PIMPRI CHINCHWAD EDUCATION TRUST's.

PIMPRI CHINCHWAD COLLEGE OF ENGINEERING

(An Autonomous Institute)

Class : SY BTech **Acad. Yr. 2025-26** **Semester : I**

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Department: Computer Engineering **Division :** A

Course Name : Data Structures and Laboratory

Course Code: BCE23PC02

Completion Date : 12/08/2025

(Extra Assignment)

Problem Statement:

Write a C++ program to perform **expression conversion and evaluation** using **stack operations**.
The program should include:

- Checking for **balanced parentheses**
- **Infix to Postfix** and **Infix to Prefix** conversion
- **Postfix to Infix** and **Prefix to Infix** conversion
- **Postfix and Prefix expression evaluation** using stacks

Source Code :

https://github.com/omkhalane/DSAL-SY-PCCOE/blob/main/lab_assignments/assignment11.cpp

```cpp
#include <bits/stdc++.h>
using namespace std;
```

```cpp
#define MAX 100

// ---------------- Stack for char ----------------
class StackChar
{
    char arr[MAX];
    int top;

public:
    StackChar() { top = -1; }
    bool isEmpty() { return top == -1; }
    bool isFull() { return top == MAX - 1; }
    void push(char ch)
    {
        if (!isFull())
            arr[++top] = ch;
    }
    char pop()
    {
        if (!isEmpty())
            return arr[top--];
        return '\0';
    }
    char peek()
    {
        if (!isEmpty())
            return arr[top];
        return '\0';
    }
};
```

```
    // ---------------- Stack for int ----------------
    class StackInt
    {
        int arr[MAX];
        int top;

    public:
        StackInt() { top = -1; }
        bool isEmpty() { return top == -1; }
        void push(int val) { arr[++top] = val; }
        int pop() { return arr[top--]; }
        int peek() { return arr[top]; }
    };

    // ---------------- Parenthesis Check ----------------
    bool isMatchingPair(char a, char b)
    {
        return (a == '(' && b == ')') || (a == '{' && b == '}') || (a == '[' && b == ']');
    }
    bool isBalanced(string expr)
    {
        StackChar s;
        for (char ch : expr)
        {
            if (ch == '(' || ch == '{' || ch == '[')
                s.push(ch);
            else if (ch == ')' || ch == '}' || ch == ']')
            {
                if (s.isEmpty() || !isMatchingPair(s.pop(), ch))
                    return false;
            }
```

```
        }
        return s.isEmpty();
    }

    // ---------------- Infix to Postfix ----------------
    int precedence(char op)
    {
        if (op == '+' || op == '-')
            return 1;
        if (op == '*' || op == '/')
            return 2;
        if (op == '^')
            return 3;
        return 0;
    }
    bool isOperator(char ch)
    {
        return ch == '+' || ch == '-' || ch == '*' || ch == '/' || ch == '^';
    }
    string infixToPostfix(string infix)
    {
        StackChar s;
        string postfix = "";
        for (char ch : infix)
        {
            if ((ch >= 'a' && ch <= 'z') || (ch >= 'A' && ch <= 'Z') || (ch >= '0' && ch <= '9'))
                postfix += ch;
            else if (ch == '(')
                s.push(ch);
            else if (ch == ')')
            {
```

```
                while (!s.isEmpty() && s.peek() != '(')
                    postfix += s.pop();
                s.pop();
            }
            else if (isOperator(ch))
            {
                while (!s.isEmpty() && precedence(ch) <= precedence(s.peek()))
                    postfix += s.pop();
                s.push(ch);
            }
        }
        while (!s.isEmpty())
            postfix += s.pop();
        return postfix;
    }

    // ---------------- Infix to Prefix ----------------
    string reverseString(string s)
    {
        string r = "";
        for (int i = s.size() - 1; i >= 0; i--)
            r += s[i];
        return r;
    }
    string infixToPrefix(string infix)
    {
        string rev = reverseString(infix);
        for (int i = 0; i < rev.size(); i++)
        {
            if (rev[i] == '(')
                rev[i] = ')';
            else if (rev[i] == ')')
```

```
                rev[i] = '(';
            }
            string post = infixToPostfix(rev);
            return reverseString(post);
        }

        // ---------------- Postfix to Infix ----------------
        string postfixToInfix(string postfix)
        {
            string stack[MAX];
            int top = -1;
            for (char ch : postfix)
            {
                if ((ch >= 'a' && ch <= 'z') || (ch >= 'A' && ch <= 'Z') || (ch >= '0' && ch <= '9'))
                    stack[++top] = string(1, ch);
                else
                {
                    string op2 = stack[top--];
                    string op1 = stack[top--];
                    stack[++top] = "(" + op1 + ch + op2 + ")";
                }
            }
            return stack[top];
        }

        // ---------------- Prefix to Infix ----------------
        string prefixToInfix(string prefix)
        {
            string stack[MAX];
            int top = -1;
            for (int i = prefix.size() - 1; i >= 0; i--)
```

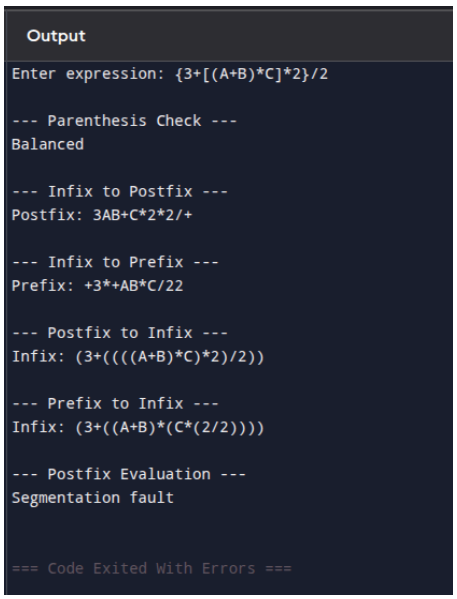
```
        {
            char ch = prefix[i];
            if ((ch >= 'a' && ch <= 'z') || (ch >= 'A' && ch <= 'Z') || (ch >= '0' && ch <= '9'))
                stack[++top] = string(1, ch);
            else
            {
                string op1 = stack[top--];
                string op2 = stack[top--];
                stack[++top] = "(" + op1 + ch + op2 + ")";
            }
        }
        return stack[top];
    }

    // ---------------- Postfix Evaluation ----------------
    int postfixEval(string postfix)
    {
        StackInt s;
        for (char ch : postfix)
        {
            if (ch >= '0' && ch <= '9')
                s.push(ch - '0');
            else
            {
                int b = s.pop();
                int a = s.pop();
                if (ch == '+')
                    s.push(a + b);
                else if (ch == '-')
                    s.push(a - b);
                else if (ch == '*')
```

```
                s.push(a * b);
            else if (ch == '/')
                s.push(a / b);
        }
    }
    return s.pop();
}

// ---------------- Prefix Evaluation ----------------
int prefixEval(string prefix)
{
    StackInt s;
    for (int i = prefix.size() - 1; i >= 0; i--)
    {
        char ch = prefix[i];
        if (ch >= '0' && ch <= '9')
            s.push(ch - '0');
        else
        {
            int a = s.pop();
            int b = s.pop();
            if (ch == '+')
                s.push(a + b);
            else if (ch == '-')
                s.push(a - b);
            else if (ch == '*')
                s.push(a * b);
            else if (ch == '/')
                s.push(a / b);
        }
    }
    return s.pop();
```

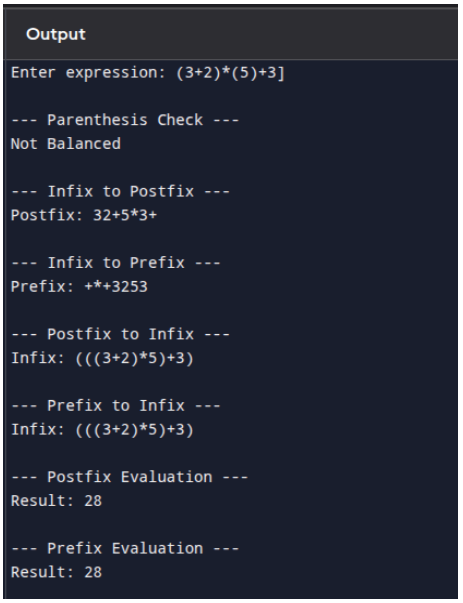
```
}

// ---------------- Main ----------------
int main()
{
    string expr;
    cout << "Enter expression: ";
    cin >> expr;

    cout << "\n--- Parenthesis Check ---\n";
    cout << (isBalanced(expr) ? "Balanced\n" : "Not Balanced\n");

    cout << "\n--- Infix to Postfix ---\n";
    string postfix = infixToPostfix(expr);
    cout << "Postfix: " << postfix << "\n";

    cout << "\n--- Infix to Prefix ---\n";
    string prefix = infixToPrefix(expr);
    cout << "Prefix: " << prefix << "\n";

    cout << "\n--- Postfix to Infix ---\n";
    cout << "Infix: " << postfixToInfix(postfix) << "\n";

    cout << "\n--- Prefix to Infix ---\n";
    cout << "Infix: " << prefixToInfix(prefix) << "\n";

    cout << "\n--- Postfix Evaluation ---\n";
    cout << "Result: " << postfixEval(postfix) << "\n";

    cout << "\n--- Prefix Evaluation ---\n";
    cout << "Result: " << prefixEval(prefix) << "\n";
```

```
        return 0;
    }
```

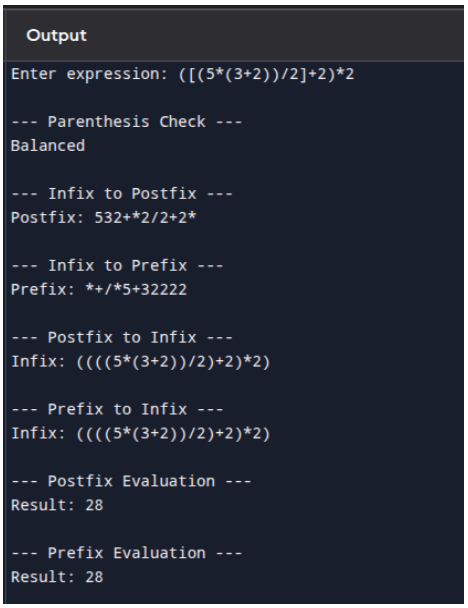
Output :



```
Output

Enter expression: {3+[(A+B)*C]*2}/2

--- Parenthesis Check ---
Balanced

--- Infix to Postfix ---
Postfix: 3AB+C*2*2/+

--- Infix to Prefix ---
Prefix: +3*+AB*C/22

--- Postfix to Infix ---
Infix: (3+((((A+B)*C)*2)/2))

--- Prefix to Infix ---
Infix: (3+((A+B)*(C*(2/2))))

--- Postfix Evaluation ---
Segmentation fault


=== Code Exited With Errors ===
```



```
Output

Enter expression: (3+2)*(5)+3]

--- Parenthesis Check ---
Not Balanced

--- Infix to Postfix ---
Postfix: 32+5*3+

--- Infix to Prefix ---
Prefix: +*+3253

--- Postfix to Infix ---
Infix: (((3+2)*5)+3)

--- Prefix to Infix ---
Infix: (((3+2)*5)+3)

--- Postfix Evaluation ---
Result: 28

--- Prefix Evaluation ---
Result: 28
```



```
Output

Enter expression: ([(5*(3+2))/2]+2)*2

--- Parenthesis Check ---
Balanced

--- Infix to Postfix ---
Postfix: 532+*2/2+2*

--- Infix to Prefix ---
Prefix: *+/*5+32222

--- Postfix to Infix ---
Infix: ((((5*(3+2))/2)+2)*2)

--- Prefix to Infix ---
Infix: ((((5*(3+2))/2)+2)*2)

--- Postfix Evaluation ---
Result: 28

--- Prefix Evaluation ---
Result: 28
```

Conclusion:

- The **Stack data structure (LIFO)** is essential for expression conversion and evaluation because it stores operators and operands in order of usage.
- The program demonstrates multiple stack-based operations such as:
    - **Parenthesis Checking:** Ensures expressions are syntactically correct by matching brackets.
    - **Infix → Postfix / Prefix Conversion:** Rearranges operators based on precedence and associativity.
    - **Postfix / Prefix → Infix Conversion:** Reconstructs readable infix expressions from symbolic notations.
    - **Evaluation of Postfix & Prefix Expressions:** Computes the actual result using integer stacks.

Time Complexity (TC):

- **Parenthesis Check:** O(n)
- **Infix/Postfix/Prefix Conversion:** O(n)
- **Evaluation:** O(n)

Space Complexity (SC):

- **O(n)** (for stack storage of operators/operands).