, 3, 2, 5, 4, 7, 6
(d) 2, 3, 4, 5, 6, 7, 1

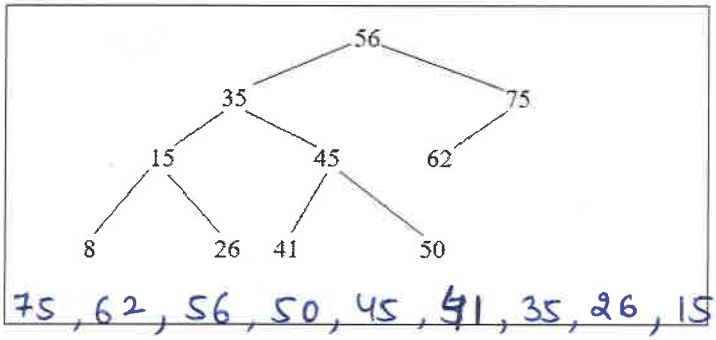
19. A hash function *h* defined as h(key) = key mod 7, with linear probing, is used to insert the keys 44, 45, 79, 55, 91, 18, 63 into a table indexed from 0 to 6. What will be the location of key 18? 5

Ques.2 Short Answer Questions:

1. What would be the minimum height of a Binary Search Tree with 24 nodes? 5 **(1 Mark)**
2. What is the minimum and maximum number of nodes in an AVL tree of height 5. **(1 Mark)**
   Minimum: 20 **Maximum:** 63
3. You are given a Binary min heap of height 'h'. The minimum and maximum number of comparisons we might have to do when inserting the next value (in terms of h) is: **(1 Mark)**
   Minimum: 1 **Maximum:** h

4. Write the output of the following function when applied on the tree shown. **(1 Mark)**

```
void display (struct node *node)
{
    if (node == NULL)
                return;
    display (node->right);
    printf("%d, ", node->data);
    display(node->left);
}
```

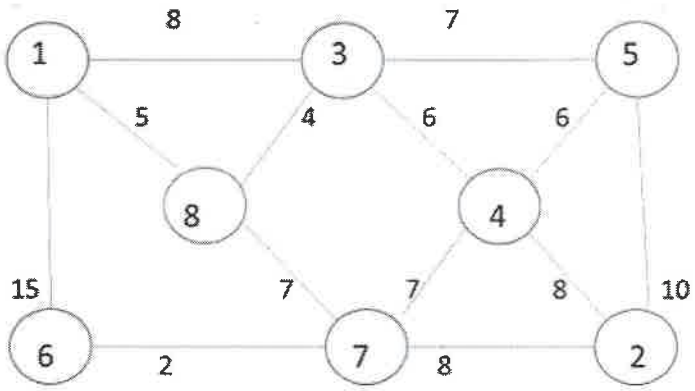


75, 62, 56, 50, 45, 41, 35, 26, 15, 8

5. Insert 29, 58, 44, 51, 73, 84, 22, 18 in a hash tale of size 11using the hash function f(x) = x mod 11. In case of a collision, use Quadratic probing. Note number of elements is less than the table size. You do not need to show working while inserting each element. Write the sequence of inserted elements starting from index 0 till index 10. You may represent an empty cell with a hyphen (~). **(2 Marks)**

0	1	2	3	4	5	6	7	8	9	10
44	84	~	58	22	73	~	29	51	~	18

6. Apply Dijkstra's algorithm on the following graph and compute the distance of the shortest paths of all the nodes starting from node 1. You do not show the complete working of the algorithm, only write the distances of all the nodes in sequence starting from node 1 to node 8. **Also write the order in which nodes are visited.** **(3 Marks)**



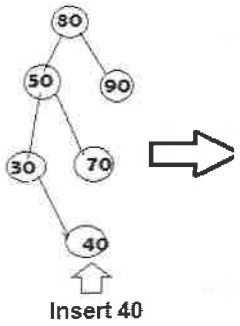
1	2	3	4	5	6	7	8
0	20	8	14	15	14	12	5

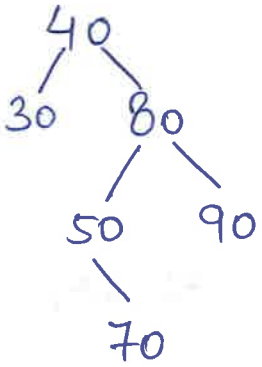
Order in which nodes are visited: 1 → 8 → 3 → 7 → 6 → 4 → 5 → 2

7. 'T' is a binary tree of height 3. What is the maximum number of nodes that 'T' can have? What is the minimum number of nodes that 'T' can have? **(1 Mark)**

Minimum = 4 Maximum = 15

8. Draw the resultant splay tree after the insertion operation? **(2 Marks)**



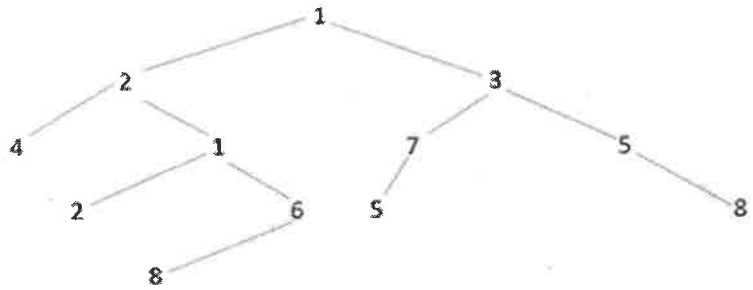


9. **(1 Mark)**

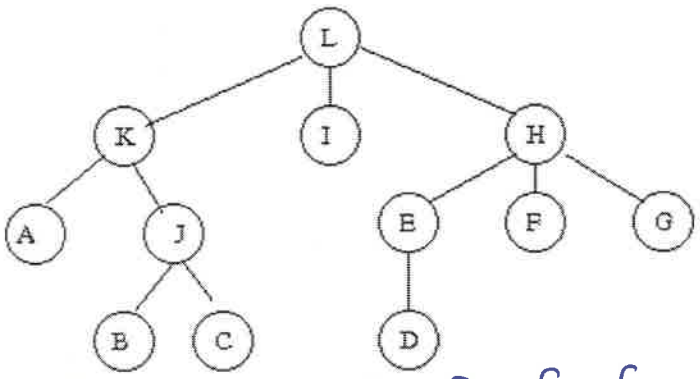
What value of count will be returned by the following function when applied on the tree shown?

```
int count = 0;
int tree(struct node * t) {
   if (t != NULL) {
        tree( t→left);
        if (( t→ left==NULL) || (t→right==NULL))
             count++;
        tree(t→right); }
   return count;
}
```

8



10. List the nodes of the tree below in preorder, postorder, and breadth-first order. **(3 Marks)**



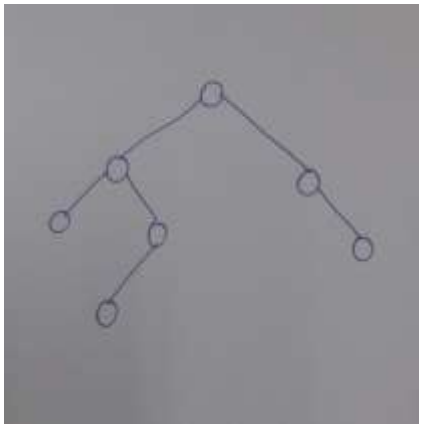
Preorder: L, K, A, J, B, C, I, H, E, D, F, G

Postorder: A, B, C, J, K, I, D, E, F, G, H, L

Breadth-First Order: L, K, I, H, A, J, E, F, G, B, C, D

*Question 3 onwards, write all answers in the Answer Sheet:

Ques.3 Label the following binary tree with numbers from the set {6, 22, 9, 14, 13, 1, 8} so that it is a legal binary search tree (you can choose the numbers in this set in any order). **(5 Marks)**



Show how the tree above would look like after each of the following operations:

(i) delete 13
(ii) insert 34 (use the original tree before deletion of 13)

Ques.4 Consider a hash table of size 7, with starting index zero, and a hash function *(3x + 4)mod7*. Assuming the hash table is initially empty, what will be the resultant table when the sequence 1, 3, 8, 10 is inserted into the table using double hashing? **(3 Marks)**

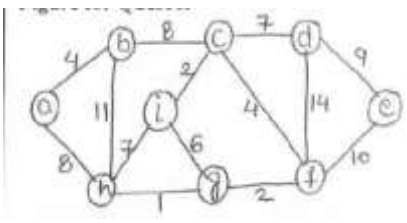
Ques.5 Sort the following elements using Heap Sort. **(3 Marks)**

5, 13, 17, 10, 84, 19, 6, 22, 9

Ques.6 Construct Huffman Tree for the below given characters. Assign codes to each symbol as per Huffman Coding Scheme. **(3 Marks)**

Symbol	Frequency
A	60
B	79
C	69
D	81
E	26
F	15
G	3
H	5
I	2

Ques.7 Find the Minimum Spanning Tree for the following graph using Prim's Algorithm: **(3 Marks)**



Ques.8 In the following questions, consider the list of numbers: 62, 31, 70, 91, 25, 11, 9, 61, 73, 6.

1. Show the result of inserting the numbers in the list in the same order specified above into an initially empty minimum heap. Note that you need to show how the heap looks like after each number is inserted. **(3 Marks)**
2. Show the result of inserting the numbers in the list in the same order specified above into an initially empty binary search tree. Note that you need to show how the binary search tree looks like after each number is inserted. **(3 Marks)**

3. Use the binary search tree you created in question 2. What are the two possible binary search trees after 62 is deleted? **(2 Marks)**

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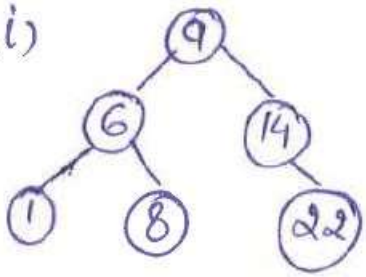
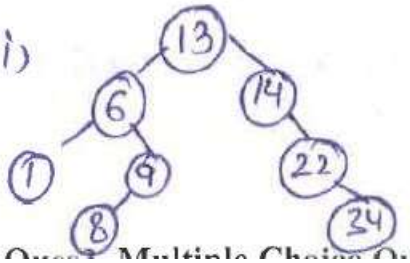
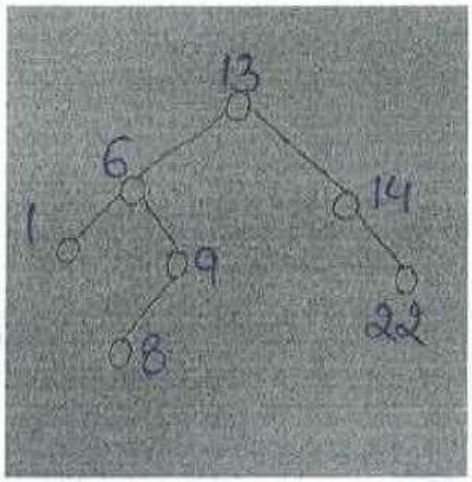
Ques. 3

(i)



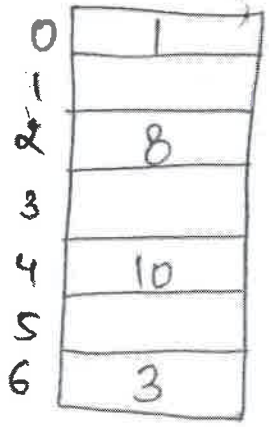
(ii)





Ques 2. Multiple Choice Questions:

Q-4



$h_0(1) = (3*1+4) \% 7 = 0$

$h_0(3) = (3*3+4) \% 7 = 6$

$h_0(8) = (3*8+4) \% 7 = 0$

$h_1(8) = 0 + F(i)$

$i * Hash_2(8)$

$= 5 - (8 \% 5)$

$= 5 - 3$

$= 2$

$h_1(8) = 0 + (1*2) = 2$

$h_0(10) = (3*10+4) \% 7 = 6$

$h_1(10) = 6 + F(i)$

$1 * Hash_2(10)$

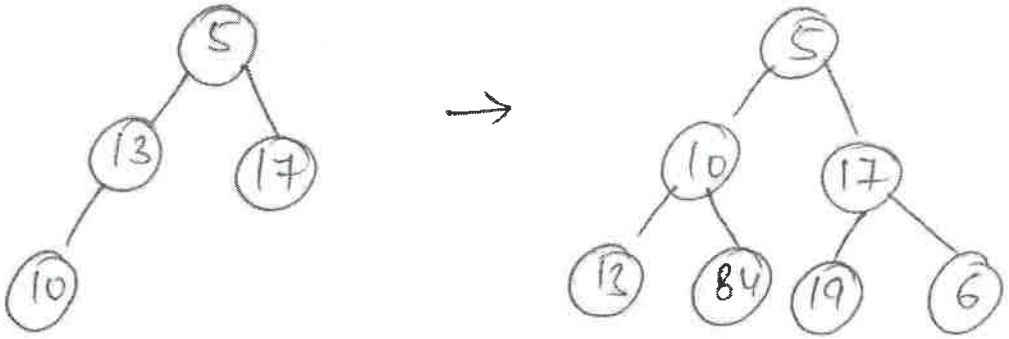
$= 5 - (10 \% 5)$

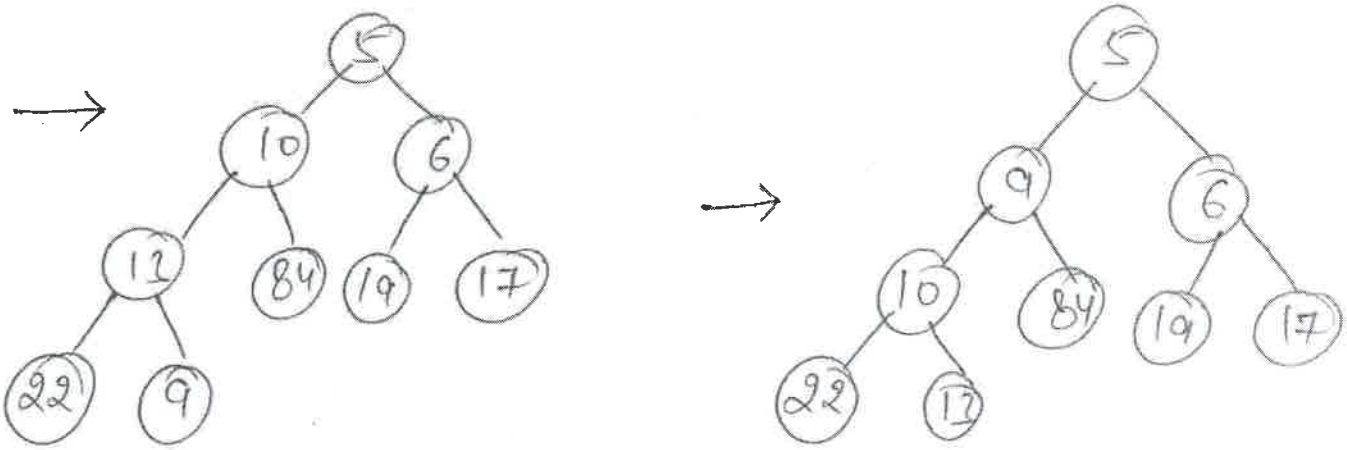
$= 5$

$= 6 + 5 = 11 = 4$

~~Q-15~~ (Q-5)

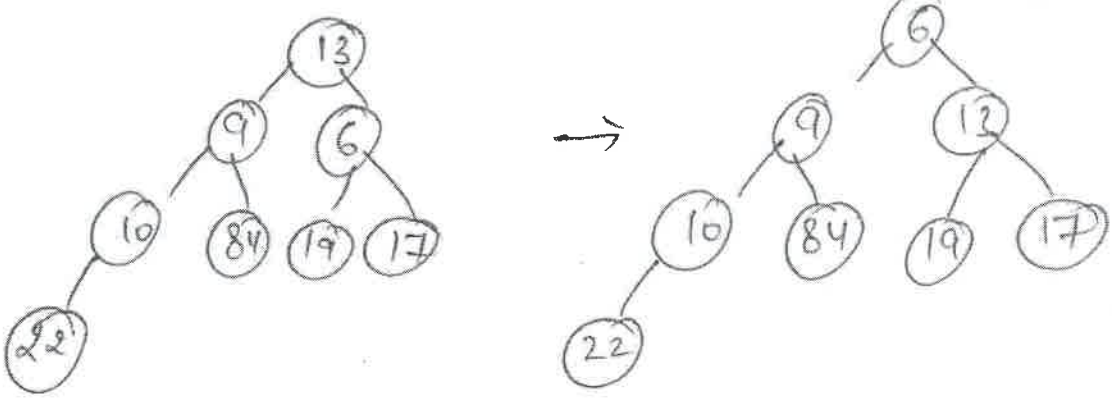
Step-1 Build a Heap



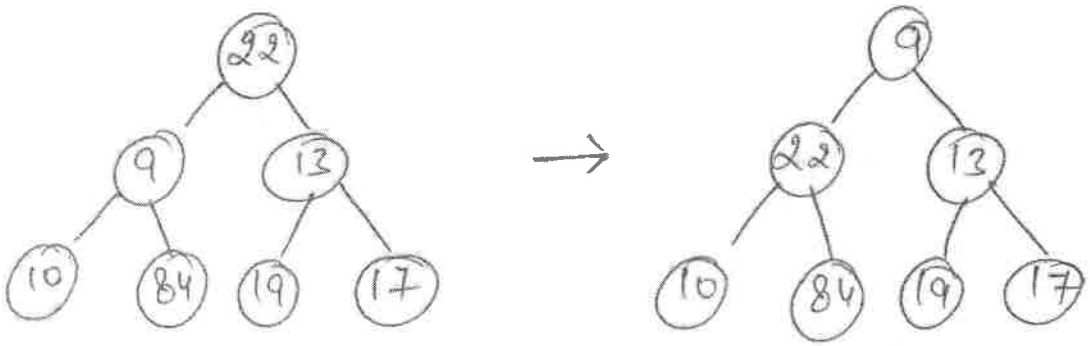


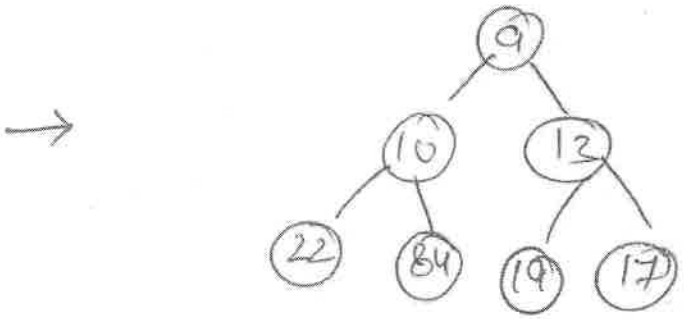
So, we have 5, 9, 6, 10, 84, 19, 17, 22, 13

(i) Delete 5 & Heapify



(ii) Delete 6 & Heapify 5, 6



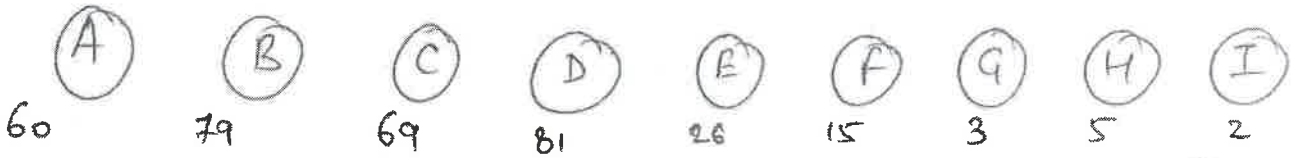


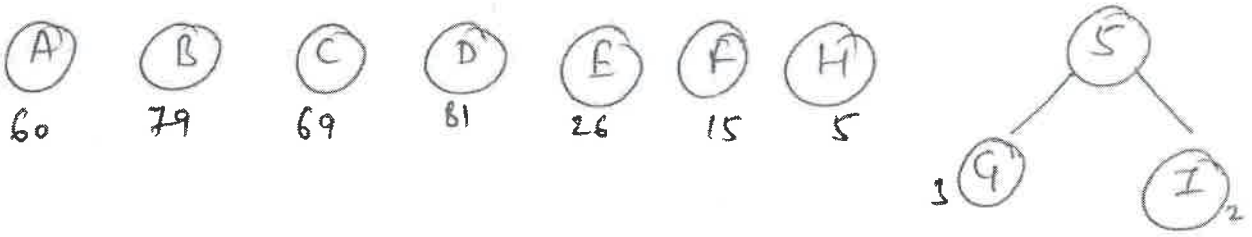
(iii) Delete 9 & Heapify

So, finally, we get

5, 6, 9, 10, 13, 17, 19, 22, 84.

~~Q-6~~ (Q-6)


A
B
C
D
E
F
G
H
I
60
79
69
81
26
15
3
5
2


A
B
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60
79
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26
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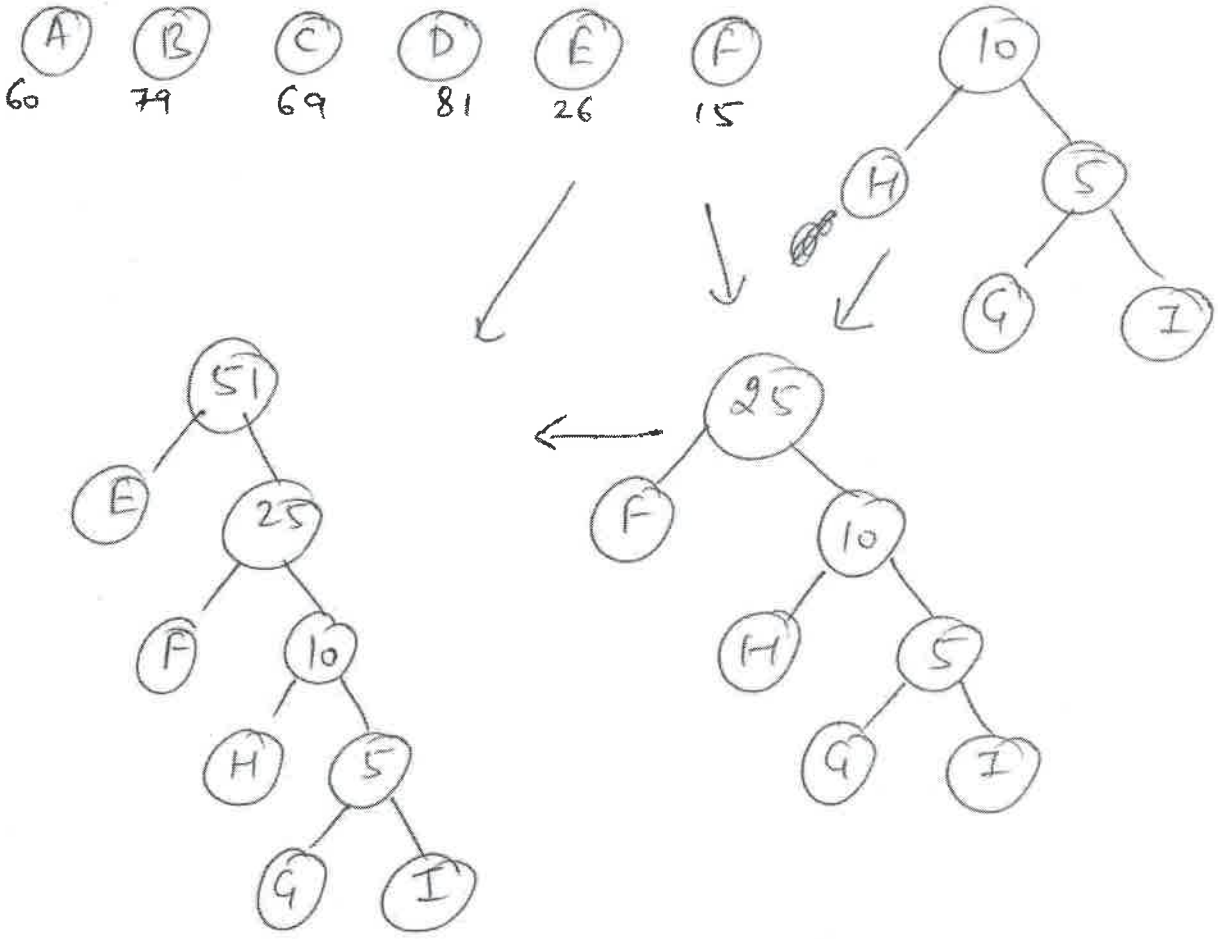
A
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69
81
26
15
10
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51
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H
5
G
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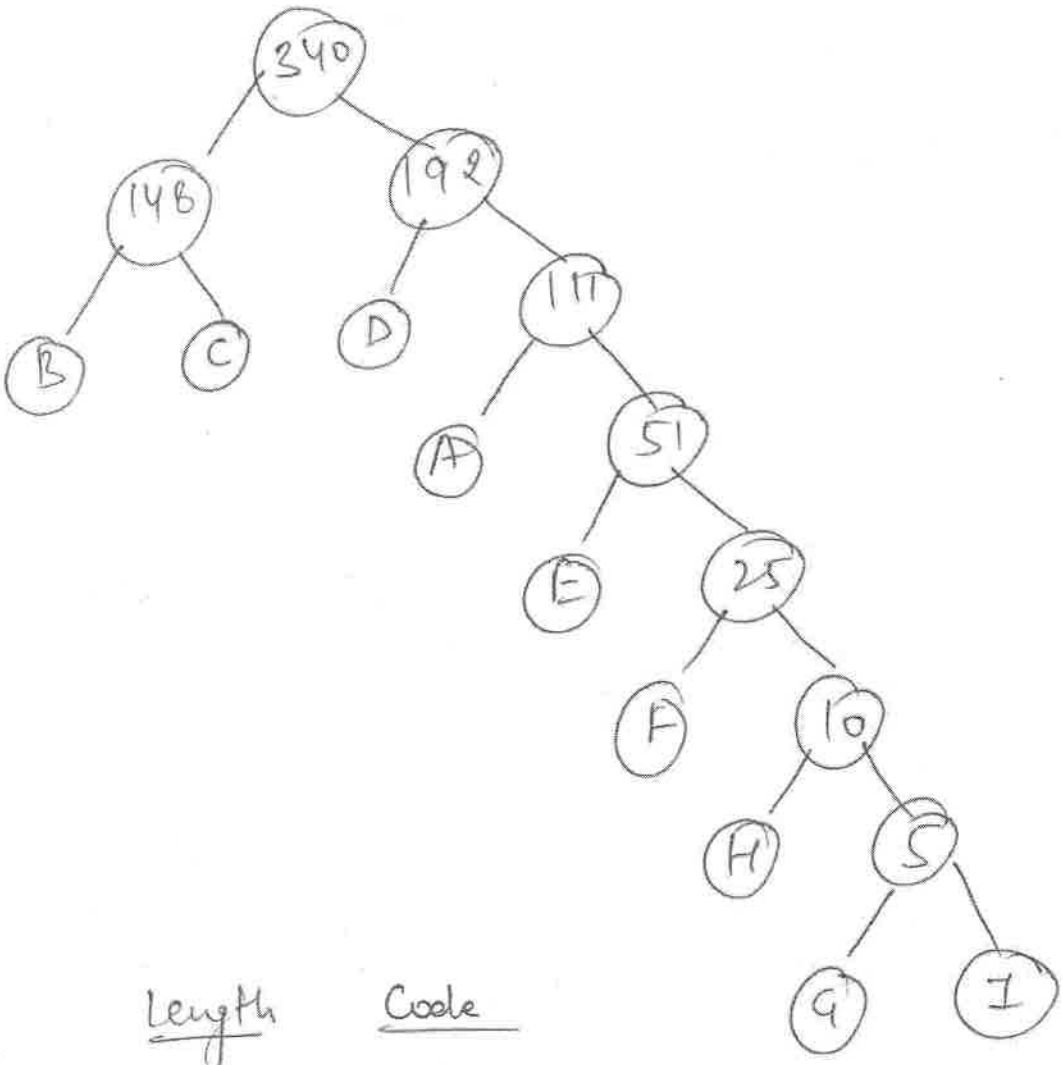
25
F
10
H
5
G
I

So, final Huffman Tree will be

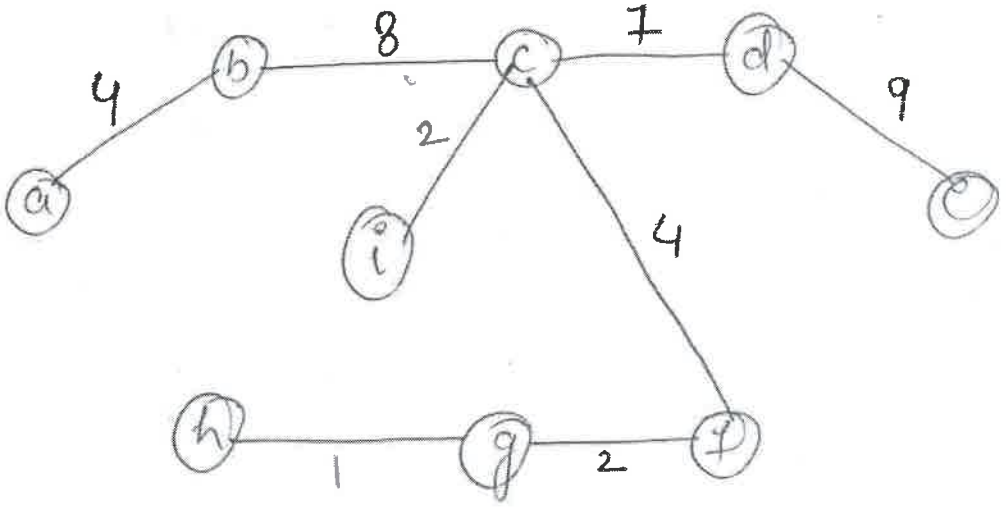


Symbol	Length	Code
A	110	3
B	00	2
C	01	2
D	10	2
E	1110	4
F	11110	5
9	1111110	7
H	111110	6
I	1111111	7

$$\text{Compression Ratio} = \frac{1838}{2720} = \frac{919}{1360}$$ Ans.

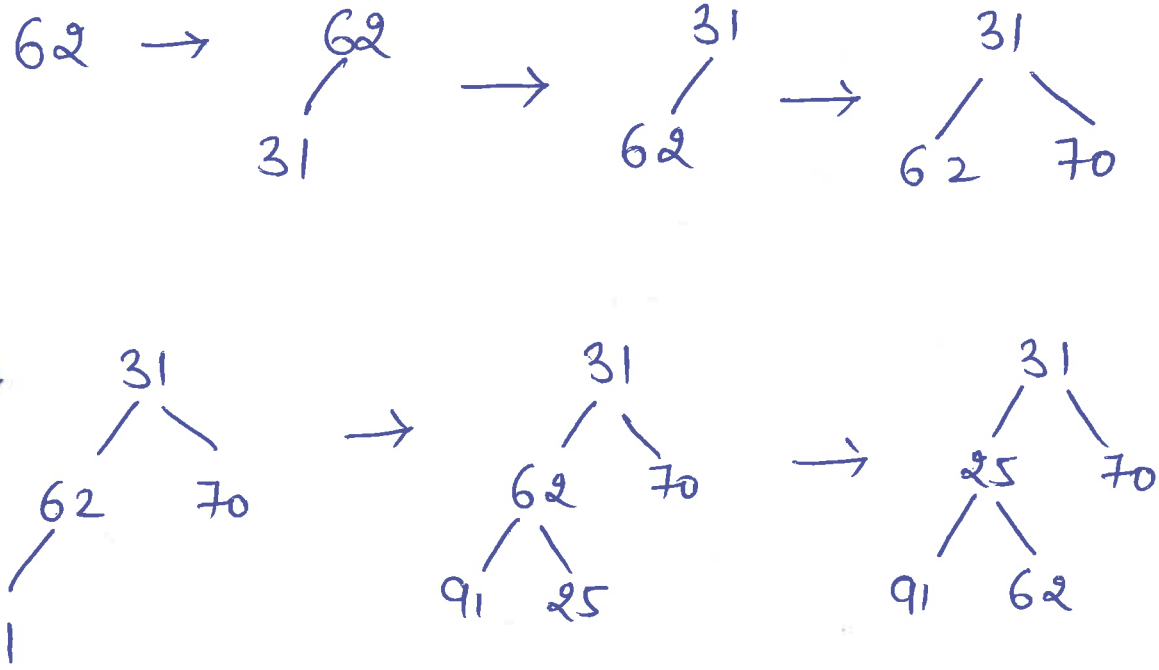
Q-14 (Q-7)

vertex	Distance	Parent
a	0	NIL
b	4	a
c	8	b
d	7	c
e	9	d
f	4	c
g	2	f
h	1	g
i	2	c



Total weight = 37

Q-8 1.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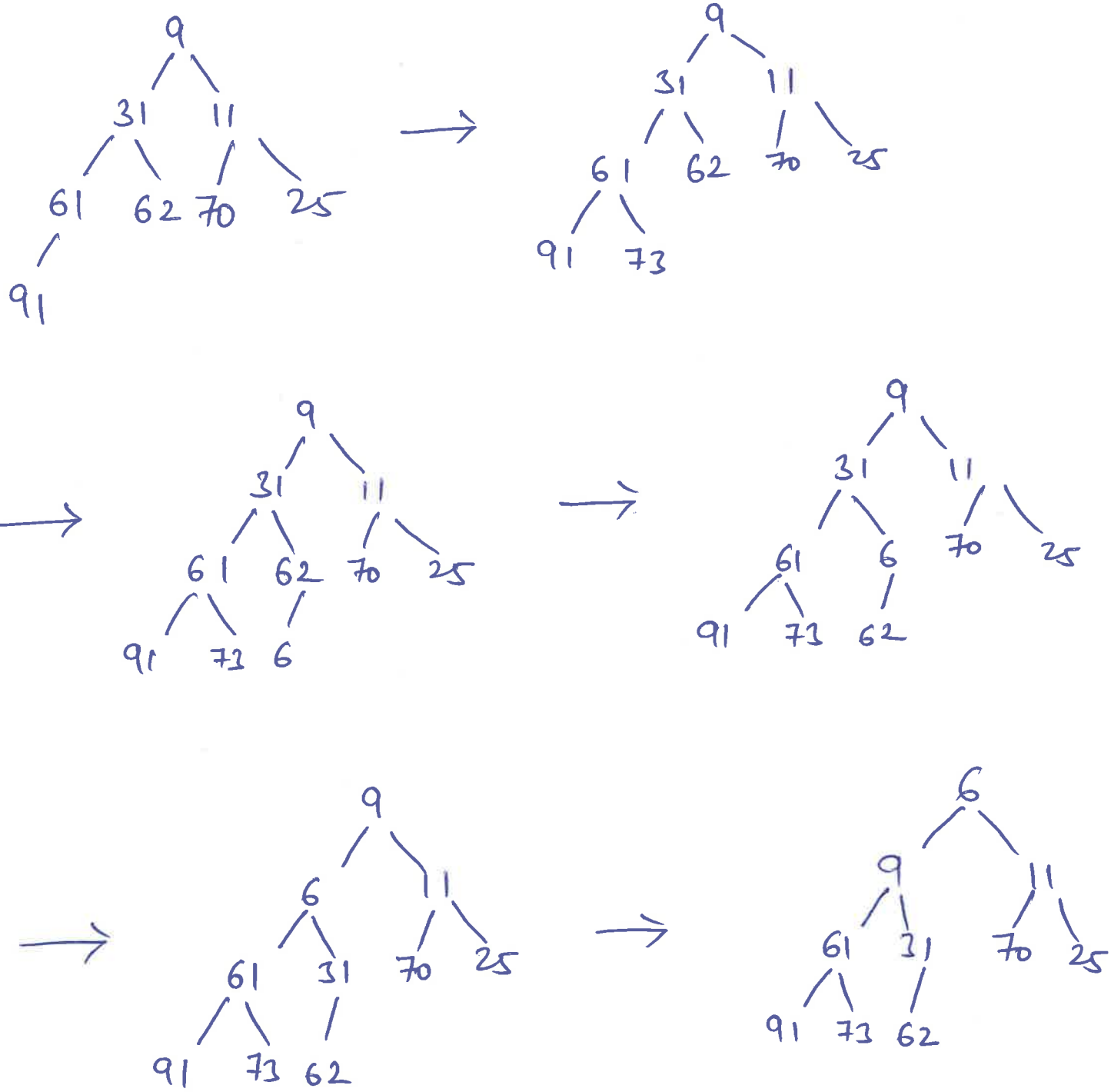
61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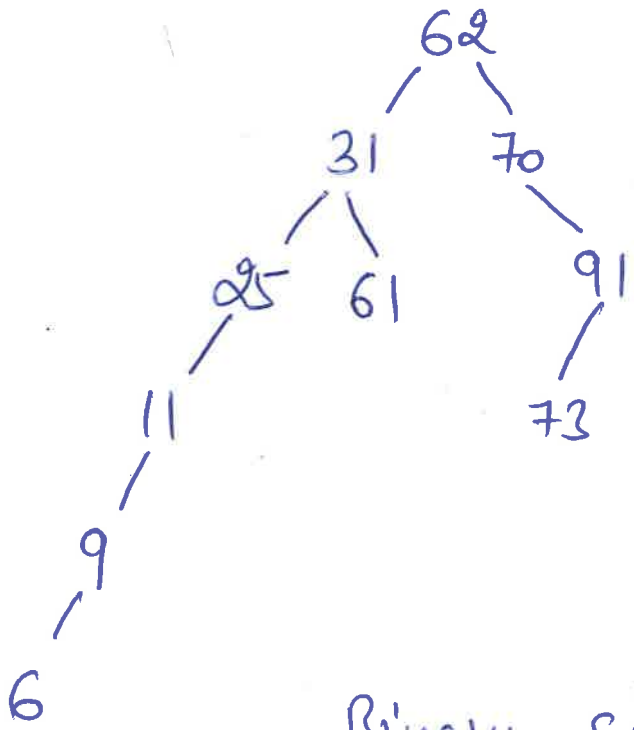
25
91
73
6

Ques. 8

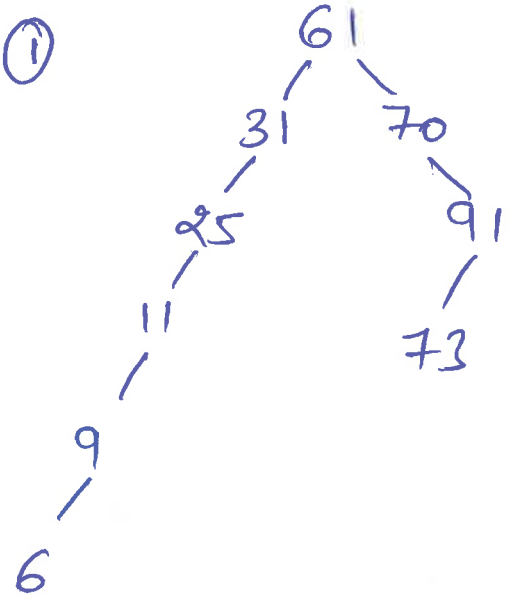
2.



Binary Search Tree

3.

①



②