Data Structures and Algorithms(UCS540)

Sixth-Semester

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3EE2

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Electrical Engineering

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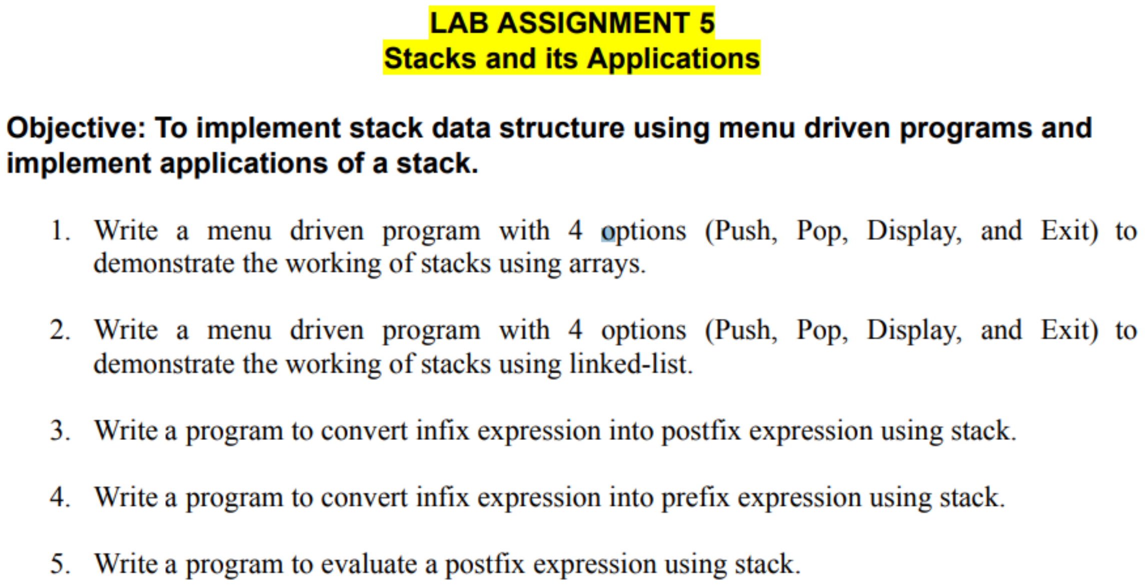
List of Experiments



LAB ASSIGNMENT 5
Stacks and its Applications

Objective: To implement stack data structure using menu driven programs and implement applications of a stack.

1. Write a menu driven program with 4 options (Push, Pop, Display, and Exit) to demonstrate the working of stacks using arrays.

2. Write a menu driven program with 4 options (Push, Pop, Display, and Exit) to demonstrate the working of stacks using linked-list.

3. Write a program to convert infix expression into postfix expression using stack.

4. Write a program to convert infix expression into prefix expression using stack.

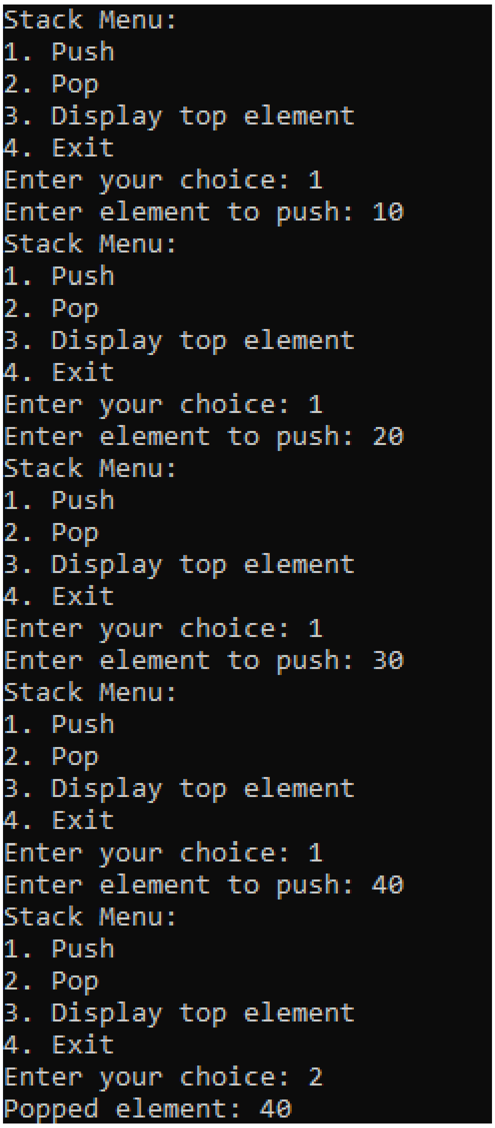
5. Write a program to evaluate a postfix expression using stack.

Q1.

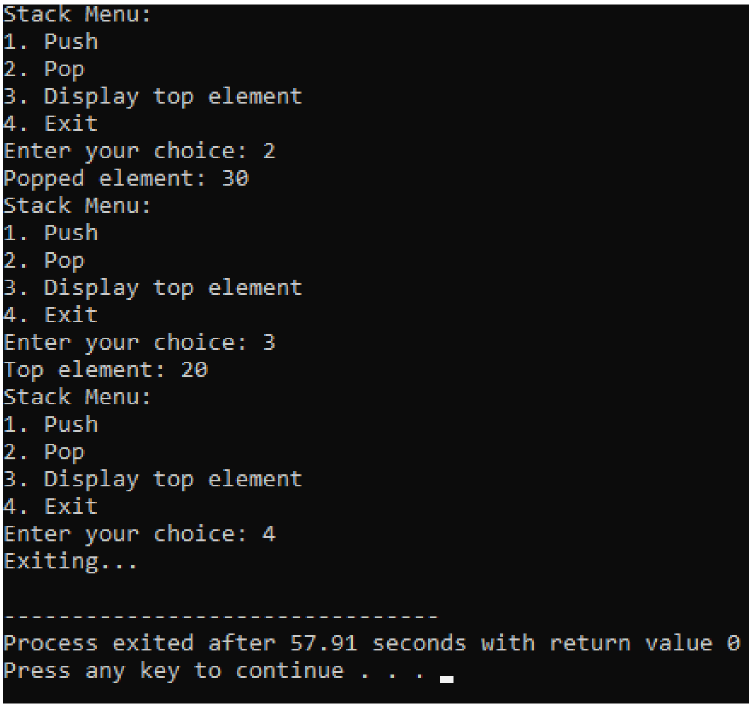
```
#include<iostream>
#include<climits>//for INT_MIN
using namespace std;

template<typename T>
class StackUsingTemplateArrays
{
        T* data;
        int nextIndex;
        int capacity;
        public:
                StackUsingTemplateArrays()
                {
                        capacity = 4;
                        data = new T[capacity];
                        nextIndex = 0;
                }

                //return no. of elements in the stack
                int size()
                {
                        return nextIndex;
                }

                bool isEmpty()
                {
                        return nextIndex == 0;//Shortest way to write instead of writing if else
statements
                }

                //insert element
                void push(T element)
                {
                        if(nextIndex == capacity)
                        {
                                T* newData = new T[2 * capacity];
                                for(int i=0;i<nextIndex;i++)
                                {
                                        newData[i] = data[i];
                                }
                                capacity *= 2;
                                delete [] data;
                                data = newData;
                        }
                        data[nextIndex] = element;
                        nextIndex++;
                }

                //delete element
                T pop()
                {
                        if(isEmpty())
```

```
            {
                cout<<"Stack empty"<<endl;
                return 0;
            }
            else
            {
                nextIndex--;
                T temp = data[nextIndex];
                data[nextIndex] = 0;
                return temp;
            }
        }

        T top()
        {
            if(isEmpty())
            {
                cout<<"Stack is empty"<<endl;
                return 0;
            }
            return data[nextIndex - 1];
        }
};

int main()
{
    StackUsingTemplateArrays<int> s;
    int choice;
    while(true) {
        cout << "Stack Menu:" << endl;
        cout << "1. Push" << endl;
        cout << "2. Pop" << endl;
        cout << "3. Display top element" << endl;
        cout << "4. Exit" << endl;
        cout << "Enter your choice: ";
        cin >> choice;

        switch(choice) {
            case 1:
                int element;
                cout << "Enter element to push: ";
                cin >> element;
                s.push(element);
                break;
            case 2:
                cout << "Popped element: " << s.pop() << endl;
                break;
            case 3:
                cout << "Top element: " << s.top() << endl;
                break;
            case 4:
                cout << "Exiting..." << endl;
                exit(0);
            default:
                cout << "Invalid choice! Please try again." << endl;
        }
    }
    return 0;
}
```

Output:



```
Stack Menu:
1. Push
2. Pop
3. Display top element
4. Exit
Enter your choice: 1
Enter element to push: 10
Stack Menu:
1. Push
2. Pop
3. Display top element
4. Exit
Enter your choice: 1
Enter element to push: 20
Stack Menu:
1. Push
2. Pop
3. Display top element
4. Exit
Enter your choice: 1
Enter element to push: 30
Stack Menu:
1. Push
2. Pop
3. Display top element
4. Exit
Enter your choice: 1
Enter element to push: 40
Stack Menu:
1. Push
2. Pop
3. Display top element
4. Exit
Enter your choice: 2
Popped element: 40
```



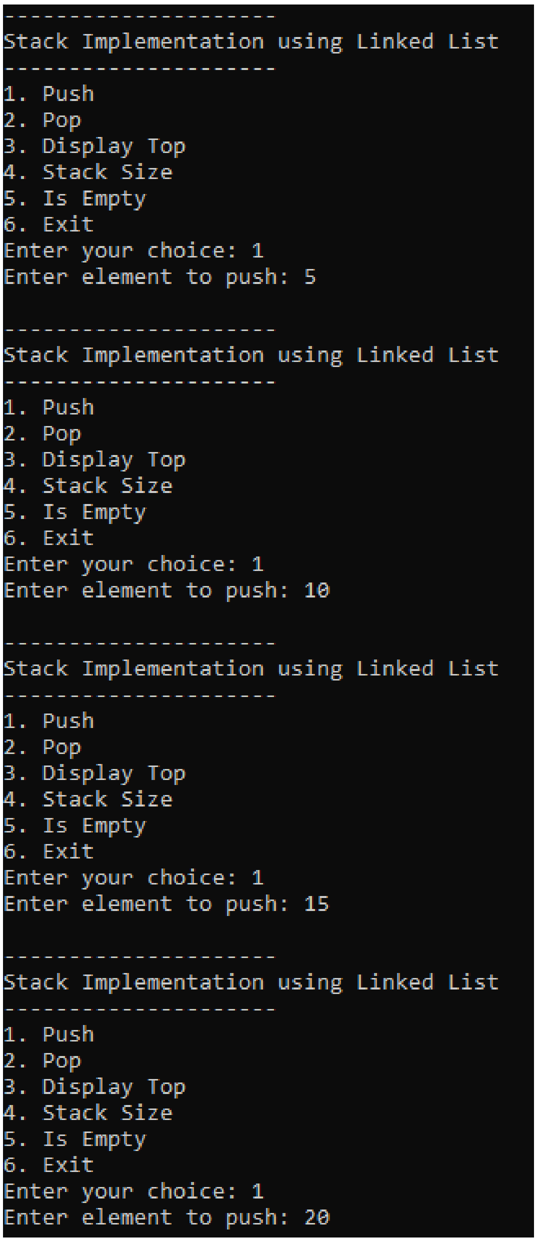
```
Stack Menu:
1. Push
2. Pop
3. Display top element
4. Exit
Enter your choice: 2
Popped element: 30
Stack Menu:
1. Push
2. Pop
3. Display top element
4. Exit
Enter your choice: 3
Top element: 20
Stack Menu:
1. Push
2. Pop
3. Display top element
4. Exit
Enter your choice: 4
Exiting...

--------------------------------
Process exited after 57.91 seconds with return value 0
Press any key to continue . . .
```

Q2.

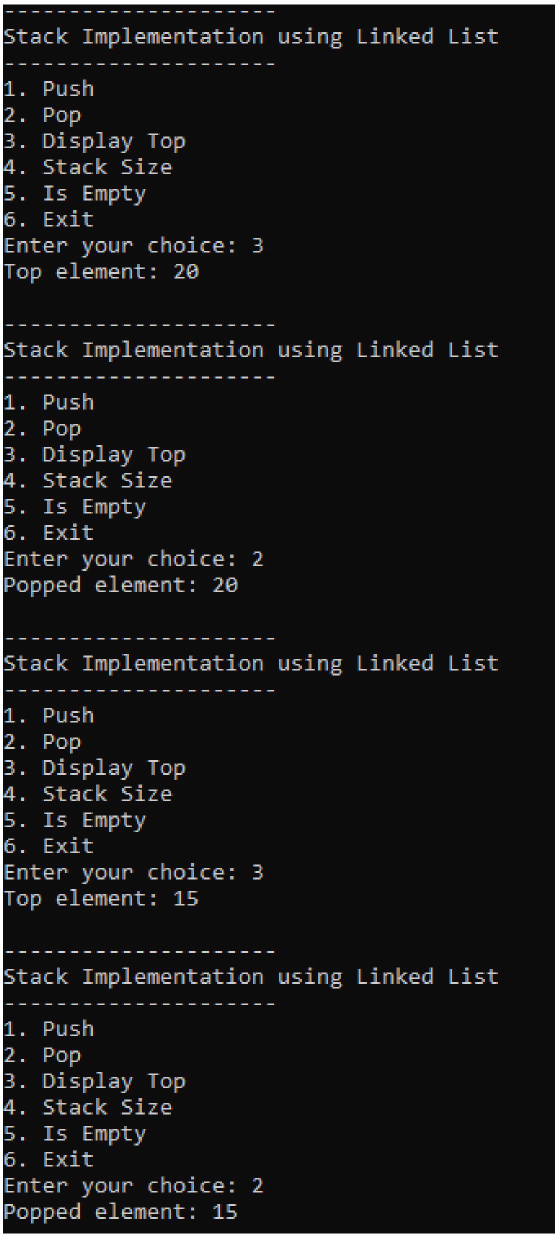
```
#include<iostream>

using namespace std;

class Node
{
public:
    int data;
    Node *next;
    Node(int data)
    {
        this->data = data;
        this->next = NULL;
    }
};

//template<typename T>
class StackUsingLinkedList
{
            int stacksize;
            Node* head;
            //Node* top;
            public:
                        StackUsingLinkedList()
                        {
                                    head = NULL;
                                    //top = NULL;
                                    stacksize = 0;
                        }

                        void push(int g)
                        {
                                    Node* temp = new Node(g);
                                    temp->next = head;
                                    head = temp;
                                    stacksize++;
                        }

                        int pop()
                        {
                                    if(head == NULL)
                                    {
                                                return -1;
                                    }
                                    int ans = head->data;
                                    Node* temp = head;
                                    head = head->next;

                                    delete temp;
                                    stacksize--;
                                    return ans;
                        }

                        int top()
                        {
                                    if(head == NULL)
                                    {
                                                return -1;
                                    }
                                    return head->data;
                        }

                        int StackSize()
                        {
                                    return stacksize;
                        }
```

```
                bool isEmpty()
                {
                        if(stacksize == 0)
                        {
                                return true;
                        }
                        else
                        {
                                return false;
                        }
                }
};


int main()
{
    StackUsingLinkedList stack;
    int choice, item;
    while (true)
    {
        cout << "\n---------------------" << endl;
        cout << "Stack Implementation using Linked List" << endl;
        cout << "---------------------" << endl;
        cout << "1. Push" << endl;
        cout << "2. Pop" << endl;
        cout << "3. Display Top" << endl;
        cout << "4. Stack Size" << endl;
        cout << "5. Is Empty" << endl;
        cout << "6. Exit" << endl;
        cout << "Enter your choice: ";
        cin >> choice;

        switch (choice)
        {
        case 1:
            cout << "Enter element to push: ";
            cin >> item;
            stack.push(item);
            break;
        case 2:
            item = stack.pop();
            if (item == -1)
                cout << "Stack is empty!" << endl;
            else
                cout << "Popped element: " << item << endl;
            break;
        case 3:
            item = stack.top();
            if (item == -1)
                cout << "Stack is empty!" << endl;
            else
                cout << "Top element: " << item << endl;
            break;
        case 4:
            cout << "Stack Size: " << stack.StackSize() << endl;
            break;
        case 5:
            if (stack.isEmpty())
                cout << "Stack is empty" << endl;
            else
                cout << "Stack is not empty" << endl;
            break;
        case 6:
            cout << "Exiting..." << endl;
            return 0;
        default:
            cout << "Invalid choice! Please enter again." << endl;
        }
    }
    return 0;
}
```

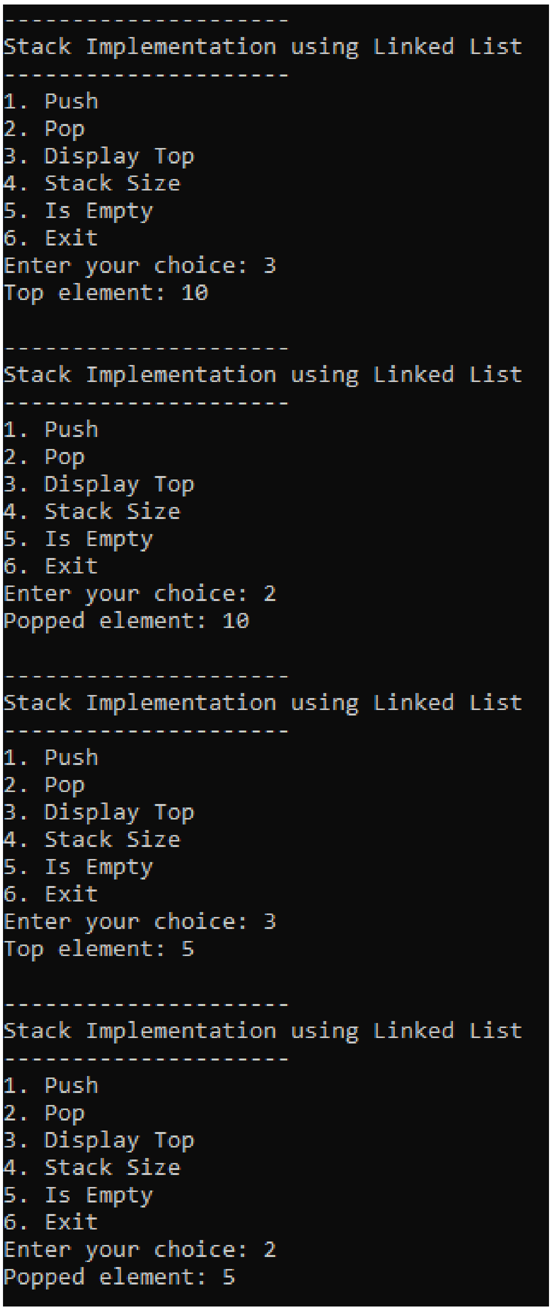
Output:



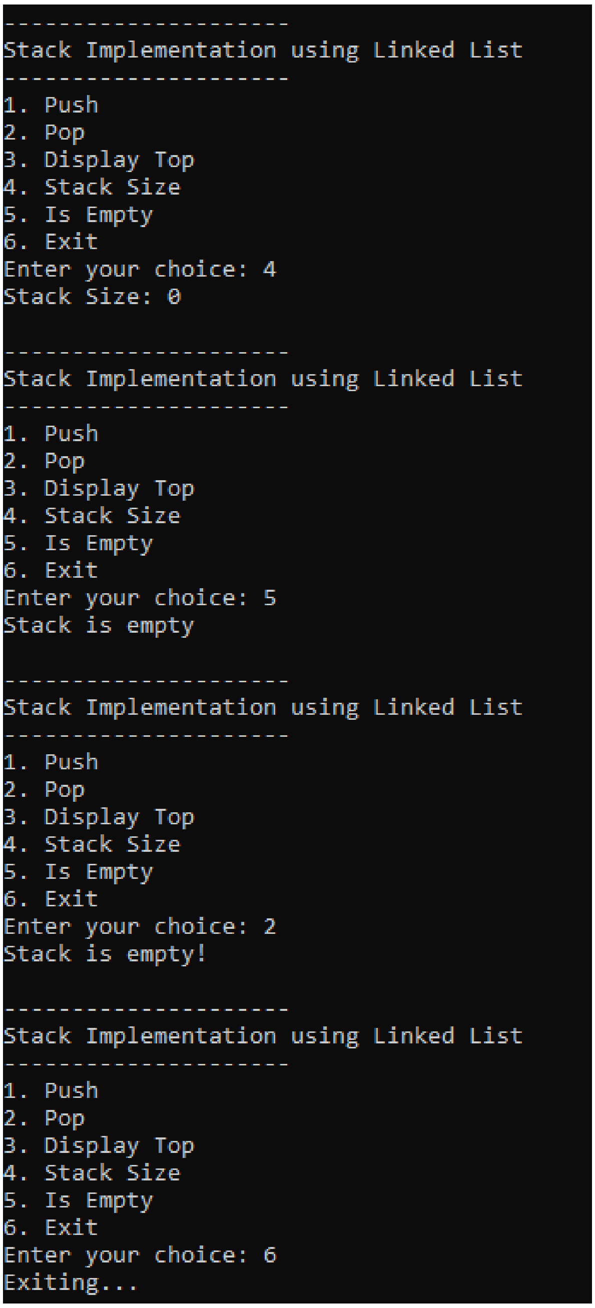
```
---------------------
Stack Implementation using Linked List
---------------------
1. Push
2. Pop
3. Display Top
4. Stack Size
5. Is Empty
6. Exit
Enter your choice: 1
Enter element to push: 5

---------------------
Stack Implementation using Linked List
---------------------
1. Push
2. Pop
3. Display Top
4. Stack Size
5. Is Empty
6. Exit
Enter your choice: 1
Enter element to push: 10

---------------------
Stack Implementation using Linked List
---------------------
1. Push
2. Pop
3. Display Top
4. Stack Size
5. Is Empty
6. Exit
Enter your choice: 1
Enter element to push: 15

---------------------
Stack Implementation using Linked List
---------------------
1. Push
2. Pop
3. Display Top
4. Stack Size
5. Is Empty
6. Exit
Enter your choice: 1
Enter element to push: 20
```



```
---------------------
Stack Implementation using Linked List
---------------------
1. Push
2. Pop
3. Display Top
4. Stack Size
5. Is Empty
6. Exit
Enter your choice: 3
Top element: 20

---------------------
Stack Implementation using Linked List
---------------------
1. Push
2. Pop
3. Display Top
4. Stack Size
5. Is Empty
6. Exit
Enter your choice: 2
Popped element: 20

---------------------
Stack Implementation using Linked List
---------------------
1. Push
2. Pop
3. Display Top
4. Stack Size
5. Is Empty
6. Exit
Enter your choice: 3
Top element: 15

---------------------
Stack Implementation using Linked List
---------------------
1. Push
2. Pop
3. Display Top
4. Stack Size
5. Is Empty
6. Exit
Enter your choice: 2
Popped element: 15
```



```
---------------------
Stack Implementation using Linked List
---------------------
1. Push
2. Pop
3. Display Top
4. Stack Size
5. Is Empty
6. Exit
Enter your choice: 3
Top element: 10

---------------------
Stack Implementation using Linked List
---------------------
1. Push
2. Pop
3. Display Top
4. Stack Size
5. Is Empty
6. Exit
Enter your choice: 2
Popped element: 10

---------------------
Stack Implementation using Linked List
---------------------
1. Push
2. Pop
3. Display Top
4. Stack Size
5. Is Empty
6. Exit
Enter your choice: 3
Top element: 5

---------------------
Stack Implementation using Linked List
---------------------
1. Push
2. Pop
3. Display Top
4. Stack Size
5. Is Empty
6. Exit
Enter your choice: 2
Popped element: 5
```



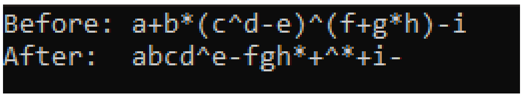
```
---------------------
Stack Implementation using Linked List
---------------------
1. Push
2. Pop
3. Display Top
4. Stack Size
5. Is Empty
6. Exit
Enter your choice: 4
Stack Size: 0

---------------------
Stack Implementation using Linked List
---------------------
1. Push
2. Pop
3. Display Top
4. Stack Size
5. Is Empty
6. Exit
Enter your choice: 5
Stack is empty

---------------------
Stack Implementation using Linked List
---------------------
1. Push
2. Pop
3. Display Top
4. Stack Size
5. Is Empty
6. Exit
Enter your choice: 2
Stack is empty!

---------------------
Stack Implementation using Linked List
---------------------
1. Push
2. Pop
3. Display Top
4. Stack Size
5. Is Empty
6. Exit
Enter your choice: 6
Exiting...
```

Q3.

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

int precedence(char c) {
    if (c == '^')
        return 3;
    else if (c == '/' || c == '*')
        return 2;
    else if (c == '+' || c == '-')
        return 1;
    else
        return -1;
}
```

```
char associativity(char c) {
    if (c == '^')
        return 'R';
    return 'L';
}

void infixToPostfix(string s) {
    stack<char> st;
    string result;

    for (int i = 0; i < s.length(); i++) {
        char ch = s[i];

        if ((ch >= 'a' && ch <= 'z') || (ch >= 'A' && ch <= 'Z') || (ch >= '0' && ch <= '9'))
            result += ch;
        else if (ch == '(')
            st.push('(');
        else if (ch == ')') {
            while (st.top() != '(') {
                result += st.top();
                st.pop();
            }
            st.pop();
        }
        else {
            while (!st.empty() && precedence(s[i]) < precedence(st.top()) ||
                !st.empty() && precedence(s[i]) == precedence(st.top()) &&
                associativity(s[i]) == 'L') {
                result += st.top();
                st.pop();
            }
            st.push(ch);
        }
    }

    while (!st.empty()) {
        result += st.top();
        st.pop();
    }

    cout << "After:  " << result << endl;
}

int main() {
    string exp = "a+b*(c^d-e)^(f+g*h)-i";
    cout << "Before: " << exp << endl;
    infixToPostfix(exp);

    return 0;
}
```

Output:

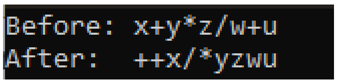


```
Before:  a+b*(c^d-e)^(f+g*h)-i
After:   abcd^e-fgh*+^*+i-
```

Q4.

```
#include <iostream>
#include <stack>

using namespace std;

bool isOperator(char c) {
    return (!isalpha(c) && !isdigit(c));
}

int getPriority(char C) {
    if (C == '-' || C == '+')
        return 1;
    else if (C == '*' || C == '/')
        return 2;
    else if (C == '^')
        return 3;
    return 0;
}

string reverseString(string str) {
    string rev_str = "";
    for (int i = str.size() - 1; i >= 0; i--)
        rev_str += str[i];
    return rev_str;
}

string infixToPostfix(string infix) {
    infix = '(' + infix + ')';
    int l = infix.size();
    stack<char> char_stack;
    string output;

    for (int i = 0; i < l; i++) {
        if (isalpha(infix[i]) || isdigit(infix[i]))
            output += infix[i];
        else if (infix[i] == '(')
            char_stack.push('(');
        else if (infix[i] == ')') {
            while (char_stack.top() != '(') {
                output += char_stack.top();
                char_stack.pop();
            }
            char_stack.pop();
        }
        else {
            if (isOperator(char_stack.top())) {
                if (infix[i] == '^') {
                    while (getPriority(infix[i]) <= getPriority(char_stack.top())) {
                        output += char_stack.top();
                        char_stack.pop();
                    }
                } else {
                    while (getPriority(infix[i]) < getPriority(char_stack.top())) {
                        output += char_stack.top();
                        char_stack.pop();
                    }
                }
                char_stack.push(infix[i]);
            }
        }
    }
    while (!char_stack.empty()) {
        output += char_stack.top();
        char_stack.pop();
    }
    return output;
}

string infixToPrefix(string infix) {
    infix = reverseString(infix);
    int l = infix.size();
    for (int i = 0; i < l; i++) {
        if (infix[i] == '(') {
            infix[i] = ')';
        } else if (infix[i] == ')') {
            infix[i] = '(';
        }
    }
    string prefix = infixToPostfix(infix);
    return reverseString(prefix);
}

int main() {
    string s = "x+y*z/w+u";
    cout << "Before: " << s << endl;
    cout << "After:  " << infixToPrefix(s) << endl;
    return 0;
}
```

Output:

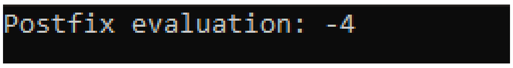


```
Before: x+y*z/w+u
After:  ++x/*yzwu
```

Q5.

```
#include <iostream>
#include <stack>

using namespace std;

bool isDigit(char c) {
    return c >= '0' && c <= '9';
}

int evaluatePostfix(string exp) {
    stack<int> stack;
    for (int i; i<exp.length(); i++) {
            char c = exp[i];
        if (isDigit(c))
            stack.push(c - '0');
        else {
            int val1 = stack.top();
            stack.pop();
            int val2 = stack.top();
            stack.pop();
            switch (c) {
            case '+':
                stack.push(val2 + val1);
                break;
            case '-':
                stack.push(val2 - val1);
                break;
            case '*':
                stack.push(val2 * val1);
                break;
            case '/':
                stack.push(val2 / val1);
                break;
            }
        }
    }
    return stack.top();
}

int main() {
    string exp = "231*+9-";
    cout << "Postfix evaluation: " << evaluatePostfix(exp) << endl;
    return 0;
}
```

Output:



```
Postfix evaluation: -4
```