INDEX

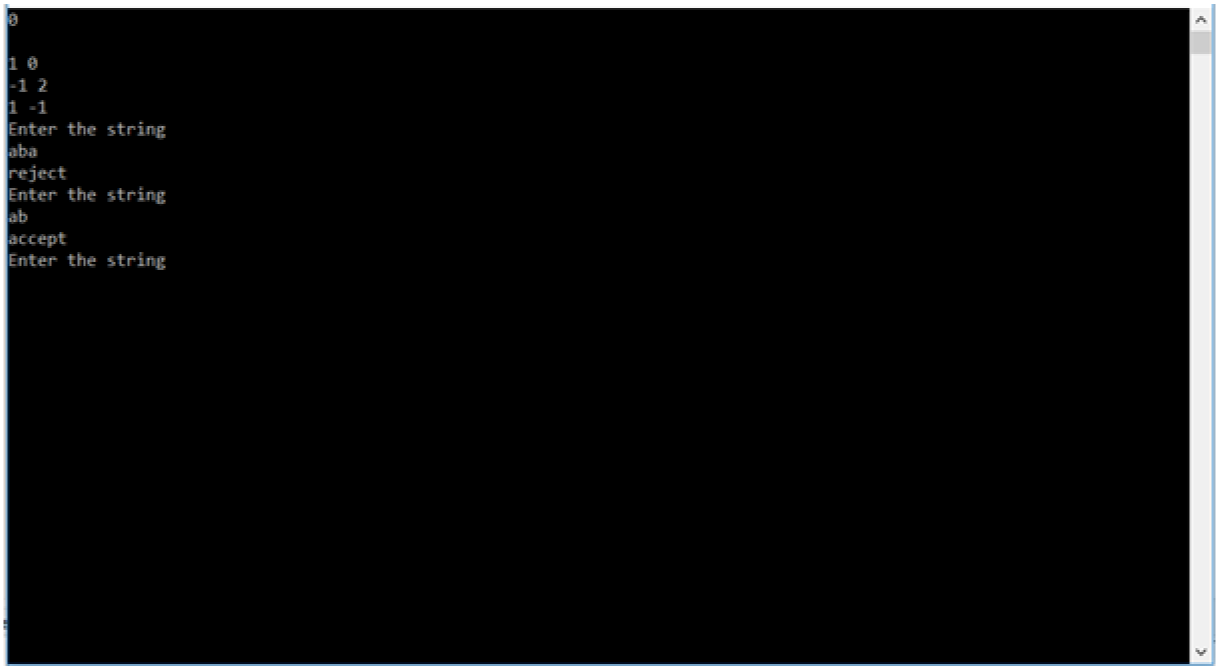
1. *WAP to implement a Regular expression. The program should read a RE through a file and should check whether a string given from the console is acceptable by the given RE or not.*

```
#include <iostream>

#include <fstream>

#include<string>

using namespace std;


int main()

{

   ifstream infile;

   infile.open("fAutomata.txt");


   int initial,i=0,k=0,l=0,nf,nr,nc;

   char ch;

   //cout<<"helloworld";

   int automata[100][100],final[100];

   string rline;

   infile.get(ch);

   initial=(int)ch-48;

   getline(infile,rline);

   int j=0;

   int len;

/*

      len=rline.size();
```

```
    for(j=0;j<len;j++)
    {
        //final[j]=rline[i];
        // cout<<rline[i];
        if(rline[j]!=',')
        {
            cout<<"abdul";
        final[k]=rline[j];
        cout<<final[k];
            k++;
        }
    }
    cout<<"\n";*/
    //i++;

// cout<<rline;
 cout<<initial<<"\n";
 i=0;

 while(getline(infile,rline)){
    len=rline.size();
    k=0;
    for(j=0;j<len;j++)
    {
        if(l==0)
        {
            if(rline[j]!=',')
            {
```

```
            final[k]=rline[j]-'0';
           // cout<<final[k];
            k++;

         }
                   i=-1;
        nf=k;
      }
      else{
      //final[j]=rline[i];
     // cout<<rline[i];
         if(rline[j]!=' ')
         {
                   if(rline[j]=='-')
      automata[i][k]=-1;
                   else
                   automata[i][k]=rline[j]-'0';
      cout<<automata[i][k]<<" ";
            k++;
         }
      }
   }
   l=1;
   cout<<"\n";
   i++;
}
```

```
//cout<<automata[0][0];

    string inputVal;
    int inputvalIndex;
while(1){
    cout<<"Enter the string\n";
    cin>>inputVal;
    i=0;
    j=initial;k=0;
    int result;
    while(inputVal[i]!='\0')
    {
        inputvalIndex=inputVal[i]-'a';
//cout<<inputvalIndex<<"\n";

            result= automata[j][inputvalIndex];
           // cout<<"\n"<<automata[j][inputvalIndex];
        j=result;
        if(j==-1)
              break;
        i++;
    }
    int flag=0;
//cout<<j;
    for(i=0;i<nf;i++)
    {
              if(j==-1)
              break;
        if(j==final[i])
            flag=1;

    }
    if(flag==1)
    {
        cout<<"accept\n";
    }
    else
        cout<<"reject\n";
}
    return 0;
}
```



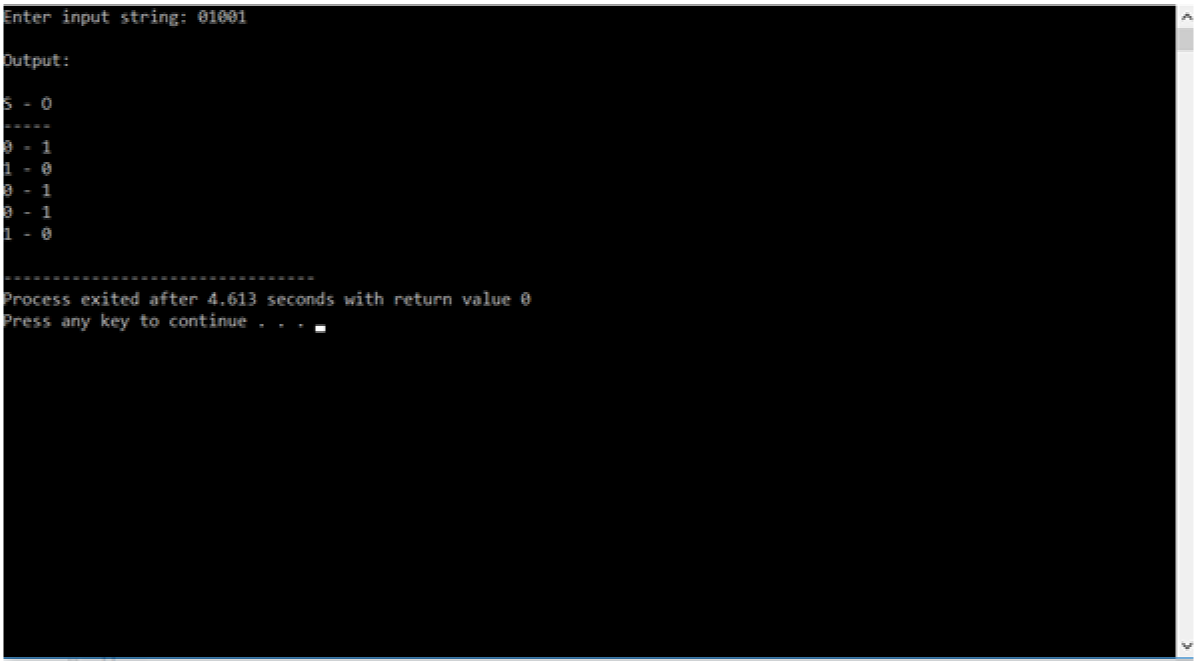
```
0

1 0
-1 2
1 -1
Enter the string
aba
reject
Enter the string
ab
accept
Enter the string
```

2. *Write a program to implement Mealy and Moore Machines.*

Mealy machine

```
#include <iostream>

#include <fstream>

#include <sstream>

#include <string>


using namespace std;


#define MAX_ROWS 5

#define MAX_COLS 5
```

```
/*

INPUT FILE FORMAT:

1/0 0/1
1/1 0/0

*/

#define INPUT_FILE "input.txt"

int  state_matrix[MAX_ROWS][MAX_COLS];
int output_matrix[MAX_ROWS][MAX_COLS];

////////////////////////////////////////////////////////////////////

void print_arr(int arr[], int size) {
   for (int i = 0; i < size; ++i) {
       cout << arr[i] << " ";
   }
   cout << endl;
}

void print_matrix(int mat[][MAX_COLS], int rows, int cols) {
   for (int i = 0; i < rows; ++i) {
       print_arr(mat[i], cols);

   }

   cout << endl;

}



//////////////////////////////////////////////////////////////////////



// Read file and fill matrices

void read_file() {

   ifstream file(INPUT_FILE);

   if (!file.is_open()) {

       cerr << "Couldn't open input file: " << INPUT_FILE;

   }



   string line;



   int i = 0;

   while (getline(file, line)) {



       string cell;

       istringstream line_stream(line);



       int j = 0;

       while(getline(line_stream, cell, ' ')) {
           // Cell is of the form 'state/output'

           // We store it by converting to int

            state_matrix[i][j] = cell[0] - 48;

           output_matrix[i][j] = cell[2] - 48;


           j++;

       }


       i++;

   }

}


int main(int argc, char const *argv[])

{

   read_file();


   // Initial State

   int cur_state = 0;


   // Current Output

   int cur_output = 0;


   // Input String

   string input;
   cout << "Enter input string: ";
   cin >> input;
   cout << endl;

   // Header
   cout << "Output: " << endl << endl;
   cout << "S - O" << endl;
   cout << "-----" << endl;

   int length = input.length();
   for (int i = 0; i < length; ++i)
   {
       // Convert char '1'/'0' to int 1/0
       int cur_input = input[i] - '0';

       cur_state = state_matrix[cur_state][cur_input];
       cur_output = output_matrix[cur_state][cur_input];

       cout << cur_state << " - " << cur_output << endl;
   }

   return 0;
}
```



```
Enter input string: 01001

Output:

S - O
-----
0 - 1
1 - 0
0 - 1
0 - 1
1 - 0

--------------------------------
Process exited after 4.613 seconds with return value 0
Press any key to continue . . .
```

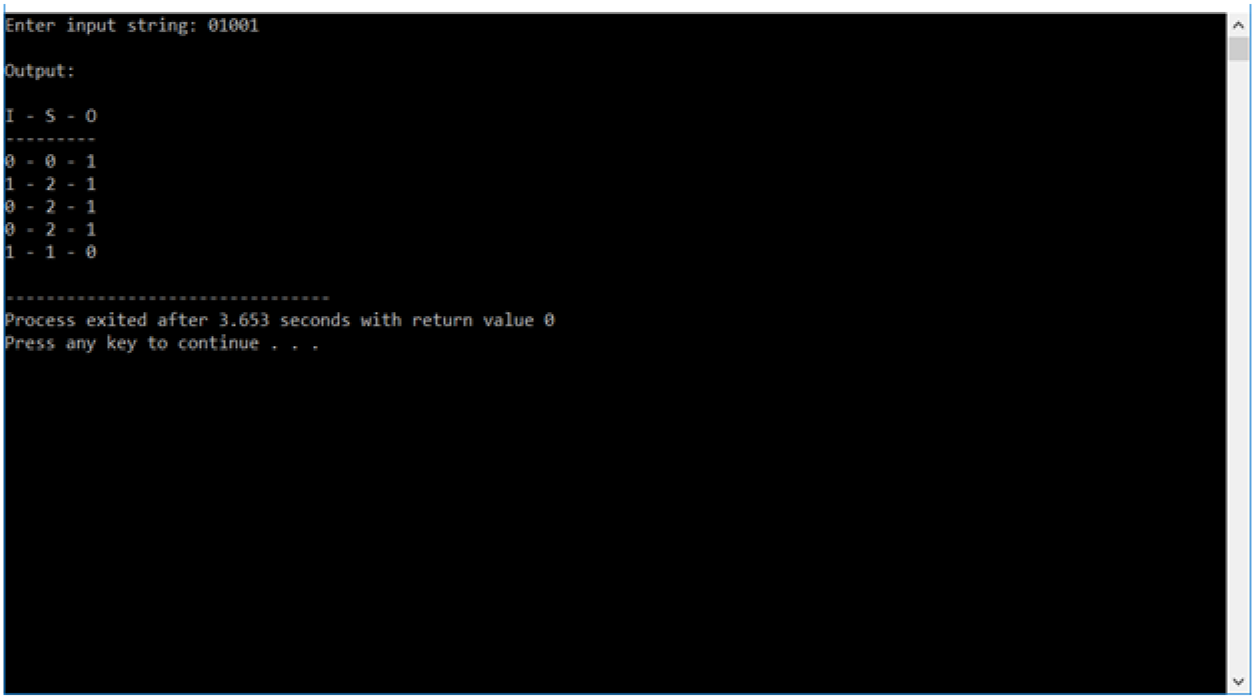
Moore machine

```
#include <iostream>

#include <fstream>

#include <sstream>

#include <string>


using namespace std;


#define MAX_ROWS 5

#define MAX_COLS 5
```

```
/*

INPUT FILE FORMAT:

states, output

0 2, 1
1 1, 0
1 0, 1

*/

#define INPUT_FILE "input.txt"

int  state_matrix[MAX_ROWS][MAX_COLS];
int  output[MAX_ROWS];

////////////////////////////////////////////////////////////////////

void print_arr(int arr[], int size) {
   for (int i = 0; i < size; ++i) {
      cout << arr[i] << " ";
   }
   cout << endl;
}

void print_matrix(int mat[][MAX_COLS], int rows, int cols) {
    for (int i = 0; i < rows; ++i) {
        print_arr(mat[i], cols);
    }
    cout << endl;
}

////////////////////////////////////////////////////////////////////

// Read file and fill matrices
void read_file() {
    ifstream file(INPUT_FILE);
    if (!file.is_open()) {
        cerr << "Couldn't open input file: " << INPUT_FILE;
    }

    string line;

    int i = 0;
    while (getline(file, line)) {

        string cell;

        // Remove the last three characters from the line; for eg: ', 2'
        istringstream line_stream(line.substr(0, line.length() - 3));

        int j = 0;
        while(getline(line_stream, cell, ' ')) {
            // Cell is of the form 'state'
            // We store it by converting to int
             state_matrix[i][j] = cell[0] - 48;

            j++;
        }

        // The last character contains the output of that state
        output[i] = line[line.length() - 1] - 48;

        i++;
    }
}

int main(int argc, char const *argv[])
{
    read_file();

    // print_matrix(state_matrix, 3, 2);
    // print_arr(output, 3);

    // Initial State
    int cur_state = 0;

    // Current Output
    int cur_output = 0;

    // Input String
```

```
string input;

cout << "Enter input string: ";
cin >> input;
cout << endl;

// Header
cout << "Output: " << endl << endl;
cout << "I - S - O" << endl;
cout << "---------" << endl;

// Print intial values
// cout << "-" << " - " << cur_state << " - " << cur_output << endl;
// cout << "---------" << endl;

int length = input.length();
for (int i = 0; i < length; ++i)
{
    // Convert char '1'/'0' to int 1/0
    int cur_input = int(input[i]) - 48;

    cur_state = state_matrix[cur_state][cur_input];
    cur_output = output[cur_state];

    cout << cur_input << " - " << cur_state << " - " << cur_output << endl;
}

return 0;
```

```
}
```



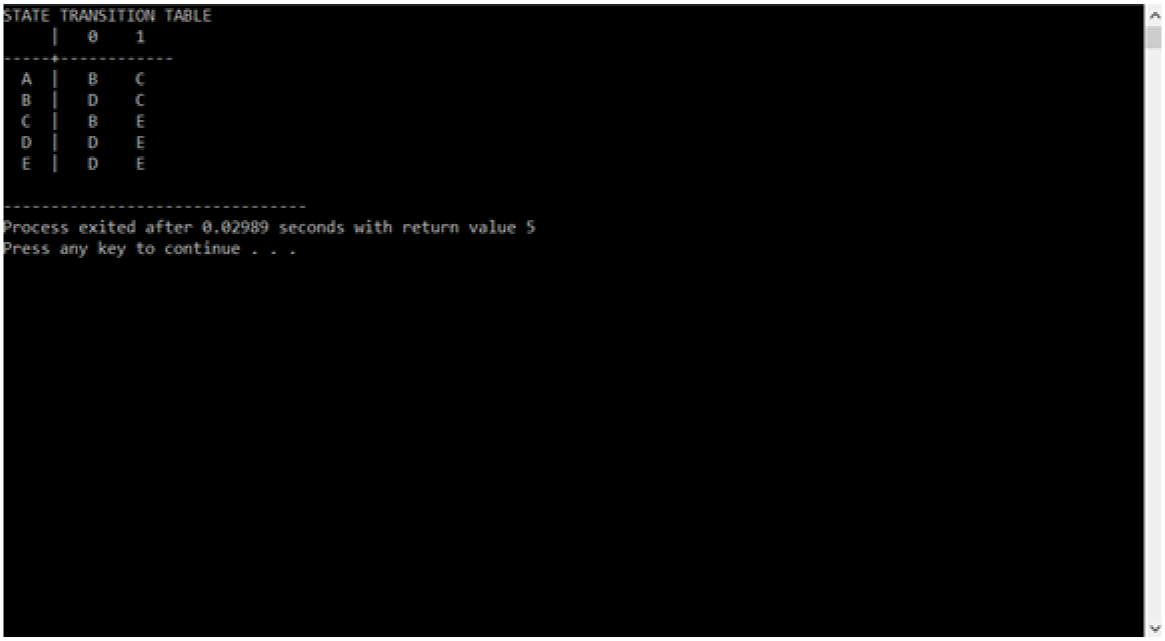
```
Enter input string: 01001

Output:

I - S - O
---------
0 - 0 - 1
1 - 2 - 1
0 - 2 - 1
0 - 2 - 1
1 - 1 - 0

--------------------------------
Process exited after 3.653 seconds with return value 0
Press any key to continue . . .
```

3. *Conversion of NFA to DFA*

```
#include <stdio.h>

#include <string.h>


#define STATES  256

#define SYMBOLS 20
```

```
int N_symbols;
int NFA_states;
char *NFAtab[STATES][SYMBOLS];

int DFA_states; /* number of DFA states */
int DFAtab[STATES][SYMBOLS];

/*Print state-transition table.*/
void put_dfa_table(
    int tab[][SYMBOLS], /* DFA table */
    int nstates,    /* number of states */
    int nsymbols)   /* number of input symbols */
{
    int i, j;

    puts("STATE TRANSITION TABLE");

    /* input symbols: '0', '1', ... */
    printf("     | ");
    for (i = 0; i < nsymbols; i++) printf("  %c  ", '0'+i);

    printf("\n-----+--");
    for (i = 0; i < nsymbols; i++) printf("-----");
    printf("\n");

    for (i = 0; i < nstates; i++) {
        printf("  %c  | ", 'A'+i);  /* state */
        for (j = 0; j < nsymbols; j++)
            printf("  %c  ", 'A'+tab[i][j]);
        printf("\n");
    }
}

/*Initialize NFA table.*/
void init_NFA_table()
{
/*
    NFA table for ex.21 at p.76

    NFAtab[0][0] = "01";
    NFAtab[0][1] = "0";
    NFAtab[1][0] = "";
    NFAtab[1][1] = "01";

    NFA_states = 2;
    DFA_states = 0;
    N_symbols = 2;
*/
/*
    NFA table for ex.17 at p.72
*/
    NFAtab[0][0] = "12";
    NFAtab[0][1] = "13";
    NFAtab[1][0] = "12";
    NFAtab[1][1] = "13";
    NFAtab[2][0] = "4";
    NFAtab[2][1] = "";
    NFAtab[3][0] = "";
    NFAtab[3][1] = "4";
    NFAtab[4][0] = "4";
    NFAtab[4][1] = "4";

    NFA_states = 5;
    DFA_states = 0;
    N_symbols = 2;
}

/*String 't' is merged into 's' in an alphabetical order.*/
void string_merge(char *s, char *t)
{
    char temp[STATES], *r=temp, *p=s;

    while (*p && *t) {
        if (*p == *t) {
            *r++ = *p++; t++;
        } else if (*p < *t) {
            *r++ = *p++;
        } else
            *r++ = *t++;
    }
    *r = '\0';

    if (*p) strcat(r, p);
    else if (*t) strcat(r, t);

    strcpy(s, temp);
}

/*Get next-state string for current-state string.*/
void get_next_state(char *nextstates, char *cur_states,
    char *nfa[STATES][SYMBOLS], int n_nfa, int symbol)
{
    int i;
    char temp[STATES];

    temp[0] = '\0';
    for (i = 0; i < strlen(cur_states); i++)
        string_merge(temp, nfa[cur_states[i]-'0'][symbol]);
    strcpy(nextstates, temp);
}


int state_index(char *state, char statename[][STATES], int *pn)
{
    int i;

    if (!*state) return -1; /* no next state */

    for (i = 0; i < *pn; i++)
        if (!strcmp(state, statename[i])) return i;
    strcpy(statename[i], state);    /* new state-name */
    return (*pn)++;
}

/*
    Convert NFA table to DFA table.
    Return value: number of DFA states.
*/
int nfa_to_dfa(char *nfa[STATES][SYMBOLS], int n_nfa,
    int n_sym, int dfa[][SYMBOLS])
{
    char statename[STATES][STATES];
    int i = 0;  /* current index of DFA */
    int n = 1;  /* number of DFA states */

    char nextstate[STATES];
    int j;

    strcpy(statename[0], "0");  /* start state */

    for (i = 0; i < n; i++) {    /* for each DFA state */
        for (j = 0; j < n_sym; j++) {    /* for each input symbol */
            get_next_state(nextstate, statename[i], nfa, n_nfa, j);
            dfa[i][j] = state_index(nextstate, statename, &n);
        }
    }

    return n;   /* number of DFA states */
```

```
}


void main()
{
   init_NFA_table();
   DFA_states = nfa_to_dfa(NFAtab, NFA_states, N_symbols, DFAtab);
   put_dfa_table(DFAtab, DFA_states, N_symbols);
}
```



```
STATE TRANSITION TABLE
     |   0   1
-----+------------
  A  |   B   C
  B  |   D   C
  C  |   B   E
  D  |   D   E
  E  |   D   E

--------------------------------
Process exited after 0.02989 seconds with return value 5
Press any key to continue . . .
```

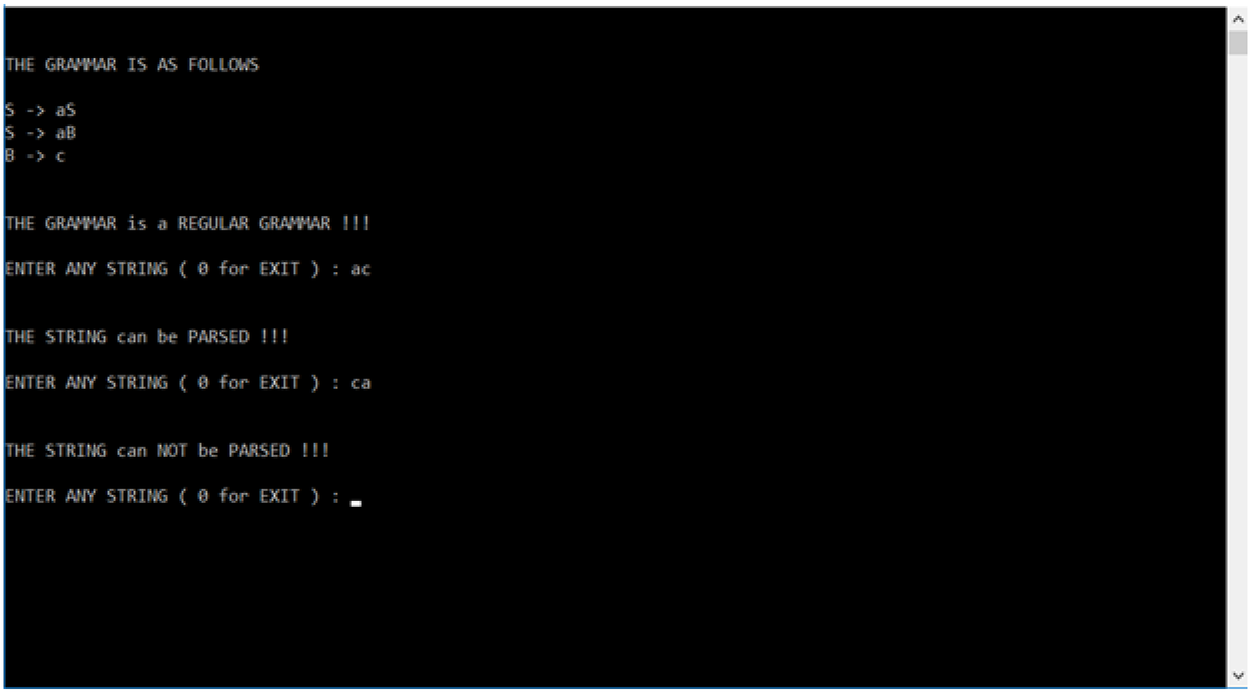
4. *Implement regular grammar*

```
/* C program to check given grammar is Regular Grammar or not. */



#include<stdio.h>

#include<conio.h>

#include<stdlib.h>

#include<string.h>


int i,j,k,l,m,n=0,o,p,nv,z=0,t,x=0;

char str[10],temp[10],temp2[10],temp3[10];


struct prod

{

   char lhs[10],rhs[10][10];

   int n;

}pro[10];


void findter()

{

   for(k=0;k<n;k++)

   {

      if(temp[i]==pro[k].lhs[0])

      {

         for(t=0;t<pro[k].n;t++)
```

```
            {
                for(x=0;x<10;x++)
                    temp2[x]='\0';
                for(l=i+1;l<strlen(temp);l++)
                    temp2[l-i-1]=temp[l];
                temp[i]='\0';
                for(l=0;l<strlen(pro[k].rhs[t]);l++)
                    temp[i+l]=pro[k].rhs[t][l];
                strcat(temp,temp2);
                if(str[i]==temp[i])
                    return;
            }
        }
    }
}
int main()
{
    FILE *f;

    for(i=0;i<10;i++)
        pro[i].n=0;

    f=fopen("tab3.txt","r");
    while(!feof(f))
    {
        fscanf(f,"%s",pro[n].lhs);
        if(n>0)
        {
            if( strcmp(pro[n].lhs,pro[n-1].lhs) == 0 )
            {
                pro[n].lhs[0]='\0';
                fscanf(f,"%s",pro[n-1].rhs[pro[n-1].n]);
                pro[n-1].n++;
                continue;
            }
        }
        fscanf(f,"%s",pro[n].rhs[pro[n].n]);
        pro[n].n++;
        n++;
    }
    n--;

    printf("\n\nTHE GRAMMAR IS AS FOLLOWS\n\n");
    for(i=0;i<n;i++)
        for(j=0;j<pro[i].n;j++)
            printf("%s -> %s\n",pro[i].lhs,pro[i].rhs[j]);

    o=0;
    for(i=0;i<n;i++)
    {
        for(j=0;j<pro[i].n;j++)
            if( pro[i].rhs[j][0]>=65 && pro[i].rhs[j][0]<=90 )
            {
                o=1;
                break;
            }
        if(o==1)
            break;
    }
    if(i==n)
        printf("\n\nTHE GRAMMAR is a REGULAR GRAMMAR !!!");
    else
    {
        printf("\n\nTHE GRAMMAR is NOT a REGULAR GRAMMAR !!!");
        exit(1);
    }

    while(1)
    {
        for(x=0;x<10;x++)
            str[x]='\0';
        printf("\n\nENTER ANY STRING ( 0 for EXIT ) : ");
        scanf("%s",str);
        if(str[0]=='0')
            exit(1);

        for(j=0;j<pro[0].n;j++)
        {
```

```
for(x=0;x<10;x++)
   temp[x]='\0';
strcpy(temp,pro[0].rhs[j]);


m=0;
for(i=0;i<strlen(str);i++)
{
   if(str[i]==temp[i])
      m++;
   else if(str[i]!=temp[i] && temp[i]>=65 && temp[i]<=90)
   {
      findter();
      if(str[i]==temp[i])
         m++;
   }
}
for(x=0;x<10;x++)
   temp3[x]='\0';
strcpy(temp3,temp);
temp3[strlen(temp)-1]='\0';
//printf("%s",temp);
if(m==strlen(str) && strcmp(temp3,str)==0 && strlen(temp3)!=1)
{
   printf("\n\nTHE STRING can be PARSED !!!");
   break;
}
```

```
      if(m==strlen(str) && strlen(str)==strlen(temp))
      {
        printf("\n\nTHE STRING can be PARSED !!!");
        break;
      }
    }

    if(j==pro[0].n)
      printf("\n\nTHE STRING can NOT be PARSED !!!");
  }

  printf("\n\n");

}
```



```
THE GRAMMAR IS AS FOLLOWS

S -> aS
S -> aB
B -> c


THE GRAMMAR is a REGULAR GRAMMAR !!!

ENTER ANY STRING ( 0 for EXIT ) : ac


THE STRING can be PARSED !!!

ENTER ANY STRING ( 0 for EXIT ) : ca


THE STRING can NOT be PARSED !!!

ENTER ANY STRING ( 0 for EXIT ) : 
```

5. *Implement CFG*

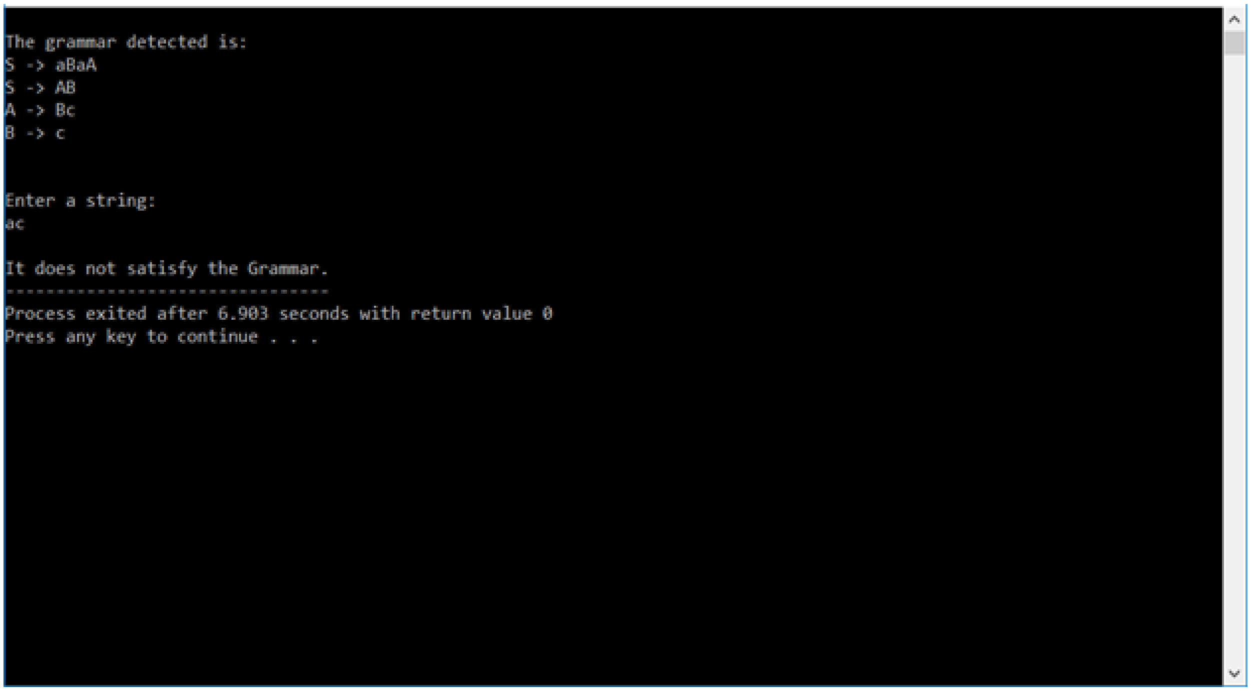
```
#include<stdio.h>

#include<string.h>

#include<stdlib.h>



int i,j,k,l,m,n=0,o,p,nv,z=0,t,x=0;

char str[10],temp[20],temp2[20],temp3[20];


struct prod

{

   char lhs[10],rhs[10][10];

   int n;

}pro[10];


void findter()

{

   for(k=0;k<n;k++)

   {

      if(temp[i]==pro[k].lhs[0])

      {

         for(t=0;t<pro[k].n;t++)

         {

            for(l=0;l<20;l++)

               temp2[l]='\0';
```

```
        for(l=i+1;l<strlen(temp);l++)
          temp2[l-i-1]=temp[l];
        for(l=i;l<20;l++)
          temp[l]='\0';
        for(l=0;l<strlen(pro[k].rhs[t]);l++)
          temp[i+l]=pro[k].rhs[t][l];
        strcat(temp,temp2);
        if(str[i]==temp[i])
          return;
        else if(str[i]!=temp[i] && temp[i]>=65 && temp[i]<=90)
          break;
      }
      break;
    }
  }
  if(temp[i]>=65 && temp[i]<=90)
    findter();
}

int main()
{
  FILE *f;


  for(i=0;i<10;i++)
    pro[i].n=0;
```

```
f=fopen("input.txt","r");
while(!feof(f))
{
    fscanf(f,"%s",pro[n].lhs);
    if(n>0)
    {
        if( strcmp(pro[n].lhs,pro[n-1].lhs) == 0 )
        {
            pro[n].lhs[0]='\0';
            fscanf(f,"%s",pro[n-1].rhs[pro[n-1].n]);
            pro[n-1].n++;
            continue;
        }
    }
    fscanf(f,"%s",pro[n].rhs[pro[n].n]);
    pro[n].n++;
    n++;
}
n--;

printf("\nThe grammar detected is:\n");
for(i=0;i<n;i++)
    for(j=0;j<pro[i].n;j++)
        printf("%s -> %s\n",pro[i].lhs,pro[i].rhs[j]);
```

```
for(l=0;l<10;l++)
    str[0]=NULL;

printf("\n\nEnter a string:\n");
scanf("%s",str);

for(j=0;j<pro[0].n;j++)
{
    for(l=0;l<20;l++)
        temp[l]=NULL;
    strcpy(temp,pro[0].rhs[j]);

    m=0;
    for(i=0;i<strlen(str);i++)
    {
        if(str[i]==temp[i])
            m++;
        else if(str[i]!=temp[i] && temp[i]>=65 && temp[i]<=90)
        {
            findter();
            if(str[i]==temp[i])
                m++;
        }
        else if( str[i]!=temp[i] && (temp[i]<65 || temp[i]>90) )
            break;
    }
```

```
      if(m==strlen(str) && strlen(str)==strlen(temp))

      {

        printf("\nIt satisfies the Grammar.");

        break;

      }

    }


    if(j==pro[0].n)

      printf("\nIt does not satisfy the Grammar.");



return 0;

}
```



```
The grammar detected is:
S -> aBaA
S -> AB
A -> Bc
B -> c


Enter a string:
ac

It does not satisfy the Grammar.
--------------------------------
Process exited after 6.903 seconds with return value 0
Press any key to continue . . .
```

6. *First and Follow*

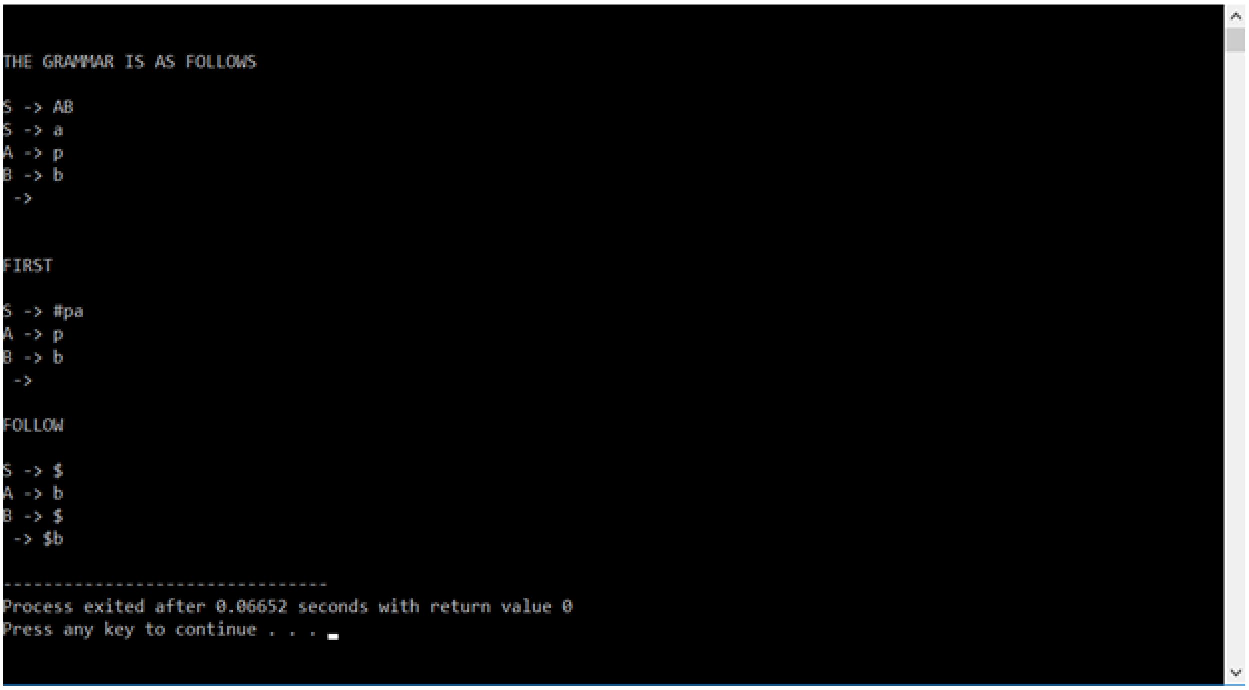
```
#include<stdio.h>

#include<string.h>


int i,j,l,m,n=0,o,p,nv,z=0,x=0;

char str[10],temp,temp2[10],temp3[20],*ptr;


struct prod

{

   char lhs[10],rhs[10][10],ft[10],fol[10];

   int n;

}pro[10];


void findter()

{

   int k,t;

   for(k=0;k<n;k++)

   {

      if(temp==pro[k].lhs[0])

      {

         for(t=0;t<pro[k].n;t++)

         {

            if( pro[k].rhs[t][0]<65 || pro[k].rhs[t][0]>90 )

               pro[i].ft[strlen(pro[i].ft)]=pro[k].rhs[t][0];

            else if( pro[k].rhs[t][0]>=65 && pro[k].rhs[t][0]<=90 )

            {
                    temp=pro[k].rhs[t][0];
                    if(temp=='S')
                        pro[i].ft[strlen(pro[i].ft)]='#';
                    findter();
                }
            }
            break;
        }
    }
}

void findfol()
{
    int k,t,p1,o1,chk;
    char *ptr1;
    for(k=0;k<n;k++)
    {
        chk=0;
        for(t=0;t<pro[k].n;t++)
        {
            ptr1=strchr(pro[k].rhs[t],temp);
            if( ptr1 )
            {
                p1=ptr1-pro[k].rhs[t];
                if(pro[k].rhs[t][p1+1]>=65 && pro[k].rhs[t][p1+1]<=90)
                {
                    for(o1=0;o1<n;o1++)
                        if(pro[o1].lhs[0]==pro[k].rhs[t][p1+1])
```

```
                  {
                        strcat(pro[i].fol,pro[o1].ft);
                        chk++;
                  }
            }
            else if(pro[k].rhs[t][p1+1]=='\0')
            {
               temp=pro[k].lhs[0];
               if(pro[l].rhs[j][p]==temp)
                  continue;
               if(temp=='S')
                  strcat(pro[i].fol,"$");
               findfol();
               chk++;
            }
            else
            {
               pro[i].fol[strlen(pro[i].fol)]=pro[k].rhs[t][p1+1];
               chk++;
            }
         }
      }
      if(chk>0)
         break;
   }
}

int main()
```

```
{
   FILE *f;
   //clrscr();

   for(i=0;i<10;i++)
      pro[i].n=0;

   f=fopen("firstFollowInput.txt","r");
   while(!feof(f))
   {
      fscanf(f,"%s",pro[n].lhs);
      if(n>0)
      {
         if( strcmp(pro[n].lhs,pro[n-1].lhs) == 0 )
         {
            pro[n].lhs[0]='\0';
            fscanf(f,"%s",pro[n-1].rhs[pro[n-1].n]);
            pro[n-1].n++;
            continue;
         }
      }
      fscanf(f,"%s",pro[n].rhs[pro[n].n]);
      pro[n].n++;
      n++;
   }

   printf("\n\nTHE GRAMMAR IS AS FOLLOWS\n\n");
   for(i=0;i<n;i++)
```

```
    for(j=0;j<pro[i].n;j++)
        printf("%s -> %s\n",pro[i].lhs,pro[i].rhs[j]);

pro[0].ft[0]='#';
for(i=0;i<n;i++)
{
    for(j=0;j<pro[i].n;j++)
    {
        if( pro[i].rhs[j][0]<65 || pro[i].rhs[j][0]>90 )
        {
            pro[i].ft[strlen(pro[i].ft)]=pro[i].rhs[j][0];
        }
        else if( pro[i].rhs[j][0]>=65 && pro[i].rhs[j][0]<=90 )
        {
            temp=pro[i].rhs[j][0];
            if(temp=='S')
                pro[i].ft[strlen(pro[i].ft)]='#';
            findter();
        }
    }
}

printf("\n\nFIRST\n");
for(i=0;i<n;i++)
{
    printf("\n%s -> ",pro[i].lhs);
    for(j=0;j<strlen(pro[i].ft);j++)
    {
        for(l=j-1;l>=0;l--)
            if(pro[i].ft[l]==pro[i].ft[j])
                break;
        if(l==-1)
            printf("%c",pro[i].ft[j]);
    }
}

for(i=0;i<n;i++)
    temp2[i]=pro[i].lhs[0];
pro[0].fol[0]='$';
for(i=0;i<n;i++)
{
    for(l=0;l<n;l++)
    {
        for(j=0;j<pro[i].n;j++)
        {
            ptr=strchr(pro[l].rhs[j],temp2[i]);
            if( ptr )
            {
                p=ptr-pro[l].rhs[j];
                if(pro[l].rhs[j][p+1]>=65 && pro[l].rhs[j][p+1]<=90)
                {
                    for(o=0;o<n;o++)
                        if(pro[o].lhs[0]==pro[l].rhs[j][p+1])
                                strcat(pro[i].fol,pro[o].ft);
                }
                else if(pro[l].rhs[j][p+1]=='\0')
        {
          temp=pro[l].lhs[0];
          if(pro[l].rhs[j][p]==temp)
            continue;
          if(temp=='S')
            strcat(pro[i].fol,"$");
          findfol();
        }
        else
          pro[i].fol[strlen(pro[i].fol)]=pro[l].rhs[j][p+1];
      }
    }
  }
}

printf("\n\nFOLLOW\n");
for(i=0;i<n;i++)
{
  printf("\n%s -> ",pro[i].lhs);
  for(j=0;j<strlen(pro[i].fol);j++)
  {
    for(l=j-1;l>=0;l--)
      if(pro[i].fol[l]==pro[i].fol[j])
        break;
    if(l==-1)
      printf("%c",pro[i].fol[j]);
  }
}
```

```
    printf("\n");
    //getch();
}
```



```
THE GRAMMAR IS AS FOLLOWS

S -> AB
S -> a
A -> p
B -> b
 ->


FIRST

S -> #pa
A -> p
B -> b
 ->

FOLLOW

S -> $
A -> b
B -> $
 -> $b

--------------------------------
Process exited after 0.06652 seconds with return value 0
Press any key to continue . . .
```

7. *WAP to verify whether a given CFG is suitable for LL(1) parsing or not.*

```
#include <iostream>
#include <vector>
#include <fstream>
#include <string>
#include<algorithm>
```

```
using namespace std;
int num_of_productions;
vector<string> productions;
vector<char> terminals;
vector<char> nonTerminals;
vector<vector <char> > firsts;
vector<vector <char> > follows;
vector<vector <string> > parsingTable;
vector<int> flag;
int globalCount=0;    //to counter chain productions
char ttc;
char startSymbol;

int positionOfNonTerminal(char c){
   for(int i=0;i<nonTerminals.size();i++){
      if(nonTerminals[i]==c){
         return i;
      }
   }
   return -23;
}


int positionOfTerminal(char c){
   for(int i=0;i<terminals.size();i++){
      if(terminals[i]==c){
         return i;
```

```
        }
    }
    return -23;
}

int isInTerminal(char c){//Check if a value is a valid Terminal
    if(find(terminals.begin(),terminals.end(),c)!=terminals.end()){
        return 1;
    }
    return 0;
}


int isInNonTerminal(char c){//Check if a value is a valid NonTerminal
    if(find(nonTerminals.begin(),nonTerminals.end(),c)!=nonTerminals.end()){
        return 1;
    }
    return 0;
}

int isTerminal(char tem){//Assume Capital Letters As non terminals and small letters as terminals
    if(tem>='A' && tem<='Z'){
        return 0;
    }else{
        return 1;
    }
}
```

```
int prepareListOfCharacter(){//Prepare List Of Valid Characters
    int f=0;
    for(int i=0;i<productions.size();i++){
        string tempString=productions[i];
        int tempStringLen = tempString.length();
        for(int j=0;j<tempStringLen;j++){
            char t = tempString[j];
            if(!(t==' ')){
                if(isInNonTerminal(t)||isInTerminal(t)){
                    continue;
                }else{
                    //Check if Terminal Or Non Terminal.
                    // Add in the respective Vector
                    if(isTerminal(t)){
                        if(t=='#'){
                            f=1;
                            continue;
                        }
                        terminals.push_back(t);
                    }else{
                        nonTerminals.push_back(t);
                        flag.push_back(0);
                        vector<char> tV;
                        tV.push_back('@');
                        firsts.push_back(tV);
                        follows.push_back(tV);
                    }
                }
            }
        }
    }
    if(f==1){
        terminals.push_back('#');
    }
    return 1;
}

int ifExists(int i,char c){
    for(int j=0;j<firsts[i].size();j++){
        if(firsts[i][j]==c){
            return 1;
        }
    }
    return 0;
}

int readProductions(){
    //Function to read the productions from the input file



    //READING BEGINS
    string fileName;
    cout<<"Enter Filename : ";
    getline(cin, fileName);
    getline(cin, fileName);
    ifstream input(fileName.c_str());
```

```
string tempString;

input>>num_of_productions;

getline(input, tempString, '\n');

while (getline(input, tempString, '\n')) {

    productions.push_back(tempString);

}

cout<<"DATA FROM INPUT FILE  "<<endl;

cout<<"Num Of Productions : "<<num_of_productions<<endl;

for(int i=0;i<productions.size();i++){

    cout<<productions[i]<<endl;

}


//READING ENDS



prepareListOfCharacter();

cout<<"\nTerminals     : ";

for(int i=0;i<terminals.size();i++){

    cout<<terminals[i]<<" ";

}

cout<<"\nNon Terminals : ";

for(int i=0;i<nonTerminals.size();i++){

    cout<<nonTerminals[i]<<" ";

}

cout<<"...";

cout<<"\n";


return 1;
```

```
}

int isFlagTrue(int i){
    return flag[i];
}


int firstCalcB(char c, int i){
    //TODO
    //Rectify for input.txt chain productions

    if((ttc==c)&&(globalCount!=0)){
        if(!ifExists(i,'#')){
            firsts[i].push_back('#');
        }
        return 1;
    }
    globalCount++;
    //cout<<"\ninside firstcalcb for"<<c;
    int posNonTerm = positionOfNonTerminal(c);
    //cout<<"\tPosition : "<<posNonTerm;
    if(isFlagTrue(posNonTerm)){
        int tempFlag=0;
        //Already Calculated the First
        vector<char> tempFirsts;
        tempFirsts = firsts[posNonTerm];
        for(int j=0;j<tempFirsts.size();j++){
            char tempC = tempFirsts[j];
            if(tempC=='@'){
                continue;
            }else if(tempC == '#'){
                tempFlag=1;
            }else{
                if(!ifExists(i,tempC)){
                    firsts[i].push_back(tempC);
                }
            }
        }
        if(tempFlag==1){
            return 22;
        }else{
            return 1;
        }
    }else{
        //Need To Calculate Now
        vector<string> tempProductions;
        int tempFlag3 = 0;
        for(int j=0;j<productions.size();j++){
            if(productions[j][0]==c){
                tempProductions.push_back(productions[j]);
            }
        }

        for(int j=0;j<tempProductions.size();j++){
            string tempProduction = tempProductions[j];
            if(isTerminal(tempProduction[2])){
```

```
    if(tempProduction[2]=='#'){
        tempFlag3 = 1;
    }else{
        if(!ifExists(i,tempProduction[2])){
            firsts[i].push_back(tempProduction[2]);
        }

    }
}else{
    int k=2;
    int tempFlag2=22;
    while(tempFlag2==22){
        //cout<<"\nCalling for tempProduction["<<k<<"] = "<<tempProduction[k];
        if(isTerminal(tempProduction[k])){
            if(!ifExists(i,tempProduction[k])){
                firsts[i].push_back(tempProduction[k]);
            }
            tempFlag2=1;
        }
        tempFlag2=firstCalcB(tempProduction[k++],i);
        //cout<<"\nTempFlag2 = "<<tempFlag2<<endl;
        if(tempFlag2==22){
            if(k==tempProduction.length()){
                if(!ifExists(i,'#')){
                    firsts[i].push_back('#');
                }
            }
        }
```

```
                }
            }
        }
        if(tempFlag3==1){
            return 22;
        }else{
            return 1;
        }
    }
    return 1;
}


int printFirsts(){
    cout<<"NonTerminal\tFirsts\n";
    for(int i=0;i<nonTerminals.size();i++){
        vector<char> tempFirsts = firsts[i];
        cout<<nonTerminals[i]<<"\t\t";
        for(int j=0;j<tempFirsts.size()-1;j++){
            if(tempFirsts[j]=='@'){
                continue;
            }
            cout<<tempFirsts[j]<<", ";
        }
        int fin=tempFirsts.size()-1;
        if(fin>=0){
            if(tempFirsts[fin]!='@'){
                cout<<tempFirsts[fin]<<endl;
            }
        }
    }
    return 1;
}



int exists(char c, int i){
    for(int j=0;j<follows[i].size();j++){
        if(follows[i][j]==c){
            return 1;
        }
    }
    return 0;
}



int followCalcB(char c, int i){

    int p = positionOfNonTerminal(c);
    if(flag[p]==1){

        for(int j=0;j<follows[p].size();j++){
            if(!exists(follows[p][j],i)){
                follows[i].push_back(follows[p][j]);
            }
        }
    }else{
```

```
//cout<<"\n\nFor Character : "<<c;

if(c==startSymbol){
    if(!exists('$',i)){
        //cout<<"\n\t\tAdding $ to follow";
        follows[i].push_back('$');
    }
}

if((ttc==c)&&(globalCount!=0)){
    return 1;
}

vector<string> tempProductions;
for(int j=0;j<productions.size();j++){
    for(int k=2;k<productions[j].length();k++){
        if(productions[j][k]==c){
            tempProductions.push_back(productions[j]);
        }
    }
}


for(int j=0;j<tempProductions.size();j++){
    string production=tempProductions[j];

    int pos=0;
    for(int k=2;k<production.length();k++){
```

```
if(production[k]==c){
  pos=k;
  //cout<<"\n\t"<<c<<" Found At Position : "<<pos<<" In String : "<<production;
  while(true){
    char tempChar = production[pos];
    if(pos==production.length()-1){
      //End Of String Reached
      if(isTerminal(tempChar)){
        if(!exists(tempChar,i)){
          //cout<<"\n\t\tAdding "<<tempChar<<" to follow";
          follows[i].push_back(tempChar);
        }
      }else{
        if(production[0]!=tempChar){
          ttc=production[0];
          globalCount++;
          followCalcB(production[0],i);
        }
      }
      break;
    }else if(isTerminal(production[pos+1])){
      if(!exists(production[pos+1],i)){
        //cout<<"\n\t\tAdding "<<production[pos+1]<<" to follow";
        follows[i].push_back(production[pos+1]);
      }
      break;
    }else{
      int tempFlag=0;
```

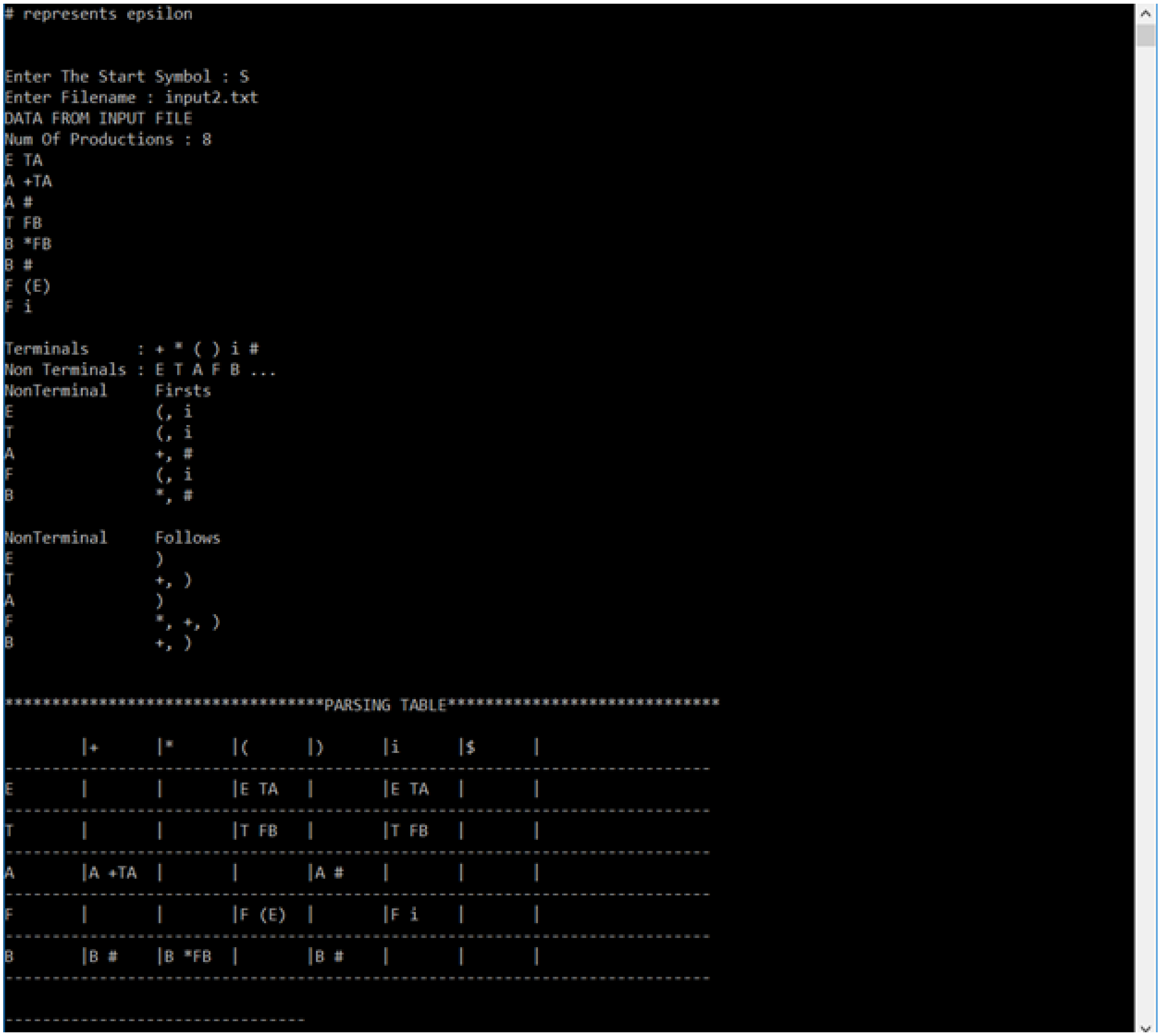
```
                            vector<char> tempFirst = firsts[positionOfNonTerminal(production[pos+1])];
                            for(int l=0;l<tempFirst.size();l++){
                                char ch = tempFirst[l];
                                if(ch!='#'){
                                    if(!exists(ch,i)){
                                        //cout<<"\n\t\tAdding "<<ch<<" to follow";
                                        follows[i].push_back(ch);
                                    }
                                }else{
                                        tempFlag=1;
                                }
                            }
                            if(tempFlag==1){
                                pos++;
                            }else{
                                break;
                            }
                        }
                    }
                }
            }
        }
    }


    return 1;
}
```

```
int printFollows(){

   cout<<"\nNonTerminal\tFollows\n";

   for(int i=0;i<nonTerminals.size();i++){

      vector<char> tempFollows = follows[i];

      cout<<nonTerminals[i]<<"\t\t";

      for(int j=0;j<tempFollows.size()-1;j++){

         if(tempFollows[j]=='@'){

            continue;

         }

         cout<<tempFollows[j]<<", ";

      }

      int fin=tempFollows.size()-1;

      if(fin>=0){

         if(tempFollows[fin]!='@'){

            cout<<tempFollows[fin]<<endl;

         }

      }

   }

   return 1;

}



int main(){


   cout<<"# represents epsilon"<<endl;

   cout<<"\n\nEnter The Start Symbol : ";

   cin>>startSymbol;
```

```
//Read All The Productions
readProductions();
//Calculating Firsts BEGINS
for(int i=0;i<nonTerminals.size();i++){
  //cout<<"\tFirst For Non Terminal["<<i<<"] : "<<nonTerminals[i]<<endl;
  int retVal = 0;
  ttc=nonTerminals[i];
  retVal = firstCalcB(nonTerminals[i],i);
  globalCount=0;
  if(retVal==22){
    firsts[i].push_back('#');
  }
  flag[i]=1;
}
printFirsts();

//Calculating Firsts ENDS

//Reset Flag
for(int i=0;i<nonTerminals.size();i++){
  flag[i]=0;
}

//Calculating Follows BEGINS
for(int i=0;i<nonTerminals.size();i++){
  followCalcB(nonTerminals[i],i);
  flag[i]=1;
  globalCount=0;
}
printFollows();
//Calculating Follows ENDS



// First And Follow Have Been Computed.
//Now Preparing the Parser Table

//Blank Parsing Table
for(int i=0;i<=nonTerminals.size();i++){
    vector<string> tempRow;
    for(int j=0;j<=terminals.size();j++){
        tempRow.push_back(" ");
    }
    parsingTable.push_back(tempRow);
}

//Adding First Row Of Parsing Table
for(int i=0;i<terminals.size();i++){
    parsingTable[0][i+1]=terminals[i];
}



//Adding First Column Of Parsing Table
for(int i=0;i<nonTerminals.size();i++){
    parsingTable[i+1][0]=nonTerminals[i];
}
```

```
//Filling the values in parsing table
for(int i=0;i<productions.size();i++){
    string production = productions[i];
    if(production[2]!='#'){
        if(isTerminal(production[2])){
            int col = positionOfTerminal(production[2]);
            if(col==-23){
                cout<<production[2];
                cout<<"ERROR CODE 001\n";
                return 0;
            }
            int row = positionOfNonTerminal(production[0]);
            if(row==-23){
                cout<<production[0];
                cout<<"ERROR CODE 002\n";
                return 0;
            }
            parsingTable[row+1][col+1]=production;
        }else{
            vector<char> tempFirst;
            int row = positionOfNonTerminal(production[0]);
            if(row==-23){
                cout<<production[0];
                cout<<"ERROR CODE 003\n";
                return 0;
            }
            tempFirst = firsts[row];
        for(int k=0;k<tempFirst.size();k++){
            if(tempFirst[k]=='@'){
                continue;
            }
            if(tempFirst[k]!='#'){
                int col = positionOfTerminal(tempFirst[k]);
                if(col==-23){
                    cout<<tempFirst[k];
                    cout<<"ERROR CODE 004\n";
                    return 0;
                }
                parsingTable[row+1][col+1]=production;
            }
        }
    }
}else{
    vector<char> tempFollow;
    int row = positionOfNonTerminal(production[0]);
    if(row==-23){
            cout<<production[0];
            cout<<"ERROR CODE 005\n";
            return 0;
        }
    tempFollow = follows[row];

    for(int k=0;k<tempFollow.size();k++){
        if(tempFollow[k]=='@'){
            continue;
```

```
                }

                int col;

                if(tempFollow[k]=='$'){

                    col = terminals.size()-1;

                }else{

                    col = positionOfTerminal(tempFollow[k]);

                    if(col==-23){

                        cout<<tempFollow[k];

                        cout<<"ERROR CODE 006\n";

                        return 0;

                    }

                }

                parsingTable[row+1][col+1]=production;

            }

        }

    }


    parsingTable[0][terminals.size()]="$";

    //Printing the parsing table

    cout<<"\n\n***********************************PARSING
TABLE*****************************\n\n";

    for(int i=0;i<=nonTerminals.size();i++){

        for(int j=0;j<=terminals.size();j++){

            cout<<parsingTable[i][j]<<"\t|";

        }

        cout<<"\n---------------------------------------------------------------------------\n";

    }
    return 1;

}
```



```
# represents epsilon


Enter The Start Symbol : S
Enter Filename : input2.txt
DATA FROM INPUT FILE
Num Of Productions : 8
E TA
A +TA
A #
T FB
B *FB
B #
F (E)
F i

Terminals     : + * ( ) i #
Non Terminals : E T A F B ...
NonTerminal     Firsts
E               (, i
T               (, i
A               +, #
F               (, i
B               *, #

NonTerminal     Follows
E               )
T               +, )
A               )
F               *, +, )
B               +, )


**********************************PARSING TABLE*****************************

        |+      |*      |(      |)      |i      |$      |
---------------------------------------------------------------------------
E       |       |       |E TA   |       |E TA   |       |
---------------------------------------------------------------------------
T       |       |       |T FB   |       |T FB   |       |
---------------------------------------------------------------------------
A       |A +TA  |       |       |A #    |       |       |
---------------------------------------------------------------------------
F       |       |       |F (E)  |       |F i    |       |
---------------------------------------------------------------------------
B       |B #    |B *FB  |       |B #    |       |       |
---------------------------------------------------------------------------


--------------------------------
```

8. *WAP to generate LL(1) parsing table for a given CFG*

```
#include <iostream>

#include <vector>

#include <fstream>

#include <string>

#include <algorithm>


using namespace std;

int num_of_productions;

vector<string> productions;

vector<char> terminals;

vector<char> nonTerminals;

vector<string> newProductions;

vector<string> deterministicProductions;


int isInTerminal(char c){

//Check if a value is a valid Terminal

   if(find(terminals.begin(),terminals.end(),c)!=terminals.end()){

      return 1;

   }

   return 0;

}



int isInNonTerminal(char c){//Check if a value is a valid NonTerminal

   if(find(nonTerminals.begin(),nonTerminals.end(),c)!=nonTerminals.end()){
        return 1;
    }
    return 0;
}

int isTerminal(char tem){//Assume Capital Letters As non terminals and small letters as terminals
    if(tem>='A' && tem<='Z'){
        return 0;
    }else{
        return 1;
    }
}

int prepareListOfCharacter(){//Prepare List Of Valid Characters
    for(int i=0;i<productions.size()-1;i++){
        string tempString=productions[i];
        int tempStringLen = tempString.length();
        for(int j=0;j<tempStringLen;j++){
            char t = tempString[j];
            if(!(t==' ')){
                if(isInNonTerminal(t)||isInTerminal(t)){
                    continue;
                }else{
                    //Check if Terminal Or Non Terminal.
                    // Add in the respective Vector
                    if(isTerminal(t)){
                        terminals.push_back(t);
                    }else{
                        nonTerminals.push_back(t);
                    }
                }
            }
        }
    }
    return 1;
}



int readProductions(){
    //Function to read the productions from the input file


    //READING BEGINS
    string fileName ="";
    cout<<"Enter File Name : ";
    cin>>fileName;
    cout<<endl;
    ifstream input(fileName.c_str());
    string tempString;
    input>>num_of_productions;
    getline(input, tempString, '\n');
    while (getline(input, tempString, '\n')) {
        productions.push_back(tempString);
    }
    cout<<"DATA FROM INPUT FILE BEGINS: "<<endl;
    cout<<"Num Of Productions : "<<num_of_productions<<endl;
    for(int i=0;i<productions.size()-1;i++){
        cout<<productions[i]<<endl;
    }
    cout<<"DATA FROM INPUT FILE ENDS: "<<endl<<endl;
    //READING ENDS



    prepareListOfCharacter();
    cout<<"\nAll The Terminals     : ";
    for(int i=0;i<terminals.size();i++){
        cout<<terminals[i]<<" ";
    }
    cout<<"\nAll The Non Terminals : ";
    for(int i=0;i<nonTerminals.size();i++){
        cout<<nonTerminals[i]<<" ";
    }
    cout<<"\n";

    return 1;
}

char nonTermGen(){
    //Generate A Non Terminal To Replace
    char nonTerm = 'A';
    while(true){
        if(isInNonTerminal(nonTerm)){
            //cout<<"\nNon Term Mai Hai";
            nonTerm += 1;
        }else{
            //cout<<"\nNon Term mai Ghanta";
            return nonTerm;
        }
        if(nonTerm==('Z'+1)){
            return '$';
        }
    }
}

int isLeftRecursive(char c){

    //cout<<"\nChar => "<<c;
    //cout<<"\n Productions : \n";
    for(int j=0;j<productions.size();j++){
        string tempString = productions[j];
        //cout<<"\nTempString["<<j<<"] => "<<tempString;
        if(tempString[0]==c){
            if(!isInNonTerminal(tempString[2])){
            //First Character Is A Terminal
            //cout<<"\n Not L Rec => "<<tempString;
            newProductions.push_back(tempString);
            }else{
                //First Character Is A Non Terminal
                if(tempString[2]==c){
                    //Direct Recursion
                    return 1;
                }else{
                    //Indirect Recursion IGNORED FOR NOW
                    newProductions.push_back(tempString);
                }
            }
        }else{
            //cout<<"\n First Character not "<<c;
        }



    }
    return 0;
}

int rectifyLeftRecursion(char c){
    //    A->Ap|B
    //      ||
    //     A->BA'
    //    A'->pA'|e

    //Adding Beta Productions
    char newNonTerm = nonTermGen();
    if(newNonTerm=='$'){
        cout<<"Ran Out Of Non Terminals To Assign. Too Many Left Recursive Entries.";
        exit;
    }

    vector<string> beta;
```

```
for(int k=0;k<productions.size();k++){
    if(productions[k][0]==c){
        if(productions[k][2]!=c){
            beta.push_back(productions[k]);
        }
    }
}
for(int k=0;k<beta.size();k++){
    //Add Beta Productions
    string betaProduction = beta[k]+newNonTerm;
    if(!isInNonTerminal(newNonTerm)){
        nonTerminals.push_back(newNonTerm);
    }
    newProductions.push_back(betaProduction);
}



//Dealing With A' Productions
for(int j=0;j<productions.size();j++){
    if(productions[j][0]==c){
        string tempString = productions[j];
        if(tempString[2]==c){
            //Direct Left Recursion Present
            string alpha = tempString.substr(3);
            //Add A' Productions
            string alphaProduction = "";
            alphaProduction += newNonTerm;
            alphaProduction += (" "+alpha);
        alphaProduction += newNonTerm;
        if(!isInNonTerminal(newNonTerm)){
          nonTerminals.push_back(newNonTerm);
        }
        newProductions.push_back(alphaProduction);
      }
    }
  }
  string epsilonProduction = "";
  epsilonProduction += newNonTerm;
  epsilonProduction += " #";
  newProductions.push_back(epsilonProduction);
  terminals.push_back(newNonTerm);
  return 1;
}

int printFinalGrammar(){
  cout<<"\nFINAL LEFT RECURSION FREE GRAMMAR IS : "<<endl;
  for(int i=0;i<newProductions.size();i++){
    cout<<newProductions[i]<<endl;
  }
  return 1;
}



int clearProductions(char c){
  vector<string> tempProds=productions;
  int j=0;
```

```
    while(true){
        if(tempProds[j][0]==c){
            tempProds.erase(tempProds.begin()+j);
        }else{
            j++;
        }
        if(j==tempProds.size()){
            break;
        }
    }
    productions = tempProds;
    return 1;
}




int isNonDeterministic(char c){
    //return 0;
    vector<string> tempProductions;
    for(int j=0;j<productions.size();j++){
        string tempString = productions[j];
        if(productions[j][0]==c){
            tempProductions.push_back(productions[j]);
        }
    }
    for(int j=0;j<tempProductions.size();j++){
```

```
string tempString = tempProductions[j];
//cout<<"\n\n\nTemp String => "<<tempString;
for(int k=0;k<tempProductions.size();k++){
  //cout<<"\nTempProduction[k] => "<<k<<"=> "<<tempProductions[k];
  if(tempString==tempProductions[k]){
    //cout<<"\t 1";
    continue;
  }else{
    if(tempString.length()>tempProductions[k].length()){
      //cout<<"\t 2";
      for(int l=tempProductions[k].length();l>1;l--){
        size_t found = tempString.find(tempProductions[k].substr(1,l));
        if(found!=string::npos){
          //Find the Element in tempString
          if(found==1){
            //Element At The Beginning This is the case We're interested in
            //cout<<"\n ND 1 "<<tempProductions[k].substr(2,l);
            return 1;
          }
        }
      }
    }else{
      //cout<<"\t 3";
      for(int l=tempString.length();l>1;l--){
        //cout<<"\n\tLooking For => "<<tempString.substr(1,l)<<"\t l = "<<l;
        size_t found = tempProductions[k].find(tempString.substr(1,l));
        if(found!=string::npos){
          //cout<<"\t=> Found => "<<tempString.substr(1,l)<<" At => "<<found;
```

```
                            //Find the Element in tempProduction
                            if(found==1){
                                //Element At The Beginning This is the case We're interested in
                                //cout<<"\n ND 2 "<<tempProductions[k].substr(1,l);
                                return 1;
                            }
                        }
                    }
                }
            }
        }
    }
    return 0;
}

int exists(string s){
    for(int m=0;m<deterministicProductions.size();m++){
        if(s == deterministicProductions[m]){
            return 1;
        }
    }
    return 0;
}

int rectifyNonDeterminism(char c){
    //return 0;

    char newNonTerm = nonTermGen();
```

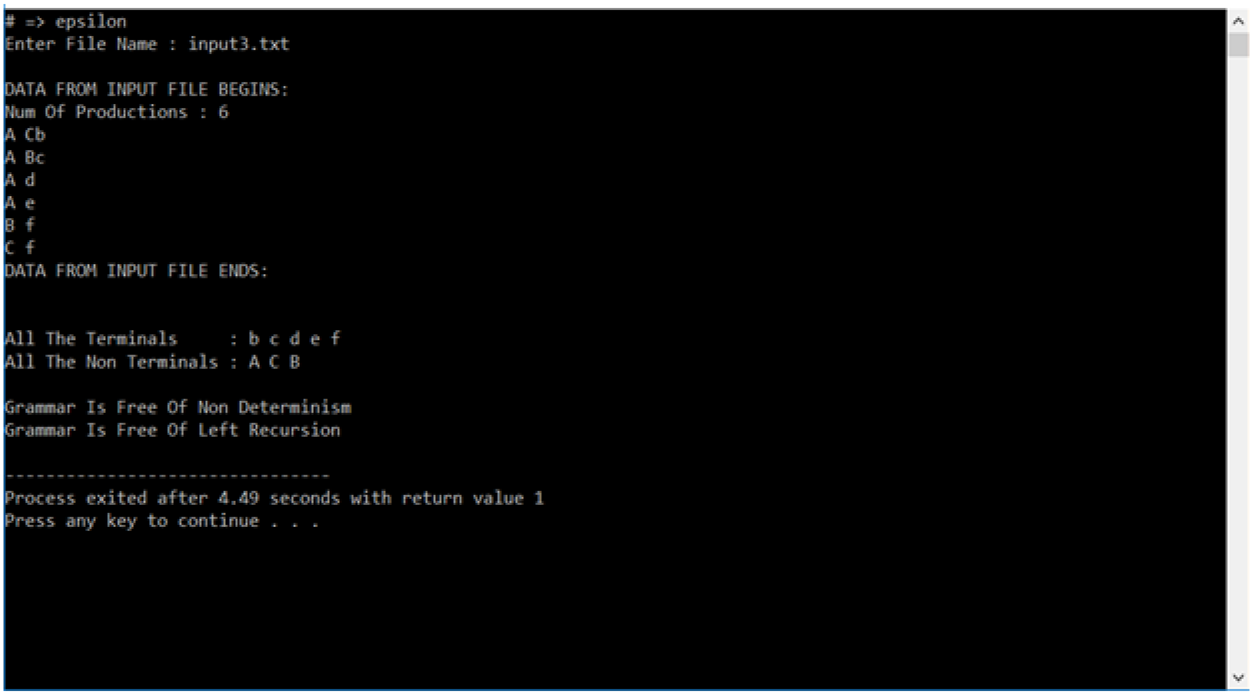
```
if(newNonTerm=='$'){
    cout<<"Ran Out Of Non Terminals To Assign. Too Many Non Deterministic Entries.";
    exit;
}

vector<string> tempProductions;
for(int j=0;j<productions.size();j++){
    string tempString = productions[j];
    if(productions[j][0]==c){
        tempProductions.push_back(productions[j]);
    }
}
//cout<<"\nChar => "<<c;
for(int j=0;j<tempProductions.size();j++){
    string tempString = tempProductions[j];
    //cout<<"\n\tTempString => "<<tempString;
    int flag=0;
    for(int k=0;k<tempProductions.size();k++){
        //cout<<"\n\tTempProduction["<<k<<"] => "<<tempProductions[k];
        if(tempString==tempProductions[k]){
            //cout<<"\n Same";
            continue;
        }else{
            //cout<<"\n\t\tDiffer";
            if(tempString.length()>tempProductions[k].length()){
                for(int l=tempProductions[k].length();l>1;l--){
                    //cout<<"\n\t\tLooking For => "<<tempProductions[k].substr(1,l);
```

```
                                           size_t found =
tempString.find(tempProductions[k].substr(1,l));
            if(found!=string::npos){
              //Find the Element in tempString
              if(found==1){
                flag=1;
                //Element At The Beginning This is the case We're interested in
                //cout<<"\n\t ND 1 Found => "<<tempProductions[k].substr(1,l)<<"\t l = "<<l;
                if(!isInNonTerminal(newNonTerm)){
                  nonTerminals.push_back(newNonTerm);
                }

                string newProd1 = "";
                newProd1+=c;
                newProd1 += (" "+tempString.substr(1,l));
                newProd1 += newNonTerm;


                string newProd2 = "";
                newProd2+=newNonTerm;
                newProd2 += (" "+tempString.substr(l+1));
                if(!exists(newProd1)){
                  //cout<<"\n\t\tnewProd1 => "<<newProd1;
                  deterministicProductions.push_back(newProd1);
                }
                if(!exists(newProd2)){
                  //cout<<"\n\t\tnewProd2 => "<<newProd2;
                  deterministicProductions.push_back(newProd2);
                }
            }
        }
    }
}else{
    for(int l=tempString.length();l>1;l--){
        size_t found = tempProductions[k].find(tempString.substr(1,l));
        //cout<<"\n\t\tLooking For => "<<tempProductions[k].substr(1,l);
        if(found!=string::npos){

            //Find the Element in tempProduction
            if(found==1){
                flag=1;
                //Element At The Beginning This is the case We're interested in
                //cout<<"\n ND 2 Found => "<<tempString.substr(1,l)<<"\t l = "<<l;
                if(!isInNonTerminal(newNonTerm)){
                    nonTerminals.push_back(newNonTerm);
                }
                string newProd1 = "";
                newProd1+=c;
                newProd1 += tempString.substr(1,l);
                newProd1 += newNonTerm;
                //cout<<"\n\tnewProd1 => "<<newProd1;
                string newProd2 = "";
                newProd2+=newNonTerm;
                newProd2 += (" "+tempString.substr(l+1));
                //cout<<"\n\tnewProd2 => "<<newProd2;
                if(!exists(newProd1)){
```

```
                                    //cout<<"\n\t\tnewProd1 => "<<newProd1;
                                    deterministicProductions.push_back(newProd1);
                                }
                                if(!exists(newProd2)){
                                    //cout<<"\n\t\tnewProd2 => "<<newProd2;
                                    deterministicProductions.push_back(newProd2);
                                }
                            }
                        }
                    }
                }
            }
        }
        if(flag==0){
            if(!exists(tempString)){
                deterministicProductions.push_back(tempString);
            }
        }
    }
    return 1;
}

int printNDGrammar(){
    cout<<"\nFINAL NON DETERMINISTIC FREE GRAMMAR IS : "<<endl;
    //return 1;
    for(int i=0;i<productions.size();i++){
        cout<<productions[i]<<endl;
    }
    return 1;
}


int main(){
    //Check For:
    //Unambiguous   -- undecidable
    //Left Recursion
    //Non Determinism


            cout<<"# => epsilon"<<endl;


    //Read All The Productions
    readProductions();
    int flag=0;


    //NON DETERMINISM CHECK BEGINS
    for(int i=0;i<nonTerminals.size();i++){
        if(isNonDeterministic(nonTerminals[i])){
            //cout<<"\nInside ND\n";
            rectifyNonDeterminism(nonTerminals[i]);
            clearProductions(nonTerminals[i]);
            flag=1;
        }else{
            //cout<<"\nInside Dete\n ";
            for(int j=0;j< productions.size();j++){
                if(productions[j][0]==nonTerminals[i]){
                    deterministicProductions.push_back(productions[j]);
                }
```

```
      }
   }
}
if(flag==0){
   cout<<"\nGrammar Is Free Of Non Determinism";
}else{
   productions = deterministicProductions;
   printNDGrammar();
}
//NON DETERMINISM CHECK ENDS

flag=0;

//LEFT RECURSION CHECK BEGINS
for(int i=0;i<nonTerminals.size();i++){
   if(isLeftRecursive(nonTerminals[i])){
      //Left Recursion Found
      //cout<<"Grammar Has Left Recursion In Production Of : "<<nonTerminals[i]<<endl;
      rectifyLeftRecursion(nonTerminals[i]);
      clearProductions(nonTerminals[i]);
      flag=1;
   }
}
if(flag==0){
   cout<<"\nGrammar Is Free Of Left Recursion"<<endl;
}else{
  printFinalGrammar();
  productions = newProductions;
```

```
    }

    //LEFT RECURSION CHECK FINISH

    flag=0;

    return 1;

}
```



```
# => epsilon
Enter File Name : input3.txt

DATA FROM INPUT FILE BEGINS:
Num Of Productions : 6
A Cb
A Bc
A d
A e
B f
C f
DATA FROM INPUT FILE ENDS:


All The Terminals     : b c d e f
All The Non Terminals : A C B

Grammar Is Free Of Non Determinism
Grammar Is Free Of Left Recursion

--------------------------------
Process exited after 4.49 seconds with return value 1
Press any key to continue . . .
```