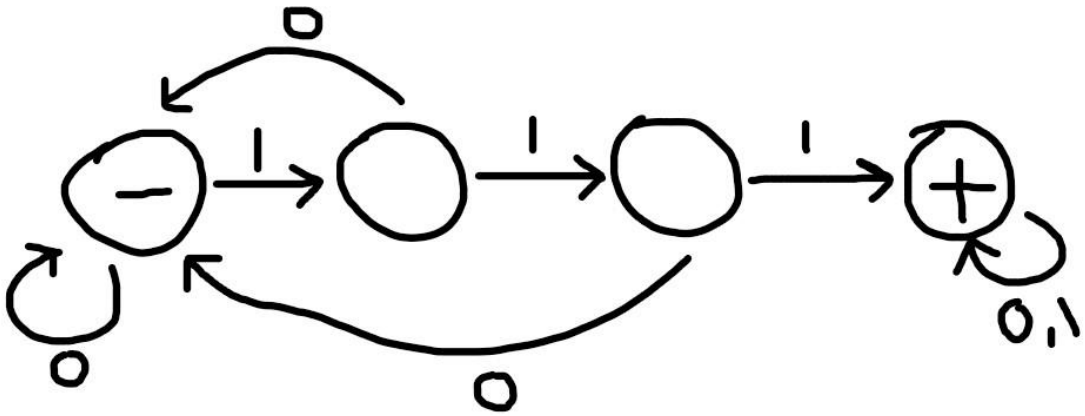
Toc Practical file

(22058570006)

Hemant kr. Singh

Practical 1

Design a Finite Automata (FA) that accepts all strings over S={0, 1} having three consecutive 1's as a substring. Write a program to simulate this FA.




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

void State1(string w,int i);
void State2(string w,int i);
void State3(string w,int i);
```

```
void State4(string w,int i);


int main(){
    string w;
    cout << "enter string: ";
    cin >> w;
    State1(w, 0);
}



void State1(string w, int i){

    cout << "state 1" << endl;
    if (i == w.length()){
        cout << "string is rejected";
        return;
    }
    else{
        if (w[i] == '1')
            State2(w, i + 1);
        if (w[i] == '0')
            State1(w, i + 1);
    }
}

void State2(string w, int i)
{
    cout << "state 2" << endl;
    if (i == w.length()){
        cout << "string is rejected";
        return;
    }
    else{
        if (w[i] == '1')
            State3(w, i + 1);
        if (w[i] == '0')
```

```
            State1(w, i + 1);
    }
}

void State3(string w, int i)
{
    cout << "state 3" << endl;
    if (i == w.length()){
        cout << "string is rejected";
        return;
    }
    else{
        if (w[i] == '1')
            State4(w, i + 1);
        if (w[i] == '0')
            State1(w, i + 1);
    }
}

void State4(string w, int i)
{
    cout << "state 4" << endl;
    if (i == w.length()){
        cout << "string is accepted"; // String has three consecutive 1s
        return;
    }
    else{
        if (w[i] == '1')
            State4(w, i + 1);
        if (w[i] == '0')
            State4(w, i + 1);
    }
}
```

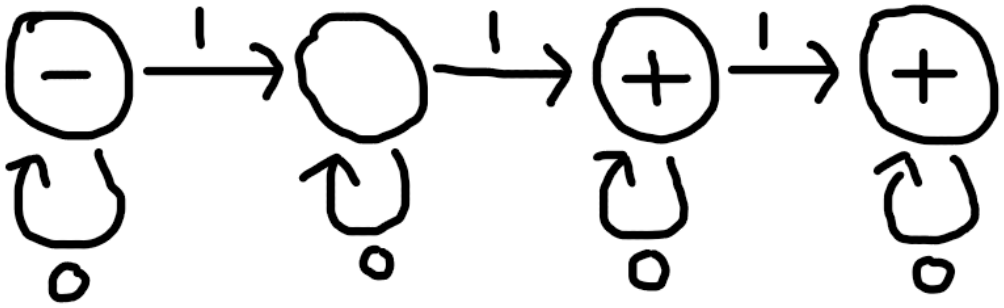
Output

```
enter string: 010101110
state 1
state 1
state 2
state 1
state 2
state 1
state 2
state 3
state 4
state 4
string is accepted
```

```
enter string: 01010110
state 1
state 1
state 2
state 1
state 2
state 1
state 2
state 3
state 1
string is rejected
```

Toc Practical 2

Design a Finite Automata (FA) that accepts all strings over S={0, 1} having either exactly two 1's or exactly three 1's, not more nor less. Write a program to simulate this FA.




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

void State1(string w,int i);
void State2(string w,int i);
void State3(string w,int i);
void State4(string w,int i);

int main(){

    string w;
    cout << "enter string: ";
    cin >> w;
    State1(w, 0);
    return 0;
}

void State1(string w, int i){

    cout << "state 1" << endl;
    if (i == w.length()){
        cout << "string is rejected";
        return;
    }
    else{
        if (w[i] == '1')
            State2(w, i + 1);
        if (w[i] == '0')
            State1(w, i + 1);
    }
}
```

```
void State2(string w, int i){

    cout << "state 2" << endl;
    if (i == w.length()){
        cout << "string is rejected";
        return;
    }
    else{
        if (w[i] == '1')
            State3(w, i + 1);
        if (w[i] == '0')
            State2(w, i + 1);
    }
}
void State3(string w, int i){

    cout << "state 3" << endl;
    if (i == w.length()){
        cout << "string is accepted";  // string has 2 ones
        return;
    }
    else{
        if (w[i] == '1')
            State4(w, i + 1);
        if (w[i] == '0')
            State3(w, i + 1);
    }
}
void State4(string w, int i){

    cout << "state 4" << endl;
    if (i == w.length()){
        cout << "string is accepted"; // String has 3 ones
        return;
    }
    else{
        if (w[i] == '1'){
            cout<<"string is rejected";
            return;
        }
        else{
            State4(w, i + 1);
        }
    }
}
```

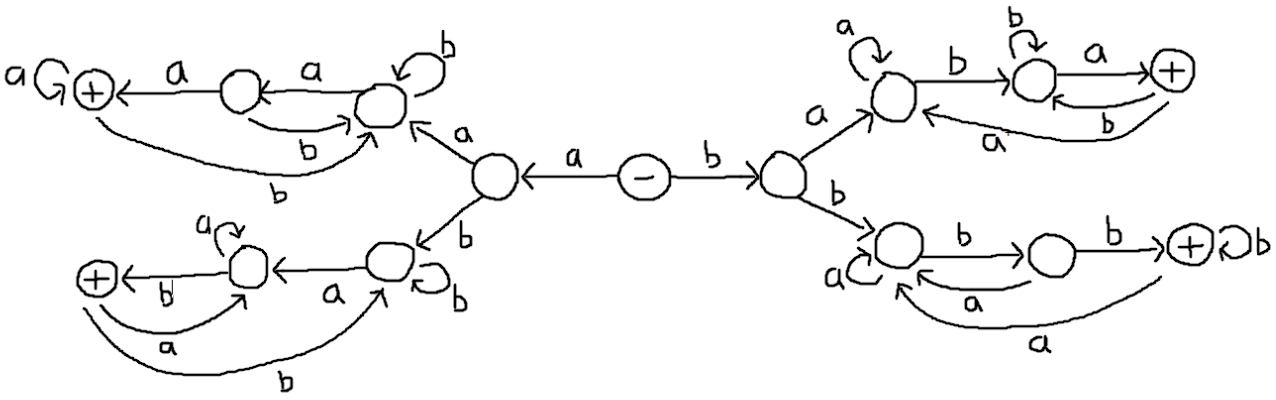
Output

```
enter string: 101000
state 1
state 2
state 2
state 3
state 3
state 3
state 3
string is accepted
```

```
enter string: 111001
state 1
state 2
state 3
state 4
state 4
state 4
string is rejected
```

practical 3

Design a Finite Automata (FA) that accepts language L1, over S={a, b}, comprising of all strings (of length 4 or more) having first two characters same as the last two. Write a program to simulate this FA.




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

void state1(string w, int i);
void state2(string w, int i);
void state3(string w, int i);
void state4(string w, int i);
void state5(string w, int i);
void state6(string w, int i);
void state7(string w, int i);
void state8(string w, int i);
void state9(string w, int i);
void state10(string w, int i);
void state11(string w, int i);
void state12(string w, int i);
void state13(string w, int i);
void state14(string w, int i);
void state15(string w, int i);

void state1(string w, int i){
    cout << "State1" << endl;
```

```
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state2(w, i + 1);
    }
    else{
        state3(w, i + 1);
    }
}
void state2(string w, int i){
    cout << "State2" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state4(w, i + 1);
    }
    else{
        state5(w, i + 1);
    }
}
void state3(string w, int i){
    cout << "State3" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state6(w, i + 1);
    }
    else{
        state7(w, i + 1);
    }
}
void state4(string w, int i){
    cout << "State4" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state8(w, i + 1);
    }
    else{
        state4(w, i + 1);
```

```
    }
}
void state5(string w, int i){
    cout << "State5" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state10(w, i + 1);
    }
    else{
        state5(w, i + 1);
    }
}
void state6(string w, int i){
    cout << "State6" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state6(w, i + 1);
    }
    else{
        state12(w, i + 1);
    }
}
void state7(string w, int i){
    cout << "State7" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state7(w, i + 1);
    }
    else{
        state14(w, i + 1);
    }
}
void state8(string w, int i){
    cout << "State8" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
```

```
        state9(w, i + 1);
    }
    else{
        state4(w, i + 1);
    }
}
void state9(string w, int i){
    cout << "State9" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state9(w, i + 1);
    }
    else{
        state4(w, i + 1);
    }
}
void state10(string w, int i){
    cout << "State10" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state10(w, i + 1);
    }
    else{
        state11(w, i + 1);
    }
}
void state11(string w, int i){
    cout << "State10" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state10(w, i + 1);
    }
    else{
        state5(w, i + 1);
    }
}

void state12(string w, int i){
    cout << "State12" << endl;
```

```
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state13(w, i + 1);
    }
    else{
        state12(w, i + 1);
    }
}
void state13(string w, int i){
    cout << "State13" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state6(w, i + 1);
    }
    else{
        state12(w, i + 1);
    }
}
void state14(string w, int i){
    cout << "State14" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state7(w, i + 1);
    }
    else{
        state15(w, i + 1);
    }
}
void state15(string w, int i){
    cout << "State15" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state7(w, i + 1);
    }
    else{
        state15(w, i + 1);
```

```
    }
}

int main(){
    string w;
    cout << "Enter the string: ";
    cin >> w;
    state1(w, 0);
}
```

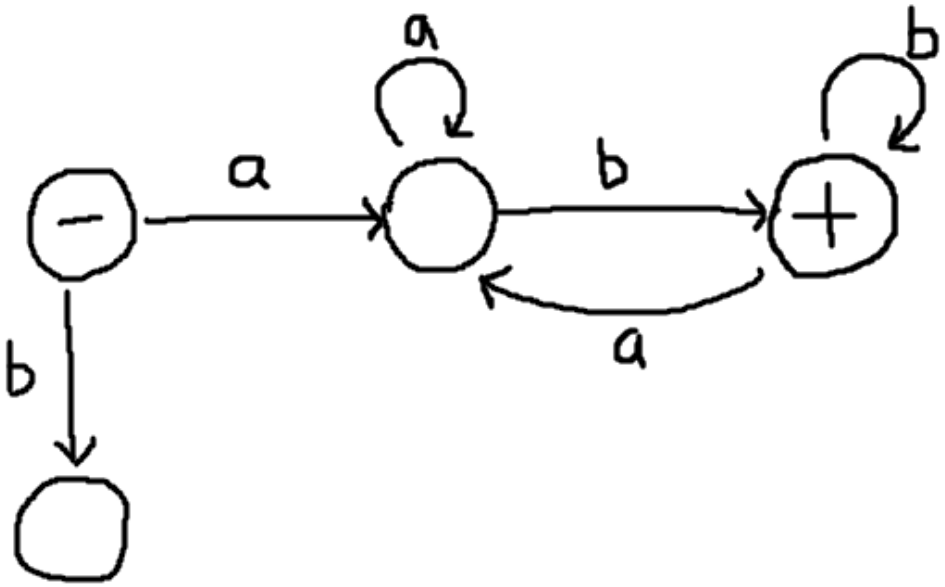
Output

```
Enter the string: abababababab
State1
State2
State5
State10
State10
State10
State10
State10
State10
State10
State10
String is accepted
```

```
Enter the string: aababababab
State1
State2
State4
State4
State8
State4
State8
State4
State8
State4
String is rejected
```

Toc practical 4

Design a Finite Automata (FA) that accepts language L2, over S= {a, b} where L2= a(a+b)*b. Write a program to simulate this FA




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

void State1(string w, int i);
void State2(string w, int i);
void State3(string w, int i);

int main(){

    string w;
    cout<<"enter your string ";
    cin>>w;

    State1(w,0);
}
```

```
void State1(string w, int i){

    cout<<"State 1"<<endl;

    if(i == w.length()){
        cout<<"string is rejected";
    }
    else{
        if(w[i] == 'a'){
            State2(w,i+1);
        }
        else{
            cout<<"string is rejected";  //dead state
        }
    }
}

void State2(string w, int i){

    cout<<"State 2"<<endl;

    if(i == w.length()){
        cout<<"string is rejected";
    }
    else{
        if(w[i] == 'a'){
            State2(w,i+1);
        }else{
            State3(w,i+1);
        }
    }
}

void State3(string w, int i){

    cout<<"State 3"<<endl;

    if(i == w.length()){
        cout<<"string is accepted";
    }
    else{
        if(w[i] == 'a'){
```

```
            State2(w,i+1);
        }else{
            State3(w,i+1);
        }
    }
}
```

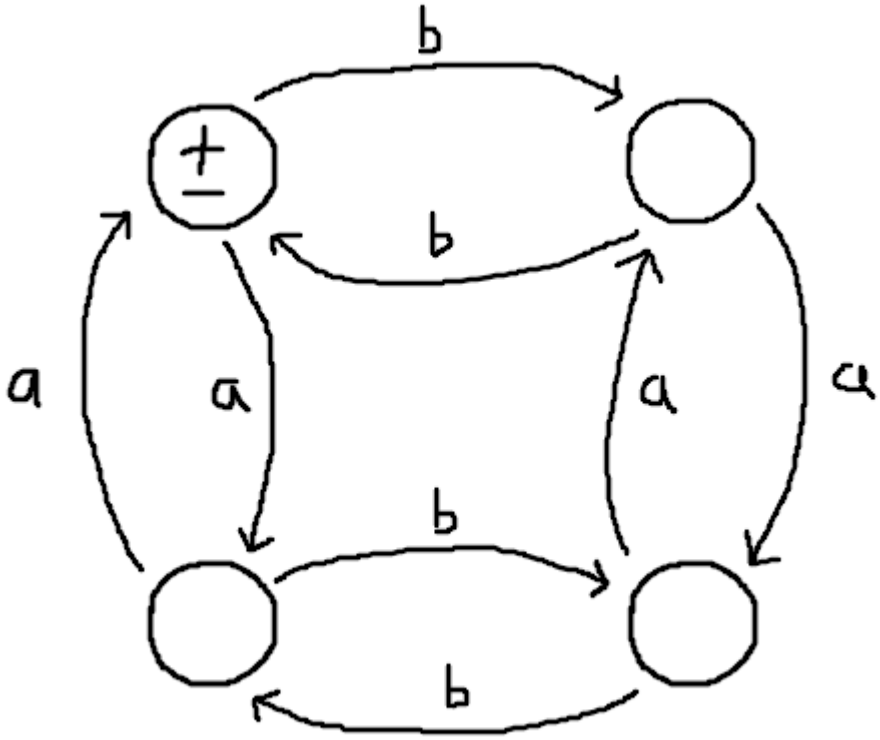
Output

```
enter your string aababababb
State 1
State 2
State 2
State 3
State 2
State 3
State 2
State 3
State 2
State 3
string is accepted
```

```
enter your string aaaabbbba
State 1
State 2
State 2
State 2
State 2
State 3
State 3
State 3
State 3
State 2
string is rejected
```

Toc Practical 5

Design a Finite Automata (FA) that accepts language EVEN-EVEN over S={a, b}. Write a program to simulate this FA




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

void State1(string w, int i);
void State2(string w, int i);
void State3(string w, int i);
void State4(string w, int i);

int main(){

    string w;
    cout<<"enter your string : ";
    cin>>w;

    State1(w,0);
}
```

```
void State1(string w, int i){

    cout<<"State 1"<<endl;

    if(i == w.length()){
        cout<<"string is accepted";
    }
    else{
        if(w[i] == 'a'){
            State4(w,i+1);
        }
        else{
            State2(w,i+1);
        }
    }
}

void State2(string w, int i){

    cout<<"State 2"<<endl;

    if(i == w.length()){
        cout<<"string is rejected";
    }
    else{
        if(w[i] == 'a'){
            State3(w,i+1);
        }else{
            State1(w,i+1);
        }
    }
}

void State3(string w, int i){

    cout<<"State 3"<<endl;

    if(i == w.length()){
        cout<<"string is rejected";
    }
    else{
        if(w[i] == 'a'){
            State2(w,i+1);
        }else{
            State4(w,i+1);
        }
    }
}
```

```
void State4(string w, int i){

    cout<<"State 4"<<endl;

    if(i == w.length()){
        cout<<"string is rejected";
    }
    else{
        if(w[i] == 'a'){
            State1(w,i+1);
        }else{
            State3(w,i+1);
        }
    }
}
```

Output

```
enter your string : aaaaaabbbb
State 1
State 4
State 1
State 4
State 1
State 4
State 1
State 2
State 1
State 2
State 1
string is accepted
```

```
enter your string : aabbaabbbbaa
State 1
State 4
State 1
State 2
State 1
State 4
State 1
State 2
State 1
State 2
State 1
State 4
State 1
string is accepted
```

```
enter your string : aabba
State 1
State 4
State 1
State 2
State 1
State 4
string is rejected
```

TOC Practical 6

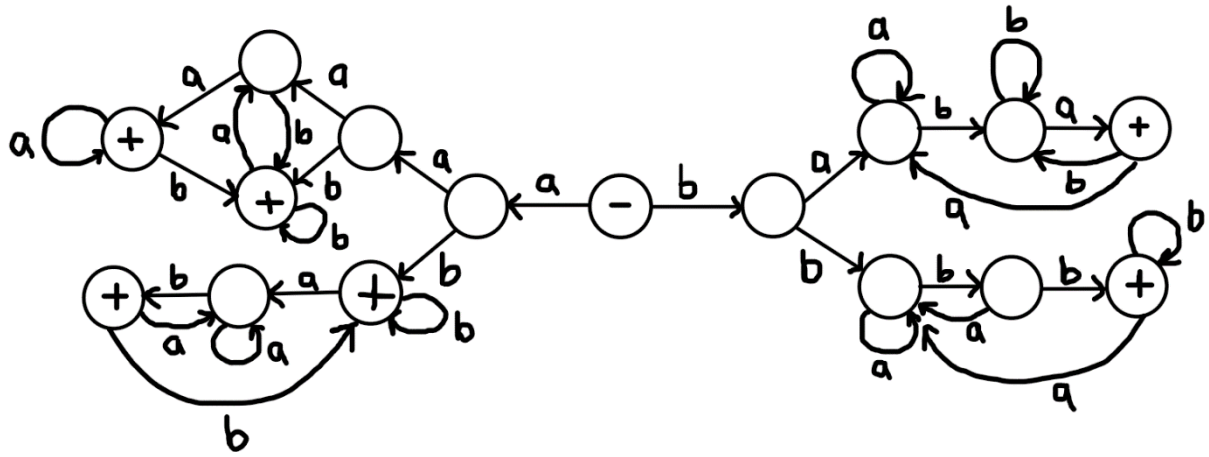
Write a program to simulate an FA that accepts

a. Union of the languages L1 and L2

b. Intersection of the languages L1 and L2

c. Language L1 L2 (concatenation)

(a)



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

void state1(string w, int i);
void state2(string w, int i);
void state3(string w, int i);
void state4(string w, int i);
void state5(string w, int i);
void state6(string w, int i);
void state7(string w, int i);
void state8(string w, int i);
void state9(string w, int i);
void state10(string w, int i);
void state11(string w, int i);
void state12(string w, int i);
void state13(string w, int i);
```

```
void state14(string w, int i);
void state15(string w, int i);
void state16(string w, int i);

void state1(string w, int i){
    cout << "State1" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state2(w, i + 1);
    }
    else{
        state3(w, i + 1);
    }
}
void state2(string w, int i){
    cout << "State2" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state4(w, i + 1);
    }
    else{
        state5(w, i + 1);
    }
}
void state3(string w, int i){
    cout << "State3" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state6(w, i + 1);
    }
    else{
        state7(w, i + 1);
    }
}
void state4(string w, int i){
    cout << "State4" << endl;
    if(i == w.length()){
        cout << "String is rejected";
```

```
        return;
    }
    if(w[i] == 'a'){
        state8(w, i + 1);
    }
    else{
        state9(w, i + 1);
    }
}
void state5(string w, int i){
    cout << "State5" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state10(w, i + 1);
    }
    else{
        state5(w, i + 1);
    }
}
void state6(string w, int i){
    cout << "State6" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state6(w, i + 1);
    }
    else{
        state11(w, i + 1);
    }
}
void state7(string w, int i){
    cout << "State7" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state7(w, i + 1);
    }
    else{
        state12(w, i + 1);
    }
```

```
}
void state8(string w, int i){
    cout << "State8" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state13(w, i + 1);
    }
    else{
        state9(w, i + 1);
    }
}
void state9(string w, int i){
    cout << "State9" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state8(w, i + 1);
    }
    else{
        state9(w, i + 1);
    }
}
void state10(string w, int i){
    cout << "State10" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state10(w, i + 1);
    }
    else{
        state14(w, i + 1);
    }
}
void state11(string w, int i){
    cout << "State10" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
```

```
        state15(w, i + 1);
    }
    else{
        state11(w, i + 1);
    }
}

void state12(string w, int i){
    cout << "State12" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state7(w, i + 1);
    }
    else{
        state16(w, i + 1);
    }
}
void state13(string w, int i){
    cout << "State13" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state13(w, i + 1);
    }
    else{
        state9(w, i + 1);
    }
}
void state14(string w, int i){
    cout << "State14" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state10(w, i + 1);
    }
    else{
        state5(w, i + 1);
    }
}
void state15(string w, int i){
```

```
    cout << "State15" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state6(w, i + 1);
    }
    else{
        state11(w, i + 1);
    }
}
void state16(string w, int i){
    cout << "State16" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state7(w, i + 1);
    }
    else{
        state16(w, i + 1);
    }
}
int main(){
    string w;
    cout << "Enter the string: ";
    cin >> w;
    state1(w, 0);
}
```

Output:-

```
Enter the string: abbaab
State1
State2
State5
State5
State10
State10
State14
String is accepted
```

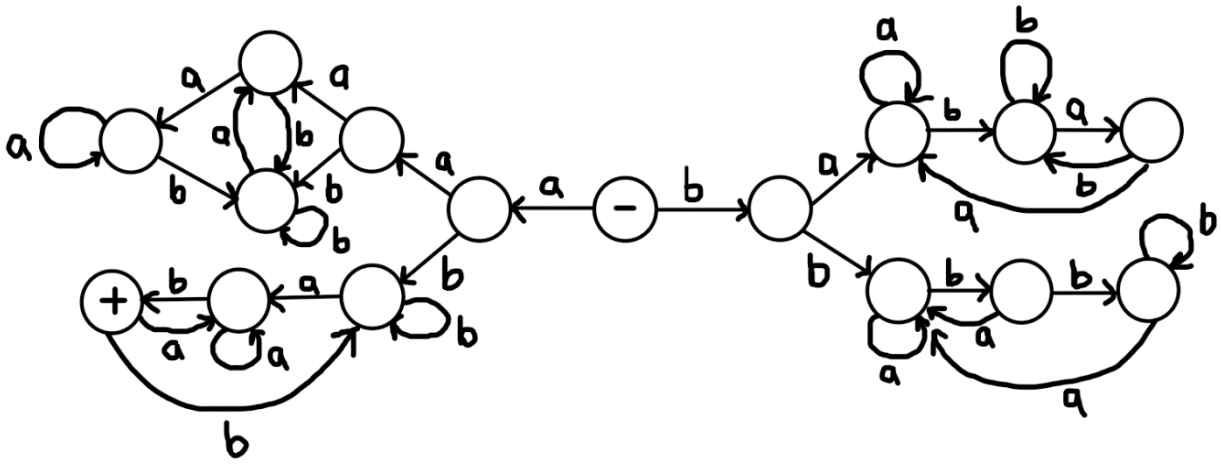
```
Enter the string: bbaababb
State1
State3
State7
State7
State7
State12
State7
State12
State16
String is accepted
```

```
Enter the string: baabba
State1
State3
State6
State6
State10
State10
State15
String is accepted
```

```
Enter the string: abaabab
State1
State2
State5
State10
State10
State14
State10
State14
String is accepted
```

```
Enter the string: bababab
State1
State3
State6
State10
State15
State10
State15
State10
String is rejected
```

(b)



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

void state1(string w, int i);
void state2(string w, int i);
```

```
void state3(string w, int i);
void state4(string w, int i);
void state5(string w, int i);
void state6(string w, int i);
void state7(string w, int i);
void state8(string w, int i);
void state9(string w, int i);
void state10(string w, int i);
void state11(string w, int i);
void state12(string w, int i);
void state13(string w, int i);
void state14(string w, int i);
void state15(string w, int i);
void state16(string w, int i);

void state1(string w, int i){
    cout << "State1" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state2(w, i + 1);
    }
    else{
        state3(w, i + 1);
    }
}
void state2(string w, int i){
    cout << "State2" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state4(w, i + 1);
    }
    else{
        state5(w, i + 1);
    }
}
void state3(string w, int i){
    cout << "State3" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
```

```
    if(w[i] == 'a'){
        state6(w, i + 1);
    }
    else{
        state7(w, i + 1);
    }
}
void state4(string w, int i){
    cout << "State4" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state8(w, i + 1);
    }
    else{
        state9(w, i + 1);
    }
}
void state5(string w, int i){
    cout << "State5" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state10(w, i + 1);
    }
    else{
        state5(w, i + 1);
    }
}
void state6(string w, int i){
    cout << "State6" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state6(w, i + 1);
    }
    else{
        state11(w, i + 1);
    }
}
void state7(string w, int i){
```

```
    cout << "State7" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state7(w, i + 1);
    }
    else{
        state12(w, i + 1);
    }
}
void state8(string w, int i){
    cout << "State8" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state13(w, i + 1);
    }
    else{
        state9(w, i + 1);
    }
}
void state9(string w, int i){
    cout << "State9" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state8(w, i + 1);
    }
    else{
        state9(w, i + 1);
    }
}
void state10(string w, int i){
    cout << "State10" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state10(w, i + 1);
    }
```

```
    else{
        state14(w, i + 1);
    }
}
void state11(string w, int i){
    cout << "State10" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state15(w, i + 1);
    }
    else{
        state11(w, i + 1);
    }
}

void state12(string w, int i){
    cout << "State12" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state7(w, i + 1);
    }
    else{
        state16(w, i + 1);
    }
}
void state13(string w, int i){
    cout << "State13" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state13(w, i + 1);
    }
    else{
        state9(w, i + 1);
    }
}
void state14(string w, int i){
    cout << "State14" << endl;
    if(i == w.length()){
```

```
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state10(w, i + 1);
    }
    else{
        state5(w, i + 1);
    }
}
void state15(string w, int i){
    cout << "State15" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state6(w, i + 1);
    }
    else{
        state11(w, i + 1);
    }
}
void state16(string w, int i){
    cout << "State16" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state7(w, i + 1);
    }
    else{
        state16(w, i + 1);
    }
}

int main(){
    string w;
    cout << "Enter the string: ";
    cin >> w;
    state1(w, 0);
}
```

Output:-

```
Enter the string: abaaabbab
State1
State2
State5
State10
State10
State10
State14
State5
State10
State14
String is accepted
```

```
Enter the string: aabaabaa
State1
State2
State4
State9
State8
State13
State9
State8
State13
String is rejected
```

(c)

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

void state1(string w, int i);
void state2(string w, int i);
void state3(string w, int i);
void state4(string w, int i);
void state5(string w, int i);
void state6(string w, int i);
void state7(string w, int i);
void state8(string w, int i);
void state9(string w, int i);
void state10(string w, int i);
void state11(string w, int i);
void state12(string w, int i);
void state13(string w, int i);
void state14(string w, int i);
void state15(string w, int i);
void state16(string w, int i);
void state17(string w, int i);
void state18(string w, int i);
void state19(string w, int i);
void state20(string w, int i);
void state21(string w, int i);
void state22(string w, int i);
void state23(string w, int i);
void state24(string w, int i);
void state25(string w, int i);
void state26(string w, int i);
void state27(string w, int i);
void state28(string w, int i);
void state29(string w, int i);
```

```
void state30(string w, int i);
void state31(string w, int i);
void state32(string w, int i);
void state33(string w, int i);
void state34(string w, int i);
void state35(string w, int i);
void state36(string w, int i);
void state37(string w, int i);
void state38(string w, int i);
void state39(string w, int i);
void state40(string w, int i);
void state41(string w, int i);
void state42(string w, int i);
void state43(string w, int i);
void state44(string w, int i);
void state45(string w, int i);
void state46(string w, int i);

void state1(string w, int i){
    cout << "State1" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state2(w, i + 1);
    }
    else{
        state3(w, i + 1);
    }
}
void state2(string w, int i){
    cout << "State2" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state4(w, i + 1);
    }
    else{
        state5(w, i + 1);
    }
}
void state3(string w, int i){
    cout << "State3" << endl;
    if(i == w.length()){
```

```
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state6(w, i + 1);
    }
    else{
        state7(w, i + 1);
    }
}
void state4(string w, int i){
    cout << "State4" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state8(w, i + 1);
    }
    else{
        state4(w, i + 1);
    }
}
void state5(string w, int i){
    cout << "State5" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state9(w, i + 1);
    }
    else{
        state5(w, i + 1);
    }
}
void state6(string w, int i){
    cout << "State6" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state6(w, i + 1);
    }
    else{
        state10(w, i + 1);
```

```
    }
}
void state7(string w, int i){
    cout << "State7" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state7(w, i + 1);
    }
    else{
        state11(w, i + 1);
    }
}
void state8(string w, int i){
    cout << "State8" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state12(w, i + 1);
    }
    else{
        state4(w, i + 1);
    }
}
void state9(string w, int i){
    cout << "State9" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state9(w, i + 1);
    }
    else{
        state13(w, i + 1);
    }
}
void state10(string w, int i){
    cout << "State10" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
```

```
    if(w[i] == 'a'){
        state14(w, i + 1);
    }
    else{
        state10(w, i + 1);
    }
}
void state11(string w, int i){
    cout << "State10" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state7(w, i + 1);
    }
    else{
        state15(w, i + 1);
    }
}

void state12(string w, int i){
    cout << "State12" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state16(w, i + 1);
    }
    else{
        state17(w, i + 1);
    }
}
void state13(string w, int i){
    cout << "State13" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state18(w, i + 1);
    }
    else{
        state19(w, i + 1);
    }
}
```

```
void state14(string w, int i){
    cout << "State14" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state20(w, i + 1);
    }
    else{
        state21(w, i + 1);
    }
}
void state15(string w, int i){
    cout << "State15" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state22(w, i + 1);
    }
    else{
        state23(w, i + 1);
    }
}
void state16(string w, int i){
    cout << "State16" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state16(w, i + 1);
    }
    else{
        state24(w, i + 1);
    }
}
void state17(string w, int i){
    cout << "State17" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state25(w, i + 1);
```

```
    }
    else{
        state17(w, i + 1);
    }
}
void state18(string w, int i){
    cout << "State18" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state18(w, i + 1);
    }
    else{
        state26(w, i + 1);
    }
}
void state19(string w, int i){
    cout << "State19" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state27(w, i + 1);
    }
    else{
        state19(w, i + 1);
    }
}
void state20(string w, int i){
    cout << "State20" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state20(w, i + 1);
    }
    else{
        state28(w, i + 1);
    }
}
void state21(string w, int i){
    cout << "State21" << endl;
    if(i == w.length()){
```

```
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state29(w, i + 1);
    }
    else{
        state21(w, i + 1);
    }
}
void state22(string w, int i){
    cout << "State22" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state22(w, i + 1);
    }
    else{
        state30(w, i + 1);
    }
}
void state23(string w, int i){
    cout << "State23" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state31(w, i + 1);
    }
    else{
        state23(w, i + 1);
    }
}
void state24(string w, int i){
    cout << "State24" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state32(w, i + 1);
    }
    else{
        state24(w, i + 1);
```

```
    }
}
void state25(string w, int i){
    cout << "State25" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state33(w, i + 1);
    }
    else{
        state17(w, i + 1);
    }
}
void state26(string w, int i){
    cout << "State26" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state18(w, i + 1);
    }
    else{
        state34(w, i + 1);
    }
}
void state27(string w, int i){
    cout << "State27" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state27(w, i + 1);
    }
    else{
        state35(w, i + 1);
    }
}
void state28(string w, int i){
    cout << "State28" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
```

```
    if(w[i] == 'a'){
        state36(w, i + 1);
    }
    else{
        state28(w, i + 1);
    }
}
void state29(string w, int i){
    cout << "State29" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state37(w, i + 1);
    }
    else{
        state21(w, i + 1);
    }
}
void state30(string w, int i){
    cout << "State30" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state22(w, i + 1);
    }
    else{
        state38(w, i + 1);
    }
}
void state31(string w, int i){
    cout << "State31" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state31(w, i + 1);
    }
    else{
        state39(w, i + 1);
    }
}
void state32(string w, int i){
```

```
    cout << "State32" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state40(w, i + 1);
    }
    else{
        state24(w, i + 1);
    }
}
void state33(string w, int i){
    cout << "State33" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state40(w, i + 1);
    }
    else{
        state17(w, i + 1);
    }
}
void state34(string w, int i){
    cout << "State34" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state41(w, i + 1);
    }
    else{
        state34(w, i + 1);
    }
}
void state35(string w, int i){
    cout << "State35" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state41(w, i + 1);
    }
```

```
    else{
        state19(w, i + 1);
    }
}
void state36(string w, int i){
    cout << "State36" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state20(w, i + 1);
    }
    else{
        state42(w, i + 1);
    }
}
void state37(string w, int i){
    cout << "State37" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state37(w, i + 1);
    }
    else{
        state42(w, i + 1);
    }
}
void state38(string w, int i){
    cout << "State38" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state22(w, i + 1);
    }
    else{
        state43(w, i + 1);
    }
}
void state39(string w, int i){
    cout << "State39" << endl;
    if(i == w.length()){
        cout << "String is accepted";
```

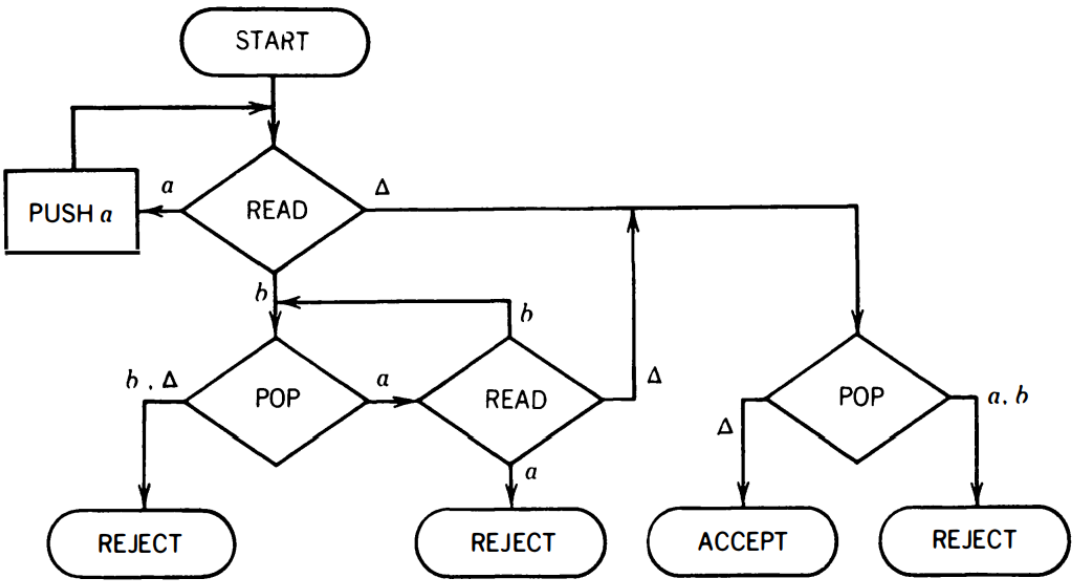
```
        return;
    }
    if(w[i] == 'a'){
        state44(w, i + 1);
    }
    else{
        state43(w, i + 1);
    }
}
void state40(string w, int i){
    cout << "State40" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state40(w, i + 1);
    }
    else{
        state24(w, i + 1);
    }
}
void state41(string w, int i){
    cout << "State41" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state41(w, i + 1);
    }
    else{
        state45(w, i + 1);
    }
}
void state42(string w, int i){
    cout << "State42" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state46(w, i + 1);
    }
    else{
        state42(w, i + 1);
    }
```

```
}
void state43(string w, int i){
    cout << "State43" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state44(w, i + 1);
    }
    else{
        state43(w, i + 1);
    }
}
void state44(string w, int i){
    cout << "State44" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
        state44(w, i + 1);
    }
    else{
        state39(w, i + 1);
    }
}
void state45(string w, int i){
    cout << "State45" << endl;
    if(i == w.length()){
        cout << "String is accepted";
        return;
    }
    if(w[i] == 'a'){
        state41(w, i + 1);
    }
    else{
        state34(w, i + 1);
    }
}
void state46(string w, int i){
    cout << "State46" << endl;
    if(i == w.length()){
        cout << "String is rejected";
        return;
    }
    if(w[i] == 'a'){
```

```
        state37(w, i + 1);
    }
    else{
        state42(w, i + 1);
    }
}

int main(){
    string w;
    cout << "Enter the string: ";
    cin >> w;
    state1(w, 0);
}
```

TOC Practical 7

Design a PDA and write a program for simulating the machine which accepts the language {$a^n b^n$ where n>0, S= {a, b}}.'

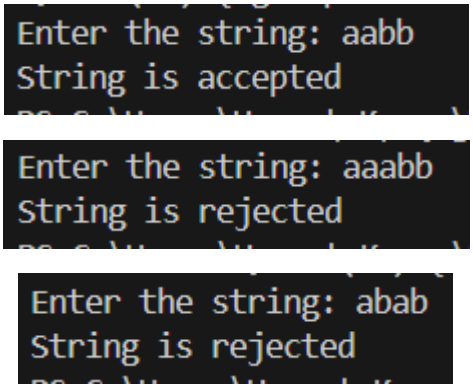


```cpp
#include <iostream>
#include <stack>

using namespace std;

void start(string w, int i);
void read1(string w, int i);
void read2(string w, int i);
void pop1(string w, int i);
void pop2(string w, int i);
void accept();
void reject();

stack<char> pd_stack;

void start(string w, int i){
    read1(w, i);
}

void read1(string w, int i){
    if(w[i]){
        if(w[i] == 'a'){
            pd_stack.push(w[i]);
            read1(w, i + 1);
        }
        else if(w[i] == 'b'){
            pop1(w, i);
        }
    }
    else{
        pop2(w, i);
    }
}

void read2(string w, int i){
    if(w[i]){
        if(w[i] == 'b'){
```

```
            pop1(w, i);
        }
        else{
            reject();
        }
    }
    else{
        pop2(w, i);
    }
}

void pop1(string w, int i){
    if(!pd_stack.empty() && (pd_stack.top() == 'a')){
        pd_stack.pop();
        read2(w, i + 1);
    }
    else{
        reject();
    }
}

void pop2(string w, int i){
    if(pd_stack.empty()){
        accept();
    }
    else{
        reject();
    }
}

void accept(){
    cout << "String is accepted";
}

void reject(){
    cout << "String is rejected";
}
```

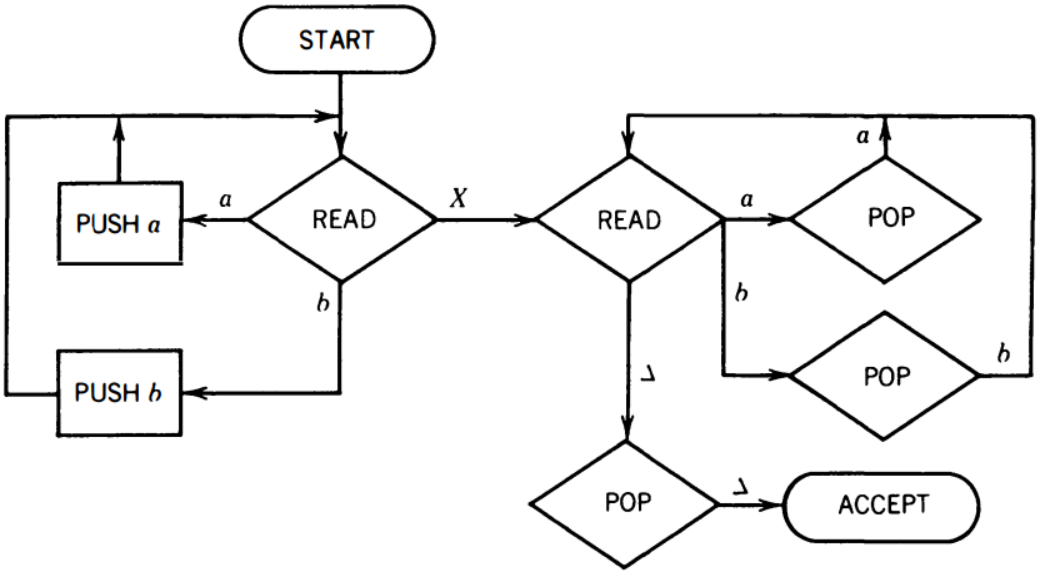
```cpp
int main() {
    string input;
    cout << "Enter a string: ";
    cin >> input;

    start(input, 0);

    return 0;
}
```

Output



Toc practical 8

Design a PDA and write a program for simulating the machine which accepts the language {wXwr| w is any string over S={a, b} and wr is reverse of that string and X is a special symbol }.




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

using namespace std;

void start(string w, int i);
void read1(string w, int i);
void read2(string w, int i);
void pop1(string w, int i);
void pop2(string w, int i);
void pop3(string w, int i);
void accept();
void reject();

stack<char> pd_stack;
```

```
void start(string w, int i){
    read1(w, i);
}

void read1(string w, int i){
    if(w[i]){
        if(w[i] == 'a' || w[i] == 'b'){
            pd_stack.push(w[i]);
            read1(w, i + 1);
        }
        else if(w[i] == 'X'){
            read2(w, i + 1);
        }
        else{
            reject();
        }
    }
    else{
        reject();
    }
}

void read2(string w, int i){
    if(w[i]){
        if(w[i] == 'a'){
            pop1(w, i);
        }
        else if(w[i] == 'b'){
            pop2(w, i);
        }
        else{
            reject();
        }
    }
    else{
        pop3(w, i);
    }
}
```

```
void pop1(string w, int i){
    if(!pd_stack.empty() && (w[i] == pd_stack.top())){
        pd_stack.pop();
        read2(w, i + 1);
    }
    else{
        reject();
    }
}

void pop2(string w, int i){
    if(!pd_stack.empty() && (w[i] == pd_stack.top())){
        pd_stack.pop();
        read2(w, i + 1);
    }
    else{
        reject();
    }
}

void pop3(string w, int i){
    if(pd_stack.empty()){
        accept();
    }
    else{
        reject();
    }
}

void accept(){
    cout << "String is accepted";
}

void reject(){
    cout << "String is rejected";
}
```

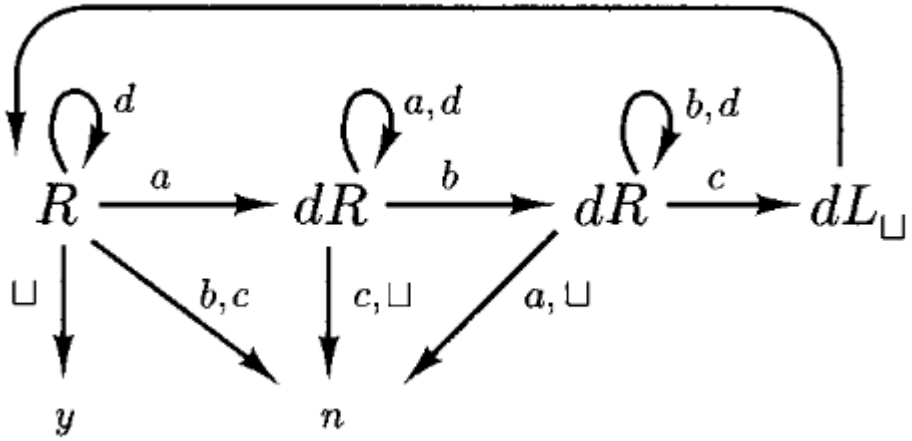
```cpp
int main() {
    string input;
    cout << "Enter a string: ";
    cin >> input;

    start(input, 0);

    return 0;
}
```

Output

```
abXba: Accepted
aXaa: Rejected
bXb: Accepted
abXaa: Rejected
X: Accepted
abXab: Rejected
aaXaa: Accepted
```

Practical 9

Design and simulate a Turing Machine that accepts the language a^n b^n c^n where n >0.



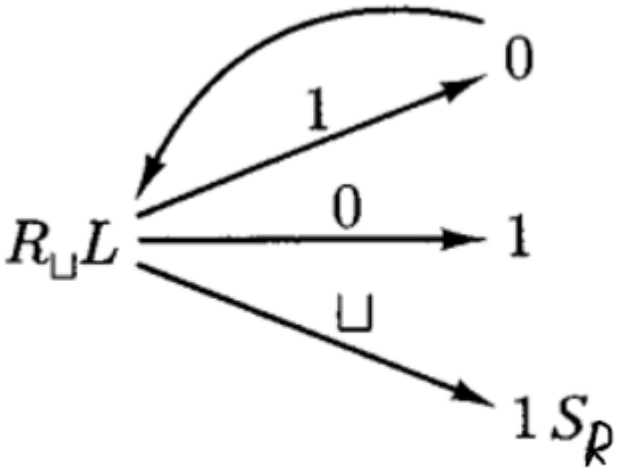
```cpp
#include <iostream>
using namespace std;

void R(string &tape, int head);
void dR_a(string &tape, int head);
void dR_b(string &tape, int head);
void dLu(string &tape, int head);
void yes();
void no();

void R(string &tape, int head) {
    if (tape[head] == 'a') {
        tape[head] = 'd'; // Mark 'a' as processed
        dR_a(tape, head + 1); // Move to find the next 'b'
    } else if (tape[head] == 'd') { // Skip over processed symbols
        R(tape, head + 1);
    } else if (tape[head] == '_') { // Check for acceptance
        // If no unprocessed symbols are left, accept
        for (char ch : tape) {
            if (ch == 'a' || ch == 'b' || ch == 'c') {
                no();
                return;
            }
        }
        yes();
    } else {
        no();
    }
}

void dR_a(string &tape, int head) {
    if (tape[head] == 'b') {
        tape[head] = 'd'; // Mark 'b' as processed
        dR_b(tape, head + 1); // Move to find the next 'c'
    } else if (tape[head] == 'a' || tape[head] == 'd') {
        dR_a(tape, head + 1); // Skip over 'a' or already processed
symbols
```

```
    } else {
        no();
    }
}

void dR_b(string &tape, int head) {
    if (tape[head] == 'c') {
        tape[head] = 'd'; // Mark 'c' as processed
        dLu(tape, head - 1); // Move left to return to the start
    } else if (tape[head] == 'b' || tape[head] == 'd') {
        dR_b(tape, head + 1); // Skip over 'b' or already processed
symbols
    } else {
        no();
    }
}

void dLu(string &tape, int head) {
    while (tape[head] != '_') {
        head--; // Move left until reaching the leftmost blank
    }
    R(tape, head + 1); // Start over from the leftmost unprocessed symbol
}

void yes() {
    cout << "String is accepted" << endl;
}

void no() {
    cout << "String is rejected" << endl;
}

int main() {
    string input;
    cout << "Enter a string over {a, b, c}: ";
    cin >> input;

    string tape = "_" + input + "_";
```

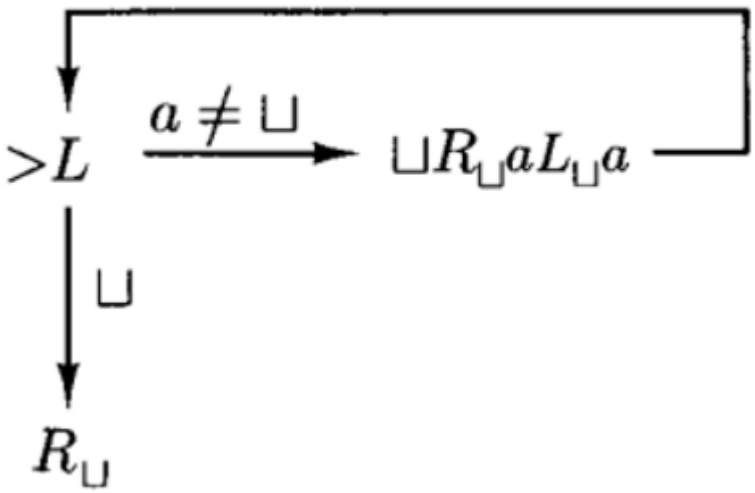
```
    R(tape, 1);
    return 0;
}
```

Practical 10

Design and simulate a Turing Machine which will increment the given binary number by 1.



Sr is our right shift machine



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

void Ru(string& tape, int head);
void L(string& tape, int head);

void Ru(string& tape, int head){
    while(tape[head] != '_'){
        head++;
    }
    L(tape, head);
}

void L(string& tape, int head){
    head--;
    if(tape[head] == '1'){
        tape[head] = '0';
        L(tape, head);
    }
    else if(tape[head] == '0'){
        tape[head] = '1';
        for(int i = 1; i < tape.size() - 1; i++){
            cout << tape[i];
        }
        return;
    }
    else if(tape[head] == '_'){
        tape[head] = '1';
        for(int i = 0; i < tape.size() - 1; i++){
            cout << tape[i];
        }
        return;
    }
}

int main(){
    string input;
    cout << "Enter a string over {0, 1}: ";
```

```
    cin >> input;

    string tape = "_" + input + "_";
    Ru(tape, 1);
    return 0;
}
```