Experiment 6

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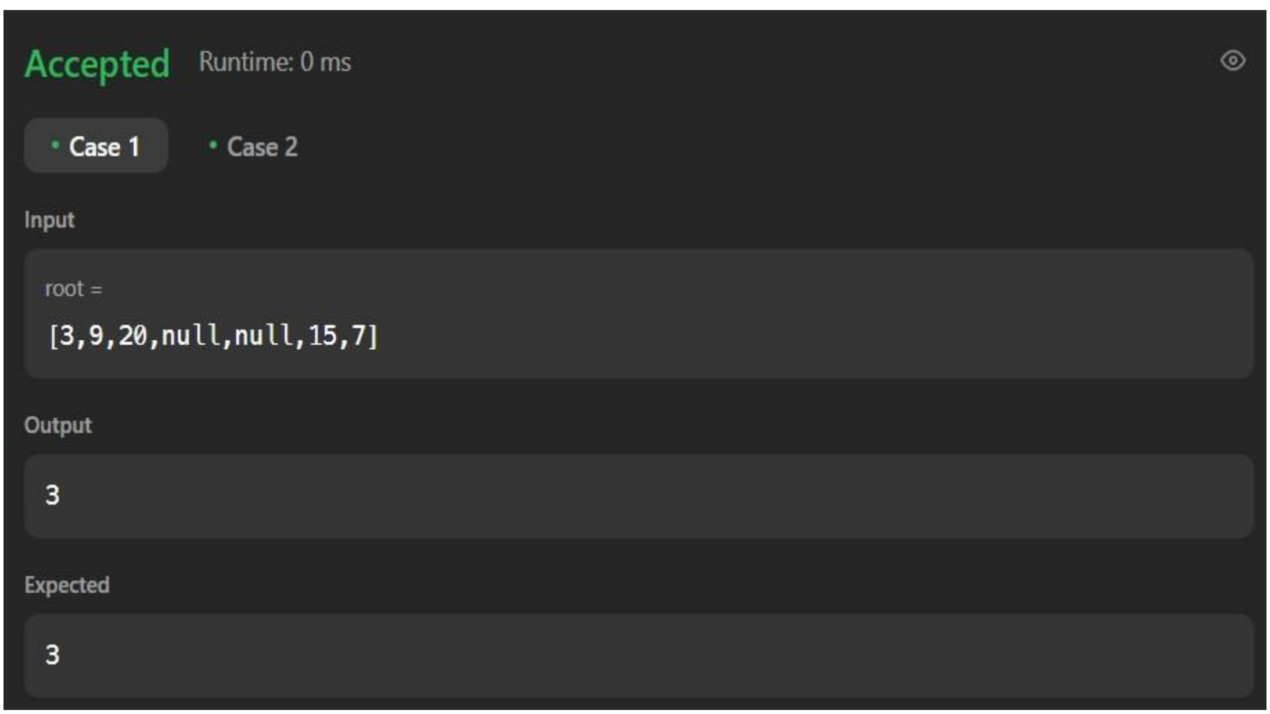
Subject Name: Advanced Programming Lab-2 **Subject Code: 22ITP-351**

Problem 1. Maximum Depth of Binary Tree- Given the root of a binary tree, return its maximum depth. A binary tree's maximum depth is the number of nodes along the longest path from the root node down to the farthest leaf node.

Code:

```
class Solution { public:
        int maxDepth(TreeNode* root) { if(!root)
            return 0;
            int maxLeft = maxDepth(root->left);
            int maxRight = maxDepth(root-
            >right); return max(maxLeft,
            maxRight)+1;
    }
};
```

Output:



Problem 2.

Validate Binary Search Tree- Given the root of a binary tree, determine if it is a valid binary search tree (BST).

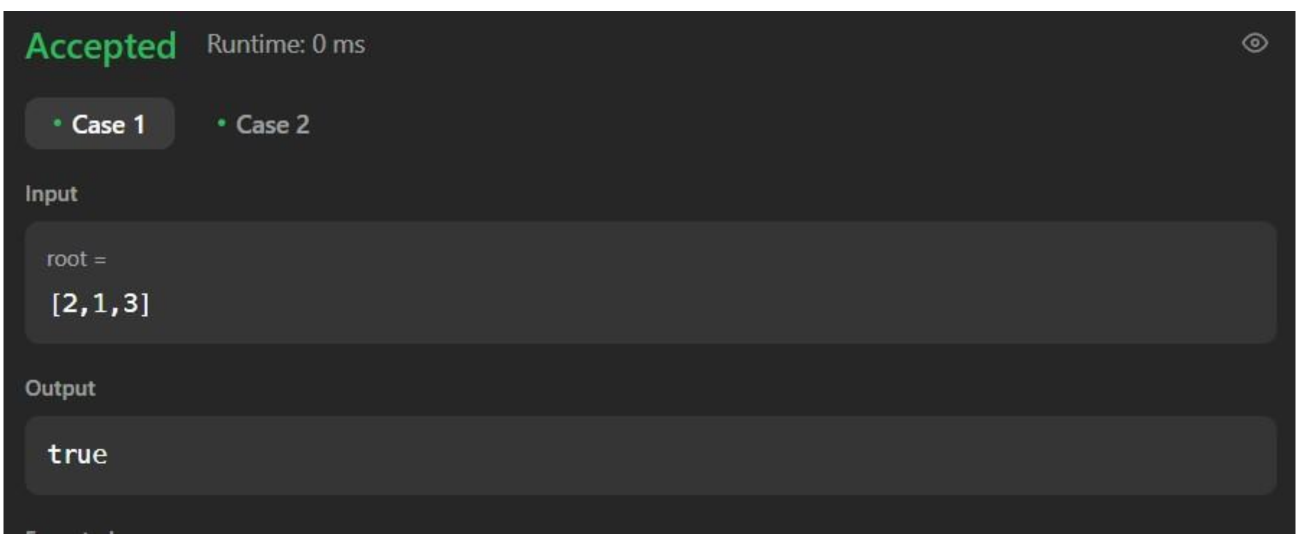
Code:

```
class Solution { public:
    void findInorder(TreeNode* root, vector<int> &inorder) { if
        (!root) return ;

        findInorder(root->left,   inorder);
    inorder.push_back(root->val);
    findInorder(root->right, inorder); }

    bool isValidBST(TreeNode* root) {
        vector<int>                  inorder;
        findInorder(root, inorder);
for (int i = 1; i < inorder.size(); i++) { if (inorder[i - 1] >=
        inorder[i]) return false; }
return true;
    }
};
```

Output:



Symmetric Tree. - Given the root of a binary tree, check whether it is a mirror of itself (i.e., symmetric around its center).

Code:

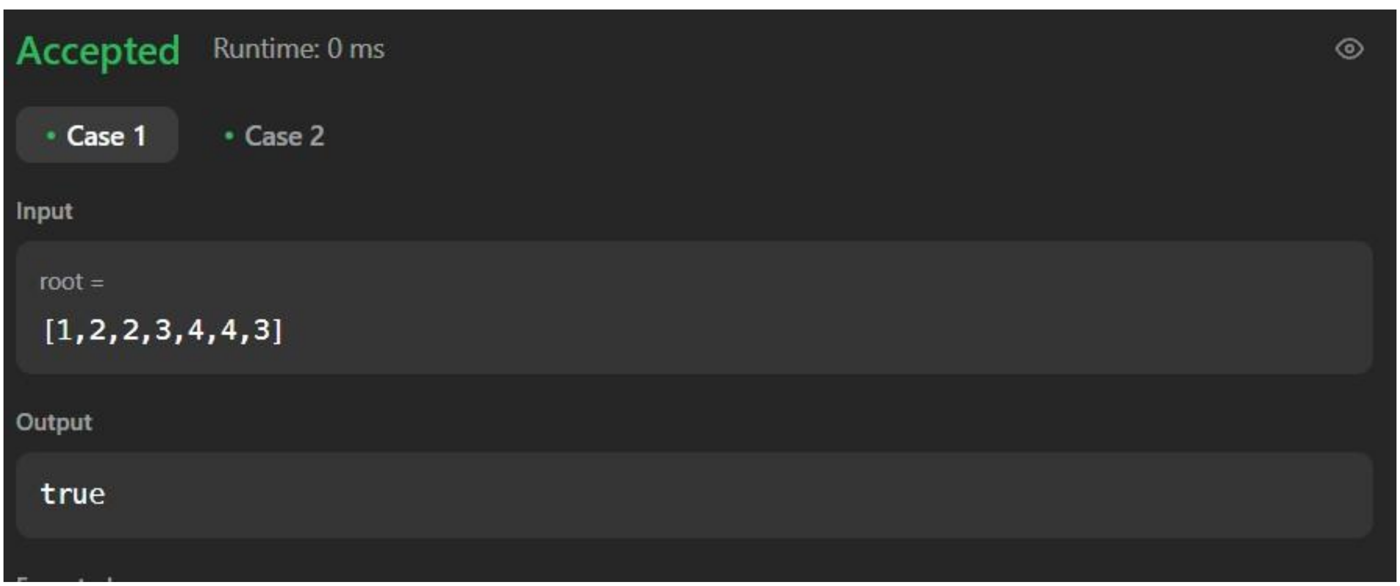
Problem 3.

```
class Solution { public:
    bool isMirror(TreeNode* left, TreeNode* right) {
    if (!left && !right) return true; if
    (!left || !right) return false;
    return (left->val == right->val) && isMirror(left->left, right->right) && isMirror(left->right, right- >left);
}

bool isSymmetric(TreeNode* root) { if
    (!root) return true;
    return isMirror(root->left, root->right); }

};
```

Output:



Binary Tree Level Order Traversal - Given the root of a binary tree, return the level order traversal of its nodes' values. (i.e., from left to right, level by level).

Code:

```
class Solution {
 public:
  vector<vector<int>> levelOrder(TreeNode* root) {
    if (root == nullptr)
      return {};
```

Problem 4.

```
vector<vector<int>> ans; queue<TreeNode*>
q{{root}};
while (!q.empty()) { vector<int>
currLevel;
  for (int sz = q.size(); sz > 0; --sz) {
    TreeNode*   node   =   q.front();
    q.pop();
    currLevel.push_back(node-
    >val); if (node->left)
      q.push(node->left);
    if (node->right)
    q.push(node->right); }
  ans.push_back(currLevel)
  ;
}
return ans;
  }
};
```

Output:

Problem 5.

Convert Sorted Array to Binary Search Tree- Given an integer array nums where the elements are sorted in ascending order, convert it to a height-balanced binary search tree

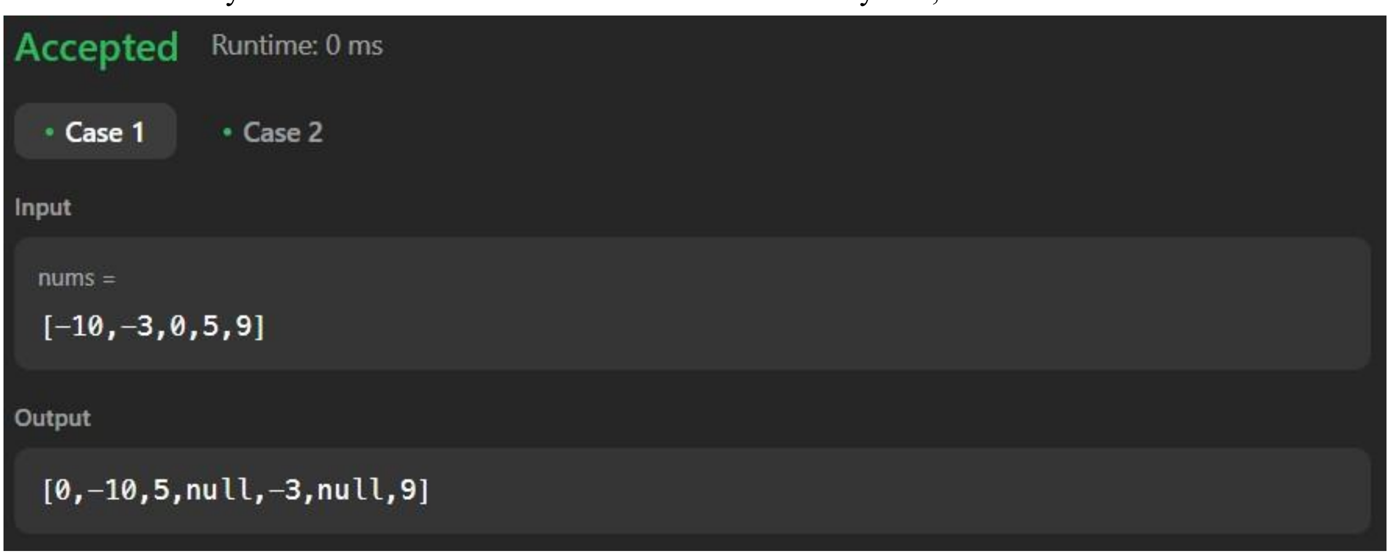
Code:

```
#include <vector> using
namespace std;

class Solution { public:
    TreeNode* sortedArrayToBST(vector<int>& nums) {
    return helper(nums, 0, nums.size() - 1); }
private:
    TreeNode* helper(vector<int>& nums, int left, int right) {
        if (left > right) return nullptr; int mid = left + (right -
        left) / 2;
        TreeNode* root = new TreeNode(nums[mid]);
        root->left = helper(nums, left, mid - 1); root-
        >right = helper(nums, mid + 1, right); return
        root;
    }
};
```

Output:

Problem 6. Binary Tree Inorder Traversal-Given the root of a binary tree, return the inorder traversal of its



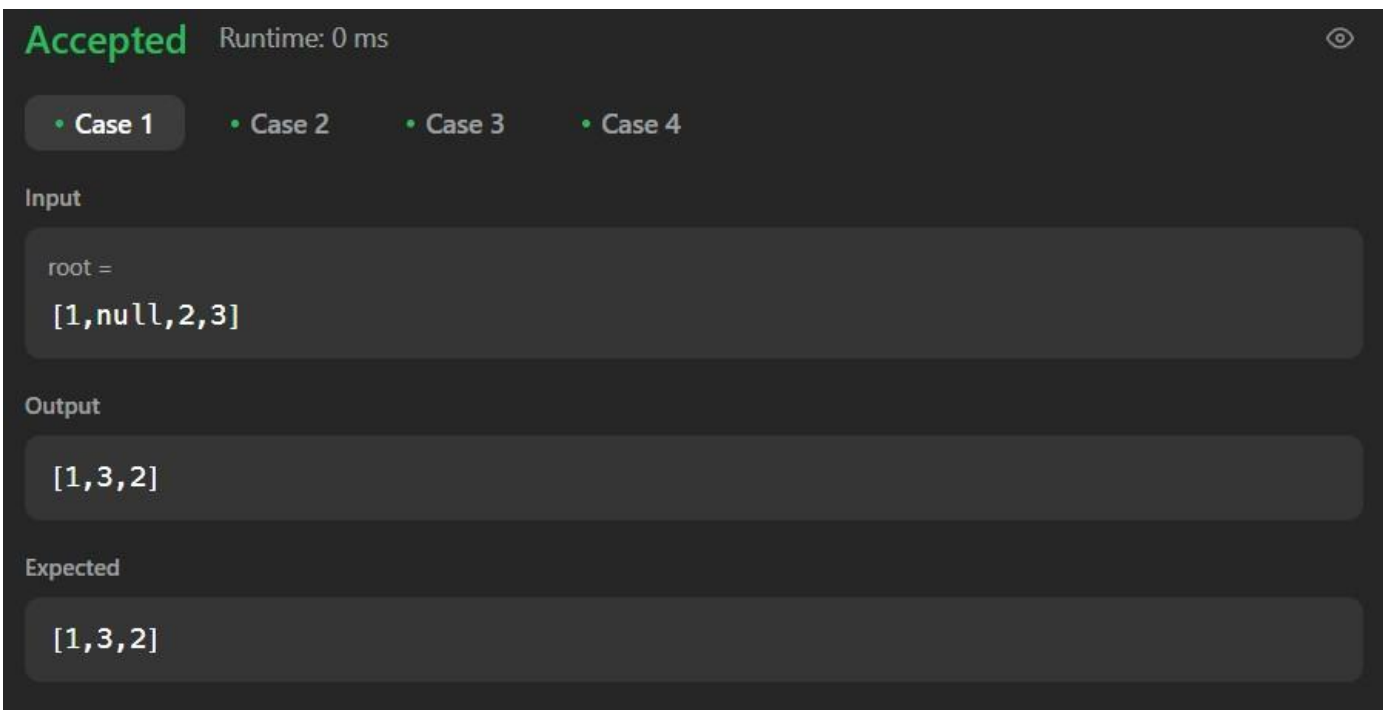
nodes' values.

Code:

```
class Solution { public:
   vector<int> inorderTraversal(TreeNode* root) {
      vector<int> result; helper(root, result); return
      result;
   }

   void helper(TreeNode* root, vector<int>& result) {
      if (root != nullptr) { helper(root->left, result);
      result.push_back(root->val);  helper(root->right,
      result); }
   }
}
```

Output:



Binary Zigzag Level Order Traversal- Given the root of a binary tree, return the zigzag level order traversal of its nodes' values. (i.e., from left to right, then right to left for the next level and alternate between)..

Code:

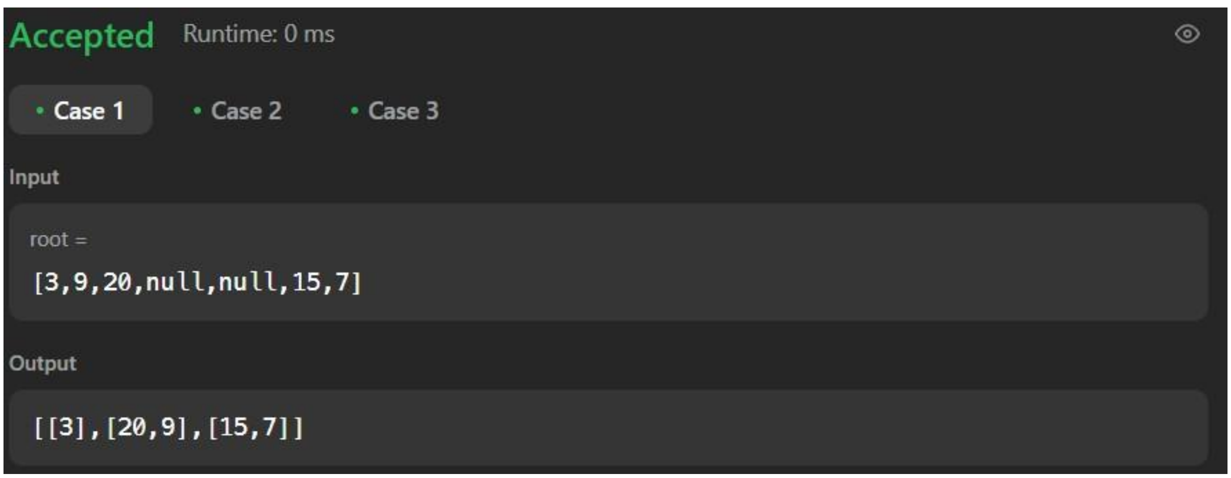
```
class Solution { public:
```

Problem 7.

```
void solve(vector<vector<int>>& ans, TreeNode* temp, int level) { if
    (temp == NULL) return;
    if (ans.size() <= level) ans.push_back({}); if (level %
2 == 0) ans[level].push_back(temp->val); else
ans[level].insert(ans[level].begin(), temp->val);
solve(ans, temp->left, level + 1); solve(ans, temp-
>right, level + 1); }

vector<vector<int>> zigzagLevelOrder(TreeNode* root) {
    vector<vector<int>> ans; solve(ans, root, 0); return ans;
}
}
```

Output:



Problem 8.

Construct Binary Tree from Inorder and Postorder Traversal- Given two integer arrays inorder and postorder where inorder is the inorder traversal of a binary tree and postorder is the postorder traversal of the same tree, construct and return the binary tree.

Code:

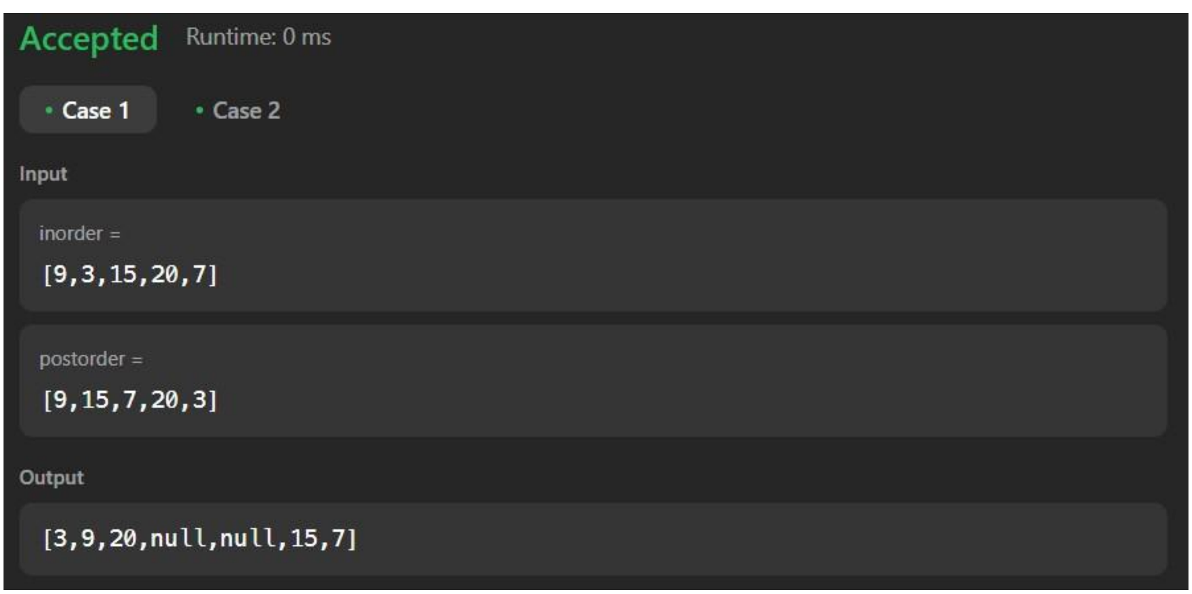
```
class Solution { public:
   TreeNode* buildTree(vector<int>& inorder, vector<int>& postorder) {
      unordered_map<int, int> inorderIndexMap; for (int i = 0; i <
      inorder.size(); ++i) { inorderIndexMap[inorder[i]] = i;
      }
      int postIndex = postorder.size() - 1;
      return constructTree(inorder, postorder, inorderIndexMap, postIndex, 0, inorder.size() - 1); }
   TreeNode* constructTree(vector<int>& inorder, vector<int>& postorder, unordered_map<int, int>&
inorderIndexMap, int& postIndex, int inStart, int inEnd) { if (inStart > inEnd) return nullptr; int rootVal
= postorder[postIndex--]; TreeNode* root = new TreeNode(rootVal); int rootIndex =
inorderIndexMap[rootVal]; root->right = constructTree(inorder, postorder, inorderIndexMap, postIndex,
rootIndex + 1, inEnd); root->left = constructTree(inorder, postorder, inorderIndexMap, postIndex,
inStart, rootIndex - 1);

      return root;
   }
};
```

Output:

Kth Smallest element in a BST- Given the root of a binary search tree, and an integer k, return the kth smallest value (1-indexed) of all the values of the nodes in the tree.

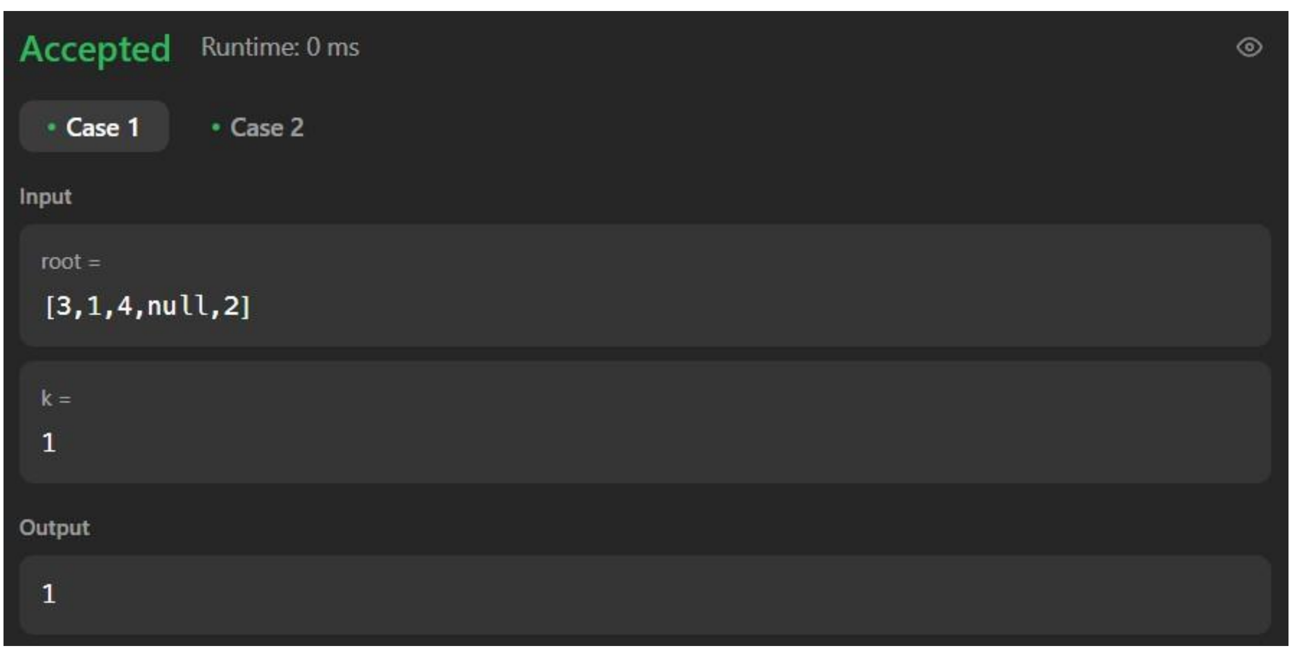
Code:



Problem 9.

```
      class Solution { public: void solve(TreeNode* root, int
      &cnt, int &ans, int k){ if(root == NULL) return;
          //left, root, right
          solve(root->left, cnt, ans, k);
          cnt++;  if(cnt  ==
          k){  ans  =  root-
          >val;
             return;
          }
          solve(root->right, cnt, ans, k);
        }
        int kthSmallest(TreeNode* root, int k) {
int cnt = 0; int ans;
          solve(root, cnt, ans, k); return
          ans;
        }
};
```

Output:



Problem 10. Populating Next Right Pointers in Each Node- You are given a perfect binary tree where all leaves are on the same level, and every parent has two children. The binary tree has the following definition:

Code:

```
class Solution { public:
   Node* connect(Node* root) {
      if(root==nullptr) return {};
```

```
        queue<Node*>            q;
        q.push(root);
        while(!q.empty()){ int n =
        q.size();                for(int
        i=0;i<n;i++){ Node* t =
        q.front(); q.pop(); if(i!=n-
        1){ t->next=q.front();
            } if(t->left) q.push(t->left);
        if(t->right) q.push(t->right); } }
        return root;
    }
};
```

Output: