Name : Zeeshan Ali

Roll no: SU92-BSITM-F22-019

Data Structure and Algorithm(Lab)

Final Paper

Question no 01:

Code:

```
// Question no 01
#include<iostream>
#include <queue>
using namespace std;
class BST{
	int data;
	BST* left;
	BST* right;
	public:
		BST();
		BST(int);
		BST* insert(BST* ,int );
		BST* Delete (BST*,int);
		void preorder(BST*);
		void inorder(BST*);
		void postorder(BST*);
		void DFS_preorder(BST*);
		void DFS_inorder(BST*);
		void DFS_postorder(BST*);
		void BFS_LevelOrder(BST*);
};
```

```
BST :: BST(){
	data=0;
	left=NULL;
	right=NULL;
}
BST :: BST(int value){
	data=value;
	left=NULL;
	right=NULL;
}
BST* BST::insert(BST* root,int value){
	if(root==NULL){
		return new BST(value);
	}
	if(value<=root->data){
		root->left=insert(root->left,value);
	}
	else if(value>root->data){
		root->right=insert(root->right,value);
	}
	return root;
}
void BST::preorder(BST* root){
	if(root==NULL){
		return;
	}
	cout<<root->data<<" ";
```

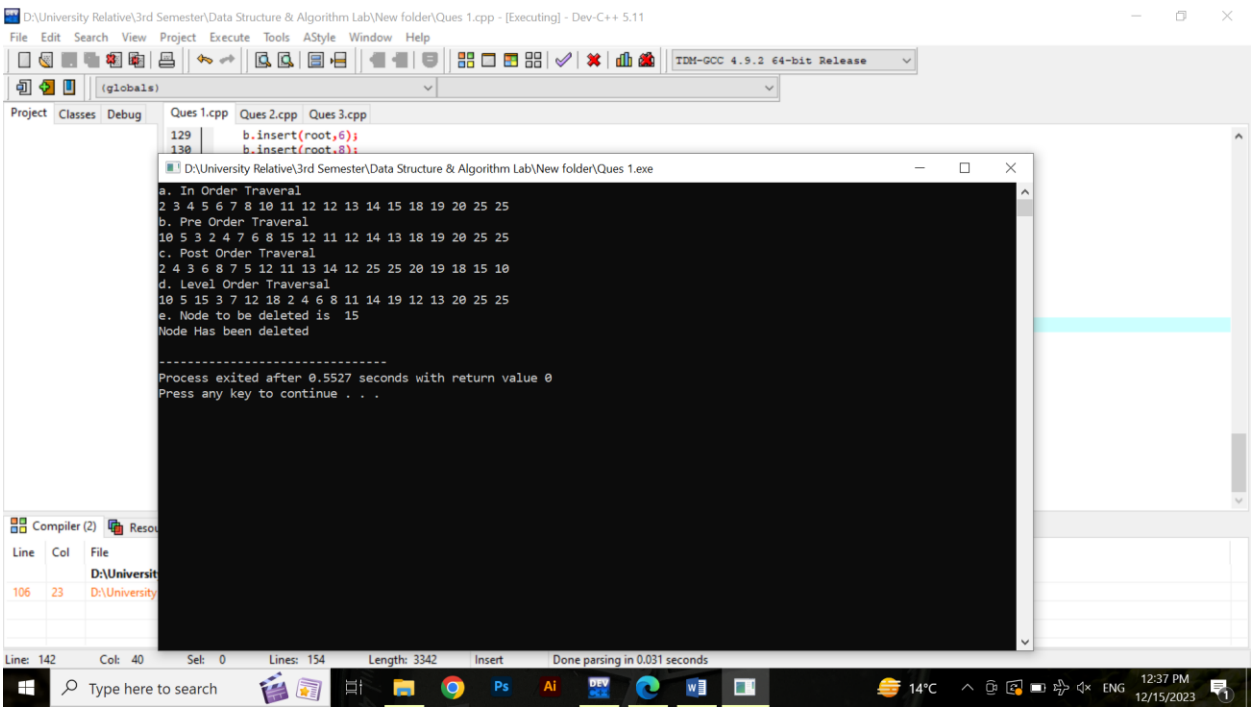
```
        preorder(root->left);
        preorder(root->right);
}
void BST::inorder(BST* root){
        if(root==NULL){
                return;
        }
        inorder(root->left);
        cout<<root->data<<" ";
        inorder(root->right);
}
void BST::postorder(BST* root){
        if(root==NULL){
                return;
        }
        postorder(root->left);
        postorder(root->right);
        cout<<root->data<<" ";
}
BST* BST :: Delete (BST* root , int value){
   if(root==NULL){
                return root;
        }
        else{
        if(value<=root->data){
                root->left=Delete(root->left,value);
        }
```

```
        else if(value>root->data){
                root->right=Delete(root->right,value);
        }else {
    if (root->left == NULL) {
        BST* temp = root->right;
        delete root;
        return temp;
    } else if (root->right == NULL) {
        BST* temp = root->left;
        delete root;
        return temp;
    }
    BST* temp = root->right;
    while (temp->left != NULL) {
        temp = temp->left;
    }
    root->data = temp->data;
    root->right = Delete(root->right, temp->data);
  }
  return root;
}
}
void BST::BFS_LevelOrder(BST* root) {
  if (root == NULL) {
    return;
  }
```

```
    queue<BST*> q;
    q.push(root);

    while (q.empty()==NULL) {
        BST* current = q.front();
        cout << current->data << " ";
        if (current->left != NULL) {
            q.push(current->left);
        }
        if (current->right != NULL) {
            q.push(current->right);
        }
        q.pop();
    }
}
int main(){
            BST b, *root=NULL;
            root=b.insert(root,10);
            b.insert(root,5);
            b.insert(root,15);
            b.insert(root,3);
            b.insert(root,7);
            b.insert(root,12);
            b.insert(root,18);
            b.insert(root,2);
            b.insert(root,4);
            b.insert(root,6);
```

```
        b.insert(root,8);
        b.insert(root,11);
        b.insert(root,14);
        b.insert(root,13);
        b.insert(root,19);
        b.insert(root,20);
        b.insert(root,25);
// Now inserting the said nodes
        b.insert(root,25);
        b.insert(root,12);
   cout << "a. In Order Traveral" << endl;
   b.inorder(root);
   cout << "\nb. Pre Order Traveral" << endl;
   b.preorder(root);
   cout << "\nc. Post Order Traveral" << endl;
   b.postorder(root);
   cout << "\nd. Level Order Traversal" << endl;
   b.BFS_LevelOrder(root);
        cout << "\ne. Node to be deleted is  15 " << endl;
        int key_to_be_deleted = 15;
        root = b.Delete(root,key_to_be_deleted);
        cout << "Node Has been deleted " << endl;


        return 0;
}
```

Output:



Question no 02:

Code:

```
/*You'll need to implement the member functions of the AVLTree
class (e.g., insert, getHeight, getBalanceFactor, rightRotate, leftRotate, and Show).
These functions are responsible for inserting nodes into the
AVL tree, balancing it, and Showing the tree structure.*/
#include <iostream>
using namespace std;
class AVL {
    int data;
    AVL *left, *right;
    int height;
public:
    AVL();
    AVL(int);
```

```
    AVL* Insert(AVL*, int);
    AVL* Delete(AVL*, int);
    void Inorder(AVL*);
    void preorder(AVL*);
    void postorder(AVL*);
    int getHeight(AVL* node);
    int getBalance(AVL* node);
    AVL* rightRotate(AVL* y);
    AVL* leftRotate(AVL* x);
    AVL* minValueNode(AVL* node);
};
AVL::AVL() {
    data = 0;
    left = right = NULL;
    height = 1;
}
AVL::AVL(int value) {
    data = value;
    left = right = NULL;
    height = 1;
}
AVL* AVL::Insert(AVL* root, int value) {
    if (root == NULL) {

        return new AVL(value);
    }
    if (value < root->data) {
```

```
        root->left = Insert(root->left, value);
    } else if (value > root->data) {

        root->right = Insert(root->right, value);
    }
    root->height = 1 + max(getHeight(root->left), getHeight(root->right));
    int balance = getBalance(root);

    if (balance > 1 && value < root->left->data) {
        return rightRotate(root);
    }
    if (balance < -1 && value > root->right->data) {
        return leftRotate(root);
    }
    if (balance > 1 && value > root->left->data) {
        root->left = leftRotate(root->left);
        return rightRotate(root);
    }
    if (balance < -1 && value < root->right->data) {
        root->right = rightRotate(root->right);
        return leftRotate(root);
    }
    return root;
}
int AVL::getHeight(AVL* node) {
    if (node == NULL) {
```

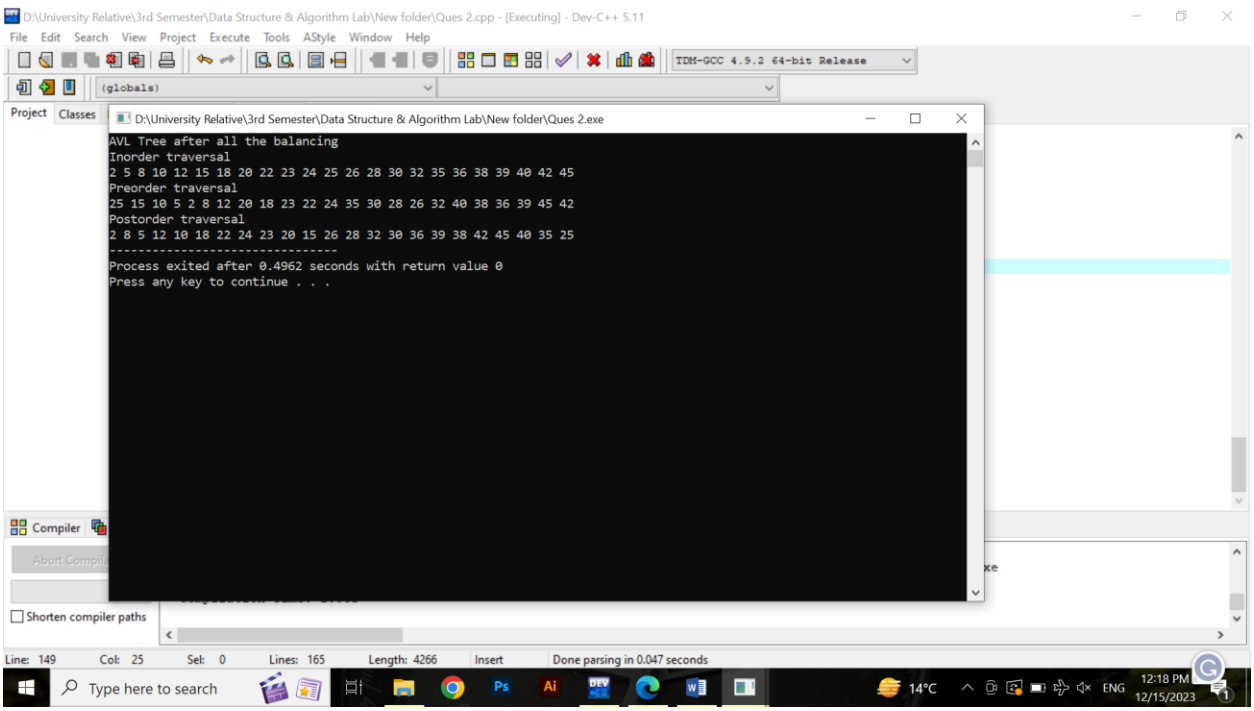
```
        return 0;
    }
    return node->height;
}
int AVL::getBalance(AVL* node) {
    if (node == NULL) {
        return 0;
    }
    return getHeight(node->left) - getHeight(node->right);
}
AVL* AVL::rightRotate(AVL* y) {
    AVL* x = y->left;
    AVL* T2 = x->right;
    x->right = y;
    y->left = T2;
    y->height = 1 + max(getHeight(y->left), getHeight(y->right));
    x->height = 1 + max(getHeight(x->left), getHeight(x->right));
    return x;
}
AVL* AVL::leftRotate(AVL* x) {
    AVL* y = x->right;
    AVL* T2 = y->left;
    y->left = x;
    x->right = T2;
    x->height = 1 + max(getHeight(x->left), getHeight(x->right));
    y->height = 1 + max(getHeight(y->left), getHeight(y->right));
    return y;
```

```
}
AVL* AVL::minValueNode(AVL* node) {
   AVL* current = node;



   while (current->left != NULL) {
      current = current->left;
   }


   return current;
}
void AVL::Inorder(AVL* root) {
   if (root == NULL) {
      return;
   }
   Inorder(root->left);
   cout << root->data << " ";
   Inorder(root->right);
}
void AVL::preorder(AVL* root) {
   if (root == NULL) {
      return;
   }
   cout << root->data << " ";
   preorder(root->left);
   preorder(root->right);
}
```

```
void AVL::postorder(AVL* root) {
    if (root == NULL) {
        return;
    }
    postorder(root->left);
    postorder(root->right);
    cout << root->data << " ";
}
int main() {
    AVL avl, *root = NULL;
    root = avl.Insert(root, 25);
    avl.Insert(root,15);
    avl.Insert(root,35);
    avl.Insert(root,10);
    avl.Insert(root,20);
    avl.Insert(root,30);
    avl.Insert(root,40);
    avl.Insert(root,5);
    avl.Insert(root,12);
    avl.Insert(root,18);
    avl.Insert(root,22);
    avl.Insert(root,28);
    avl.Insert(root,32);
    avl.Insert(root,38);
    avl.Insert(root,45);
    avl.Insert(root,2);
    avl.Insert(root,8);
```

```
    avl.Insert(root,26);
    avl.Insert(root,36);
    avl.Insert(root,42);
    avl.Insert(root,24);
    avl.Insert(root,39);
    avl.Insert(root,8);
    avl.Insert(root,23);
    cout << "AVL Tree after all the balancing " << endl;
     cout << "Inorder traversal" << endl;
    avl.Inorder(root);
    cout << "\nPreorder traversal" << endl;
    avl.preorder(root);
    cout << "\nPostorder traversal" << endl;
    avl.postorder(root);
    return 0;
}
```

Output:



Question no 03:

Code:

```
/*Define a function RemoveDuplicateNode(Node *head) which remove the
duplicate node ( repeating ) from
the sorted link list and display the resultant list. Sample:
1 -> 2 -> 3 -> 3 -> 8
Output: 1 -> 2 -> 3 -> 8*/
#include <iostream>
using namespace std;
struct Node {
    int data;
    Node* next;
    Node(int value) {
        data = value;
        next = NULL;
    }
```

```
};
void RemoveDuplicateNode(Node* head) {
   if (head == NULL) {
      return;
   }
   Node* current = head;
   while (current != NULL && current->next != NULL) {
      if (current->data == current->next->data) {

         Node* duplicate = current->next;
         current->next = current->next->next;
         delete duplicate;
      } else {

         current = current->next;
      }
   }
}
void DisplayList(Node* head) {
   while (head != NULL) {
      cout << head->data;
      if (head->next != NULL) {
         cout << " -> ";
      }
      head = head->next;
   }
   cout << endl;
```

```
}
int main() {
    Node* head = new Node(1);
    head->next = new Node(2);
    head->next->next = new Node(3);
    head->next->next->next = new Node(3);
    head->next->next->next->next = new Node(8);
    cout << "Original List: ";
    DisplayList(head);
    RemoveDuplicateNode(head);
    cout << "List after removing duplicates: ";
    DisplayList(head);
    return 0;
}
```

Output: