```
 /*
                            ASSIGNMENT NO. 4
      NAME- ABRAR SHAIKH                          ROLL NO. - 23570
                            TOPIC- Expression Tree
*/
#include <iostream>
using namespace std;

// Node structure for expression tree
struct Node {
    char data;
    Node* left;
    Node* right;
};

// Stack class for tree nodes
class Stack {
private:
    Node* arr[100];
    int top;

public:
    Stack() {
        top = -1;
    }

    void push(Node* node) {
        arr[++top] = node;
    }
```

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    Node* pop() {
        return arr[top--];
    }

    bool isEmpty() {
        return top == -1;
    }
};

// Utility function to create a new node
Node* createNode(char data) {
    Node* newNode = new Node();
    newNode->data = data;
    newNode->left = newNode->right = NULL;
    return newNode;
}

// Function to check if the character is an operator
bool isOperator(char ch) {
    return (ch == '+' || ch == '-' || ch == '*' || ch == '/');
}

// Function to build expression tree from postfix
Node* constructTreeFromPostfix(char postfix[]) {
    Stack stack;
    int i = 0;
    while (postfix[i] != '\0') {
        char ch = postfix[i];
```

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        // If operand, create a node and push it
        if (ch >= '0' && ch <= '9') {
            stack.push(createNode(ch));
        }
        // If operator, pop two nodes, make them children, and push
new node
        else if (isOperator(ch)) {
            Node* node = createNode(ch);
            node->right = stack.pop(); // Right child
            node->left = stack.pop();  // Left child
            stack.push(node);
        }
        i++;
    }
    return stack.pop(); // Final node is the root of the expression
tree
}

// Function to build expression tree from prefix
Node* constructTreeFromPrefix(char prefix[], int length) {
    Stack stack;

    // Traverse the prefix expression from right to left
    for (int i = length - 1; i >= 0; i--) {
        char ch = prefix[i];

        // If operand, create a node and push it
        if (ch >= '0' && ch <= '9') {
            stack.push(createNode(ch));
        }
```

```
        // If operator, pop two nodes, make them children, and push
new node
        else if (isOperator(ch)) {
            Node* node = createNode(ch);
            node->left = stack.pop();  // Left child
            node->right = stack.pop(); // Right child
            stack.push(node);
        }
    }
    return stack.pop(); // Final node is the root of the expression
tree
}

// Inorder traversal (Left, Root, Right)
void inorder(Node* root) {
    if (root != NULL) {
        inorder(root->left);
        cout << root->data << " ";
        inorder(root->right);
    }
}

// Preorder traversal (Root, Left, Right)
void preorder(Node* root) {
    if (root != NULL) {
        cout << root->data << " ";
        preorder(root->left);
        preorder(root->right);
    }
}
```

```
// Postorder traversal (Left, Right, Root)
void postorder(Node* root) {
    if (root != NULL) {
        postorder(root->left);
        postorder(root->right);
        cout << root->data << " ";
    }
}

//inorder Non-Recursive Traversal
void inorderNonRecursive(Node *root)
{
      Stack s;
      Node *tmp=root;

      //current should not be null (if null there is no node), stack
should not be empty (initially can be)
      while(tmp!=NULL || !s.isEmpty())
      {
            while(tmp!=NULL)
            {
                  s.push(tmp);
                  tmp=tmp->left;
            }

            //popping stored left subtree elements
            tmp=s.pop();
            //printing data
            cout<<tmp->data<<" ";
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            //traversing right subtree
            tmp=tmp->right;
      }
}

//preorder Non-Recursive Traversal
void preorderNonRecursive(Node *root)
{
      Stack s;

      if(root==NULL)
            return;

      s.push(root);

      while(!s.isEmpty())
      {
            Node *temp=s.pop();
            cout<<temp->data<<" ";

            if(temp->right!=NULL)
                  s.push(temp->right);

            if(temp->left!=NULL)
                  s.push(temp->left);
      }
}

//postorder Non-Recursive
void postorderNonRecursive(Node *root)
```
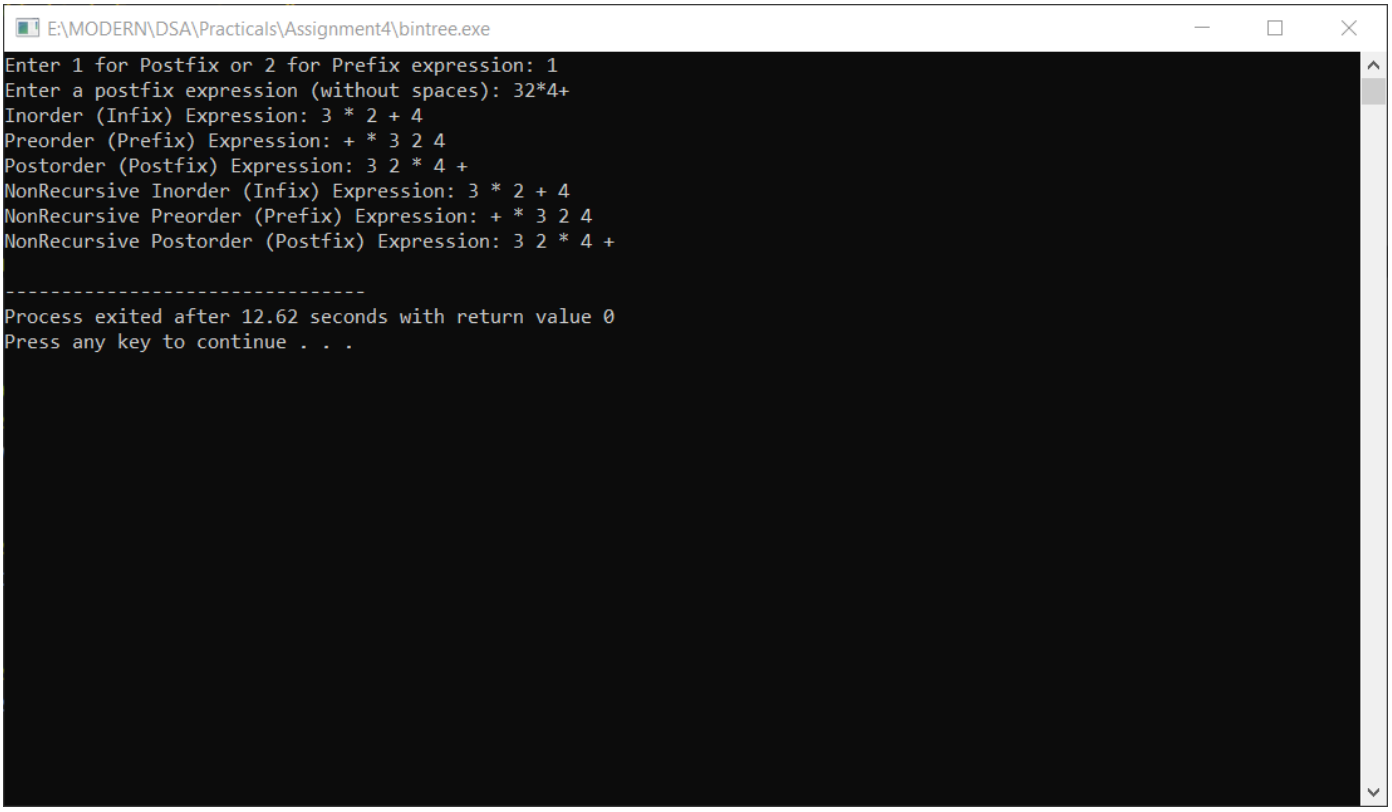
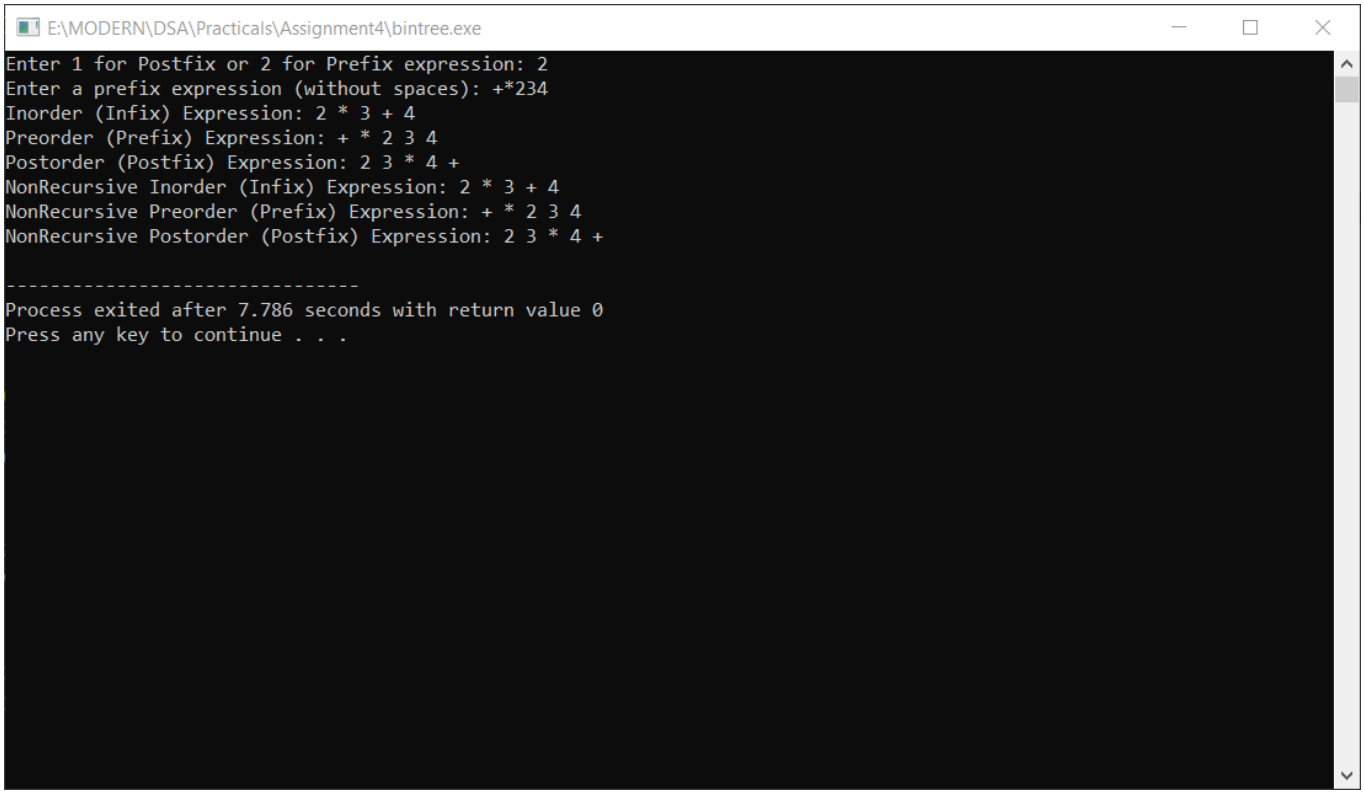

```
{
      if(root==NULL)
            return;

      Stack s,s1;
      s.push(root);

      while(!s.isEmpty())
      {
            Node *temp=s.pop();
            s1.push(temp);

            if(temp->left!=NULL)
                  s.push(temp->left);
            if(temp->right!=NULL)
                  s.push(temp->right);
      }
      while(!s1.isEmpty())
            cout<<s1.pop()->data<<" ";
}

int main() {
    char expression[100];
    int choice;

    cout << "Enter 1 for Postfix or 2 for Prefix expression: ";
    cin >> choice;
    if (choice == 1) {
        cout << "Enter a postfix expression (without spaces): ";
        cin >> expression;
```

```
    // Construct the expression tree from postfix
    Node* root = constructTreeFromPostfix(expression);

    // Display the tree in different orders
    cout << "Inorder (Infix) Expression: ";
    inorder(root);
    cout << endl;

    cout << "Preorder (Prefix) Expression: ";
    preorder(root);
    cout << endl;

    cout << "Postorder (Postfix) Expression: ";
    postorder(root);
    cout << endl;

    // Display the tree in different orders nonrecursive
    cout << "NonRecursive Inorder (Infix) Expression: ";
    inorderNonRecursive(root);
    cout << endl;

    cout << "NonRecursive Preorder (Prefix) Expression: ";
    preorderNonRecursive(root);
    cout << endl;

    cout << "NonRecursive Postorder (Postfix) Expression: ";
    postorderNonRecursive(root);
    cout << endl;
}
```

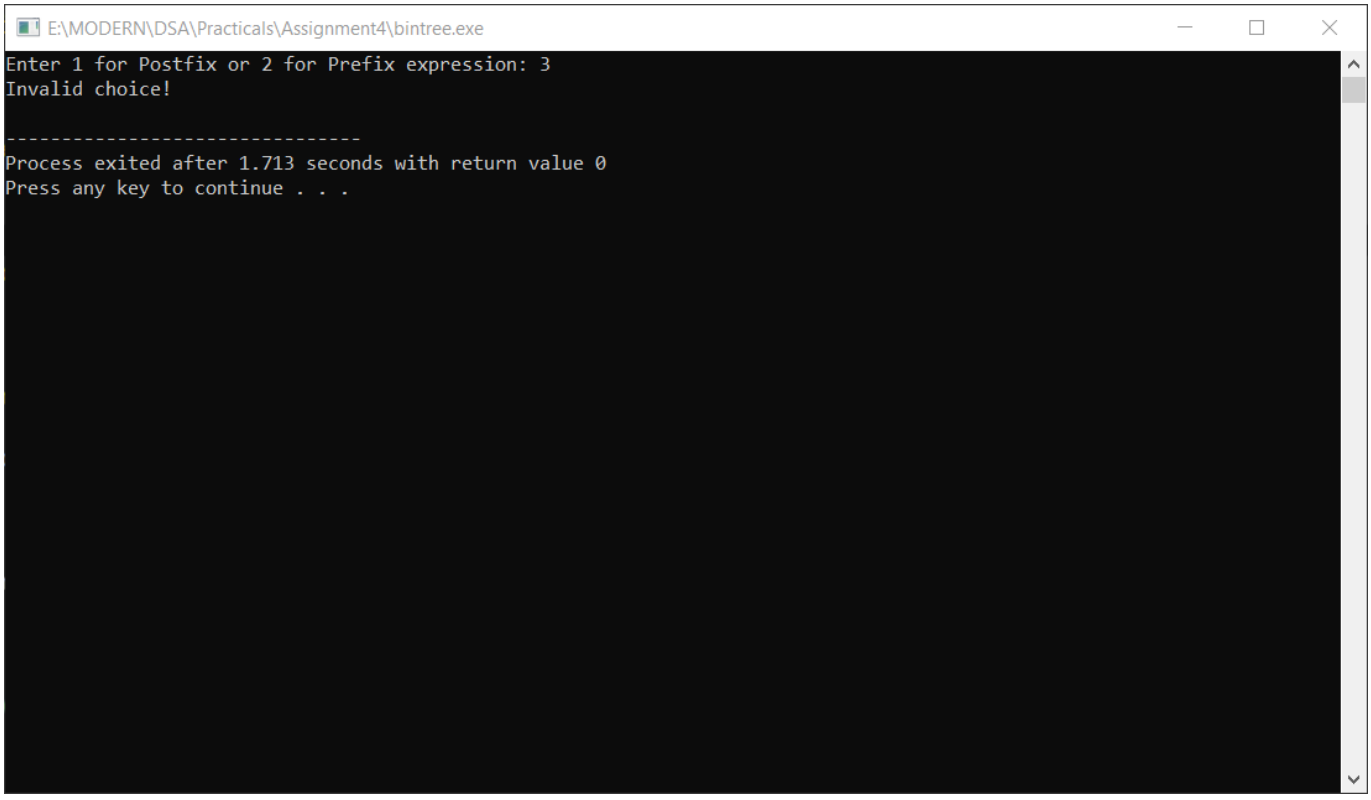
```
    else if (choice == 2) {
        cout << "Enter a prefix expression (without spaces): ";
        cin >> expression;

        // Get the length of the prefix expression
        int length = 0;
        while (expression[length] != '\0') {
            length++;
        }

        // Construct the expression tree from prefix
        Node* root = constructTreeFromPrefix(expression, length);

        // Display the tree in different orders
        cout << "Inorder (Infix) Expression: ";
        inorder(root);
        cout << endl;

        cout << "Preorder (Prefix) Expression: ";
        preorder(root);
        cout << endl;

        cout << "Postorder (Postfix) Expression: ";
        postorder(root);
        cout << endl;

        // Display the tree in different orders nonrecursive
        cout << "NonRecursive Inorder (Infix) Expression: ";
        inorderNonRecursive(root);
        cout << endl;
```

```
        cout << "NonRecursive Preorder (Prefix) Expression: ";
        preorderNonRecursive(root);
        cout << endl;

        cout << "NonRecursive Postorder (Postfix) Expression: ";
        postorderNonRecursive(root);
        cout << endl;
    }
    else {
        cout << "Invalid choice!" << endl;
    }

    return 0;
}
```




E:\MODERN\DSA\Practicals\Assignment4\bintree.exe
Enter 1 for Postfix or 2 for Prefix expression: 2
Enter a prefix expression (without spaces): +*234
Inorder (Infix) Expression: 2 * 3 + 4
Preorder (Prefix) Expression: + * 2 3 4
Postorder (Postfix) Expression: 2 3 * 4 +
NonRecursive Inorder (Infix) Expression: 2 * 3 + 4
NonRecursive Preorder (Prefix) Expression: + * 2 3 4
NonRecursive Postorder (Postfix) Expression: 2 3 * 4 +

Process exited after 7.786 seconds with return value 0
Press any key to continue . . .


E:\MODERN\DSA\Practicals\Assignment4\bintree.exe
Enter 1 for Postfix or 2 for Prefix expression: 3
Invalid choice!

Process exited after 1.713 seconds with return value 0
Press any key to continue . . .