DATA STRUCTURES AND ALGORITHM
WEEK-10, LAB-A

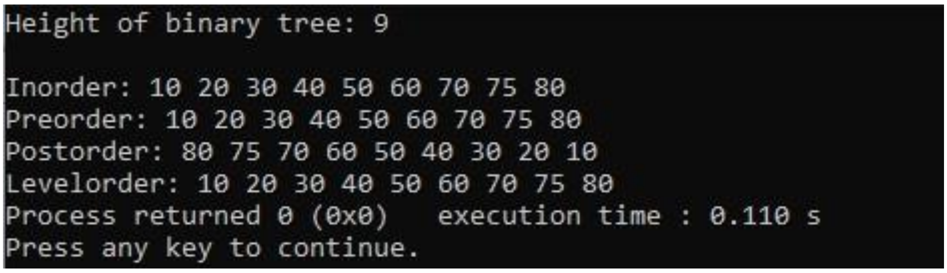
1.
CODE:

```
#include<iostream>
#include<stack>
#include<queue>
using namespace std;

class Node
{
public:     int
data;
Node* left;
   Node* right;
};

Node* createnode(int data)
{
   Node* root=new Node();
root->data=data;     root-
>left=NULL;     root-
>right=NULL;
   return root;
}

int getheight(Node* n)
{
   if(n==NULL)
   {
      return 0;
   }
   else
{
      int height=max(getheight(n->left),getheight(n->right));
return height+1;
   }
}

void Insert(Node* root,int key)
{
   Node* prev=NULL;
while(root!=NULL)     {
      prev=root;
      if(key==root->data)
      {
         cout<<"CANNOT INSERT "<<key<<endl;
         return;
      }
      else if(key<root->data)
      {
         root= root->left;
      }
else
      {
         root = root->right;
      }
   }
   Node* n = createnode(key);
   if(key<prev->data)
   {
      prev->left=n;
   }
   else
   {
      prev->right=n;
   }

}

void inorder(Node* root)
{
   stack<Node*>s;     Node* curr=root;
while(curr!=NULL || s.empty()==false)
   {
      while(curr!=NULL)
      {
         s.push(curr);
         curr=curr->left;
      }
      curr=s.top();
s.pop();        cout<<curr-
>data<<" ";
      curr=curr->right;
   }
}

void preorder(Node* root)
{
   if(root==NULL)
return;
```

```
  stack<Node*>s;
s.push(root);
while(s.empty()==false)
  {
    Node* n=s.top();
cout<<n->data<<" ";
s.pop();        if(n->right)
    {
      s.push(n->right);
    }        if(n-
>left)
    {
      s.push(n->left);
    }
  }
}

void postorder(Node* root)
{
  if(root==NULL)
return;
  stack<Node*>s1,s2;
s1.push(root);     Node*
node;
while(s1.empty()==false)
  {
    node=s1.top();
s1.pop();
s2.push(node);        if(node-
>left)
    {
      s1.push(node->left);
    }
    if(node->right)
    {
      s1.push(node->right);
    }

  }
  while(s2.empty()==false)
  {
    node=s2.top();
s2.pop();        cout<<node-
>data<<" ";
  }


}
```

```
void levelorder(Node* root)
{
   if(root==NULL)
return;
   queue<Node*>q;
q.push(root);
   while(q.empty()==false)
   {
      Node* node=q.front();
      cout<<node->data<<" ";
q.pop();       if(node->left)
         q.push(node->left);
if(node->right)
         q.push(node->right);
   }
}

int main()
{
   Node* root=NULL;
root=createnode(10);
Insert(root,20);
   Insert(root,30);
   Insert(root,40);
   Insert(root,50);
   Insert(root,60);
   Insert(root,70);
   Insert(root,75);    Insert(root,80);    int
height=getheight(root);    cout<<"Height of
binary tree: "<<height<<endl;
   cout<<endl;
cout<<"Inorder: ";
inorder(root);    cout<<endl;
cout<<"Preorder: ";
preorder(root);
cout<<endl;
cout<<"Postorder: ";
postorder(root);
cout<<endl;
cout<<"Levelorder: ";
levelorder(root);    return 0;
}
```

OUTPUT:



```
Height of binary tree: 9

Inorder: 10 20 30 40 50 60 70 75 80
Preorder: 10 20 30 40 50 60 70 75 80
Postorder: 80 75 70 60 50 40 30 20 10
Levelorder: 10 20 30 40 50 60 70 75 80
Process returned 0 (0x0)   execution time : 0.110 s
Press any key to continue.
```

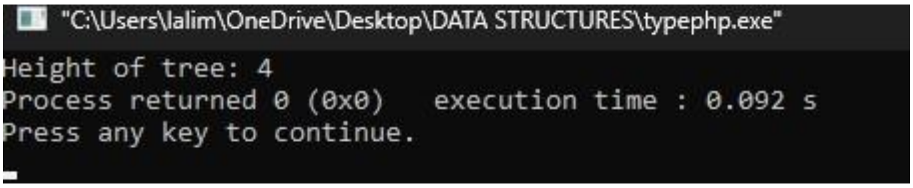
2.

CODE:

```
#include <iostream>
#include <stack> using
namespace std;
class Node
{
public:
  int key;    Node*
left,*right;    int
height;    Node(int
n)
  {
    key=n;
    left=right=NULL;
  }
};
int height(Node *root)
{
  if(root==NULL)
return 0;
  return 1 + max(height(root->left),height(root->right));
}
Node *rightRotate(Node *y)
{
  Node *x = y->left;
Node *T2 = x->right;
x->right = y;    y->left
= T2;
  y->height = max(height(y->left),height(y->right)) + 1;    x-
>height = max(height(x->left),height(x->right)) + 1;    return
x;
}
Node *leftRotate(Node *x)
{
  Node *y = x->right;
Node *T2 = y->left;
y->left = x;    x->right
= T2;
```

```
  x->height = max(height(x->left),height(x->right)) + 1;    y-
>height = max(height(y->left),height(y->right)) + 1;    return
y;
}
int getBalance(Node *N)
{
  if (N == NULL)
    return 0;
  return height(N->left) - height(N->right);
}
Node* insertNode(Node* node, int key)
{
  if (node == NULL)
  {
    Node * n=new Node(key);
    return n;
  }

  if (key < node->key)
    node->left = insertNode(node->left, key);
else if (key > node->key)       node->right =
insertNode(node->right, key);    else       return
node;

  node->height = 1 + max(height(node->left),
                height(node->right));    int
balance = getBalance(node);    if (balance >
1 && key < node->left->key)       return
rightRotate(node);    if (balance < -1 && key
> node->right->key)
    return leftRotate(node);    if (balance
> 1 && key > node->left->key)
  {
    node->left = leftRotate(node->left);
    return rightRotate(node);
  }

  if (balance < -1 && key < node->right->key)
  {
    node->right = rightRotate(node->right);
    return leftRotate(node);
  }
  return node;
}
int main()
{
   Node *root=NULL;
root=insertNode(root,10);
root=insertNode(root,20);
root=insertNode(root,30);
root=insertNode(root,40);
root=insertNode(root,50);
root=insertNode(root,60);
root=insertNode(root,70);
root=insertNode(root,75);
root=insertNode(root,80);     cout<<"Height
of tree: "<<height(root);
   return 0;
}
```

OUTPUT:



"C:\Users\lalim\OneDrive\Desktop\DATA STRUCTURES\typephp.exe"

```
Height of tree: 4
Process returned 0 (0x0)   execution time : 0.092 s
Press any key to continue.
```

3.

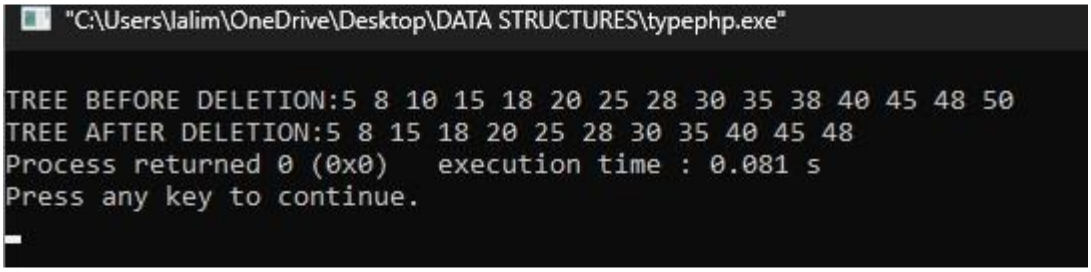
```
CODE: #include<iostream>
using namespace std;

class Node
{
   public:     int
key;     Node*
left;     Node*
right;
   int height;
};

int getheight(Node* root)
{
   if(root==NULL)
   {
      return 0;
   }
   else
   {
      return root->height;
   }
}

int max(int a,int b)
```

```
{
   return (a>b)?a:b;
}

Node* createnode(int val)
{
   Node* root=new Node();     root-
>key=val;     root->left=NULL;
root->right=NULL;     root-
>height=1;
   return root;
}


int getbf(Node* root)
{
   if(root==NULL)
   {
      return 0;
   }
   return getheight(root->left) - getheight(root->right);

}

Node* rightrotate(Node* y)
{
   Node* x = y->left;
Node* T2= x->right;     x-
>right=y;     y->left=T2;
   y->height=max(getheight(y->right),getheight(y->left))+1;
x->height=max(getheight(x->right),getheight(x->left))+1;
return x;
}
Node* leftrotate(Node* x)
{
   Node* y = x->right;
Node* T2= y->left;     y-
>left=x;     x->right=T2;
   y->height=max(getheight(y->right),getheight(y->left))+1;
x->height=max(getheight(x->right),getheight(x->left))+1;
return y;
}

Node* insert(Node* node, int key)
{
        if (node == NULL)
                return(createnode(key));
```

```
    if (key < node->key)            node->left =
insert(node->left, key);
    else if (key > node->key)            node-
>right = insert(node->right, key);
    else
return node;

    node->height= 1 + max(getheight(node->left),
                        getheight(node->right));

    int balance = getbf(node);     if
(balance > 1 && key < node->left->key)
return rightrotate(node);
    if (balance < -1 && key > node->right->key)
return leftrotate(node);

    if (balance > 1 && key > node->left->key)
    {
        node->left = leftrotate(node->left);
        return rightrotate(node);
    }
    if (balance < -1 && key < node->right->key)
    {
        node->right = rightrotate(node->right);
        return leftrotate(node);
    }
    return node;
}


void inorder(Node* root)
{
  if (root!=NULL)
  {
    inorder(root->left);     cout<<root-
>key<<" ";
    inorder(root->right);

  }

}
Node * minValueNode(Node* node)
{
  Node* current = node;
while (current->left != NULL)
    current = current->left;
    return current;
}

Node* deleteNode(Node* root, int key)
{
    if (root == NULL)
        return root;

    if ( key < root->key )         root->left =
deleteNode(root->left, key);      else if( key >
root->key )         root->right = deleteNode(root-
>right, key);
    else
    {
        if( (root->left == NULL) ||
            (root->right == NULL) )
        {
            Node *temp = root->left ?
root->left :                        root->right;

            if (temp == NULL)
            {
                temp = root;
                root = NULL;
            }
            else
            *root = *temp;
delete(temp);
        }
        else
        {
            Node* temp = minValueNode(root->right);
            root->key = temp->key;             root-
>right = deleteNode(root->right,
                                    temp->key);
        }
    }
    if (root == NULL)
return root;
    root->height = 1 + max(getheight(root->left),
                            getheight(root->right));

    int balance = getbf(root);

    if (balance > 1 &&        getbf(root-
>left) >= 0)
```

```
        return rightrotate(root);


    if (balance > 1 &&
        getbf(root->left) < 0)
    {
        root->left = leftrotate(root->left);
        return rightrotate(root);
    }


    if (balance < -1 &&        getbf(root-
>right) <= 0)
        return leftrotate(root);

    if (balance < -1 &&
        getbf(root->right) > 0)
    {
        root->right = rightrotate(root->right);
        return leftrotate(root);
    }

    return root;
}


int main()
{
    Node* head=NULL;
head=insert(head,10);
head=insert(head,20);
head=insert(head,30);
head=insert(head,40);
head=insert(head,50);
head=insert(head,45);
head=insert(head,35);
head=insert(head,25);
head=insert(head,15);
head=insert(head,5);
head=insert(head,8);
head=insert(head,18);
head=insert(head,28);
head=insert(head,38);
head=insert(head,48);     cout<<endl;
cout<<"TREE BEFORE DELETION:";
inorder(head);
deleteNode(head,38);
deleteNode(head,50);
deleteNode(head,10);    cout<<endl;
   cout<<"TREE AFTER DELETION:";
   inorder(head);


   return 0;
}
```

OUTPUT:



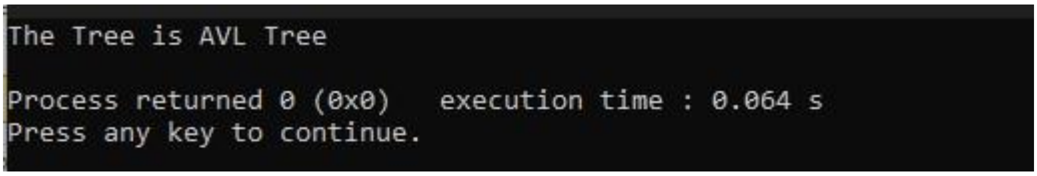
```
"C:\Users\lalim\OneDrive\Desktop\DATA STRUCTURES\typephp.exe"

TREE BEFORE DELETION:5 8 10 15 18 20 25 28 30 35 38 40 45 48 50
TREE AFTER DELETION:5 8 15 18 20 25 28 30 35 40 45 48
Process returned 0 (0x0)   execution time : 0.081 s
Press any key to continue.
```

4.

CODE:

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

class Node
{
public:    int
data;
Node* left;
   Node* right;
};

Node* createnode(int data)
{
   Node* root=new Node();    root-
>data=data;    root->left=NULL;
root->right=NULL;
   return root;
}

int getheight(Node* n)
{
   if(n==NULL)
   {
      return 0;
   }
   else
   {
      int height=max(getheight(n->left),getheight(n->right));
return height+1;
   }
}

int max(int a,int b)
{
   return (a>b)?a:b;
}

bool AVL(Node *root) {
  int lh;
  int rh;    if(root
== NULL)
return 1;
  lh = getheight(root->left);
rh = getheight(root->right);
  if(abs(lh-rh) <= 1 && AVL(root->left) && AVL(root->right)) return 1;
return 0;
}

int main()
{
   Node *root = createnode(7);    root-
>left = createnode(6);    root->right =
createnode(12);    root->left->left =
createnode(4);    root->left->right =
createnode(5);    root->right->right =
createnode(13);
  if(AVL(root))
     cout << "The Tree is AVL Tree"<<endl;
else
     cout << "The Tree is not AVL Tree "<<endl;
return 0;

}
```

OUTPUT:



```
The Tree is AVL Tree

Process returned 0 (0x0)   execution time : 0.064 s
Press any key to continue.
```

5.

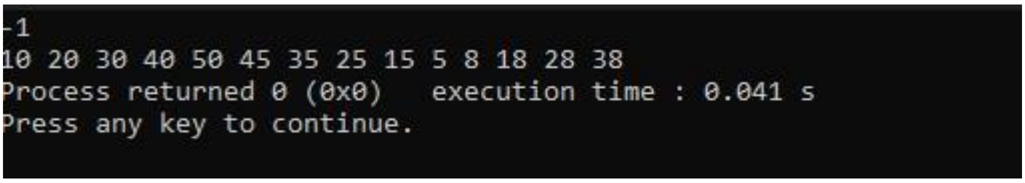
CODE:

```
#include <iostream>
```

```
#include <vector>
#include<algorithm> using
namespace std;
class Node
{
public:
    int val;
    vector<Node *> child;
    Node(int data)
    {
        val=data;
    }
};
void insert(Node *root, int parent, Node *node)
{    if
(!root)
    {
        root = node;
    }
    else
    {
        if (root->val == parent)
        {
            root->child.push_back(node);
        }
        else
        {
            int l = root->child.size();

            for(int i = 0; i < l; i++)
            {
                if (root->child[i]->val == parent)
                    insert(root->child[i], parent, node);
                else
                    insert(root->child[i], parent, node);
            }
        }
    }
}
void levelorder(vector<Node *> &prev_level)
{
    vector<Node *> cur_level;
vector<int> print_data;
    int l = prev_level.size();

    if (l == 0)
    {
        exit(0);
    }

    for(int i = 0; i < l; i++)
    {
        int prev_level_len = prev_level[i]->child.size();

        for(int j = 0; j < prev_level_len; j++)
        {
            cur_level.push_back(prev_level[i]->child[j]);
            print_data.push_back(prev_level[i]->child[j]->val);
        }
    }

    prev_level = cur_level;
    for(auto i : print_data)
    {
        cout << i << " ";
    }
    levelorder(prev_level);
}
void levelorder_root(Node *root)
{    if
(root)
    {
        vector<Node *> level;
level.push_back(root);        cout<<root-
>val<<endl;
        levelorder(level);
    }
}
int main()
{
    int arr[] = {10,20,30,40,50,45,35,25,15,5,8,18,28,38};
int arr2[]={-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1};     Node
*root = new Node(-1);
    int l = sizeof(arr) / sizeof(int);
vector<int> que;     que.push_back(-1);
    while (true)
    {
        vector<int> temp;
        for(int i = 0; i < l; i++)
        {
            if (find(que.begin(),que.end(), arr2[i]) != que.end())
            {
                insert(root, arr2[i], new Node(arr[i]));
temp.push_back(i);
```

```
            }
        }
        que = temp;
        if (que.size() == 0)
        {
            break;
        }
    }
    levelorder_root(root);
}
```

OUTPUT:



```
-1
10 20 30 40 50 45 35 25 15 5 8 18 28 38
Process returned 0 (0x0)   execution time : 0.041 s
Press any key to continue.
```