EXPERIMENT-1

AIM: Practice of LEX/YACC of compiler writing.

THEORY: Lex is a tool or a computer program that generates Lexical Analyzers (converts the stream of characters into tokens). The Lex tool itself is a compiler. The Lex compiler takes the input and transforms that input into input patterns. It is commonly used with YACC(Yet Another Compiler Compiler). It was written by Mike Lesk and Eric Schmidt. Below is a basic structure of a Lex program:

```
%{

// Header section for including libraries and declarations

#include <stdio.h>

%}

// Definitions section for defining macros and regular expressions

DIGIT [0-9]

%}

// Rules section for defining patterns and corresponding actions

{DIGIT}+      { printf("Number: %s\n", yytext); }

[a-zA-Z]+    { printf("Identifier: %s\n", yytext); }

[ \t\n]       ;    // Ignore whitespace characters

{ printf("Unknown character: %s\n", yytext); }

%%

// User code section for additional C code

int main() {

      // Code to initialize the lexer and call yylex() to start parsing

      yylex();

      return 0;

}
```

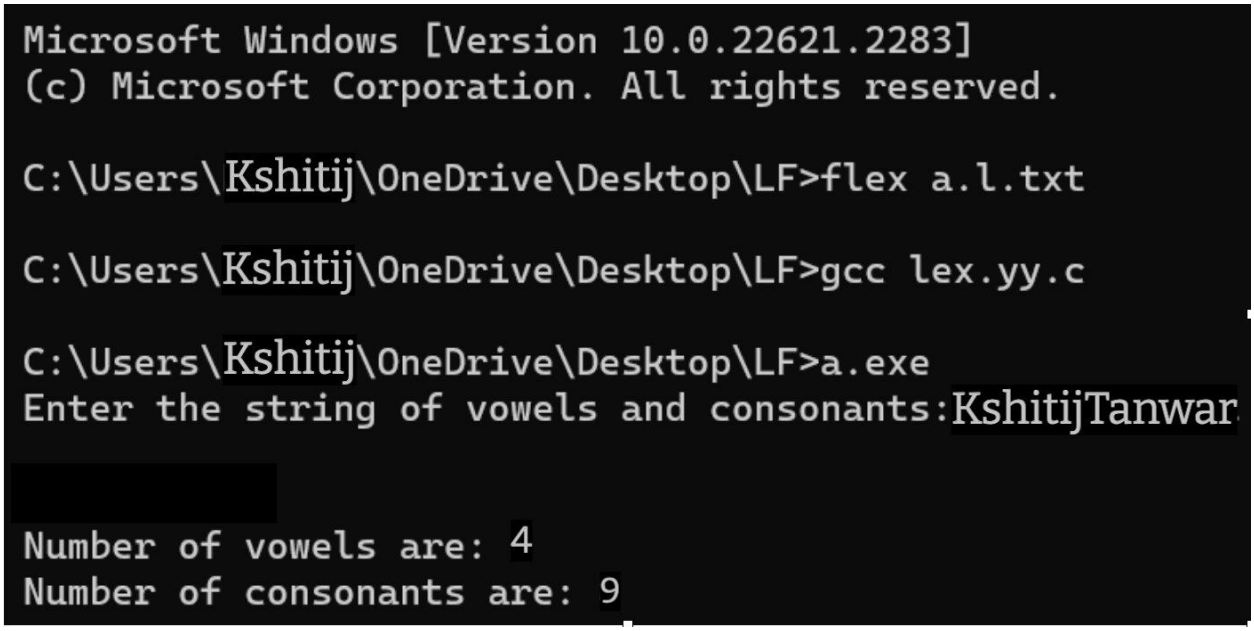
YACC (for "yet another compiler compiler.") is the standard parser generator for the Unix operating system. An open-source program, Yacc generates code for the parser in the O programming language. The acronym is usually rendered in lowercase but is occasionally seen as YACC or Yacc.

SOURCE CODE:

1) LEX Program to count number of vowels and consonants

```
%{
        int vow_count=0;
        int const_count =0;
%}

%%
[aeiouAEIOU] {vow_count++;}
[a-zA-Z] {const_count++;}
%%
int yywrap(){}
int main()
{
        printf("Enter the string of vowels and consonants:");
        yylex();
        printf("Number of vowels are: %d\n", vow_count);
        printf("Number of consonants are: %d\n", const_count);
        return 0;
}
```

OUTPUT:



2) YACC Program to implement a Calculator and recognize a valid Arithmetic Expression

LEXICAL ANALYZER SOURCE CODE

```
%{
/* Definition section */
#include<stdio.h>
#include "y.tab.h"
extern int yylval;
%}
/* Rule Section */
%%
[0-9]+ {
        yylval=atoi(yytext);
        return NUMBER;
      }
```

```
[\t] ;

[\n] return 0;

. return yytext[0];

%%

int yywrap() {

return 1;

}
```

PARSER SOURCE CODE

```
%{

/* Definition section */

#include<stdio.h>

int flag=0;

%}

%token NUMBER

%left '+' '-'

%left '*' '/' '%'

%left '(' ')'

/* Rule Section */

%%

ArithmeticExpression: E{

                        printf("\nResult=%d\n", $$);

                        return 0;

                        };

E:E'+'E {$$=$1+$3;}
```

```
|E'-'E {$$=$1-$3;}

|E'*'E {$$=$1*$3;}

|E'/'E {$$=$1/$3;}

|E'%'E {$$=$1%$3;}

|'('E')' {$$=$2;}

| NUMBER {$$=$1;}

;

%%

//driver code

void main() {

printf("\nEnter Any Arithmetic Expression which can have operations Addition, Subtraction, Multiplication, Division, Modulus and Round brackets:\n");

yyparse();

if(flag==0)

printf("\nEntered arithmetic expression is Valid\n\n");

}

void yyerror() {

printf("\nEntered arithmetic expression is Invalid\n\n");

flag=1;

}
```

OUTPUT:

```
C:\Users\Kshitij\OneDrive\Desktop\LF\yacc>a.exe
Enter Any Arithmetic Expression which can have operations Addition, Subtraction, Multiplication, Divison, Modulus and Round brackets:
10-5
Result=5
Entered arithmetic expression is Valid

C:\Users\Kshitij\OneDrive\Desktop\LF\yacc>a.exe
Enter Any Arithmetic Expression which can have operations Addition, Subtraction, Multiplication, Divison, Modulus and Round brackets:
10+5-
Entered arithmetic expression is Invalid

C:\Users\Kshitij\OneDrive\Desktop\LF\yacc>a.exe
Enter Any Arithmetic Expression which can have operations Addition, Subtraction, Multiplication, Divison, Modulus and Round brackets:
10/5
Result=2
Entered arithmetic expression is Valid
```

```
C:\Users\Kshitij\OneDrive\Desktop\LF\yacc>a.exe
Enter Any Arithmetic Expression which can have operations Addition, Subtraction, Multiplication, Divison, Modulus and Round brackets:
(2+5)*3
Result=21
Entered arithmetic expression is Valid

C:\Users\Kshitij\OneDrive\Desktop\LF\yacc>a.exe
Enter Any Arithmetic Expression which can have operations Addition, Subtraction, Multiplication, Divison, Modulus and Round brackets:
12%5
Result=2
Entered arithmetic expression is Valid
```

EXPERIMENT -2

AIM: Write a program to check whether a string belong to the grammar or not.

Theory: Context Free Grammar is a formal grammar; the syntax structure of a formal language can be described using context-free grammar (CFG) a type of formal grammar. The grammar has 4 tuples: (V, T, P, S).

V - It is the collection of variables or nonterminal symbols.

T - It is a set of terminals.

P - It Is the production rule that consists of both terminals and non-terminals.

S – It is the starting symbol.

A grammar is said to be Context-free grammar if every production is in the form of:

$$G \rightarrow (V \cup T)^* \text{ , where } G \in V$$

And the left-hand side of G here in the example can only be a variable. It cannot be a terminal

But on the right-hand side it can be a variable or terminal, or both combination of variable and terminal.

In the CFG, the production rules (P) are the driving force behind the language generation process. Each rule has the form A -> β, where A is a non-terminal symbol and β is a string comprising terminals and/or non-terminals. Notably, every production adheres to the structure G -> (V U T)*, where G belongs to V. This structure signifies that while the left-hand side of a production must be a variable, the right-hand side can encompass a combination of variables and terminals or even be purely terminals. This flexibility grants CFGs the expressive power required to articulate diverse syntactic structures.

Derivations in a CFG involve applying production rules iteratively, transforming the start symbol into a string of terminals, known as a sentential form.

SOURCE CODE:

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

int length(string str){
    int i=0;
    while (str[i])
        i++;
    return i;}
```

```
void first(){
	char str[100];
	cout<<"\nThe grammar is as follows --> \nS -> aS\nS -> Sb\nS -> ab\n";
	cout<<"Enter a string --> ";
	cin>>str;
	if(str[0]!='a'){
		cout<<"String is invalid because of incorrect first character!!";
		exit(0);
	}
	int n=1;
	while(str[n]=='a')
		n++;
	if ( str[n] != 'b'){
		cout<<"String does not belong to grammar!!";
		exit(0);
	}
	n++;
	while (str[n]=='b')
		n++;
	if (str[n] != '\0'){
		cout<<"String does not belong to grammar!!";
		exit(0);
	}
	cout<<"String is Valid!!";
}

void second(){
	char str[100];
	cout<<"\nThe grammar is as follows --> \nS -> aSa\nS -> bSb\nS -> a\nS -> b\n";
	cout<<"Enter a string --> ";
	cin>>str;
	if(str[0]!='a'&& str[0]!='b'){
		cout<<"String is invalid because of incorrect first character!!";
		exit(0);
	}
	if(length(str)%2 ==0){
		cout<<"String is invalid because of Even Length!!";
		exit(0);
	}
	int i = 0;
	int j = length(str)-1;
```

```
    while(i<length(str) && j>=0){
        if(str[i] != str[j])
            cout<<"String is Invalid!!";
            i++;
            j--;
    }
    cout<<"String belongs to the Grammar!!";
}

void third(){
    char str[100];
    cout<<"\nThe grammar is as follows --> \nS -> aSbb\nS -> abb\n";
    cout<<"Enter a string --> ";
    cin>>str;
    if(str[0]!='a'){
        cout<<"String is invalid because of incorrect first character!!";
        exit(0);
    }
    int n=1;
    int c=1;
    while(str[n]=='a'){
        n++;
        c++;
    }
    int j = 1;
    if (str[n] != 'b'){
        cout<<"String does not belong to grammar!!";
    exit(0);
    }
    n++;
    while (str[n]=='b'){
        n++;
        j++;
    }
    if (2*c!=j || str[n] != '\0'){
        cout<<"String does not belong to grammar!!";
        exit(0);
    }
    cout<<"String is Valid!!";
}
```

```
void fourth(){
	char str[100];
	cout<<"\nThe grammar is as follows --> \nS -> aSb\nS -> ab\n";
	cout<<"Enter a string --> ";
	cin>>str;
	if(str[0]!='a'){
		cout<<"String is invalid because of incorrect first character!!";
		exit(0);
	}
	int n=1;
	int c=1;
	while(str[n]=='a'){
		n++;
		c++;
	}
	int j = 1;
	if (str[n] != 'b'){
		cout<<"String does not belong to grammar!!";
		exit(0);
	}
	n++;
	while (str[n]=='b'){
		n++;
		j++;
	}
	if (c!=j || str[n]!='\0'){
		cout<<"String does not belong to grammar!!";
		exit(0);
	}
	cout<<"String is Valid!!";
}

int main()
{
	int a;
	cout<<"1 --> \nS -> aS\nS -> Sb\nS -> ab\nString is of the form - aab\n\n";
	cout<<"2 --> \nS -> aSa\nS -> bSb\nS -> a\nS -> b\nThe Language generated is - All Odd Length
Palindromes\n\n";
	cout<<"3 --> \nS -> aSbb\nS -> abb\nThe Language generated is - anb2n , where n>1\n\n";
	cout<<"4 --> \nS -> aSb\nS -> ab\nThe Language generated is - anbn where n>0\n\n";
	cout<<"5 --> Exit!!\n\n";
```

```
    do
    {
        cout<<"Choose one input --> ";
        cin>>a;
        switch(a)
        {
            case 1:
            {
                first();
                break;
            }
            case 2:
            {
                second();
                break;
            }
            case 3:
            {
                third();
                break;
            }
            case 4:
            {
                fourth();
                break;
            }
            default:
                cout<<"Wrong Input !!";
        }
    }
    while (a!=5);
    return 0;
}
```

OUTPUT:

```
1 -->
S -> aS
S -> Sb
S -> ab
String is of the form - aab

2 -->
S -> aSa
S -> bSb
S -> a
S -> b
The Language generated is - All Odd Length Palindromes

3 -->
S -> aSbb
S -> abb
The Language generated is - anb2n , where n>1

4 -->
S -> aSb
S -> ab
The Language generated is - anbn where n>0

5 --> Exit!!

Choose one input --> 1

The grammar is as follows -->
S -> aS
S -> Sb
S -> ab
```

```
Enter a string --> aabbb
String is Valid!!
Choose one input --> 2

The grammar is as follows -->
S -> aSa
S -> bSb
S -> a
S -> b
Enter a string --> abbba
String belongs to the Grammar!!
Choose one input --> 3

The grammar is as follows -->
S -> aSbb
S -> abb
Enter a string --> aabbbb
String is Valid!!
Choose one input --> 4

The grammar is as follows -->
S -> aSb
S -> ab
Enter a string --> aabb
String is Valid!!
Choose one input --> 5
Wrong Input !!
--------------------------------
Process exited after 39.94 seconds with return value 0
Press any key to continue . . .
```

EXPERIMENT-3

AIM: Write a program to check whether a string includes a keyword or not.

THEORY: Keywords(also known as reserved words) have special meanings to the C++ compiler and are always written or typed in short(lower) cases. Keywords are words that the language uses for a special purpose, such as void, int, public, etc. It can't be used for a variable name or function name or any other identifiers.
A list of 32 Keywords in C++ Language which are also available in C language are given below.

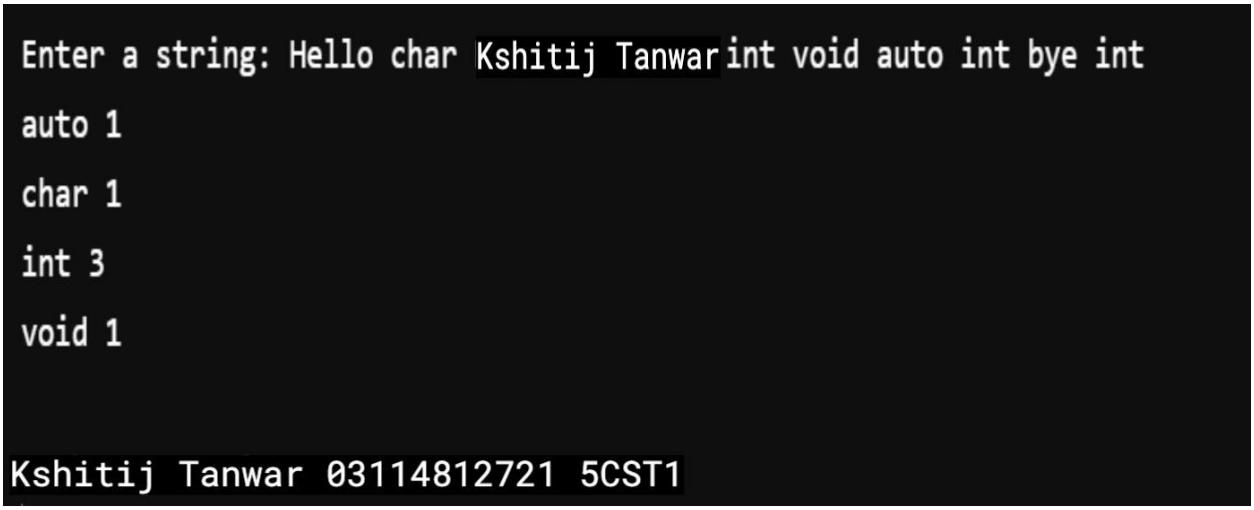
auto	break	case	char	const	continue	default	do
double	else	enum	extern	float	for	goto	if
int	long	register	return	short	signed	sizeof	static
struct	switch	typeof	union	unsigned	void	volatile	while

SOURCE CODE:

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

void simple_tokenizer(string s){
	stringstream ss(s);
	string word;
	map<string,int> m;
	string key[32] =
{"auto","break","case","char","const","continue","default","do","double","else","enum","extern","float","
for","goto","if","int","long","register","return","short","signed","sizeof","static","struct","switch","typede
f","union","unsigned","void","volatile","while"};

	while(ss >> word){
		for(int i=0;i<32;i++){
			if(key[i] == word){
				m[word]++;
			}
		}
	}

	if(!m.empty()){
		for(auto it:m){
```

```
                cout << it.first << " " << it.second << endl;
            }
        }
        else cout << "No keyword present" << endl;
}

int main(){
        string str;
    cout << "Enter a string: ";
    getline(cin,str);

    simple_tokenizer(str);
        cout << endl;

        cout<< "Vedant Nagar 03614812721 5CST1" << endl;
    return 0;
}
```

OUTPUT:



EXPERIMENT-4

AIM: Write a program to remove left recursion from the grammar

THEORY:

Left Recursion:

In the context of formal grammars and parsing, left recursion is a situation where a non-terminal A directly produces a string that starts with itself. It's a common issue in recursive descent parsers because it can lead to an infinite loop when trying to expand the non-terminal. Consider a production rule like this:

$A \rightarrow A\alpha \mid \beta$

Here, A is left recursive because it can produce a string that starts with itself ($A\alpha$). Left recursion can create ambiguity in the parsing process, making it challenging for parsers to correctly identify the structure of the input.

Elimination of Left Recursion

Left Recursion - The generation is left-recursive if the leftmost symbol on the right side is equivalent to the nonterminal on the left side. For Ex: exp → exp + term.

A grammar that contains a production having left recursion is called a Left-Recursive Grammar. Similarly, if the rightmost symbol on the right side is equal to the left side is called Right-Recursion.

Why to Eliminate Left Recursion?

Consider an example: E -> E+T/T,

The above example will go in an infinite loop because the function E keeps calling itself which causes a problem for a parser to go in an infinite loop which is a never ending process so to avoid this infinite loop problem we do Elimination of left recursion. Rules to follow to eliminate left recursion

A-->bA'

A'--> # / aA' //# stands for epsilon

Therefore, solution for above left recursion problem,

E --> TE'
E'--> eps/+TE'

SOURCE CODE:

```
#include<bits/stdc++.h>
using namespace std;
int main(){
	string ip,op1,op2,temp;
	int sizes[10] = {};
	char c;
	int n,j,l;
	cout<<"Enter the Parent Non-Terminal --> ";
	cin>>c;
	ip.push_back(c);
	op1 += ip + "\'->";
	ip += "->";
	op2+=ip;
	cout<<"Enter the Number of Productions --> ";
	cin>>n;
	for(int i=0;i<n;i++){
		cout<<"Enter Production "<<i+1<<" -> ";
		cin>>temp;
		sizes[i] = temp.size();
		ip+=temp;
		if(i!=n-1)
			ip += "|";
	}
	cout<<"Production Rule -> "<<ip<<endl;
	for(int i=0,k=3;i<n;i++){
```

```
        if(ip[0] == ip[k]){
                cout<<"Production "<<i+1<<" has left recursion."<<endl;
                if(ip[k] != '#'){
                  for(l=k+1;l<k+sizes[i];l++)
                                op1.push_back(ip[l]);
                  k=l+1;
                  op1.push_back(ip[0]);
                  op1 += "\'|";
                }
        } else{
                cout<<"Production "<<i+1<<" does not have left recursion."<<endl;
                if(ip[k] != '#'){
                  for(j=k;j<k+sizes[i];j++)
                                op2.push_back(ip[j]);
                  k=j+1;
                  op2.push_back(ip[0]);
                  op2 += "\'|";
                }    else{
                  op2.push_back(ip[0]);
                  op2 += "\'";
                }
        }
}
op1 += "#";
cout<<op2<<endl<<op1<<endl;
return 0;}
```

OUTPUT:

```
Enter the Parent Non-Terminal --> E
Enter the Number of Productions --> 2
Enter Production 1 -> E+T
Enter Production 2 -> T
Production Rule -> E->E+T|T
Production 1 has left recursion.
Production 2 does not have left recursion.
E->TE'|
E'->+TE'|#
```

```
Enter the Parent Non-Terminal --> T
Enter the Number of Productions --> 2
Enter Production 1 -> T*F
Enter Production 2 -> F
Production Rule -> T->T*F|F
Production 1 has left recursion.
Production 2 does not have left recursion.
T->FT'|
T'->*FT'|#
```

```
Enter the Parent Non-Terminal --> F
Enter the Number of Productions --> 2
Enter Production 1 -> (E)
Enter Production 2 -> id
Production Rule -> F->(E)|id
Production 1 does not have left recursion.
Production 2 does not have left recursion.
F->(E)F'|idF'|
F'->#
```

EXPERIMENT-5

AIM: Write a program to perform Left Factoring on a Grammar

THEORY:

What is Left Factoring

Left factoring is a grammar transformation that produces a grammar more suitable for predictive or top-down praising. If more than one grammar production rules has a standard prefix string, then the top-down parser cannot choose which of the productions it should take to parse the string in hand.

The process by which the grammar with a common prefix is transformed to make it worthwhile for top-down parsers is known as left factoring.

How to do Left Factoring

Left Factoring transforms the grammar to make it useful for top-down parsers. In this technique, we make one production for each common prefix, and the rest of the derivation is added by new productions.

$$A \rightarrow \alpha\beta_1 \mid \alpha\beta_2$$

Rewrite the given expression without changing the meaning,

$$A \rightarrow \alpha X$$

$$X \rightarrow \beta_1 \mid \beta_2$$

Removing Left Factoring:

Here are the general steps to remove left factoring from a grammar:

Identify Common Prefix:
Identify the common prefix among the alternatives in the production rule.

Create New Non-terminal:
Introduce a new non-terminal to represent the common prefix.

Rewrite Productions:
Modify the production rules to use the new non-terminal. Split the alternatives into two groups: one with the common prefix and another with the remaining unique parts.

For example, if you have a left-factored rule like $A \rightarrow \alpha\beta1 \mid \alpha\beta2 \mid \alpha\beta3$ you can rewrite it as:

A -> α A'
A' -> β1 | β2 | β3

Update References:
Replace references to the original non-terminal in other production rules with references to the new non-terminal.

Here's an example for better clarification:

Original grammar: A → αβ1 | αβ2 | αβ3
Modified grammar:
A -> α A'
A' -> β1 | β2 | β3

This modification removes left factoring by factoring out the common prefix
α into a new non-terminal A'

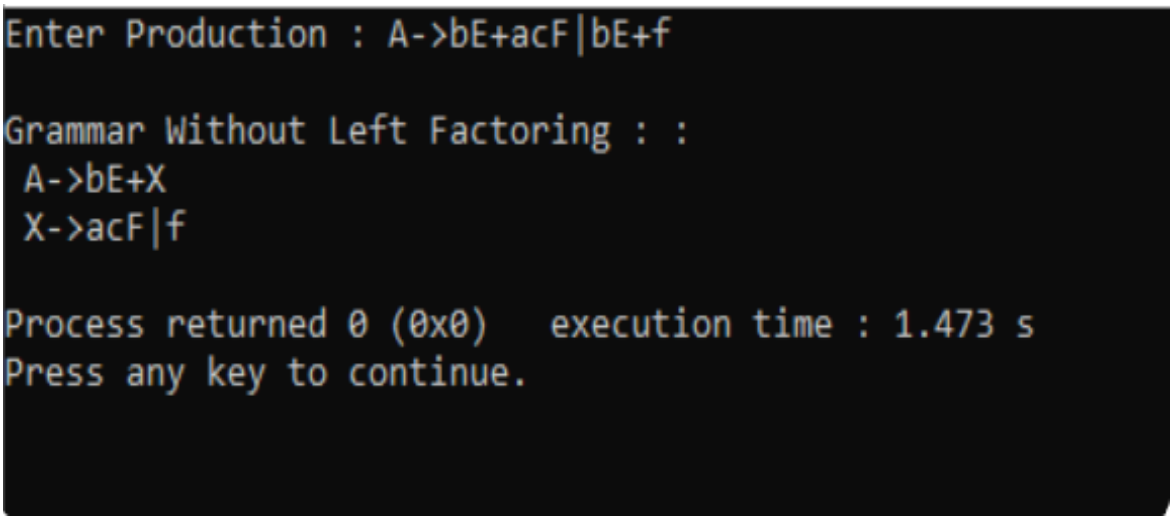
Left factoring is crucial for simplifying grammars, making them more suitable for parsing, and reducing the potential for ambiguity.

SOURCE CODE:

```
#include<stdio.h>
#include<string.h>

int main(){
    char gram[20],part1[20],part2[20],modifiedGram[20],newGram[20],tempGram[20];

    int i,j=0,k=0,l=0,pos;

    printf("Enter Production : A->");

    gets(gram);

    for(i=0;gram[i]!='|';i++,j++)

        part1[j]=gram[i];

    part1[j]='\0';

    for(j=++i,i=0;gram[j]!='\0';j++,i++)

        part2[i]=gram[j];

    part2[i]='\0';

    for(i=0;i<strlen(part1)||i<strlen(part2);i++){
```

```
        if(part1[i]==part2[i]){

            modifiedGram[k]=part1[i];

            k++;
            pos=i+1;

        }
    }

    for(i=pos,j=0;part1[i]!='\0';i++,j++){

        newGram[j]=part1[i];

    }
    newGram[j++]='|';

    for(i=pos;part2[i]!='\0';i++,j++){

        newGram[j]=part2[i];

    }
    modifiedGram[k]='X';

    modifiedGram[++k]='\0';

    newGram[j]='\0';

    printf("\nGrammar Without Left Factoring : : \n");
    printf(" A->%s",modifiedGram);

    printf("\n X->%s\n",newGram);

}
```

OUTPUT:



EXPERIMENT-6

AIM: Write a program to show all the operations of a stack.

THEORY:

What is a Stack?

The Last-In-First-Out (LIFO) concept is used by Stacks, a type of linear data structure. The Queue has two endpoints, but the Stack only has one (front and rear). It only has one pointer, top pointer, which points to the stack's topmost member. When an element is added to the stack, it is always added to the top, and it can only be removed from the stack. To put it another way, a stack is a container that allows insertion and deletion from the end known as the stack's top.

LIFO (Last in First out) Method

According to this method, the piece that was added last will appear first. As an actual illustration, consider a stack of dishes stacked on top of one another. We may claim that the plate we put last comes out first because the plate we put last is on top and we take the plate at the top.

Due to the possibility of understating inventory value, LIFO is not a reliable indicator of ending inventory value. Due to increasing COGS, LIFO leads to reduced net income (and taxes). However, under LIFO during inflation, there are fewer inventory write-downs. Results from average cost are in the middle of FIFO and LIFO.

Operations on Stack

- push() to insert an element into the stack
- pop() to remove an element from the stack
- top() Returns the top element of the stack.
- isEmpty() returns true if stack is empty else false.
- size() returns the size of stack.

SOURCE CODE:

```
#include <stdio.h>
#include <stdlib.h>
#define SIZE 4

int top = -1, inp_array[SIZE];
void push();
void pop();
```

```
void show();

int main()
{
	int choice;
	while (1)
	{
		printf("\nPerform operations on the stack:");
		printf("\n1.Push the element\n2.Pop the element\n3.Show\n4.End");
		printf("\n\nEnter the choice: ");
		scanf("%d", &choice);

		switch (choice)
		{
		case 1:
			push();
			break;
		case 2:
			pop();
			break;
		case 3:
			show();
			break;
		case 4:
			exit(0);

		default:
			printf("\nInvalid choice!!");
		}
	}
}
void push()
{
	int x;

	if (top == SIZE - 1)
	{
		printf("\nOverflow!!");
	}
```

```
    else
    {
        printf("\nEnter the element to be added onto the stack: ");
        scanf("%d", &x);
        top = top + 1;
        inp_array[top] = x;
    }
}

void pop()
{
    if (top == -1)
    {
        printf("\nUnderflow!!");
    }
    else
    {
        printf("\nPopped element: %d", inp_array[top]);
        top = top - 1;
    }
}

void show()
{
    if (top == -1)
    {
        printf("\nUnderflow!!");
    }
    else
    {
        printf("\nElements present in the stack: \n");
        for (int i = top; i >= 0; --i)
            printf("%d\n", inp_array[i]);
    }
}
```

OUTPUT:

```
Enter the size of STACK[MAX=100]:10

         STACK OPERATIONS USING ARRAY
        --------------------------------
         1.PUSH
         2.POP
         3.DISPLAY
         4.EXIT
 Enter the Choice:1
 Enter a value to be pushed:12

 Enter the Choice:1
 Enter a value to be pushed:24

 Enter the Choice:1
 Enter a value to be pushed:98

 Enter the Choice:3

 The elements in STACK

98
24
12
 Press Next Choice
 Enter the Choice:2

         The popped elements is 98
 Enter the Choice:3

 The elements in STACK

24
12
 Press Next Choice
 Enter the Choice:4

         EXIT POINT
```

EXPERIMENT-7

AIM: Write a program to find out the leading of the non-terminals in a grammar.

THEORY:

Grammar:

A grammar is a set of rules that defines the structure of a language. It consists of terminals (symbols that appear in the final output) and non-terminals (symbols that represent groups of terminals).

Production Rule:

A production rule in a grammar defines how a non-terminal can be replaced by a sequence of terminals and/or non-terminals.

Leading Set:

The leading set of a non-terminal in a grammar is the set of terminals that can appear as the first symbol in the strings derivable from that non-terminal. It helps in predicting which production rule to choose when parsing.

How to Find Leading Set:

Initialize:

For each non-terminal, initialize its leading set as an empty set.

Terminals in First:

For each production rule of a non-terminal, find the first set of the symbols in that rule.
If a terminal is in the first set, add it to the leading set of the non-terminal.

Consider Empty Productions:

If a non-terminal can derive an empty string (ε), include the leading set of the right-hand side non-terminals in the leading set of the left-hand side non-terminal.

Repeat Until No Changes:

Repeat steps 2 and 3 until no changes are made to any leading set. This ensures that the leading sets are fully computed.

Example:

Consider the following grammar:

1. S → Ab | Bc
2. A → a | ε
3. B → b | ε

Steps:
Initialize leading sets:

Leading(S) = {}
Leading(A) = {}
Leading(B) = {}

Terminals in First:

For production 1, S → Ab, First(A) = {a}, so add 'a' to Leading(S).
For production 1, S → Bc, First(B) = {b}, so add 'b' to Leading(S).
For production 2, A → a, add 'a' to Leading(A).
For production 2, A → ε, add ε to Leading(A).
For production 3, B → b, add 'b' to Leading(B).
For production 3, B → ε, add ε to Leading(B).

Consider Empty Productions:
For production 2, A → ε, add Leading(B) to Leading(A). So, add 'b' to Leading(A).

Repeat Until No Changes:
No changes are made.

Final Leading Sets:

Leading(S) = {a, b,c}
Leading(A) = {a, b,ε}
Leading(B) = {b,ε}

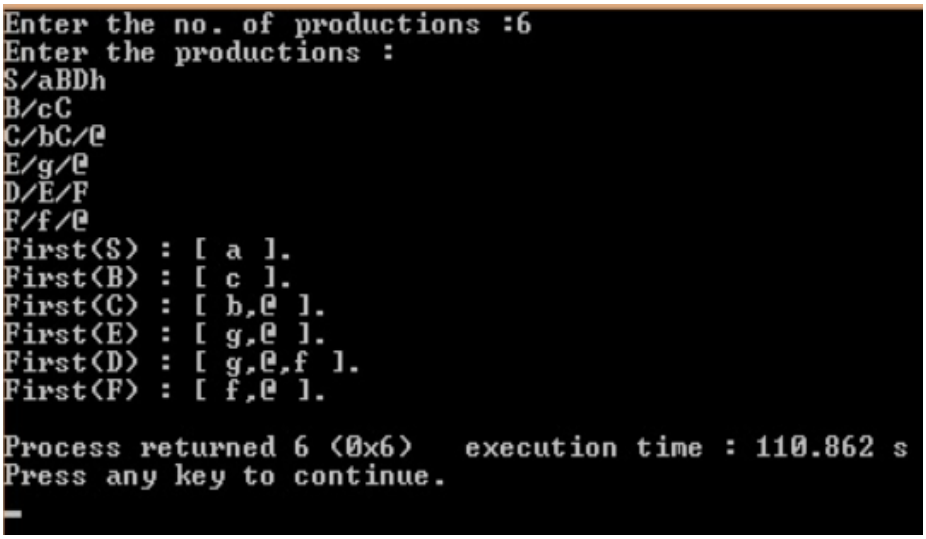
SOURCE CODE:

```
#include<stdio.h>
#include<conio.h>
char array[10][20],temp[10];
int c,n;
void fun(int,int[]);
int fun2(int i,int j,int p[],int );

void main()
{
  int p[2],i,j;
  printf("Enter the no. of productions :");
  scanf("%d",&n);
  printf("Enter the productions :\n");
  for(i=0;i<n;i++)
  scanf("%s",array[i]);
```

```
   for(i=0;i<n;i++)
   {
    c=-1,p[0]=-1,p[1]=-1;
    fun(i,p);
    printf("First(%c) : [ ",array[i][0]);
    for(j=0;j<=c;j++)
    printf("%c,",temp[j]);
    printf("\b ].\n");
    getch();
   }
}

int fun2(int i,int j,int p[],int key)
{
  int k;
  if(!key)
  {
    for(k=0;k<n;k++)
    if(array[i][j]==array[k][0])
    break;
    p[0]=i;p[1]=j+1;
    fun(k,p);
    return 0;
  }
  else
  {
    for(k=0;k<=c;k++)
    {
    if(array[i][j]==temp[k])
    break;
    }
    if(k>c)return 1;
    else return 0;
  }
}
 void fun(int i,int p[])
 {
 int j,k,key;
 for(j=2;array[i][j] != NULL; j++)
 {
 if(array[i][j-1]=='/')
 {
 if(array[i][j]>= 'A' && array[i][j]<='Z')
 {
 key=0;
 fun2(i,j,p,key);
 }
 else
 {
```

```
key = 1;
if(fun2(i,j,p,key))
temp[++c] = array[i][j];
if(array[i][j]== '@'&& p[0]!=-1) //taking '@' as null symbol
{
if(array[p[0]][p[1]]>='A' && array[p[0]][p[1]] <='Z')
{
key=0;
fun2(p[0],p[1],p,key);
}
else
if(array[p[0]][p[1]] != '/'&& array[p[0]][p[1]]!=NULL)
{
if(fun2(p[0],p[1],p,key))
temp[++c]=array[p[0]][p[1]];
}
}
```

OUTPUT:



EXPERIMENT-8

AIM: Write a program to Implement Shift Reduce parsing for a String.

THEORY:

Shift-reduce parsing is based on a bottom-up parsing technique, where the parser starts with the input tokens and aims to construct a parse tree by applying a set of grammar rules. The two main actions involved in shift-reduce parsing are "shift" and "reduce."

1. **Shift:** During the shift operation, the parser reads the next input token and pushes it onto a stack. The parser maintains a buffer to hold the remaining input tokens. The shift operation moves the parser's current position to the right in the input stream.

2. **Reduce:** The reduce operation applies a grammar rule to the tokens on top of the stack. If the tokens on the stack match the right-hand side of a grammar rule, they are replaced with the corresponding non-terminal symbol from the left-hand side of that rule. The reduce operation moves the parser's current position to the left in the input stream.

3. **Accept:** If the stack contains the start symbol only and the input buffer is empty at the same time then that action is called accept.

4. **Error:** A situation in which the parser cannot either shift or reduce the symbols, it cannot even perform accept action then it is called an error action.

Shift-reduce parsing continues until it reaches the end of the input stream and constructs a valid parse tree. It employs a parsing table, often generated using techniques like the LR(1) or LALR(1) parsing algorithm, to determine the shift or reduce action to take at each step.

SOURCE CODE:

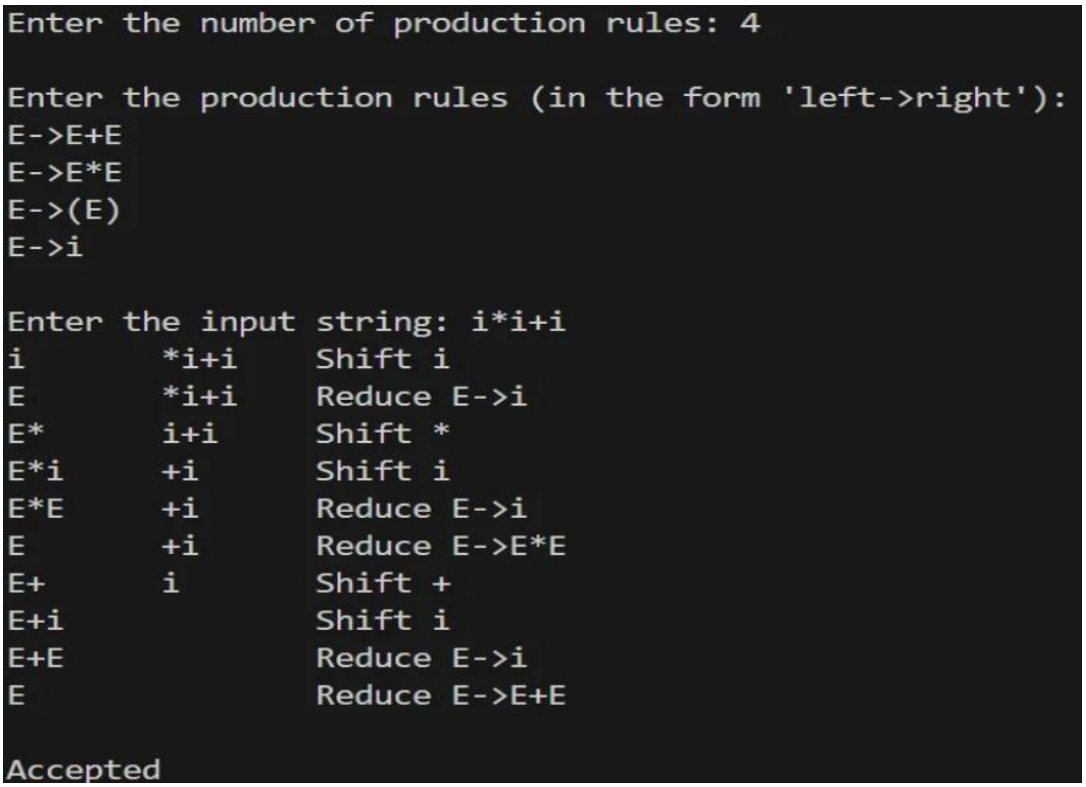
```
struct grammer{
   char p[20];
   char prod[20];
}g[10];

void main()
{
   int i,stpos,j,k,l,m,o,p,f,r;
   int np,tspos,cr;

   cout<<"\nEnter Number of productions:";
   cin>>np;
```

```
char sc,ts[10];

cout<<"\nEnter productions:\n";
for(i=0;i<np;i++)
{
   cin>>ts;
   strncpy(g[i].p,ts,1);
   strcpy(g[i].prod,&ts[3]);
}

char ip[10];

cout<<"\nEnter Input:";
cin>>ip;

int lip=strlen(ip);

char stack[10];

stpos=0;
i=0;

//moving input
sc=ip[i];
stack[stpos]=sc;
i++;stpos++;

cout<<"\n\nStack\tInput\tAction";
do
{
   r=1;
   while(r!=0)
   {
      cout<<"\n";
      for(p=0;p<stpos;p++)
      {
         cout<<stack[p];
      }
      cout<<"\t";
      for(p=i;p<lip;p++)
      {
         cout<<ip[p];
      }

      if(r==2)
      {
         cout<<"\tReduced";
      }
      else
```

```
    {
        cout<<"\tShifted";
    }
    r=0;

    //try reducing
    getch();
    for(k=0;k<stpos;k++)
    {
        f=0;

        for(l=0;l<10;l++)
        {
            ts[l]='\0';
        }

        tspos=0;
        for(l=k;l<stpos;l++) //removing first caharcter
        {
            ts[tspos]=stack[l];
            tspos++;
        }

        //now compare each possibility with production
        for(m=0;m<np;m++)
        {
            cr = strcmp(ts,g[m].prod);

            //if cr is zero then match is found
            if(cr==0)
            {
                for(l=k;l<10;l++) //removing matched part from stack
                {
                    stack[l]='\0';
                    stpos--;
                }

                stpos=k;

                //concatinate the string
                strcat(stack,g[m].p);
                stpos++;
                r=2;
            }
        }
    }
}

//moving input
```

```
    sc=ip[i];
    stack[stpos]=sc;
    i++;stpos++;

  }while(strlen(stack)!=1 && stpos!=lip);

  if(strlen(stack)==1)
  {
    cout<<"\n String Accepted";
  }

  getch();
}
```

OUTPUT:



EXPERIMENT-9

AIM: Write a program to find out the FIRST of the Non-terminals in a grammar.

THEORY:

Grammar:
A grammar is a set of rules that defines the structure of a language. It consists of terminals (symbols that appear in the final output) and non-terminals (symbols that represent groups of terminals).

Production Rule:
A production rule in a grammar defines how a non-terminal can be replaced by a sequence of terminals and/or non-terminals.

First Set:
The First set of a non-terminal in a grammar is the set of terminals that can appear as the first symbol in the strings derivable from that non-terminal. It is crucial for predictive parsing and constructing LL(1) parsing tables.

How to Find First Set:

Initialize:
For each non-terminal, initialize its First set as an empty set.

Terminals in First:
For each production rule of a non-terminal, find the first set of the symbols in that rule.
If a terminal is in the first set, add it to the First set of the non-terminal.

Consider Empty Productions:
If a non-terminal can derive an empty string (ε), include the first set of the right-hand side non-terminals in the first set of the left-hand side non-terminal.
Repeat this step until no new terminals are added.

Repeat Until No Changes:
Repeat steps 2 and 3 until no changes are made to any First set. This ensures that the First sets are fully computed.

Example:
Consider the following grammar:
1. S → AaB | Bc
2. A → Ab | ε
3. B → d | ε

Steps:
Initialize First sets:

First(S) = {}
First(A) = {}
First(B) = {}

Terminals in First:
For production 1, S → AaB, First(A) = {} (empty because A can derive ε), and First(B) = {d}. So, add 'd' to First(S).
For production 1, S → Bc, First(B) = {d}. So, add 'd' to First(S).
For production 2, A → Ab, First(A) = {} (empty because A can derive ε), and First(B) = {d}. So, add 'd' to First(A).
For production 2, A → ε, add ε to First(A).
For production 3, B → d, add 'd' to First(B).
For production 3, B → ε, add ε to First(B).

Consider Empty Productions:
For production 2, A → ε, add First(B) to First(A). So, add 'd' to First(A).
For production 3, B → ε, add ε to First(B).

Repeat Until No Changes:
No changes are made.

Final First Sets:
First(S) = {d}
First(A) = {d}
First(B) = {d, ε}

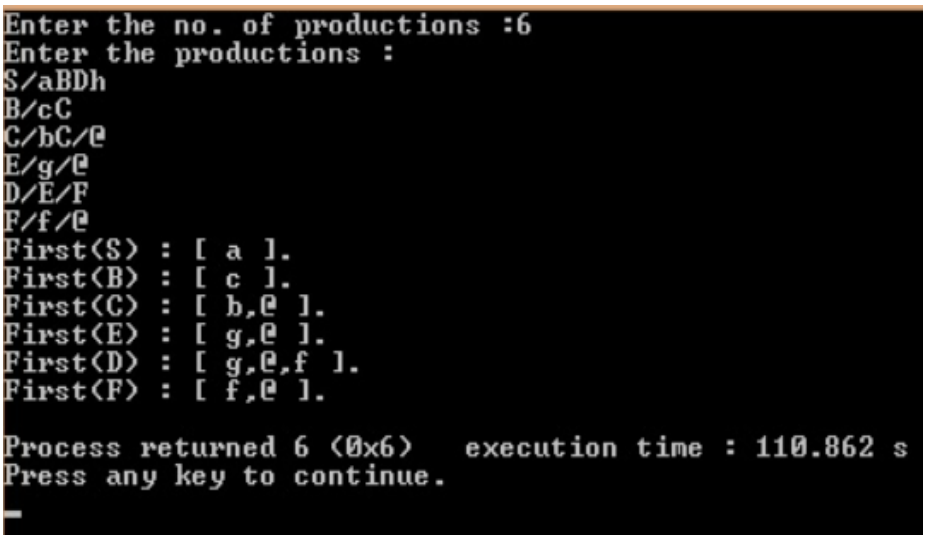
SOURCE CODE:

```
#include<stdio.h>
#include<conio.h>
char array[10][20],temp[10];
int c,n;
void fun(int,int[]);
int fun2(int i,int j,int p[],int );

void main()
{
   int p[2],i,j;
   printf("Enter the no. of productions :");
   scanf("%d",&n);
   printf("Enter the productions :\n");
```

```
   for(i=0;i<n;i++)
   scanf("%s",array[i]);
   for(i=0;i<n;i++)
   {
    c=-1,p[0]=-1,p[1]=-1;
    fun(i,p);
    printf("First(%c) : [ ",array[i][0]);
    for(j=0;j<=c;j++)
    printf("%c,",temp[j]);
    printf("\b ].\n");
    getch();
   }
}

int fun2(int i,int j,int p[],int key)
{
  int k;
  if(!key)
  {
    for(k=0;k<n;k++)
    if(array[i][j]==array[k][0])
    break;
    p[0]=i;p[1]=j+1;
    fun(k,p);
    return 0;
  }
  else
  {
    for(k=0;k<=c;k++)
    {
    if(array[i][j]==temp[k])
    break;
    }
    if(k>c)return 1;
    else return 0;
  }
}
 void fun(int i,int p[])
 {
 int j,k,key;
 for(j=2;array[i][j] != NULL; j++)
 {
 if(array[i][j-1]=='/')
 {
 if(array[i][j]>= 'A' && array[i][j]<='Z')
 {
 key=0;
 fun2(i,j,p,key);
 }
```

```
else
{
key = 1;
if(fun2(i,j,p,key))
temp[++c] = array[i][j];
if(array[i][j]== '@'&& p[0]!=-1) //taking '@' as null symbol
{
if(array[p[0]][p[1]]>='A' && array[p[0]][p[1]] <='Z')
{
key=0;
fun2(p[0],p[1],p,key);
}
else
if(array[p[0]][p[1]] != '/'&& array[p[0]][p[1]]!=NULL)
{
if(fun2(p[0],p[1],p,key))
temp[++c]=array[p[0]][p[1]];
}
}
```

OUTPUT:



EXPERIMENT-10

AIM: Write a program to check whether a grammar is operator precedent.

THEORY:

Operator precedence grammar is kinds of shift reduce parsing method. It is applied to a small class of operator grammars.

A grammar is said to be operator precedence grammar if it has two properties:

- No R.H.S. of any production has a∈.
- No two non-terminals are adjacent.

Operator precedence can only established between the terminals of the grammar. It ignores the non-terminal.

Precedence table:

	+	*	(	)	id	$
+	⋗	⋖	⋖	⋗	⋖	⋗
*	⋗	⋗	⋖	⋗	⋖	⋗
(	⋖	⋖	⋖	≐	⋖	X
)	⋗	⋗	X	⋗	X	⋗
id	⋗	⋗	X	⋗	X	⋗
$	⋖	⋖	⋖	X	⋖	X

Parsing Action

- Both end of the given input string, add the $ symbol.
- Now scan the input string from left right until the ⋗ is encountered.
- Scan towards left over all the equal precedence until the first left most ⋖ is encountered.
- Everything between left most ⋖ and right most ⋗ is a handle.
- $ on $ means parsing is successful.

SOURCE CODE:

```
#include <stdio.h>
#include <stdbool.h>

// Function to check whether the grammar is operator-precedent
bool isOperatorPrecedent(char grammar[][3], int numRules) {
```

```
    for (int i = 0; i < numRules - 1; i++) {
        // Check if the precedence of the current rule is greater than or equal to the next rule
        if (grammar[i][1] >= grammar[i + 1][1]) {
            return false;
        }
        // Check if the associativity of the current rule is the same as the next rule
        if (grammar[i][2] != grammar[i + 1][2]) {
            return false;
        }
    }
    return true;
}

int main() {
    // Maximum number of rules for simplicity
    int maxRules = 10;

    // Example grammar: {operator, precedence, associativity}
    char grammar[maxRules][3];

    printf("Enter the grammar rules in the format (operator precedence associativity), e.g., + 1
L:\n");

    int numRules;
    printf("Enter the number of rules: ");
    scanf("%d", &numRules);

    if (numRules > maxRules) {
        printf("Exceeded maximum number of rules. Exiting.\n");
        return 1;
    }

    for (int i = 0; i < numRules; i++) {
        printf("Enter rule %d: ", i + 1);
        scanf(" %c %d %c", &grammar[i][0], &grammar[i][1], &grammar[i][2]);
    }

    if (isOperatorPrecedent(grammar, numRules)) {
        printf("The grammar is operator-precedent.\n");
    } else {
        printf("The grammar is not operator-precedent.\n");
```

```
    }

    return 0;
}
```

OUTPUT:

```
Enter the number of rules: 4
Enter rule 1: + 1 L
Enter rule 2: * 2 L
Enter rule 3: - 1 L
Enter rule 4: / 2 L

The grammar is operator-precedent.
```