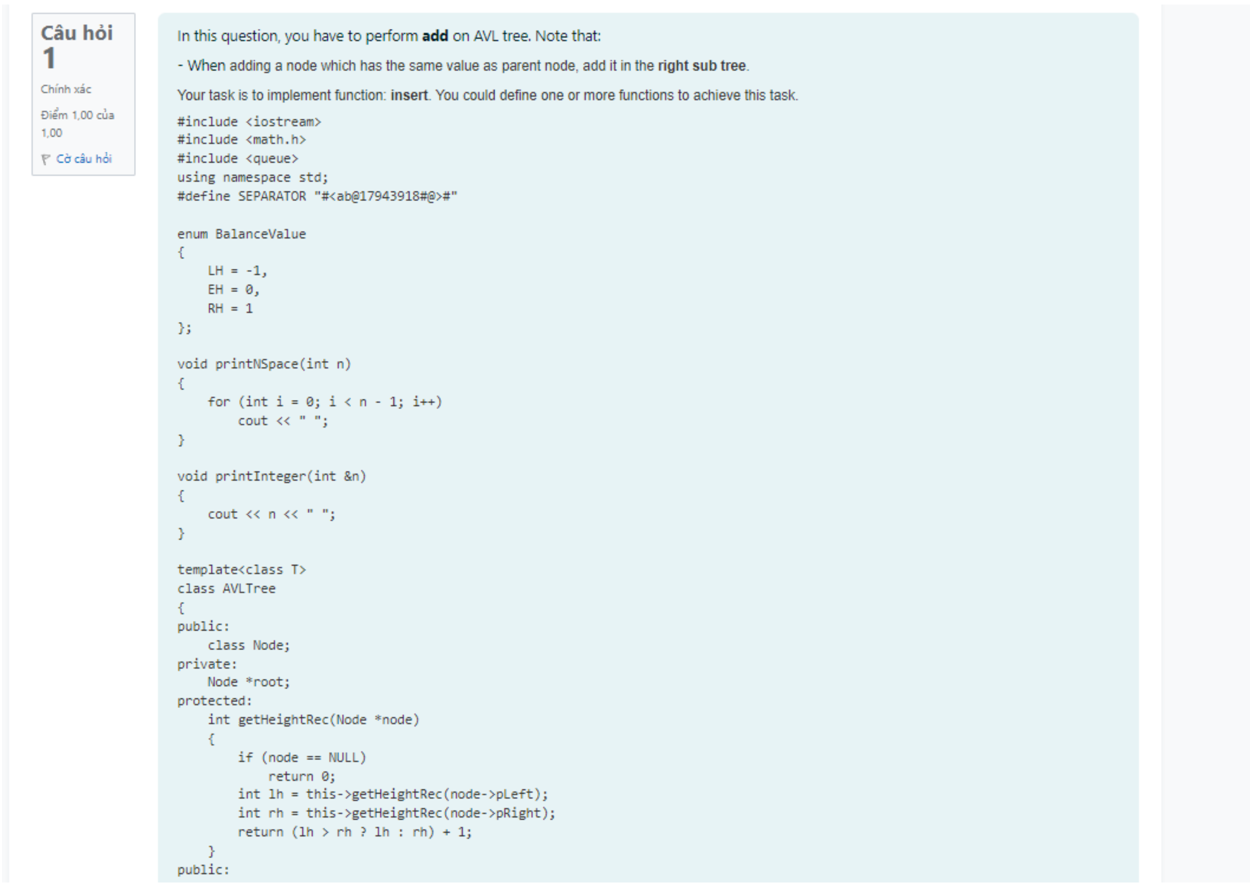


Câu hỏi **1**

Chính xác

Điểm 1,00 của 1,00

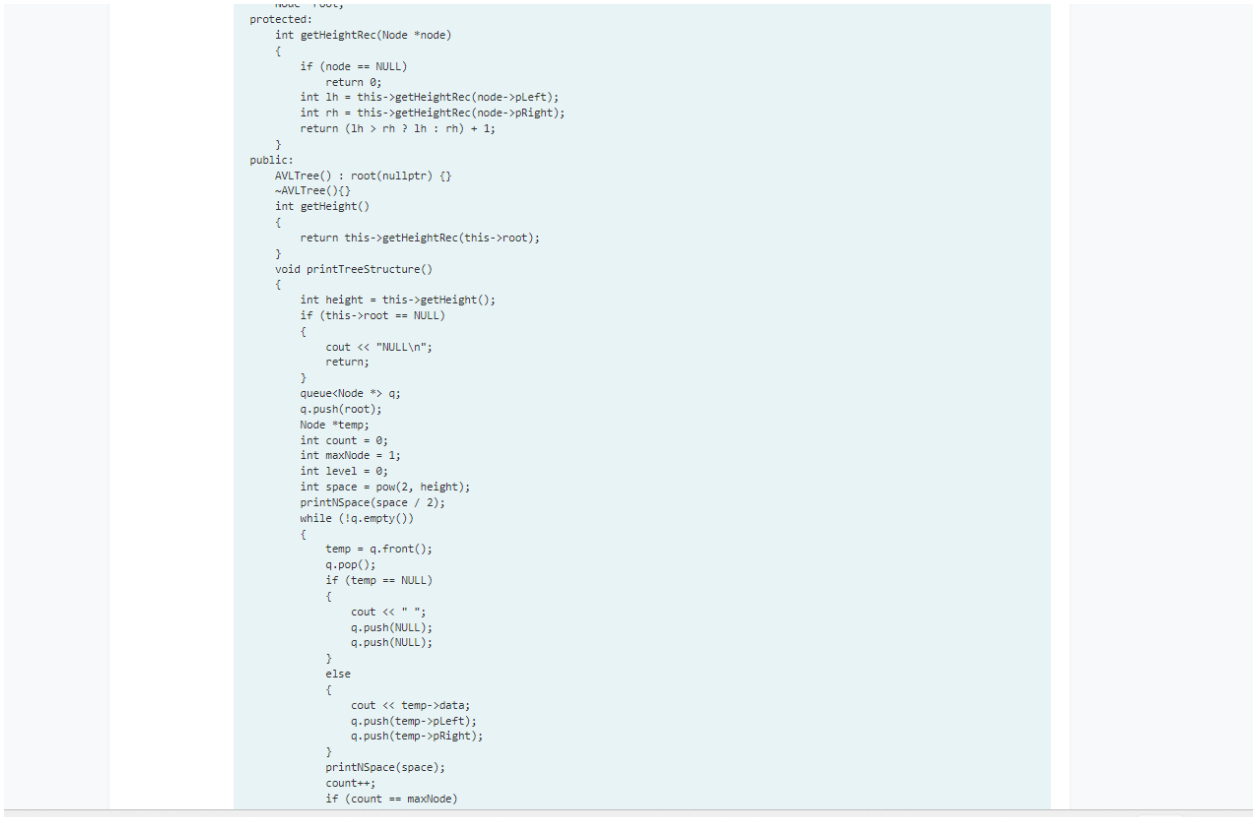
Cờ câu hỏi

In this question, you have to perform **add** on AVL tree. Note that:

- When adding a node which has the same value as parent node, add it in the **right sub tree**.

Your task is to implement function: **insert**. You could define one or more functions to achieve this task.

```
#include <iostream>
#include <math.h>
#include <queue>
using namespace std;
#define SEPARATOR "#<ab@17943918#@>#"

enum BalanceValue
{
    LH = -1,
    EH = 0,
    RH = 1
};

void printNSpace(int n)
{
    for (int i = 0; i < n - 1; i++)
        cout << " ";
}

void printInteger(int &n)
{
    cout << n << " ";
}

template<class T>
class AVLTree
{
public:
    class Node;
private:
    Node *root;
protected:
    int getHeightRec(Node *node)
    {
        if (node == NULL)
            return 0;
        int lh = this->getHeightRec(node->pLeft);
        int rh = this->getHeightRec(node->pRight);
        return (lh > rh ? lh : rh) + 1;
    }
public:
```



```
protected:
    int getHeightRec(Node *node)
    {
        if (node == NULL)
            return 0;
        int lh = this->getHeightRec(node->pLeft);
        int rh = this->getHeightRec(node->pRight);
        return (lh > rh ? lh : rh) + 1;
    }
```

```
public:
    AVLTree() : root(nullptr) {}
    ~AVLTree(){}
    int getHeight()
    {
        return this->getHeightRec(this->root);
    }
    void printTreeStructure()
    {
        int height = this->getHeight();
        if (this->root == NULL)
        {
            cout << "NULL\n";
            return;
        }
        queue<Node *> q;
        q.push(root);
        Node *temp;
        int count = 0;
        int maxNode = 1;
        int level = 0;
        int space = pow(2, height);
        printNSpace(space / 2);
        while (!q.empty())
        {
            temp = q.front();
            q.pop();
            if (temp == NULL)
            {
                cout << " ";
                q.push(NULL);
                q.push(NULL);
            }
            else
            {
                cout << temp->data;
                q.push(temp->pLeft);
                q.push(temp->pRight);
            }
            printNSpace(space);
            count++;
            if (count == maxNode)
```

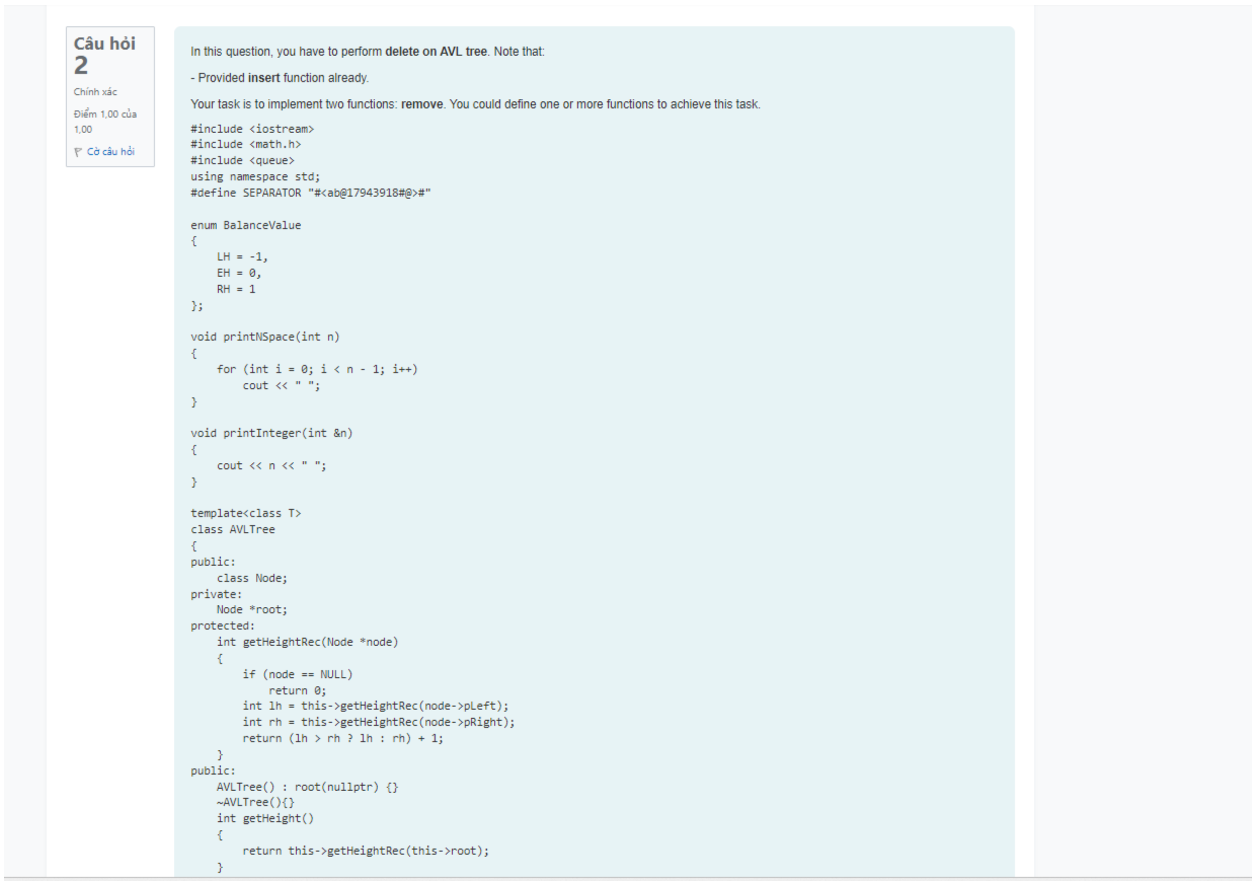
```
                cout << temp->data;
                q.push(temp->pLeft);
                q.push(temp->pRight);
            }
            printNSpace(space);
            count++;
            if (count == maxNode)
            {
                cout << endl;
                count = 0;
                maxNode *= 2;
                level++;
                space /= 2;
                printNSpace(space / 2);
            }
            if (level == height)
                return;
        }
    }

    void insert(const T &value)
    {
        //TODO
    }

    class Node
    {
    private:
        T data;
        Node *pLeft, *pRight;
        BalanceValue balance;
        friend class AVLTree<T>;

    public:
        Node(T value) : data(value), pLeft(NULL), pRight(NULL), balance(EH) {}
        ~Node() {}
    };
};
```

For example:

Test	Result

`AVLTree<int> avl;`
`for (int i = 0; i < 9; i++){`
`    avl.insert(i);`
`}`
`avl.printTreeStructure();`
	`       3`
	`   1       5`
	` 0   2   4   7`
	`            6 8`

`AVLTree<int> avl;`
`for (int i = 10; i >= 0; i--){`
`        avl.insert(i);`
`}`
`avl.printTreeStructure();`
	`       7`
	`   3       9`
	` 1   5   8   10`
	`0 2 4 6`



Câu hỏi **2**

Chính xác

Điểm 1,00 của 1,00

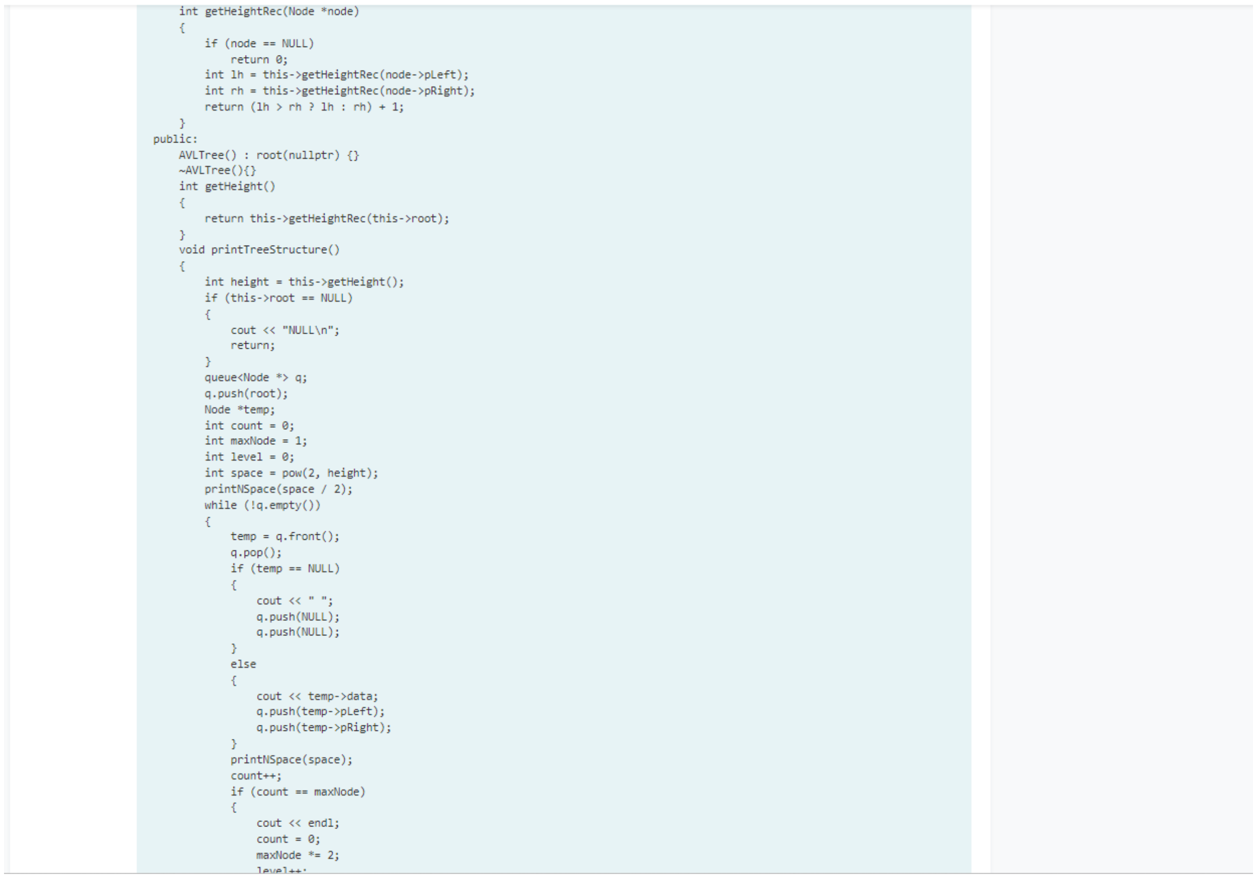
Cờ câu hỏi

In this question, you have to perform **delete on AVL tree**. Note that:

- Provided **insert** function already.

Your task is to implement two functions: **remove**. You could define one or more functions to achieve this task.

```
#include <iostream>
#include <math.h>
#include <queue>
using namespace std;
#define SEPARATOR "#<ab@17943918#@>#"

enum BalanceValue
{
    LH = -1,
    EH = 0,
    RH = 1
};

void printNSpace(int n)
{
    for (int i = 0; i < n - 1; i++)
        cout << " ";
}

void printInteger(int &n)
{
    cout << n << " ";
}

template<class T>
class AVLTree
{
public:
    class Node;
private:
    Node *root;
protected:
    int getHeightRec(Node *node)
    {
        if (node == NULL)
            return 0;
        int lh = this->getHeightRec(node->pLeft);
        int rh = this->getHeightRec(node->pRight);
        return (lh > rh ? lh : rh) + 1;
    }
public:
    AVLTree() : root(nullptr) {}
    ~AVLTree(){}
    int getHeight()
    {
        return this->getHeightRec(this->root);
    }
```



```
    int getHeightRec(Node *node)
    {
        if (node == NULL)
            return 0;
        int lh = this->getHeightRec(node->pLeft);
        int rh = this->getHeightRec(node->pRight);
        return (lh > rh ? lh : rh) + 1;
    }
public:
    AVLTree() : root(nullptr) {}
    ~AVLTree(){}
    int getHeight()
    {
        return this->getHeightRec(this->root);
    }
```

```
    void printTreeStructure()
    {
        int height = this->getHeight();
        if (this->root == NULL)
        {
            cout << "NULL\n";
            return;
        }
        queue<Node *> q;
        q.push(root);
        Node *temp;
        int count = 0;
        int maxNode = 1;
        int level = 0;
        int space = pow(2, height);
        printNSpace(space / 2);
        while (!q.empty())
        {
            temp = q.front();
            q.pop();
            if (temp == NULL)
            {
                cout << " ";
                q.push(NULL);
                q.push(NULL);
            }
            else
            {
                cout << temp->data;
                q.push(temp->pLeft);
                q.push(temp->pRight);
            }
            printNSpace(space);
            count++;
            if (count == maxNode)
            {
                cout << endl;
                count = 0;
                maxNode *= 2;
                level++;
            count++;
            if (count == maxNode)
            {
                cout << endl;
                count = 0;
                maxNode *= 2;
                level++;
                space /= 2;
                printNSpace(space / 2);
            }
            if (level == height)
                return;
        }
    }

    void remove(const T &value)
    {
        //TODO
    }

    class Node
    {
    private:
        T data;
        Node *pLeft, *pRight;
        BalanceValue balance;
        friend class AVLTree<T>;

    public:
        Node(T value) : data(value), pLeft(NULL), pRight(NULL), balance(EH) {}
        ~Node() {}
    };
};
```

For example:

Test	Result

`AVLTree<int> avl;`
`int arr[] = {10,52,98,32,68,92,40,13,42,63};`
`for (int i = 0; i < 10; i++){`
`        avl.insert(arr[i]);`
`}`
`avl.remove(10);`
`avl.printTreeStructure();`
	`      52`
	`  32        92`
	`13    40    68    98`
	`      42 63`

`AVLTree<int> avl;`
`int arr[] = {10,52,98,32,68,92,40,13,42,63,99,100};`
`for (int i = 0; i < 12; i++){`
`        avl.insert(arr[i]);`
`}`
`avl.remove(13);`
`avl.printTreeStructure();`
	`      52`
	`  32        92`
	`10    40    68    99`
	`      42 63   98 100`

Câu hỏi **3**

Chính xác

Điểm 1,00 của 1,00

Cờ câu hỏi

In this question, you have to search and print inorder on **AVL tree**. You have o implement functions: **search** and **printInorder** to complete the task. Note that:

- When the tree is null, don't print anything.

- There's a whitespace at the end when print the tree inorder in case the tree is not null.

- When tree contains value, search return true.

```
#include <iostream>
#include <queue>
using namespace std;
#define SEPARATOR "#<ab@17943918#@>#"

enum BalanceValue
{
    LH = -1,
    EH = 0,
    RH = 1
};

template<class T>
class AVLTree
{
public:
    class Node;
private:
    Node *root;
public:
    AVLTree() : root(nullptr) {}
    ~AVLTree(){}

    void printInorder(){
        //TODO
    }

    bool search(const T &value){
        //TODO
    }

    class Node
    {
    private:
        T data;
        Node *pLeft, *pRight;
        BalanceValue balance;
        friend class AVLTree<T>;

    public:
        Node(T value) : data(value), pLeft(NULL), pRight(NULL), balance(EH) {}
    bool search(const T &value){
        //TODO
    }

    class Node
    {
    private:
        T data;
        Node *pLeft, *pRight;
        BalanceValue balance;
        friend class AVLTree<T>;

    public:
        Node(T value) : data(value), pLeft(NULL), pRight(NULL), balance(EH) {}
        ~Node() {}
    };
};
```

For example:

Test	Result

`AVLTree<int> avl;`
`int arr[] = {10,52,98,32,68,92,40,13,42,63,99,100};`
`for (int i = 0; i < 12; i++){`
`        avl.insert(arr[i]);`
`}`
`avl.printInorder();`
`cout << endl;`
`cout << avl.search(10);`
	`10 13 32 40 42 52 63 68 92 98 99 100`
	`1`

Answer: (penalty regime: 0 %)