Programming Lab

Assignment-5

1. Write a menu-driven program for a binary tree using linked representation to

(a)Create (b) Preorder traversal (c) Inorder traversal (d) Postorder traversal

2. Write a menu-driven program for a binary tree using an array to

(a)Create (b) Preorder traversal (c) Inorder traversal (d) Postorder traversal

3. Implement a threaded binary tree (inorder)

4. Write a menu-driven program for a binary search tree to

(a) Create (b) search an element (c) insert element (d) delete an element

5. Write a menu-driven program to implement an AVL tree through functions

(a)Create (b) search an element (c) insert element (d) delete an element

Program 1:

```
#include<stdio.h>

#include<stdlib.h>


struct node{

   int data;

   struct node *left;

   struct node *right;

};


struct node* createNode(int val){

   struct node *newnode = (struct node *)malloc(sizeof(struct node));

   newnode->data = val;

   newnode->left = NULL;

   newnode->right = NULL;

   return newnode;

}


struct node *insert(struct node *root,int val){

   if(root == NULL){

      root = createNode(val);

   } else if(val > root->data){

      root->right = insert(root->right,val);

   }else{

      root->left = insert(root->left,val);

   }

   return root;

}


struct node *createTree(struct node *root){
   int val;
   printf("Enter the value \n");
   scanf("%d",&val);
   if(val == -1){
      return NULL;
   }

   root = createNode(val);
   printf("Enter a value at the left of %d \n",val);
   root->left = createTree(root->left);
   printf("Enter a value at the right of %d \n",val);
   root->right = createTree(root->right);

   return root;
}

void inorder(struct node *root){
   if(root != NULL){
      inorder(root->left);
      printf("%d ",root->data);
      inorder(root->right);
   }
}

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

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

int main(){
    struct node *root = NULL;
    int op;

    printf("1 to create the tree\n2 to display the tree in inorder\n3 to display the tree in preorder\n4 to display the tree in postorder\n");
    while(1){
        printf("Enter your operation...\n");
        scanf("%d",&op);
        switch (op)
        {
        case 1:
            root = createTree(root);
            break;
        case 2:
            inorder(root);
            printf("\n");
            break;
        case 3:
            preorder(root);
            printf("\n");
            break;
        case 4:
            postorder(root);
            printf("\n");
            break;
        default:
            exit(0);
        }
    }
}
```

Program 2:

```
#include<stdio.h>
#include<stdlib.h>

void createTree(int arr[],int ind,int *limit){
    int n;
    printf("Enter the value to insert...(-1 to exit)\n");
    scanf("%d",&n);
    if(n != -1){
        arr[ind] = n;
        *limit = *limit + 1;
        printf("Enter element at left of %d\n",n);
        createTree(arr,2*ind,limit);
        printf("Enter element at right of %d\n",n);
        createTree(arr,2*ind + 1,limit);
    }
}

void inorder(int arr[],int ind,int limit){
    if(ind <= limit){
        inorder(arr,2*ind,limit);
        printf("%d ",arr[ind]);
        inorder(arr, 2*ind + 1,limit);
    }
}

void preorder(int arr[],int ind,int limit){
    if(ind <= limit){
        printf("%d ",arr[ind]);
        preorder(arr,2*ind,limit);
        preorder(arr, 2*ind + 1,limit);
    }
}

void postorder(int arr[],int ind,int limit){
    if(ind <= limit){
        postorder(arr,2*ind,limit);
        postorder(arr, 2*ind + 1,limit);
        printf("%d ",arr[ind]);
    }
}

int main(){
    int op,arr[100],limit = 0;
    arr[0] = -1;

    printf("1 to create the tree(max 100 elements are allowed)\n2 to display the tree in inorder\n3 to display the tree in preorder\n4 to display the tree in postorder\n");
    while(1){
        printf("Enter your operation...\n");
        scanf("%d",&op);
        switch (op)
        {
```

```
        case 1:
          createTree(arr,1,&limit);
          printf("\n%d\n",limit);
          break;
        case 2:
          inorder(arr,1,limit);
          printf("\n");
          break;
        case 3:
          preorder(arr,1,limit);
          printf("\n");
          break;
        case 4:
          postorder(arr,1,limit);
          printf("\n");
          break;
        default:
          exit(0);
        }
    }
}
```

Program 3:

```
#include<stdio.h>
#include<stdlib.h>
#include<string.h>

struct node {
  int data;
  struct node *left;
  struct node *right;
```

```
    int lthread;
    int rthread;
};

struct node *createNode(int val){
    struct node *newNode = (struct node *)malloc(sizeof(struct node));
    newNode->data = val;
    newNode->left = NULL;
    newNode->right = NULL;
    newNode->lthread = 1;
    newNode->rthread = 1;
}

struct node *insertNode(struct node *root,int val){
    struct node *queue[1000];
    struct node *temp,*newNode;
    int front = 0,top = 1;
    queue[front] = root;
    while(1){
        temp = queue[front];
        front++;
        if(temp->lthread == 1){
            newNode = createNode(val);
            newNode->left = temp->left;
            newNode->right = temp;
            temp->left = newNode;
            temp->lthread = 0;
            return root;
        } else {
            queue[top] = temp->left;
            top++;
```

```
      }
      if(temp->rthread == 1){
         newNode = createNode(val);
         newNode->right = temp->right;
         newNode->left = temp;
         temp->right = newNode;
         temp->rthread = 0;
         return root;
      } else {
         queue[top] = temp->right;
         top++;
      }
   }
}

struct node *createTree(struct node *root){
   int n;
   while(1){
      printf("Enter the value... ");
      scanf("%d",&n);
      if(n == -1)
         break;
      if(root == NULL)
         root = createNode(n);
      else
         root = insertNode(root,n);
   }
   return root;
}

struct node *leftMost(struct node *root){
    while(root->lthread == 0)
        root = root->left;
    return root;
}

void inorder(struct node *root){
    struct node *cur = leftMost(root);
    int count = 0;

    while(cur){
        if(count == 10)
            break;
        printf("%d ",cur->data);
        if(cur->rthread)
            cur = cur->right;
        else
            cur = leftMost(cur->right);
        count++;
    }
}

int main(){
    struct node *root = NULL;
    root = createTree(root);
    printf("Inorder of the tree is: ");
    inorder(root);
}
```

Program 4:

```
#include<stdio.h>

#include<stdlib.h>


struct node{

   int data;

   struct node *left;

   struct node *right;

};


struct node* createNode(int val){

   struct node *newnode = (struct node *)malloc(sizeof(struct node));

   newnode->data = val;

   newnode->left = NULL;

   newnode->right = NULL;


   return newnode;

}


struct node *insert(struct node *root,int val){

   if(root == NULL){

      root = createNode(val);

   } else if(val > root->data){

      root->right = insert(root->right,val);

   }else{

      root->left = insert(root->left,val);

   }

   return root;

}


struct node *createTree(struct node *root){
    int val;

    printf("Enter the value...(-1 to exit)\n");

    while (1)

    {

        scanf("%d",&val);

        if(val == -1){

            break;

        }

        root = insert(root,val);

    }

    return root;

}


void levelorder(struct node *root){

    struct node *queue[100];

    for(int j=0;j<100;j++){

        queue[j] = NULL;

    }

    int front = 0,i = 2;

    queue[0] = root;


    while(1){

        if(queue[front] == 0){

            i++;

            printf("\n");

            if(queue[front + 1] == 0)

                break;

        } else {

            printf("%d ",queue[front]->data);

            if(queue[front]->left)

                queue[i++] = queue[front]->left;
            if(queue[front]->right)
                queue[i++] = queue[front]->right;
        }
        front++;
    }
}

void search(struct node *root,int val){
    if(root == NULL)
        printf("Element doesn't exist...\n");
    else{
        if(root->data == val)
            printf("It exists...\n");
        else if(val > root->data)
            search(root->right,val);
        else
            search(root->left,val);
    }
}

int get_max(struct node *root){
    int val;
    struct node *temp = root;
    while (temp->right){
        temp = temp->right;
    }
    return temp->data;
}

struct node *delete(struct node *root,int val){
    if(root->data == val){
        // no child
        if(root->left == NULL && root->right == NULL)
            return NULL;
        // only left
        else if(root->left != NULL && root->right == NULL)
            return root->left;
        // only right
        else if(root->left == NULL && root->right != NULL)
            return root->right;
        // both child
        else {
            int max_left = get_max(root->left);
            root->data = max_left;
            root->left = delete(root->left,max_left);
        }
    } else if(val > root->data)
        root->right = delete(root->right,val);
    else
        root->left = delete(root->left,val);

    return root;
}

int main(){
    struct node *root = NULL;
    int op,n;

    printf("1 to create the tree\n2 to display the tree in levelorder\n3 to insert an element\n4 to search an element\n5 to delete an element\n");
    while(1){
        printf("Enter your operation...\n");
        scanf("%d",&op);
        switch (op)
        {
        case 1:
            root = createTree(root);
            break;
        case 2:
            levelorder(root);
            printf("\n");
            break;
        case 3:
            printf("Enter the lement to insert...\n");
            scanf("%d",&n);
            root = insert(root,n);
            printf("Element inserted...\n");
            break;
        case 4:
            printf("Enter the element to search...\n");
            scanf("%d",&n);
            search(root,n);
            break;
        case 5:
            printf("Enter the element to delete...\n");
            scanf("%d",&n);
            root = delete(root,n);
            printf("Element deleted...\n");
            break;
        default:
            exit(0);
        }
    }}
```

Program 5:

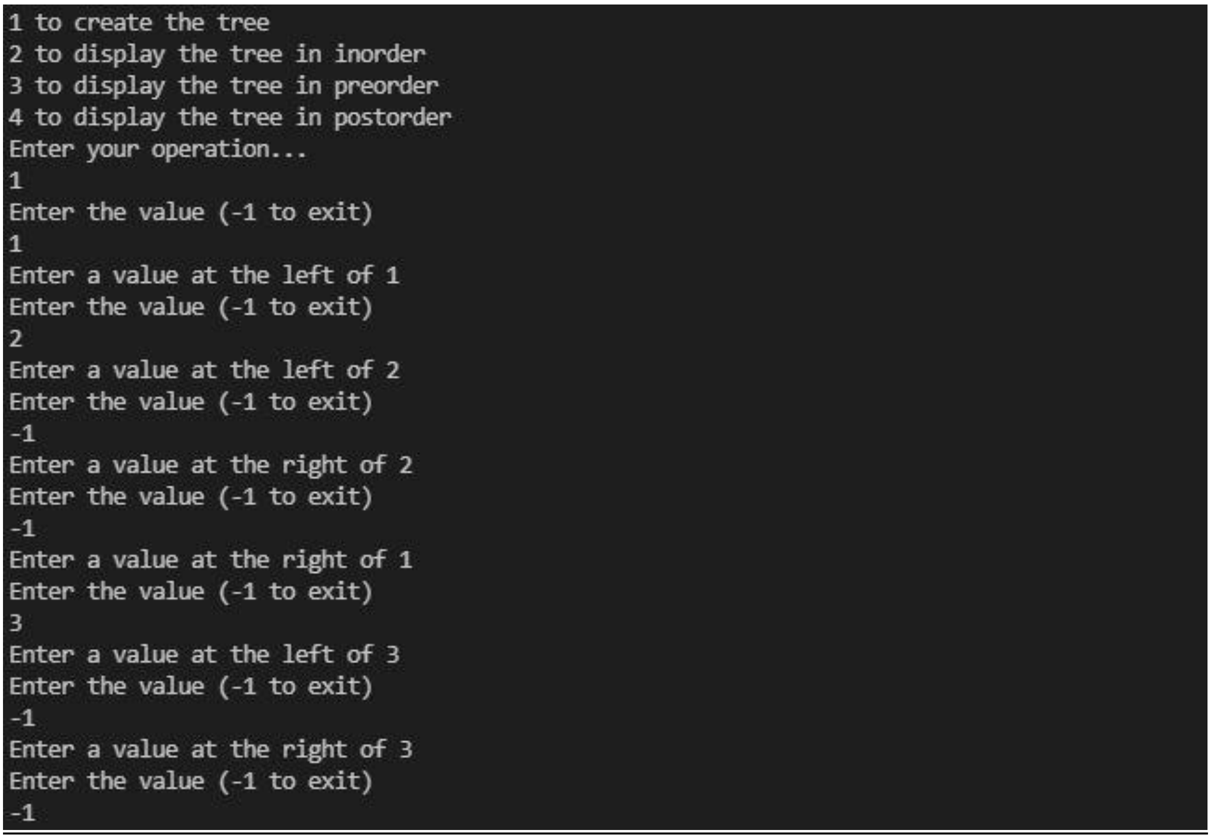
```
#include<stdio.h>

#include<stdlib.h>


struct node{

   int data;

   struct node *left,*right;

   int height;

};


struct node *createNode(int val){

   struct node *newNode = (struct node *)malloc(sizeof(struct node));

   newNode->data = val;

   newNode->left = NULL;

   newNode->right = NULL;

   newNode->height = 1;


   return newNode;

}


int max(int a,int b){

   return (a > b)? a:b;

}


int height(struct node *node){

   if(node == NULL)

      return 0;

   return node->height;

}


int getBalance(struct node *node){
    if(node == NULL)
        return 0;
    return height(node->left) - height(node->right);
}

int get_max(struct node *root){
    int val;
    struct node *temp = root;
    while (temp->right){
        temp = temp->right;
    }
    return temp->data;
}

struct node *rightRotation(struct node *a){
    struct node *b = a->left;
    struct node *TR = b->right;

    // rotation
    b->right = a;
    a->left = TR;

    a->height = max(height(a->left),height(a->right)) + 1;
    b->height = max(height(b->left),height(b->right)) + 1;

    return b;
}

struct node *leftRotation(struct node *a){
    struct node *b = a->right;
    struct node *TL = b->left;
```

```
   // rotation
   b->left = a;
   a->right = TL;

   a->height = max(height(a->left),height(a->right)) + 1;
   b->height = max(height(b->left),height(b->right)) + 1;

   return b;
}

struct node *insertNode(struct node *root,int val){
   if(root == NULL)
      return createNode(val);
   else if(val > root->data)
      root->right = insertNode(root->right,val);
   else
      root->left = insertNode(root->left,val);

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

   // left left
   if(balance > 1 && (val < root->left->data))
      return rightRotation(root);
   // right right
   else if(balance < -1 && (val > root->right->data))
      return leftRotation(root);
   // left right
   else if(balance > 1 && (val > root->left->data)){
      root->left = leftRotation(root->left);
```

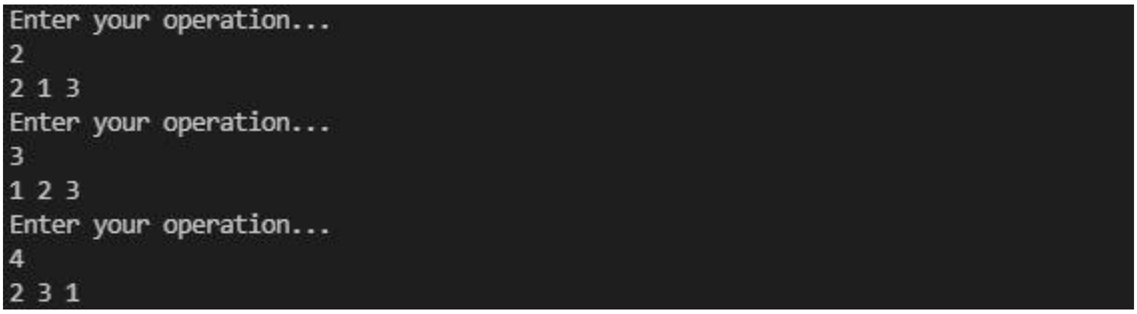
```
        return rightRotation(root);
    }
    // right left
    else if(balance < -1 && (val < root->right->data)){
        root->right = rightRotation(root->right);
        return leftRotation(root);
    }

    return root;
}

struct node *createTree(struct node *root){
    int n;
    while(1){
        printf("Enter the value: ");
        scanf("%d",&n);
        if(n == -1)
            break;
        root = insertNode(root,n);
    }
    return root;
}

void search(struct node *root,int val){
    if(root == NULL)
        printf("Element doesn't exist...\n");
    else{
        if(root->data == val)
            printf("It exists...\n");
        else if(val > root->data)
            search(root->right,val);
        else
            search(root->left,val);
    }
}

struct node *delete(struct node *root,int val){
    if(root->data == val){
        // no child
        if(root->left == NULL && root->right == NULL)
            return NULL;
        // only left
        else if(root->left != NULL && root->right == NULL)
            return root->left;
        // only right
        else if(root->left == NULL && root->right != NULL)
            return root->right;
        // both child
        else {
            int max_left = get_max(root->left);
            root->data = max_left;
            root->left = delete(root->left,max_left);
        }
    } else if(val > root->data)
        root->right = delete(root->right,val);
    else
        root->left = delete(root->left,val);

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

    // left left
    if(balance > 1 && getBalance(root->left) >=0)
        return rightRotation(root);
    // right right
    else if(balance < -1 && getBalance(root->right) <= 0)
        return leftRotation(root);
    // left right
    else if(balance > 1 && getBalance(root->left) < 0){
        root->left = leftRotation(root->left);
        return rightRotation(root);
    }
    // right left
    else if(balance < -1 && getBalance(root->right) > 0){
        root->right = rightRotation(root->right);
        return leftRotation(root);
    }

    return root;
}

void preorder(struct node *root){
    if(root){
        printf("%d ",root->data);
        preorder(root->left);
        preorder(root->right);
    }
}

int main(){
    struct node *root = NULL;
    int op,n;
```

```
  printf("1 to create the tree\n2 to display the tree in preorder\n3 to insert an element\n4 to search
an element\n5 to delete an element\n");

  while(1){

    printf("Enter your operation...\n");

    scanf("%d",&op);

    switch (op)

    {

    case 1:

      root = createTree(root);

      break;

    case 2:

      preorder(root);

      printf("\n");

      break;

    case 3:

      printf("Enter the lement to insert...\n");

      scanf("%d",&n);

      root = insertNode(root,n);

      printf("Element inserted...\n");

      break;

    case 4:

      printf("Enter the element to search...\n");

      scanf("%d",&n);

      search(root,n);

      break;

    case 5:

      printf("Enter the element to delete...\n");

      scanf("%d",&n);

      root = delete(root,n);

      printf("Element deleted...\n");

      break;
      default:
        exit(0);
      }
    }
}
```

Output 1:

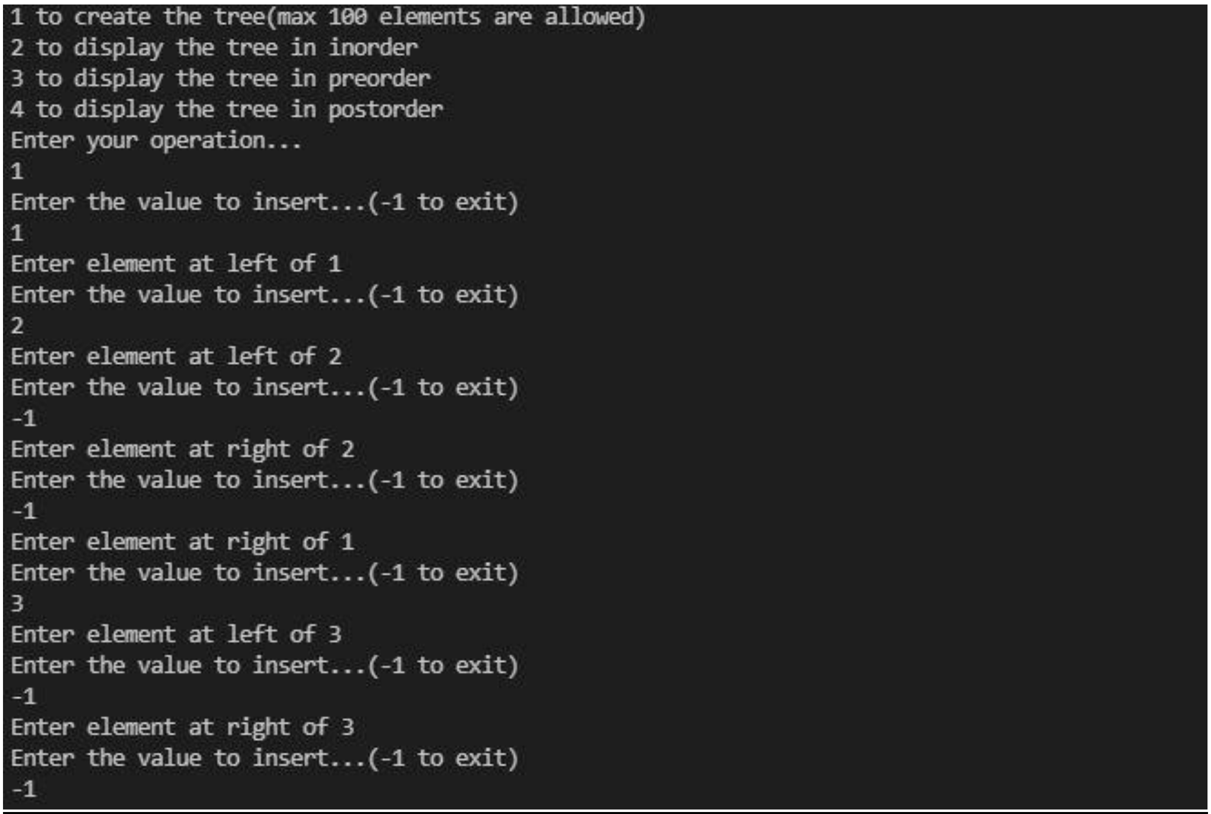


```
1 to create the tree
2 to display the tree in inorder
3 to display the tree in preorder
4 to display the tree in postorder
Enter your operation...
1
Enter the value (-1 to exit)
1
Enter a value at the left of 1
Enter the value (-1 to exit)
2
Enter a value at the left of 2
Enter the value (-1 to exit)
-1
Enter a value at the right of 2
Enter the value (-1 to exit)
-1
Enter a value at the right of 1
Enter the value (-1 to exit)
3
Enter a value at the left of 3
Enter the value (-1 to exit)
-1
Enter a value at the right of 3
Enter the value (-1 to exit)
-1
```

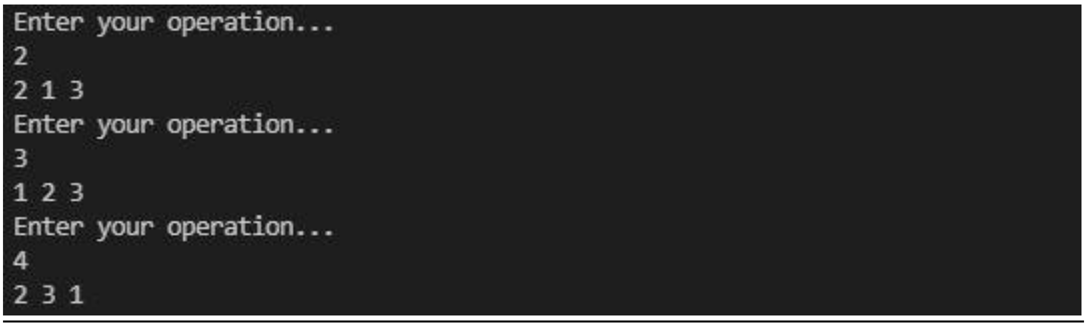


```
Enter your operation...
2
2 1 3
Enter your operation...
3
1 2 3
Enter your operation...
4
2 3 1
```

Output 2:

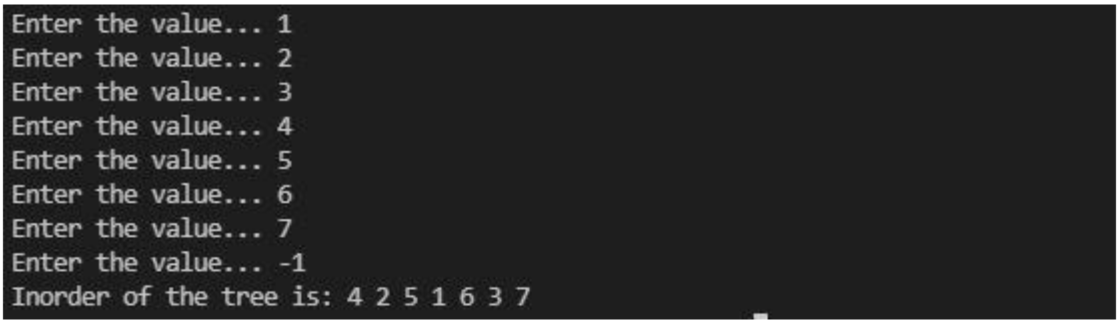


```
1 to create the tree(max 100 elements are allowed)
2 to display the tree in inorder
3 to display the tree in preorder
4 to display the tree in postorder
Enter your operation...
1
Enter the value to insert...(-1 to exit)
1
Enter element at left of 1
Enter the value to insert...(-1 to exit)
2
Enter element at left of 2
Enter the value to insert...(-1 to exit)
-1
Enter element at right of 2
Enter the value to insert...(-1 to exit)
-1
Enter element at right of 1
Enter the value to insert...(-1 to exit)
3
Enter element at left of 3
Enter the value to insert...(-1 to exit)
-1
Enter element at right of 3
Enter the value to insert...(-1 to exit)
-1
```



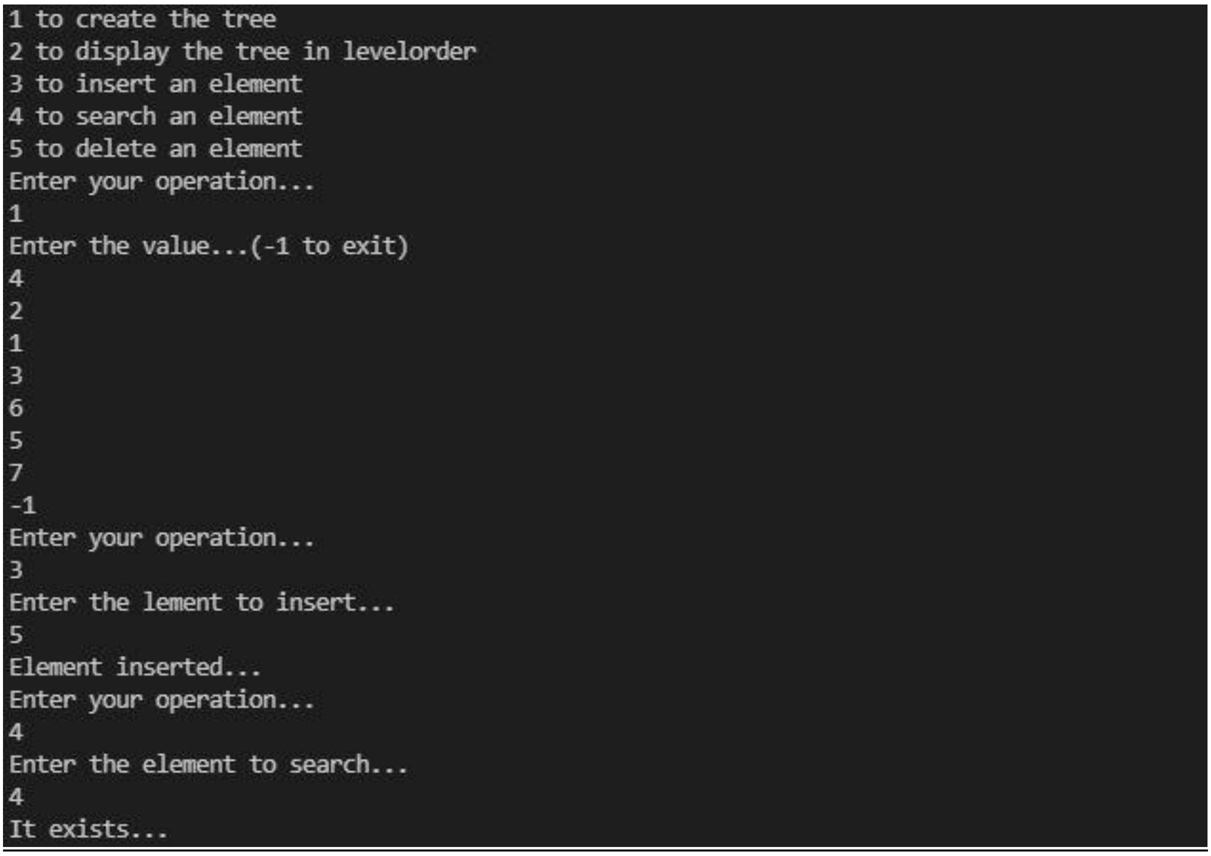
```
Enter your operation...
2
2 1 3
Enter your operation...
3
1 2 3
Enter your operation...
4
2 3 1
```

Output 3:



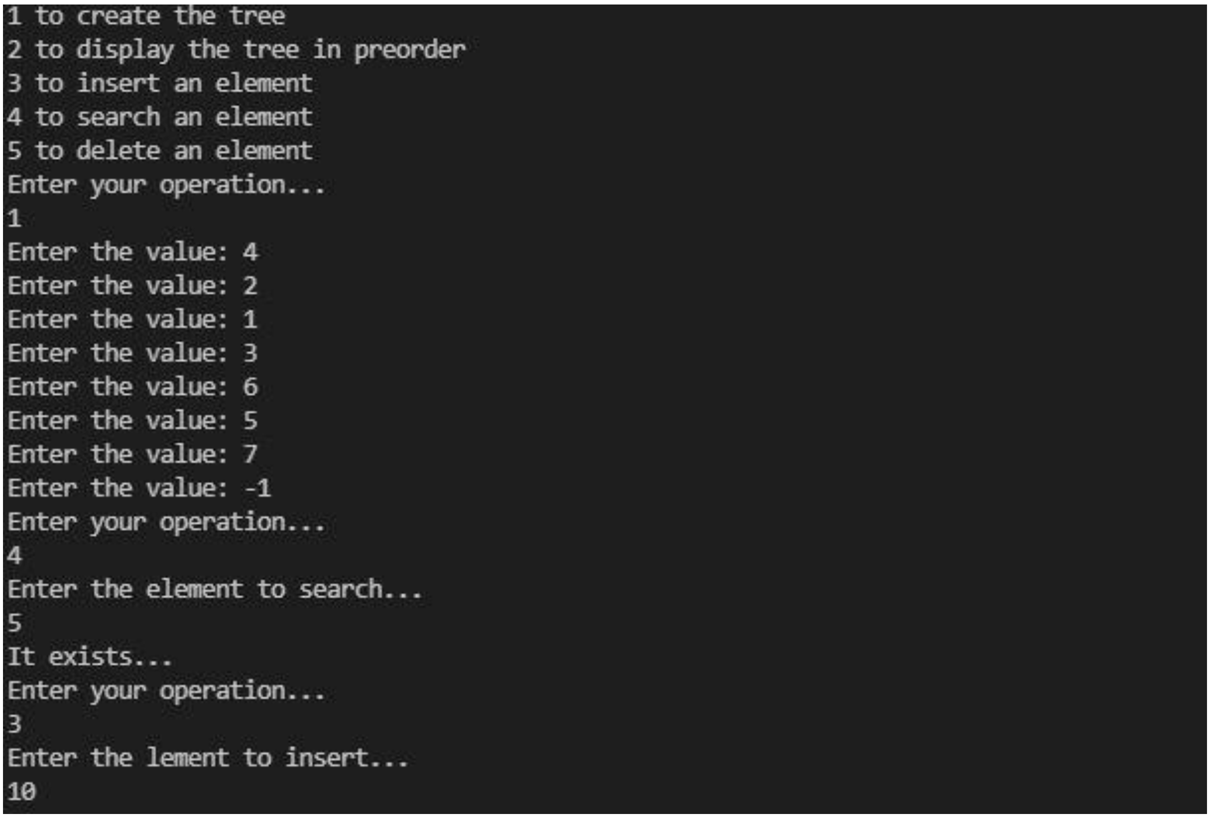
```
Enter the value... 1
Enter the value... 2
Enter the value... 3
Enter the value... 4
Enter the value... 5
Enter the value... 6
Enter the value... 7
Enter the value... -1
Inorder of the tree is: 4 2 5 1 6 3 7
```

Output 4:

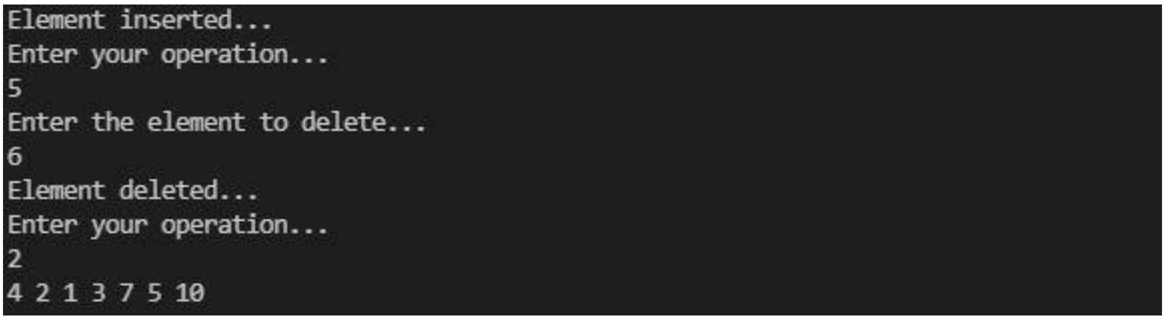


```
1 to create the tree
2 to display the tree in levelorder
3 to insert an element
4 to search an element
5 to delete an element
Enter your operation...
1
Enter the value...(-1 to exit)
4
2
1
3
6
5
7
-1
Enter your operation...
3
Enter the lement to insert...
5
Element inserted...
Enter your operation...
4
Enter the element to search...
4
It exists...
```

Output 5:



```
1 to create the tree
2 to display the tree in preorder
3 to insert an element
4 to search an element
5 to delete an element
Enter your operation...
1
Enter the value: 4
Enter the value: 2
Enter the value: 1
Enter the value: 3
Enter the value: 6
Enter the value: 5
Enter the value: 7
Enter the value: -1
Enter your operation...
4
Enter the element to search...
5
It exists...
Enter your operation...
3
Enter the lement to insert...
10
```



```
Element inserted...
Enter your operation...
5
Enter the element to delete...
6
Element deleted...
Enter your operation...
2
4 2 1 3 7 5 10
```