EXPERIMENT NUMBER – 1

AIM: To find the number of lines, words, characters in a given text.

DESCRIPTION: In this program, we try to find the number of lines, words and characters present in the given text file

ALGORITHM:
Step-1: Start
Step-2: Define a function count(fname):
    Step-2.1: num_line->0
    Step-2.2: num_words->0
    Step-2.3: num_char->0
    Step-2.4: with open(fname, ‘r’) as f:
        Step-2.4.1: for line in f:
            Step-2.4.1.1: num_line+=1
            Step-2.4.1.2: w=line.split()
            Step-2.4.1.3: num_words -> num_words+len(w)
            Step-2.4.1.4: for l in line:
                Step-2.4.1.4.1: for i in l: if (i!=” “): num_char +=1
    Step-2.5: Print num_line
    Step-2.6: Print num_words
    Step-2.7: Print num_char
Step-3: Read the file name from the user
Step-4: try:
    Count(fname)
Step-5: except:
    Print “File not Found”
Step-6: End

PROGRAM:
program1.py file:
```
def count(fname):
    num_line = 0
    num_words = 0
    num_char = 0
    with open(fname, 'r') as f:
        for line in f:
            num_line += 1
            w = line.split()
            num_words = num_words + len(w)
            for l in line:
                for i in l:
                    if (i != ' '):
                        num_char += 1
    print("Number of lines in text file: ", num_line)
    print("Number of words in text file: ", num_words)
```

```
    print('Number of characters in text file: ', num_char)

if __name__ == '__main__':
    fname = input("Enter the file name: ")
    try:
        count(fname)
    except:
        print('File not found')
```

demo.txt file:
Compiler Design Lab
Write a Program to find number of lines, words, characters in a text

OUTPUT:

```
==== RESTART: D:\Engineering\SEM-6\Compiler Design\Lab Work\Week-1\Prog1.py ====
Enter the file name: Demo.txt
Number of lines in text file:  2
Number of words in text file:  16
Number of characters in text file:  74
```

CONCLUSION:
By executing the above program, we have successfully found number of lines, words and characters in a given text file

EXPERIMENT NUMBER – 2

AIM: To display the number of tokens in a given file

DESCRIPTION: In this program, we try to display number of tokens and the type of token present in a given file

ALGORITHM:

```
Step-1: Start
Step-2: Define a function tokens(fname)
        Step-2.1: num_tokens->0
        Step-2.2: keywords = ['int', 'float', 'char', 'boolean', 'double', 'def', 'if', 'while', 'with']
        Step-2.3: operators = ['=', '+', '-', '==', '*', '/', '%', '!=', '**']
        Step-2.4: Special = [',', '(', ')', ';', ':', '[', ']', '&']
        Step-2.5: with open (fname, 'r') as f:
                Step-2.5.1: for line in f:
                        Step-2.5.1.1: w -> line.split()
                        Step-2.5.1.2: key->'N'
                        Step-2.5.1.3: num_token->num_token+len(w)
                        Step-2.5.1.4: for i in w:
                                Step-2.5.1.4.1: if ( i in Special):
                                        Print 'Special Characters'
                                        key='N'
                                Step-2.5.1.4.2: else if ( i in keywords):
                                        Print 'Keywords'
                                        key='N'
                                Step-2.5.1.4.3: else if ( i.isdigit()):
                                        Print 'Constant'
                                        key='N'
                                Step-2.5.1.4.4: else if ( i in operators):
                                        Print 'Operator'
                                        key='N'
                                Step-2.5.1.4.5: else:
                                        if (key=='Y'):
                                                Print "Identifier"
                                                key='N'
                                        else:
                                                Print "String"
        Step-2.6: Print num_token
Step-3: Read the file name from the user
Step-4: try:
        Count(fname)
Step-5: except:
        Print "File not Found"
Step-6: End
```

PROGRAM:
program2.py file:
```
def tokens(fname):
    num_token = 0
    keywords = ['int', 'float', 'char', 'boolean', 'double', 'def', 'if', 'while', 'with']
    operators = ['=', '+', '-', '==', '*', '/', '%', '!=', '**']
    Special = [',', '(', ')', ';', ':', '[', ']', '&']
    with open(fname,'r') as f:
        for line in f:
            w = line.split()
            key = 'N'
            num_token = num_token + len(w)
            for i in w:
                if (i in Special):
                    print(i, ": Special Character")
                    key = 'N'
                elif (i in keywords):
                    print(i, ": Keyword")
                    key = 'Y'
                elif (i.isdigit()):
                    print(i, ": Constant")
                    key = 'N'
                elif (i in operators):
                    print(i, ": Operator")
                    key = 'N'
                else:
                    if (key == 'Y'):
                        print(i, ": Identifier")
                        key = 'N'
                    else:
                        print(i,": String")
    print("Number of Tokens in text file: ", num_token)

if __name__ == '__main__':
    fname = input("Enter the file name: ")
    try:
        tokens(fname)
    except:
        print("File not found")
```

file.txt file:
```
Compiler Design Lab
int a = 1
Write a Program to find number of lines , words , characters in a text
int abc = nikhitha
```

OUTPUT:

```
== RESTART: D:\Engineering\SEM-6\Compiler Design\Lab Work\Week-1\Program-2.py ==
Enter the file name: file.txt
Compiler : String
Design : String
Lab : String
int : Keyword
a : Identifier
= : Operator
1 : Constant
Write : String
a : String
Program : String
to : String
find : String
number : String
of : String
lines : String
, : Special Character
words : String
, : Special Character
characters : String
in : String
a : String
text : String
int : Keyword
abc : Identifier
= : Operator
nikhitha : String
Number of Tokens in text file:  26
```

CONCLUSION:

By executing the above program, we have successfully displayed the number of tokens and type of tokens present in a file

EXPERIMENT NUMBER – 3

AIM: To identify whether an alphabet is vowel or consonant and also display its count using lex tool

DESCRIPTION: In this program, we try to take the input from the user and identify the vowels and consonants and also display its count in the given string.

ALGORITHM:
Step-1: Start
Step-2: Declare the variables vow->0 and const_count->0
Step-3: Declare the regular expressions
    [aeiouAEIOU] {vow++;}
    [a-zA-Z] {const_count++;}
Step-4: Read the string from the user
Step-5: Print vow
Step-6: Print const_count
Step-7: End

PROGRAM:
```
%{
	#include<stdio.h>
	int vow=0;
	int const_count=0;
%}

%%
[aeiouAEIOU] {vow++;}
[a-zA-Z] {const_count++;}
%%

int yywrap(){
	return 1;
}
int main(){
	printf("Enter the string: ");
	yylex();
	printf("no. of vowels are: %d\n",vow);
	printf("no. of consonants are %d",const_count);
	return 0;
}
```

OUTPUT:

```
student@CSELab3-06:~$ gedit vowels.l
student@CSELab3-06:~$ lex vowels.l
student@CSELab3-06:~$ gcc lex.yy.c
student@CSELab3-06:~$ ./a.out
Enter the string: Nikhitha

no. of vowels are: 3
no. of consonants are 5student@CSELab3-06:~$
```

CONCLUSION:

By executing the above program, we have successfully identified whether an alphabet is vowel or consonant and also displayed its count in given string

EXPERIMENT NUMBER – 4

AIM: To identify integer or real number using lex tool

DESCRIPTION: In this program, we try to identify whether the number given by the user is integer or real number

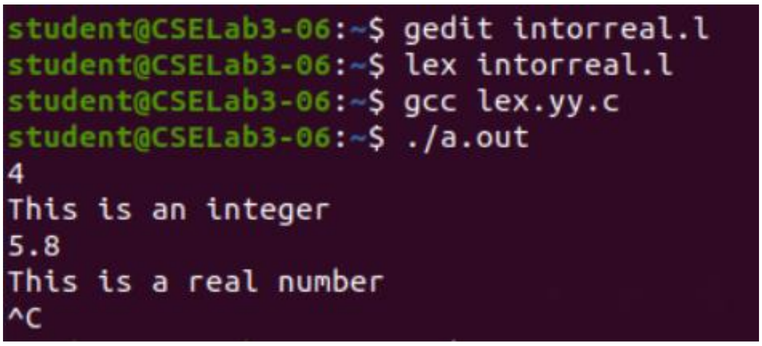
ALGORITHM:
Step-1: Start
Step-2: Declare the regular expressions
    integer [0-9]+
    float [0-9]+\.[0-9]+
Step-3: {integer} Print "Integer"
Step-4: {float} Print "Real Number"
Step-5: End

PROGRAM:
```
%{
	#include<stdio.h>
%}

integer [0-9]+
float   [0-9]+\.[0-9]+
%%

{integer} printf("This is an integer");
{float}   printf("This is a real number");
%%
int main(){
	yylex();
}
int yywrap(){
return 1;
}
```

OUTPUT:



```
student@CSELab3-06:~$ gedit intorreal.l
student@CSELab3-06:~$ lex intorreal.l
student@CSELab3-06:~$ gcc lex.yy.c
student@CSELab3-06:~$ ./a.out
4
This is an integer
5.8
This is a real number
^C
```

CONCLUSION:

By executing the above program, we have successfully identified whether the number given by the user is integer or real number

EXPERIMENT NUMBER – 5

AIM: To capitalize the character of a string using lex tool

DESCRIPTION: In this program, we try to capitalize every character of a string given by the user using lex tool

ALGORITHM:
Step-1: Start
Step-2: Declare the regular expression
lower [a-z]
Step-3: {lower} print yytext[0]-32
Step-4: End

PROGRAM:
```
%{
%}
lower [a-z]
%%
{lower} printf("%c",yytext[0]-32);
%%
int main(){
yylex();
}
int yywrap(){
return 1;
}
```

OUTPUT:

CONCLUSION:
By executing the above program, we have successfully capitalized every character of a string given by the user

EXPERIMENT NUMBER – 6

AIM: To implement scanner or lexical analyzer without using lex tool

DESCRIPTION: In this program, we try to scanner or lexical analyzer without using the lex tool

ALGORITHM:

Step-1: Start
Step-2: Define a function tokens(fname)
    Step-2.1: num_tokens->0, number->0
    Step-2.2: keywords = ['int', 'float', 'char', 'boolean', 'double', 'def', 'if', 'while', 'with']
    Step-2.3: operators = ['=', '+', '-', '==', '*', '/', '%', '!=', '**']
    Step-2.4: Special = [',', '(', ')', ';', ':', '[', ']', '&']
    Step-2.5: with open (fname, 'r') as f:
        Step-2.5.1: for line in f:
            Step-2.5.1.1: w -> line.split()
            Step-2.5.1.2: key->'N'
            Step-2.5.1.3: num_token->num_token+len(w)
            Step-2.5.1.4: for i in w:
                Step-2.5.1.4.1: if (i in Special):
                    Print number
                    Print 'Special Characters'
                    key='N'
                Step-2.5.1.4.2: else if (i in keywords):
                    Print number
                    Print 'Keywords'
                    key='N'
                Step-2.5.1.4.3: else if (i.isdigit()):
                    Print number
                    Print 'Constant'
                    key='N'
                Step-2.5.1.4.4: else if (i in operators):
                    Print number
                    Print 'Operator'
                    key='N'
                Step-2.5.1.4.5: else:
                    if (key=='Y'):
                        Print number
                        Print "Identifier"
                        key='N'
                    else:
                        Print number
                        Print "String"
        Step-2.5.1.5: number->number+1
    Step-2.6: Print num_token
Step-3: Read the file name from the user

Step-4: try:
    Count(fname)
Step-5: except:
    Print “File not Found”
Step-6: End

PROGRAM:
program-1.py file:

```
def tokens(fname):
   num_token = 0
   number=1
   keywords = ['int', 'float', 'char', 'boolean', 'double', 'def', 'if', 'while', 'with']
   operators = ['=', '+', '-', '==', '*', '/', '%', '!=', '**']
   Special = [',', '(', ')', ';', ':', '[', ']', '&']
   print("Line No    lexeme   token")
   with open(fname,'r') as f:
      for line in f:
         w = line.split()
         key = 'N'
         num_token = num_token + len(w)
         for i in w:
            if (i in Special):
               print(number,'    ', i, "    Special Character")
               key = 'N'
            elif (i in keywords):
               print(number,'    ',i, "    Keyword")
               key = 'Y'
            elif (i.isdigit()):
               print(number,'    ', i, "    Constant")
               key = 'N'
            elif (i in operators):
               print(number,'    ', i, "    Operator")
               key = 'N'
            else:
               if (key == 'Y'):
                  print(number,'    ', i, "    Identifier")
                  key = 'N'
               else:
                  print(number,'    ', i,"    String")
         number=number+1
   print("Number of Tokens in text file: ", num_token)

if __name__ == '__main__':
   fname = input("Enter the file name: ")
   try:
      tokens(fname)
   except:
```

```
    print("File not found")
```

demo.txt:
int l = 1
nikhitha @

OUTPUT:

```
== RESTART: D:/Engineering/SEM-6/Compiler Design/Lab Work/Week-2/Program-1.py ==
Enter the file name: demo.txt
Line No     lexeme    token
1       int      Keyword
1       l      Identifier
1       =      Operator
1       1      Constant
2       nikhitha      String
2       @      String
Number of Tokens in text file:   6
```

CONCLUSION:
By executing the above program, we have successfully implemented scanner or lexical analyzer without using lex tool

EXPERIMENT NUMBER – 7

AIM: To identify octal or hexadecimal number using lex tool

DESCRIPTION: In this program, we try to identify whether the given number is octal or hexadecimal number using lex tool

ALGORITHM:
Step-1: Start
Step-2: Declare the regular expressions
Oct[o][0-7]+
Hex[0][x][X][0-9 A-F]+
Step-3: {Hex} Print 'Hexadecimal number'
Step-4: {Oct} Print 'Octal number'
Step-5: End

PROGRAM:
```
%{
  /*program*/
%}
Oct[o][0-7]+
Hex[0][x][X][0-9 A-F]+
%%
{Hex} printf("This is Hexadecimal number");
{Oct} printf("This is an Octal number");
%%
main()
{
yylex();
}
int yywrap()
{
return 1;
}
```

OUTPUT:

```
student@CSELab3-12:~$ gedit hex.l
student@CSELab3-12:~$ lex hex.l
student@CSELab3-12:~$ gcc lex.yy.c
hex.l:10:1: warning: return type defaults to ‘int’ [-Wimplicit-int]
   10 | main()
      | ^~~~
student@CSELab3-12:~$ ./a.out
o32
This is an Octal number
0xX4F
This is Hexadecimal number
```

CONCLUSION:

By executing the above program, we have successfully identified whether the given number is octal or hexadecimal number.

EXPERIMENT NUMBER – 8

AIM: To accept the words starting with A or a using lex tool

DESCRIPTION: In this program, we try to accept the words starting with A or a using lex tool

ALGORITHM:
Step-1: Start
Step-2: Declare the regular expressions
    A [A][a-z A-Z]+
    a [a][a-z A-Z]+
    b [^A][a-z A-Z]+
    c [^a][a-z A-z]+
Step-3: {A} print 'Accepted
Step-4: {a} print 'Accepted'
Step-5: {b} print 'Not accepted'
Step-6: {c} print 'Not accepted'
Step-7: End

PROGRAM:
```
%{
/* Lex Program to accept string starting with vowel */
%}
A [A][a-z A-Z]+
a [a][a-z A-Z]+
b [^A][a-z A-Z]+
c [^a][a-z A-z]+
%%
{A} printf("Accepted");
{a} printf("Accepted");
{b} printf("Not accepted");
{c} printf("Not accepted");
%%
main()
{
yylex();
}
int yywrap(){
return 1;
}
```

OUTPUT:

```
student@CSELab3-12:~$ gedit A.l
student@CSELab3-12:~$ lex A.l
student@CSELab3-12:~$ gcc lex.yy.c
A.l:14:1: warning: return type defaults to ‘int’ [-Wimplicit-int]
   14 | main()
      | ^~~~
student@CSELab3-12:~$ ./a.out
Asdf
Accepted^C
student@CSELab3-12:~$ ./a.out
ghjk
Not accepted
```

CONCLUSION:
By executing the above program, we have successfully accepted the words starting with A or a using lex tool

EXPERIMENT NUMBER – 9

AIM: To design token separator for the given file using lex tool

DESCRIPTION: In this program, we try to design a token separator for the given file using lex tool

ALGORITHM:
Step-1: Start
Step-2: l = 1
Step-3: Declare the regular expressions

```
delim [ \t\b]
ws {delim}*
ident [A-Za-z][A-Za-z0-9]*
op [\+\-\*/%=]
special [;\{\}\[\]\(\)<>]
```

Step-4: {ws} print ‘Keyword’
Step-5: {ident} print ‘Identifier’
Step-6: {op} print ‘Operator’
Step-7: {special} print ‘Special’
Step-8: l++
Step-9: yyin -> fopen(“sample.c”, ‘r’)
Step-10: End

PROGRAM:

```
%{
#include<stdio.h>
int l = 1;
%}
delim [ \t\b]
ws {delim}*
ident [A-Za-z][A-Za-z0-9]*
op [\+\-\*/%=]
special [;\{\}\[\]\(\)<>]
%%
{ws}(int|return|include) { printf("%d\t\"%s\"\t\t\tKeyword\n", l, yytext); }
{ident} { printf("%d\t\"%s\"\t\t\tIdentifier\n", l, yytext); }
{op} { printf("%d\t\"%s\"\t\t\tOperator\n", l, yytext); }
{special} { printf("%d\t\"%s\"\t\t\tSpecial\n", l, yytext); }
\n { l++; }
. {}
%%
int main() {
   extern FILE *yyin;
   printf("LineNumber\tLexme\t\tToken\n");
   yyin = fopen("sample.c", "r");
   yylex();
```

```
    return 0;
}
int yywrap(){
return 1;
}
```

OUTPUT:

```
student@CSELab3-12:~$ gedit parse.l
student@CSELab3-12:~$ lex parse.l
student@CSELab3-12:~$ gcc lex.yy.c
student@CSELab3-12:~$ ./a.out
LineNumber       Lexme            Token
1        "include"                        Keyword
1        "<"                      Special
1        "stdio"                  Identifier
1        "h"                      Identifier
1        ">"                      Special
2        "int"                    Keyword
2        "main"                   Identifier
2        "("                      Special
2        ")"                      Special
2        "{"                      Special
3        "     int"                        Keyword
3        "num"                    Identifier
3        ";"                      Special
4        "printf"                         Identifier
4        "("                      Special
4        "Enter"                  Identifier
4        "an"                     Identifier
4        " int"                   Keyword
4        "eger"                   Identifier
4        ")"                      Special
4        ";"                      Special
5        "scanf"                  Identifier
5        "("                      Special
5        "%"                      Operator
5        "d"                      Identifier
5        "num"                    Identifier
5        ")"                      Special
5        ";"                      Special
7        "if"                     Identifier
```

CONCLUSION:

By executing the above program, we have successfully designed a token separator for the given file using the lex tool

EXPERIMENT NUMBER – 10

AIM: To implement FIRST Function for a given grammar

DESCRIPTION: In this program, we try to find the FIRST Functions of every non-terminal present in the given grammar

ALGORITHM:

```
Step-1: Start
Step-2: Define a function first(string):
        Step-2.1: first_ ->set()
        Step-2.2: if string in non_terminals:
                Step-2.2.1: alternatives = productions_dict[string]
                Step-2.2.2: for alternative in alternatives:
                        Step-2.2.2.1: first_2 = first(alternative)
                        Step-2.2.2.2: first_ = first_ |first_2
        Step-2.3: elif string in terminals:
                Step-2.3.1: first_ = {string}
        Step-2.4: elif string=='' or string=='@':
                Step-2.4.1: first_ = {'@'}
        Step-2.5: else:
                Step-2.5.1: first_2 = first(string[0])
                Step-2.5.2: if '@' in first_2:
                        Step-2.5.2.1: i = 1
                        Step-2.5.2.2: while '@' in first_2:
                                first_ = first_ | (first_2 - {'@'})
                                if string[i:] in terminals:
                                        first_ = first_ | {string[i:]}
                                        break
                                elif string[i:] == '':
                                        first_ = first_ | {'@'}
                                        break
                                first_2 = first(string[i:])
                                first_ = first_ | first_2 - {'@'}
                                i += 1
                Step-2.5.3: else:
                        Step-2.5.3.1: first_ = first_ | first_2
        Step-2.6: return  first_
Step-3: Read the number of terminals and the terminals
Step-4: Read the number of non-terminals and the non-terminals
Step-5: Read the Starting symbol
Step-6: Read the number of productions and the productions
Step-7: FIRST = {}
Step-8: for non_terminal in non_terminals:
        Step-8.1: FIRST[non_terminal]=set()
Step-9: for non_terminal in non_terminals:
        Step-9.1: FIRST[non_terminal] = FIRST[non_terminal] | first(non_terminal)
```

Step-10: for non_terminal in non_terminals:
    Step-10.1: Print FIRST(non_terminal)
Step-11: End

PROGRAM:

```
import sys
sys.setrecursionlimit(60)
def first(string):
   first_ = set()
   if string in non_terminals:
      alternatives = productions_dict[string]
      for alternative in alternatives:
         first_2 = first(alternative)
         first_ = first_ |first_2
   elif string in terminals:
      first_ = {string}
   elif string=='' or string=='@':
      first_ = {'@'}
   else:
      first_2 = first(string[0])
      if '@' in first_2:
         i = 1
         while '@' in first_2:
            first_ = first_ | (first_2 - {'@'})
            if string[i:] in terminals:
               first_ = first_ | {string[i:]}
               break
            elif string[i:] == '':
               first_ = first_ | {'@'}
               break
            first_2 = first(string[i:])
            first_ = first_ | first_2 - {'@'}
            i += 1
      else:
         first_ = first_ | first_2
   return  first_
no_of_terminals=int(input("Enter no. of terminals: "))
terminals = []
print("Enter the terminals :")
for _ in range(no_of_terminals):
   terminals.append(input())
no_of_non_terminals=int(input("Enter no. of non terminals: "))
non_terminals = []
print("Enter the non terminals :")
for _ in range(no_of_non_terminals):
   non_terminals.append(input())
starting_symbol = input("Enter the starting symbol: ")
```

```
no_of_productions = int(input("Enter no of productions: "))
productions = []
print("Enter the productions:")
for _ in range(no_of_productions):
    productions.append(input())
productions_dict = {}
for nT in non_terminals:
    productions_dict[nT] = []
for production in productions:
    nonterm_to_prod = production.split("->")
    alternatives = nonterm_to_prod[1].split("/")
    for alternative in alternatives:
        productions_dict[nonterm_to_prod[0]].append(alternative)
FIRST = {}
for non_terminal in non_terminals:
    FIRST[non_terminal] = set()
for non_terminal in non_terminals:
    FIRST[non_terminal] = FIRST[non_terminal] | first(non_terminal)
print("{: ^20}{: ^20}".format('Non Terminals','First'))
for non_terminal in non_terminals:
    print("{: ^20}{: ^20}".format(non_terminal,str(FIRST[non_terminal])))
```

OUTPUT:

```
====== RESTART: D:\Engineering\SEM-6\Compiler Design\Lab Work\Week-3\1.py ======
Enter no. of terminals: 5
Enter the terminals :
id
(
)
+
*
Enter no. of non terminals: 5
Enter the non terminals :
A
B
C
D
E
Enter the starting symbol: A
Enter no of productions: 5
Enter the productions:
A->CB
B->+CB/@
C->ED
D->*ED/@
E->(A)/id
   Non Terminals            First
         A               {'(', 'id'}
         B                {'@', '+'}
         C               {'(', 'id'}
         D                {'@', '*'}
         E               {'(', 'id'}
```

CONCLUSION:

By executing the above program, we have successfully implemented the FIRST Function for the given grammar

EXPERIMENT NUMBER – 11

AIM: To implement FOLLOW Function for a given grammar

DESCRIPTION: In this program, we try to find the FOLLOW Functions of every non-terminal present in the given grammar

ALGORITHM:

```
Step-1: Start
Step-2: Define a function first(string) as defined in the previous program
Step-3: Define a function follow(string):
        Step-3.1: follow_ = set()
        Step-3.2: prods = productions_dict.items
        Step-3.3: for nt,rhs in prods:
                Step-3.3.1: for alt in rhs:
                        Step-3.3.1.1: for char in alt:
                                if char==nT:
                                        following_str = alt[alt.index(char) + 1:]
                                        if following_str=='':
                                                if nt==nT:
                                                        continue
                                                else:
                                                        follow_ = follow_ | follow(nt)
                                        else:
                                                follow_2 = first(following_str)
                                                if '@' in follow_2:
                                                        follow_ = follow_ | follow_2-{'@'}
                                                        follow_ = follow_ | follow(nt)
                                                else:
                                                        follow_ = follow_ | follow_2
        Step-3.4: return follow_
Step-4: Read the number of terminals and the terminals
Step-5: Read the number of non-terminals and the non-terminals
Step-6: Read the Starting symbol
Step-7: Read the number of productions and the productions
Step-8: FOLLOW={}
Step-9: FOLLOW[starting_symbol] = FOLLOW[starting_symbol] | {'$'}
Step-10: for non_terminal in non_terminals:
        Step-10.1: FOLLOW[non_terminal] = FOLLOW[non_terminal] | follow(non_terminal)
Step-11: for non_terminal in non_terminals:
        Step-11.1: Print FOLLOW[non_terminals]
Step-12: End
```

PROGRAM:

```
import sys
sys.setrecursionlimit(60)
def first(string):
   first_ = set()
   if string in non_terminals:
      alternatives = productions_dict[string]
      for alternative in alternatives:
         first_2 = first(alternative)
         first_ = first_ |first_2
   elif string in terminals:
      first_ = {string}
   elif string=='' or string=='@':
      first_ = {'@'}
   else:
      first_2 = first(string[0])
      if '@' in first_2:
         i = 1
         while '@' in first_2:
            first_ = first_ | (first_2 - {'@'})
            if string[i:] in terminals:
               first_ = first_ | {string[i:]}
               break
            elif string[i:] == '':
               first_ = first_ | {'@'}
               break
            first_2 = first(string[i:])
            first_ = first_ | first_2 - {'@'}
            i += 1
      else:
         first_ = first_ | first_2
   return  first_
def follow(nT):
   follow_ = set()
   prods = productions_dict.items()
   if nT==starting_symbol:
      follow_ = follow_ | {'$'}
   for nt,rhs in prods:
      for alt in rhs:
         for char in alt:
            if char==nT:
               following_str = alt[alt.index(char) + 1:]
               if following_str=='':
                  if nt==nT:
                     continue
                  else:
                     follow_ = follow_ | follow(nt)
```

```
            else:
                follow_2 = first(following_str)
                if '@' in follow_2:
                    follow_ = follow_ | follow_2-{'@'}
                    follow_ = follow_ | follow(nt)
                else:
                    follow_ = follow_ | follow_2
    return follow_
no_of_terminals=int(input("Enter no. of terminals: "))
terminals = []
print("Enter the terminals :")
for _ in range(no_of_terminals):
    terminals.append(input())
no_of_non_terminals=int(input("Enter no. of non terminals: "))
non_terminals = []
print("Enter the non terminals :")
for _ in range(no_of_non_terminals):
    non_terminals.append(input())
starting_symbol = input("Enter the starting symbol: ")
no_of_productions = int(input("Enter no of productions: "))
productions = []
print("Enter the productions:")
for _ in range(no_of_productions):
    productions.append(input())
productions_dict = {}
for nT in non_terminals:
    productions_dict[nT] = []
for production in productions:
    nonterm_to_prod = production.split("->")
    alternatives = nonterm_to_prod[1].split("/")
    for alternative in alternatives:
        productions_dict[nonterm_to_prod[0]].append(alternative)
FOLLOW = {}
for non_terminal in non_terminals:
    FOLLOW[non_terminal] = set()
FOLLOW[starting_symbol] = FOLLOW[starting_symbol] | {'$'}
for non_terminal in non_terminals:
    FOLLOW[non_terminal] = FOLLOW[non_terminal] | follow(non_terminal)
print("{: ^20}{: ^20}".format('Non Terminals','Follow'))
for non_terminal in non_terminals:
    print("{: ^20}{: ^20}".format(non_terminal,str(FOLLOW[non_terminal])))
```

OUTPUT:

```
============ RESTART: D:\Engineering\SEM-6\Compiler Design\Lab Work\Week-3\2.py ===========
Enter no. of terminals: 5
Enter the terminals :
id
(
)
+
*
Enter no. of non terminals: 5
Enter the non terminals :
A
B
C
D
E
Enter the starting symbol: A
Enter no of productions: 5
Enter the productions:
A->CB
B->+CB/@
C->ED
D->*ED/@
E->(A)/id
   Non Terminals            Follow
         A               {'$', ')'}
         B               {'$', ')'}
         C            {')', '$', '+'}
         D            {')', '$', '+'}
         E          {')', '$', '*', '+'}
```

CONCLUSION:

By executing the above program, we have successfully implemented the FOLLOW Function for the given grammar

EXPERIMENT NUMBER – 12

AIM: To construct LL(1) parsing table and also check whether the string is valid or not

DESCRIPTION: In this program, we have to construct LL(1) parsing table for the given grammar and also have to check whether the given string is valid or not

ALGORITHM:
Step-1: Start
Step-2: Read the grammar from the user
Step-3: Eliminate ambiguity from the grammar
Step-4: Eliminate left Recursion from the grammar
Step-5: Left Factor the grammar
Step-6: Compute the FIRST function
Step-7: Compute the FOLLOW function
Step-8: Compute the LL(1) Parsing table
Step-9: Display the LL(1) Parsing table
Step-10: Read the input string from the user
Step-11: Check whether the given string is valid or not.
Step-12: End

PROGRAM:
```
def removeLeftRecursion(rulesDiction):
    store = {}
    for lhs in rulesDiction:
        alphaRules = []
        betaRules = []
        allrhs = rulesDiction[lhs]
        for subrhs in allrhs:
            if subrhs[0] == lhs:
                alphaRules.append(subrhs[1:])
            else:
                betaRules.append(subrhs)
        if len(alphaRules) != 0:
            lhs_ = lhs + "'"
            while (lhs_ in rulesDiction.keys()) or (lhs_ in store.keys()):
                lhs_ += "'"
            for b in range(0, len(betaRules)):
                betaRules[b].append(lhs_)
            rulesDiction[lhs] = betaRules
            for a in range(0, len(alphaRules)):
                alphaRules[a].append(lhs_)
            alphaRules.append(['#'])
            store[lhs_] = alphaRules
    for left in store:
        rulesDiction[left] = store[left]
    return rulesDiction
```

```
def LeftFactoring(rulesDiction):
    newDict = {}
    for lhs in rulesDiction:
        allrhs = rulesDiction[lhs]
        temp = dict()
        for subrhs in allrhs:
            if subrhs[0] not in list(temp.keys()):
                temp[subrhs[0]] = [subrhs]
            else:
                temp[subrhs[0]].append(subrhs)
        new_rule = []
        tempo_dict = {}
        for term_key in temp:
            allStartingWithTermKey = temp[term_key]
            if len(allStartingWithTermKey) > 1:
                lhs_ = lhs + "'"
                while (lhs_ in rulesDiction.keys()) or (lhs_ in tempo_dict.keys()):
                    lhs_ += "'"
                new_rule.append([term_key, lhs_])
                ex_rules = []
                for g in temp[term_key]:
                    ex_rules.append(g[1:])
                tempo_dict[lhs_] = ex_rules
            else:
                new_rule.append(allStartingWithTermKey[0])
        newDict[lhs] = new_rule
        for key in tempo_dict:
            newDict[key] = tempo_dict[key]
    return newDict
def first(rule):
    global rules, nonterm_userdef, term_userdef, diction, firsts
    if len(rule) != 0 and (rule is not None):
        if rule[0] in term_userdef:
            return rule[0]
        elif rule[0] == '#':
            return '#'
    if len(rule) != 0:
        if rule[0] in list(diction.keys()):
            fres = []
            rhs_rules = diction[rule[0]]
            for itr in rhs_rules:
                indivRes = first(itr)
                if type(indivRes) is list:
                    for i in indivRes:
                        fres.append(i)
                else:
                    fres.append(indivRes)
```

```
        if '#' not in fres:
            return fres
        else:
            newList = []
            fres.remove('#')
            if len(rule) > 1:
                ansNew = first(rule[1:])
                if ansNew != None:
                    if type(ansNew) is list:
                        newList = fres + ansNew
                    else:
                        newList = fres + [ansNew]
                else:
                    newList = fres
                return newList
            fres.append('#')
            return fres
def follow(nt):
    global start_symbol, rules, nonterm_userdef, term_userdef, diction, firsts, follows
    solset = set()
    if nt == start_symbol:
        solset.add('$')
    for curNT in diction:
        rhs = diction[curNT]
        for subrule in rhs:
            if nt in subrule:
                while nt in subrule:
                    index_nt = subrule.index(nt)
                    subrule = subrule[index_nt + 1:]
                    if len(subrule) != 0:
                        res = first(subrule)
                        if '#' in res:
                            newList = []
                            res.remove('#')
                            ansNew = follow(curNT)
                            if ansNew != None:
                                if type(ansNew) is list:
                                    newList = res + ansNew
                                else:
                                    newList = res + [ansNew]
                            else:
                                newList = res
                            res = newList
                    else:
                        if nt != curNT:
                            res = follow(curNT)
                    if res is not None:
```

```
                if type(res) is list:
                    for g in res:
                        solset.add(g)
                else:
                    solset.add(res)
    return list(solset)
def computeAllFirsts():
    global rules, nonterm_userdef, \
        term_userdef, diction, firsts
    for rule in rules:
        k = rule.split("->")
        k[0] = k[0].strip()
        k[1] = k[1].strip()
        rhs = k[1]
        multirhs = rhs.split('|')
        for i in range(len(multirhs)):
            multirhs[i] = multirhs[i].strip()
            multirhs[i] = multirhs[i].split()
        diction[k[0]] = multirhs
    print(f"\nAfter elimination of left recursion:\n")
    diction = removeLeftRecursion(diction)
    for y in diction:
        print(f"{y}->{diction[y]}")
    print("\nAfter left factoring:\n")
    diction = LeftFactoring(diction)
    for y in diction:
        print(f"{y}->{diction[y]}")
    for y in list(diction.keys()):
        t = set()
        for sub in diction.get(y):
            res = first(sub)
            if res != None:
                if type(res) is list:
                    for u in res:
                        t.add(u)
                else:
                    t.add(res)
        firsts[y] = t
    print("\nCalculated firsts: ")
    key_list = list(firsts.keys())
    index = 0
    for gg in firsts:
        print(f"first({key_list[index]}) "
              f"=> {firsts.get(gg)}")
        index += 1
def computeAllFollows():
    global start_symbol, rules, nonterm_userdef,\
```

```
        term_userdef, diction, firsts, follows
    for NT in diction:
        solset = set()
        sol = follow(NT)
        if sol is not None:
            for g in sol:
                solset.add(g)
        follows[NT] = solset
    print("\nCalculated follows: ")
    key_list = list(follows.keys())
    index = 0
    for gg in follows:
        print(f"follow({key_list[index]})"
              f" => {follows[gg]}")
        index += 1
def createParseTable():
    import copy
    global diction, firsts, follows, term_userdef
    print("\nFirsts and Follow Result table\n")
    mx_len_first = 0
    mx_len_fol = 0
    for u in diction:
        k1 = len(str(firsts[u]))
        k2 = len(str(follows[u]))
        if k1 > mx_len_first:
            mx_len_first = k1
        if k2 > mx_len_fol:
            mx_len_fol = k2
    print(f"{{:<{10}}} "
          f"{{:<{mx_len_first + 5}}} "
          f"{{:<{mx_len_fol + 5}}}"
          .format("Non-T", "FIRST", "FOLLOW"))
    for u in diction:
        print(f"{{:<{10}}} "
              f"{{:<{mx_len_first + 5}}} "
              f"{{:<{mx_len_fol + 5}}}"
              .format(u, str(firsts[u]), str(follows[u])))
    ntlist = list(diction.keys())
    terminals = copy.deepcopy(term_userdef)
    terminals.append('$')
    mat = []
    for x in diction:
        row = []
        for y in terminals:
            row.append('')
        mat.append(row)
    grammar_is_LL = True
```

```
    for lhs in diction:
        rhs = diction[lhs]
        for y in rhs:
            res = first(y)
            if '#' in res:
                if type(res) == str:
                    firstFollow = []
                    fol_op = follows[lhs]
                    if fol_op is str:
                        firstFollow.append(fol_op)
                    else:
                        for u in fol_op:
                            firstFollow.append(u)
                    res = firstFollow
                else:
                    res.remove('#')
                    res = list(res) +\
                          list(follows[lhs])
            ttemp = []
            if type(res) is str:
                ttemp.append(res)
                res = copy.deepcopy(ttemp)
            for c in res:
                xnt = ntlist.index(lhs)
                yt = terminals.index(c)
                if mat[xnt][yt] == '':
                    mat[xnt][yt] = mat[xnt][yt] \
                                   + f"{lhs}->{' '.join(y)}"
                else:
                    if f"{lhs}->{y}" in mat[xnt][yt]:
                        continue
                    else:
                        grammar_is_LL = False
                        mat[xnt][yt] = mat[xnt][yt] \
                                       + f",{lhs}->{' '.join(y)}"
    print("\nGenerated parsing table:\n")
    frmt = "{:>12}" * len(terminals)
    print(frmt.format(*terminals))
    j = 0
    for y in mat:
        frmt1 = "{:>12}" * len(y)
        print(f"{ntlist[j]} {frmt1.format(*y)}")
        j += 1
    return (mat, grammar_is_LL, terminals)
def validateStringUsingStackBuffer(parsing_table, grammarll1, table_term_list, input_string,
term_userdef,start_symbol):
    print(f"\nValidate String => {input_string}\n")
```

```
    if grammarll1 == False:
        return f"\nInput String = " \
               f"\"{input_string}\"\n" \
               f"Grammar is not LL(1)"
    stack = [start_symbol, '$']
    buffer = []
    input_string = input_string.split()
    input_string.reverse()
    buffer = ['$'] + input_string
    print("{:>20} {:>20} {:>20}".format("Buffer", "Stack","Action"))
    while True:
        if stack == ['$'] and buffer == ['$']:
            print("{:>20} {:>20} {:>20}".format(' '.join(buffer),
                          ' '.join(stack),"Valid"))
            return "\nValid String!"
        elif stack[0] not in term_userdef:
            x = list(diction.keys()).index(stack[0])
            y = table_term_list.index(buffer[-1])
            if parsing_table[x][y] != '':
                entry = parsing_table[x][y]
                print("{:>20} {:>20} {:>25}".
                      format(' '.join(buffer),
                             ' '.join(stack),
                             f"T[{stack[0]}][{buffer[-1]}] = {entry}"))
                lhs_rhs = entry.split("->")
                lhs_rhs[1] = lhs_rhs[1].replace('#', '').strip()
                entryrhs = lhs_rhs[1].split()
                stack = entryrhs + stack[1:]
            else:
                return f"\nInvalid String! No rule at " \
                       f"Table[{stack[0]}][{buffer[-1]}]."
        else:
            if stack[0] == buffer[-1]:
                print("{:>20} {:>20} {:>20}"
                      .format(' '.join(buffer),
                              ' '.join(stack),
                              f"Matched:{stack[0]}"))
                buffer = buffer[:-1]
                stack = stack[1:]
            else:
                return "\nInvalid String! " \
                       "Unmatched terminal symbols"
sample_input_string = None
no_of_terminals=int(input("Enter no. of terminals: "))
term_userdef=[]
print("Enter the terminals: ")
for _ in range(no_of_terminals):
```

```
    term_userdef.append(input())
no_of_non_terminals=int(input("Enter no. of non terminals: "))
nonterm_userdef=[]
print("Enter the non terminals: ")
for _ in range(no_of_non_terminals):
    nonterm_userdef.append(input())
no_of_productions = int(input("Enter no of productions: "))
rules = []
print("Enter the productions: ")
for _ in range(no_of_productions):
    rules.append(input())
sample_input_string=input("Enter the input string: ")
diction = {}
firsts = {}
follows = {}
computeAllFirsts()
start_symbol = list(diction.keys())[0]
computeAllFollows()
(parsing_table, result, tabTerm) = createParseTable()
if sample_input_string != None:
  validity = validateStringUsingStackBuffer(parsing_table, result, tabTerm,
sample_input_string, term_userdef,start_symbol)
  print(validity)
else:
  print("\nNo input String detected")
```

OUTPUT:

```
Enter no. of terminals: 7
Enter the terminals:
k
o
d
a
c
b
r
Enter no. of non terminals: 3
Enter the non terminals:
A
B
C
Enter no of productions: 4
Enter the productions:
S -> A k o
A -> A d | a B | a C
C -> c
B -> b B C | r
Enter the input string: a r k o

After elimination of left recursion:

S->[['A', 'k', 'o']]
A->[['a', 'B', "A'"], ['a', 'C', "A'"]]
C->[['c']]
B->[['b', 'B', 'C'], ['r']]
A'->[['d', "A'"], ['#']]

After left factoring:

S->[['A', 'k', 'o']]
A->[['a', "A''"]]
A''->[['B', "A'"], ['C', "A'"]]
C->[['c']]
B->[['b', 'B', 'C'], ['r']]
A'->[['d', "A'"], ['#']]

Calculated firsts:
first(S) => {'a'}
first(A) => {'a'}
first(A'') => {'c', 'r', 'b'}
first(C) => {'c'}
first(B) => {'r', 'b'}
first(A') => {'d', '#'}
```

```
Calculated follows:
follow(S) => {'$'}
follow(A) => {'k'}
follow(A'') => {'k'}
follow(C) => {'c', 'd', 'k'}
follow(B) => {'c', 'd', 'k'}
follow(A') => {'k'}

Firsts and Follow Result table

Non-T       FIRST                 FOLLOW
S           {'a'}                 {'$'}
A           {'a'}                 {'k'}
A''         {'c', 'r', 'b'}       {'k'}
C           {'c'}                 {'c', 'd', 'k'}
B           {'r', 'b'}            {'c', 'd', 'k'}
A'          {'d', '#'}            {'k'}

Generated parsing table:

            k           o           d           a           c           b           r
    $
S                                           S->A k o

A                                           A->a A''

A''                                                     A''->C A'   A''->B A'   A''->B A'

C                                                          C->c

B                                                                   B->b B C        B->r

A'        A'->#                 A'->d A'
```

```
Validate String => a r k o

              Buffer                 Stack              Action
           $ o k r a                   S $        T[S][a] = S->A k o
           $ o k r a               A k o $        T[A][a] = A->a A''
           $ o k r a           a A'' k o $            Matched:a
             $ o k r             A'' k o $      T[A''][r] = A''->B A'
             $ o k r            B A' k o $            T[B][r] = B->r
             $ o k r            r A' k o $            Matched:r
               $ o k              A' k o $         T[A'][k] = A'->#
               $ o k                 k o $            Matched:k
                 $ o                   o $            Matched:o
                   $                     $                Valid

Valid String!
```

CONCLUSION:

By executing the above program, we have successfully constructed LL(1) parsing table for the given grammar and also checked whether the given string is valid or not.

EXPERIMENT NUMBER – 13

AIM: To find whether the number is even or odd number using lex tool

DESCRIPTION: In this program, we try to read the input from the user and find whether the number is even or odd using lex tool

ALGORITHM:
Step-1: Start
Step-2: Declare i
Step-3: Declare the regular expression and conditions:

```
    [0-9]+ {i= atoi(yytext);
    if (i%2==0)
            printf("Even");
    else
            printf("Odd");}
```

Step-4: Read input from the user
Step-5: End

PROGRAM:

```
%{
#include <stdio.h>
int i;
%}
%%
[0-9]+ {i= atoi(yytext);
if (i%2==0)
printf("Even");
else
printf("Odd");}
%%
int yywrap() {}
int main()
{
yylex();
return 0;
}
```

OUTPUT:

```
nikki@nikki-VirtualBox:~$ gedit evenorodd.l
nikki@nikki-VirtualBox:~$ lex evenorodd.l
nikki@nikki-VirtualBox:~$ gcc lex.yy.c
nikki@nikki-VirtualBox:~$ ./a.out
10
Even
5
Odd
4
Even
3
Odd
7
Odd
^C
nikki@nikki-VirtualBox:~$
```

CONCLUSION:

By executing the above program, we have successfully found whether the given number is even or odd number

EXPERIMENT NUMBER – 14

AIM: To identify the characters other than alphabets using lex tool

DESCRIPTION: In this program, we try to read the input from the user and identify the characters other than alphabets present in the input

ALGORITHM:
Step-1: Start
Step-2: Declare len -> 0
Step-3: Declare the regular expressions

```
[a-zA-Z]+ {printf("No character other than alphabets");}
.* {printf("character other than alphabets present"); }
```

Step-4: Read the input
Step-5: End

PROGRAM:

```
%{
 int len=0;
%}
%%
[a-zA-Z]+ {printf("No character other than alphabets");}
.* {printf("character other than alphabets present"); }
%%
int yywrap() { }
int main()
 {
  yylex();
  return 0;
 }
```

OUTPUT:

```
nikki@nikki-VirtualBox:~$ gedit prog2.l
nikki@nikki-VirtualBox:~$ lex prog2.l
nikki@nikki-VirtualBox:~$ gcc lex.yy.c
nikki@nikki-VirtualBox:~$ ./a.out
abcd
No character other than alphabets
Password@123
character other than alphabets present
098231
character other than alphabets present
^C
```

CONCLUSION:
By executing the above program, we have successfully identified the characters other than alphabets

EXPERIMENT NUMBER – 15

AIM: To add line number to statements in the given file

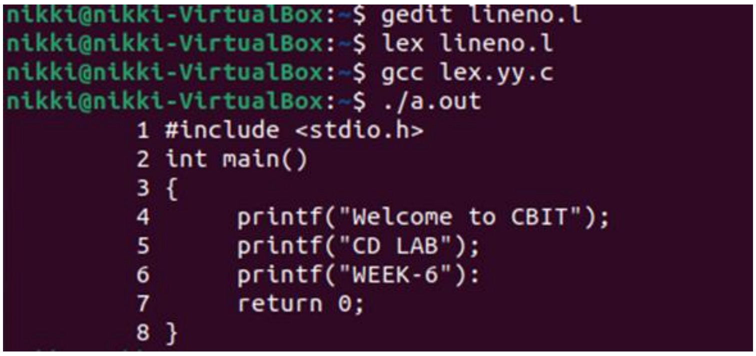
DESCRIPTION: In this program, we try to add line numbers to the statements present in a particular file

ALGORITHM:
Step-1: Start
Step-2: Declare line_number->1
Step-3: Declare the conditions
    {line} { printf("%10d %s", line_number++, yytext); }
Step-4: extern FILE *yyin
Step-5: yyin -> fopen("sample.c",''r")
Step-6: End

PROGRAM:
lineno.l:
```
%{
int line_number = 1;
%}
line .*\n
%%
{line} { printf("%10d %s", line_number++, yytext); }
%%
int yywrap(){}
int main(int argc, char*argv[])
{
extern FILE *yyin;
yyin = fopen("sample.c","r");
yylex();
return 0;
}
```

sample.c:
```
#include <stdio.h>
int main()
{
printf("Welcome to CBIT");
printf("CD LAB");
printf("WEEK-6"):
return 0;
}
```

OUTPUT:



```
nikki@nikki-VirtualBox:~$ gedit lineno.l
nikki@nikki-VirtualBox:~$ lex lineno.l
nikki@nikki-VirtualBox:~$ gcc lex.yy.c
nikki@nikki-VirtualBox:~$ ./a.out
        1 #include <stdio.h>
        2 int main()
        3 {
        4       printf("Welcome to CBIT");
        5       printf("CD LAB");
        6       printf("WEEK-6"):
        7       return 0;
        8 }
```

CONCLUSION:

By executing the above program, we have successfully added the line numbers to the statements present in a particular file

EXPERIMENT NUMBER – 16

AIM: To implement Recursive Decent Parser

DESCRIPTION: In this program, we try to implement recursive decent parser

ALGORITHM:
Step-1: Start
Step-2: Declare a global variable s
Step-3: Read the string from user and store it as s
Step-4: Declare a global variable i=0
Step-5: Define a match function used to match the sting elements with the productions
Step-6: Define E, F, T, Tx, Ex for different productions
Step-7: if (E())
    Step-7.1: if i==len(s)
        Step-7.1.1: Print "String is accepted"
    Step-7.2: else
        Step-7.2.1: Print "String is not accepted"
Step-8: else
    Step-8.1: Print "String is not accepted"
Step-9: Stop

PROGRAM:
```
print("Recursive Desent Parsing For following grammar\n")
print("E->TE'\nE'->+TE'/@\nT->FT'\nT'->*FT'/@\nF->(E)/i\n")
print("Enter the string want to be checked\n")
global s
s=list(input())
global i
i=0
def match(a):
   global s
   global i
   if(i>=len(s)):
      return False
   elif(s[i]==a):
      i+=1
      return True
   else:
      return False
def F():
   if(match("(")):
      if(E()):
         if(match(")")):
            return True
         else:
            return False
```

```
        else:
            return False
    elif(match("i")):
        return True
    else:
        return False
def Tx():
    if(match("*")):
        if(F()):
            if(Tx()):
                return True
            else:
                return False
        else:
            return False
    else:
        return True
def T():
    if(F()):
        if(Tx()):
            return True
        else:
            return False
    else:
        return False
def Ex():
    if(match("+")):
        if(T()):
            if(Ex()):
                return True
            else:
                return False
        else:
            return False
    else:
        return True
def E():
    if(T()):
        if(Ex()):
            return True
        else:
            return False
    else:
        return False
if(E()):
    if(i==len(s)):
        print("String is accepted")
```

```
    else:
        print("String is not accepted")

else:
    print("string is not accepted")
```

OUTPUT:

```
Recursive Desent Parsing For following grammar

E->TE'
E'->+TE'/@
T->FT'
T'->*FT'/@
F->(E)/i

Enter the string want to be checked

(i)*i
String is accepted
```

CONCLUSION:

By executing the above program, we have successfully implemented the Recursive Decent Parser.

EXPERIMENT NUMBER – 17

AIM: To implement Canonical LR(0) items

DESCRIPTION: In this program, we try to implement canonical LR(0) items

ALGORITHM:

Step-1: Start
Step-2: Define a function findlr0:
    Step-2.1: for i in range(len(rhs)+1):
        Step-2.1.1: x=lhs+'->'+rhs[:i]+'.'+rhs[i:]
        Step-2.1.2: lr0.append(x)
Step-3: Read the number of productions
Step-4: Read the productions
Step-5: for i in range(n):
    Step-5.1: lr0=[]
    Step-5.2: for i in range(len(arr)):
        Step-5.2.1: ip=arr[i]
        Step-5.2.2: lhs,rhs=ip.split("->")
        Step-5.2.3: productions=list(rhs.split('|'))
        Step-5.2.4: for prod in productions:
            Step-5.2.4.1: findlr0(lhs,prod,lr0)
Step-6: Print lr0
Step-7: End

PROGRAM:

```
def findlr0(lhs,rhs,lr0):
   for i in range(len(rhs)+1):
      x=lhs+'->'+rhs[:i]+'.'+rhs[i:]
      lr0.append(x)
n=int(input("Enter the no. of productions:"))
arr=[]
for i in range(n):
   arr.append(str(input()))
   lr0=[]
   for i in range(len(arr)):
      ip=arr[i]
      lhs,rhs=ip.split("->")
      productions=list(rhs.split('|'))
      for prod in productions:
         findlr0(lhs,prod,lr0)
print("LR(0) items for given production:")
for i in range(len(lr0)):
   print(i,"->",lr0[i])
```

OUTPUT:

```
Enter the no. of productions:3
E->E+T|T
T->T*F|F
F->(E)|i
LR(0) items for given production:
0 -> E->.E+T
1 -> E->E.+T
2 -> E->E+.T
3 -> E->E+T.
4 -> E->.T
5 -> E->T.
6 -> T->.T*F
7 -> T->T.*F
8 -> T->T*.F
9 -> T->T*F.
10 -> T->.F
11 -> T->F.
12 -> F->.(E)
13 -> F->(.E)
14 -> F->(E.)
15 -> F->(E).
16 -> F->.i
17 -> F->i.
```

CONCLUSION:

By executing the above program, we have successfully implemented Canonical LR(0) items

EXPERIMENT NUMBER – 18

AIM: To recognize a valid arithmetic expression that uses operator +, -, *, % using lex and yacc tool

DESCRIPTION: In this program, we try to recognize a valid arithmetic expression that uses operator +, -, *, % using lex and yacc tool

ALGORITHM:

Step-1: Start
Step-2: Create a lex file
Step-3: Declare the regular expressions

```
[a-zA-Z_][a-zA-Z_0-9]* return id;
[0-9]+(\.[0-9]*)?      return num;
[+/*]                  return op;
.                      return yytext[0];
\n                     return 0;
```

Step-4: Create a Yacc file
Step-5: valid = 1
Step-6: Declare required variables

```
start : id '=' s ';'
s :    id x
     | num x
     | '-' num x
     | '(' s ')' x
     ;
x :    op s
     | '-' s
     |
     ;
```

Step-7: Read the expression from user
Step-8: if(valid) Print “Valid Expression”
Step-9: else Print “Invalid Expression”
Step-10: End

PROGRAM:

Lex part:

```
%{
   #include "y.tab.h"
%}
%%
[a-zA-Z_][a-zA-Z_0-9]* return id;
[0-9]+(\.[0-9]*)?      return num;
[+/*]                  return op;
.                      return yytext[0];
\n                     return 0;
%%
```

```
int yywrap()
{
return 1;
}
```

Yacc Part:

```
%{
   #include<stdio.h>
   int valid=1;
%}
%token num id op
%%
start : id '=' s ';'
s :     id x
      | num x
      | '-' num x
      | '(' s ')' x
      ;
x :     op s
      | '-' s
      |
      ;
%%
int yyerror()
{
   valid=0;
   printf("\nInvalid expression!\n");
   return 0;
}
int main()
{
   printf("\nEnter the expression:\n");
   yyparse();
   if(valid)
   {
      printf("\nValid expression!\n");
   }
}
```

OUTPUT:

```
nikki@nikki-VirtualBox:~$ gedit arth.l
nikki@nikki-VirtualBox:~$ gedit arth.y
nikki@nikki-VirtualBox:~$ lex arth.l
nikki@nikki-VirtualBox:~$ yacc -d arth.y
arth.y:17 parser name defined to default :"parse"
nikki@nikki-VirtualBox:~$ gcc lex.yy.c y.tab.c -w
nikki@nikki-VirtualBox:~$ ./a.out

Enter the expression:
a=b+c;

Valid expression!
nikki@nikki-VirtualBox:~$ ./a.out

Enter the expression:
a+b-;

Invalid expression!
```

CONCLUSION:

By executing the above program, we have successfully recognized a valid arithmetic expression that uses operator +, -, *, % using lex and yacc tool

EXPERIMENT NUMBER – 19

AIM: To recognize a valid variable using lex and yacc tool

DESCRIPTION: In this program, we try to recognize a valid variable using lex and yacc tool

ALGORITHM:

Step-1: Start
Step-2: Create a lex file
Step-3: Declare the regular expressions

```
[a-zA-Z_][a-zA-Z_0-9]* return letter;
[0-9]              return digit;
.                return yytext[0];
\n                return 0;
```

Step-4: Create a yacc file
Step-5: valid=1
Step-6: Declare required variables

```
start : letter s
s :    letter s
     | digit s
     |
     ;
```

Step-7: Read the string for the user
Step-8: if (valid) Print “It’s an Identifier”
Step-9: else Print “It’s not an Identifier”
Step-10: End

PROGRAM:

Lex Part:

```
%{
  #include "y.tab.h"
%}
%%
[a-zA-Z_][a-zA-Z_0-9]* return letter;
[0-9]              return digit;
.                return yytext[0];
\n                return 0;
%%
int yywrap()
{
return 1;
}
```

Yacc Part:

```
 %{
   #include<stdio.h>
   int valid=1;
%}
%token digit letter
%%
start : letter s
s :     letter s
      | digit s
      |
      ;
%%
int yyerror()
{
   printf("\nIts not a identifier!\n");
   valid=0;
   return 0;
}
int main()
{
   printf("\nEnter a name to tested for identifier ");
   yyparse();
   if(valid)
   {
      printf("\nIt is a identifier!\n");
   }
}
```

OUTPUT:

```
nikki@nikki-VirtualBox:~$ gedit var.l
nikki@nikki-VirtualBox:~$ gedit var.y
nikki@nikki-VirtualBox:~$ lex var.l
nikki@nikki-VirtualBox:~$ yacc -d var.y
var.y:12 parser name defined to default :"parse"
nikki@nikki-VirtualBox:~$ gcc lex.yy.c y.tab.c -w
nikki@nikki-VirtualBox:~$ ./a.out

Enter a name to tested for identifier var_21

It is a identifier!
nikki@nikki-VirtualBox:~$ ./a.out

Enter a name to tested for identifier 9var

Its not a identifier!
```

CONCLUSION:

By executing the above program, we have successfully recognized a valid variable or Identifier

EXPERIMENT NUMBER – 20

AIM: To demonstrate calculator using lex and yacc tool

DESCRIPTION: In this program, we try to demonstrate the calculator operations using lex and yacc tool

ALGORITHM:

Step-1: Start
Step-2: Create a lex file
Step-3: Declare the regular expressions

```
yylval=atoi(yytext);
return NUMBER;
      }
[\t] ;
[\n] return 0;
. return yytext[0];
```

Step-4: Create a yacc file
Step-5: Declare required variables

```
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;}
;
```

Step-6: Read the expression from the user
Step-7: if (valid) Print result of the expression and “Valid Expression
Step-8: else Print “Invalid Expression”
Step-9: End

PROGRAM:
Lex Part:

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

```
	}
[\t] ;
[\n] return 0;
. return yytext[0];
%%
int yywrap()
{
return 1;
}
```

Yacc Part:

```
%{
   #include<stdio.h>
   int flag=0;
%}
%token NUMBER
%left '+' '-'
%left '*' '/' '%'
%left '(' ')'
%%
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;}
;
%%
void main()
{
   printf("\nEnter Any Arithmetic Expression which can have operations Addition, 
Subtraction, Multiplication, Divison, 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:

```
nikki@nikki-VirtualBox:~$ gedit calc.l
nikki@nikki-VirtualBox:~$ gedit calc.y
nikki@nikki-VirtualBox:~$ lex calc.l
nikki@nikki-VirtualBox:~$ yacc -d calc.y
calc.y:22 parser name defined to default :"parse"
nikki@nikki-VirtualBox:~$ gcc lex.yy.c y.tab.c -w
nikki@nikki-VirtualBox:~$ ./a.out

Enter Any Arithmetic Expression which can have operations Addition, Subtraction
, Multiplication, Divison, Modulus and Round brackets:
54+980

Result=1034

Entered arithmetic expression is Valid

nikki@nikki-VirtualBox:~$ ./a.out

Enter Any Arithmetic Expression which can have operations Addition, Subtraction
, Multiplication, Divison, Modulus and Round brackets:
69+90-

Entered arithmetic expression is Invalid
```

CONCLUSION:

By executing the above program, we have successfully demonstrated calculator operations using lex and yacc tool

EXPERIMENT NUMBER – 21

AIM: To check whether a given string is accepted by the given grammar

DESCRIPTION: In this program, we try to check whether the string aaabbb is accepted by the given grammar S->aSb|ε

ALGORITHM:

Step-1: Start
Step-2: Create a lex file
Step-3: Declare the regular expressions

```
[a] {return A;}
[b] {return B;}
[\n] {return '\n';}
```

Step-4: Create a yacc file
Step-5: Declare required variable

```
start : S '\n' {return 0;}
S: A S B
|;
```

Step-6: Read the string from the user
Step-7: if (valid) Print "Valid"
Step-8: else Print "Invalid"
Step-9: End

PROGRAM:

Lex Part:

```
%{
#include "y.tab.h"
%}
%%
[a] {return A;}
[b] {return B;}
[\n] {return '\n';}
%%
```

Yacc Part:

```
%{
#include<stdio.h>
%}
%token A B
%%
start : S '\n' {return 0;}
S: A S B
|;
%%
main()
{
```

```
printf("enter string");
if(yyparse()==0)
printf("valid");
}
yyerror()
{printf("not accepted");
exit(0);
}
yywrap()
{
return 1;
}
```

OUTPUT:

```
nikki@nikki-VirtualBox:~$ gedit string.l
nikki@nikki-VirtualBox:~$ gedit string.y
nikki@nikki-VirtualBox:~$ lex string.l
nikki@nikki-VirtualBox:~$ yacc -d string.y
string.y:9 parser name defined to default :"parse"
nikki@nikki-VirtualBox:~$ gcc lex.yy.c y.tab.c -w
nikki@nikki-VirtualBox:~$ ./a.out
enter stringaaabbb
validnikki@nikki-VirtualBox:~$
```

CONCLUSION:

By executing the above program, we have successfully checked whether the string aaabbb is accepted by the grammar S->aSb|ε

EXPERIMENT NUMBER – 22

AIM: To stimulate symbol table management

DESCRIPTION: In this program, we try to demonstrate symbol table management

ALGORITHM:
Step-1: Start
Step-2: Read the expression from the user
Step-3: if isalpha(toascii(c)) Print “Identifier”
Step-4: else if isdigit(toascii(c)) Print “Constant”
Step-5: else Print “Operator”
Step-6: Stop

PROGRAM:
```
#include <stdio.h>
#include <ctype.h>
#include <stdlib.h>
#include <string.h>
#include <math.h>
void main()
{
 int i=0,j=0,x=0,n;
 void *p,*add[5];
 char ch,srch,b[15],d[15],c;
 printf("Expression terminated by $:");
 while((c=getchar())!='$')
 {
  b[i]=c;
  i++;
 }
 n=i-1;
 printf("Given Expression:");
 i=0;
 while(i<=n)
 {
  printf("%c",b[i]);
  i++;
 }
 printf("\n Symbol Table\n");
 printf("Symbol \t addr \t type");
 while(j<=n)
 {
  c=b[j];
  if(isalpha(toascii(c)))
  {
   p=malloc(c);
```

```
 add[x]=p;
 d[x]=c;
 printf("\n%c \t %d \t identifier\n",c,p);
 x++;
 j++;
}
else if (isdigit(c))
{
  p=malloc(c);
  add[x]=p;
  d[x]=c;
 printf("\n%c \t %d \t Constant\n",c,p);
 x++;
 j++;
}
else
{
 ch=c;
 if(ch=='+'||ch=='-'||ch=='*'||ch=='=')
 {
  p=malloc(ch);
  add[x]=p;
  d[x]=ch;
  printf("\n %c \t %d \t operator\n",ch,p);
  x++;
  j++;
 }}}}
```

OUTPUT:

```
Expression terminated by $:x=9$
Given Expression:x=9
 Symbol Table
Symbol   addr    type
x        11801680        identifier

 =       11801808        operator

9        11801888        Constant

--------------------------------
Process exited after 6.827 seconds with return value 3
Press any key to continue . . .
```

CONCLUSION:

By executing the above program, we have successfully stimulated the symbol table management

EXPERIMENT NUMBER – 23

AIM: To implement language to an intermediate form

DESCRIPTION: In this program, we try to implement language to an intermediate form

ALGORITHM:

Step-1: Start
Step-2: Define a structure three
Step-3: f1=fopen("sum.txt","r")
Step-4: f2=fopen("out.txt","w")
Step-5: while(fscanf(f1,"%s",s[len].data)!=EOF)
Step-5.1: len++
Step-6: itoa(j,d1,7)
Step-7: strcat(d2,d1)
Step-8: strcpy(s[j].temp,d2)
Step-9: strcpy(d1,"")
Step-10: strcpy(d2,"t")
Step-11: if(!strcmp(s[3].data,"+"))
Step-11.1: Print(s[j].temp,s[i+2].data,s[i+4].data)
Step-11.2: j++
Step-12: else if(!strcmp(s[3].data,"-"))
Step-12.1: Print(s[j].temp,s[i+2].data,s[i+4].data)
Step-12.2: j++
Step-13: for(i=4;i<len-2;i+=2)
Step-13.1: itoa(j,d1,7)
Step-13.2: strcat(d2,d1)
Step-13.3: strcpy(s[j].temp,d2)
Step-13.4: if(!strcmp(s[i+1].data,"+"))
Step-13.4.1: Print(s[j].temp,s[j-1].temp,s[i+2].data)
Step-13.5: else if(!strcmp(s[i+1].data,"-"))
Step-13.5.1: Print(s[j].temp,s[j-1].temp,s[i+2].data)
Step-13.6: strcpy(d1,"")
Step-13.7: strcpy(d2,"t")
Step-13.8: j++
Step-14: Print(s[0].data,s[j-1].temp)
Step-15: fclose(f1)
Step-16: fclose(f2)
Step-17: End

PROGRAM:

```
#include<stdio.h>
#include<conio.h>
#include<stdlib.h>
#include<string.h>
struct three
{
	char data[10],temp[7];
}s[30];
void main()
{
	char d1[7],d2[7]="t";
	int i=0,j=1,len=0;
	FILE *f1,*f2;
	f1=fopen("sum.txt","r");
	f2=fopen("out.txt","w");
	while(fscanf(f1,"%s",s[len].data)!=EOF)
		len++;
	itoa(j,d1,7);
	strcat(d2,d1);
	strcpy(s[j].temp,d2);
	strcpy(d1,"");
	strcpy(d2,"t");
	if(!strcmp(s[3].data,"+"))
	{
		fprintf(f2,"%s=%s+%s",s[j].temp,s[i+2].data,s[i+4].data);
		j++;
	}
	else if(!strcmp(s[3].data,"-"))
	{
		fprintf(f2,"%s=%s-%s",s[j].temp,s[i+2].data,s[i+4].data);
		j++;
	}
	for(i=4;i<len-2;i+=2)
	{
		itoa(j,d1,7);
		strcat(d2,d1);
		strcpy(s[j].temp,d2);
		if(!strcmp(s[i+1].data,"+"))
			fprintf(f2,"\n%s=%s+%s",s[j].temp,s[j-1].temp,s[i+2].data);
		else if(!strcmp(s[i+1].data,"-"))
			fprintf(f2,"\n%s=%s-%s",s[j].temp,s[j-1].temp,s[i+2].data);
		strcpy(d1,"");
		strcpy(d2,"t");
		j++;
	}
	fprintf(f2,"\n%s=%s",s[0].data,s[j-1].temp);
```

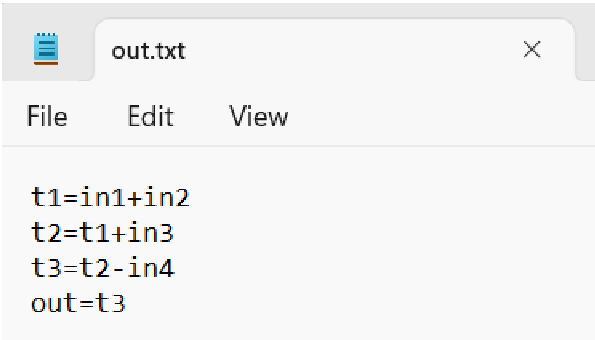
```
        fclose(f1);
        fclose(f2);
        getch();
}
```

sum.txt:

out = in1 + in2 + in3 - in4

OUTPUT:

out.txt:




```
t1=in1+in2
t2=t1+in3
t3=t2-in4
out=t3
```

CONCLUSION:

By executing the above program, we have successfully implemented language to an intermediate code

EXPERIMENT NUMBER – 24

AIM: To generate target code

DESCRIPTION: In this program, we try to generate target code from intermediate code

ALGORITHM:

Step-1: Start
Step-2: Define a structure three
Step-3: f1=fopen("exe.txt","r")
Step-4: f2=fopen("exe1.txt","w")
Step-5: while(fscanf(f1,"%s",s[len].data)!=EOF)
    Step-5.1: len++
Step-6: for(i=0;i<=len;i++)
    Step-6.1: if(!strcmp(s[i].data,"="))
        Step-6.1.1: Print(s[i+1].data)
    Step-6.2: if(!strcmp(s[i+2].data,"+"))
        Step-6.2.1: Print(s[i+3].data)
    Step-6.3: if(!strcmp(s[i+2].data,"-"))
        Step-6.3.1: Print(s[i+3].data)
    Step-6.4: Print(s[i-1].data)
Step-7: fclose(f1)
Step-8: fclose(f2)
Step-9: Stop

PROGRAM:

```
#include<stdio.h>
#include<conio.h>
#include<string.h>
struct three
{
        char data[10],temp[7];
}s[30];
void main()
{
   char *d1,*d2;
   int i=0,len=0;
   FILE *f1,*f2;
   f1=fopen("exe.txt","r");
   f2=fopen("exe1.txt","w");
   while(fscanf(f1,"%s",s[len].data)!=EOF)
        len++;
   for(i=0;i<=len;i++)
   {
        if(!strcmp(s[i].data,"="))
      {
        fprintf(f2,"\nLDA\t%s",s[i+1].data);
```

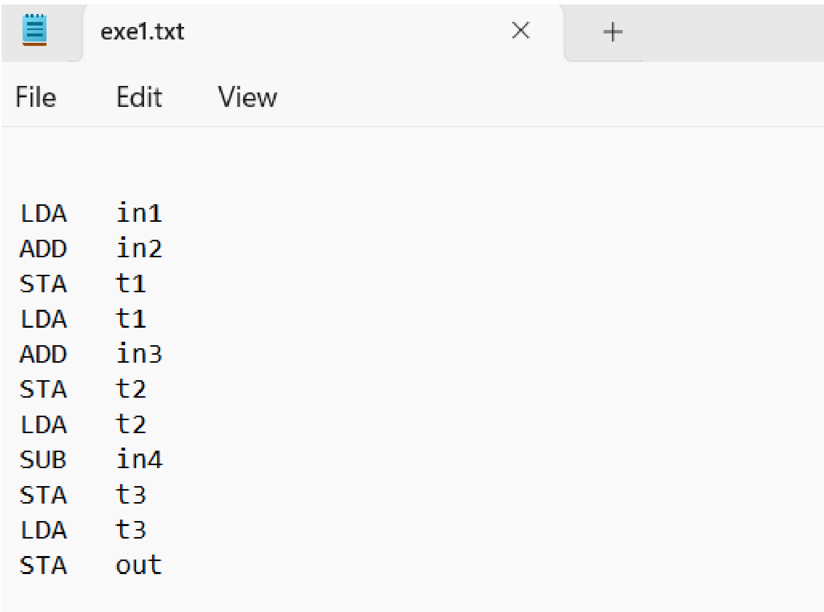
```
        if(!strcmp(s[i+2].data,"+"))
         fprintf(f2,"\nADD\t%s",s[i+3].data);
        if(!strcmp(s[i+2].data,"-"))
         fprintf(f2,"\nSUB\t%s",s[i+3].data);
         fprintf(f2,"\nSTA\t%s",s[i-1].data);
      }
    }
    fclose(f1);
    fclose(f2);
    getch();
}
```

exe.txt:

```
t1 = in1 + in2
t2 = t1 + in3
t3 = t2 - in4
out = t3
```

OUTPUT:

exe1.txt:




```
LDA   in1
ADD   in2
STA   t1
LDA   t1
ADD   in3
STA   t2
LDA   t2
SUB   in4
STA   t3
LDA   t3
STA   out
```

CONCLUSION:

By executing the above program, we have successfully generated target code from the intermediate code.

EXPERIMENT NUMBER – 25

AIM: To implement Yacc program to check for relational operator.

DESCRIPTION: In this program, we try to implement Yacc program to check for relational operator.

ALGORITHM:
Step-1: Start the program.
Step-2: Reading an expression.
Step-3: Checking the validating of the given expression for relational operator according to the rule using Yacc.
Step-4: Using expression rule print the result of the given values
Step-5: Stop the program.

PROGRAM:
Lex Part:

```
%{
#include "y.tab.h"
%}
%%
[0-9]+      { yylval = atoi(yytext); return NUM; }
"=="        { return EQ; }
"!="        { return NEQ; }
"<"         { return LT; }
">"         { return GT; }
"<="        { return LTE; }
">="        { return GTE; }
[ \t]       ; /* ignore whitespace */
\n          ; /* ignore newline */
.           { return yytext[0]; } /* catch-all rule for unmatched characters */
%%
int yywrap() {
   return 1;
}
```

Yacc Part:

```
%{
#include <stdio.h>
int valid=1;
%}
%token NUM
%token EQ NEQ LT GT LTE GTE
%left EQ NEQ LT GT LTE GTE
%start expr
%%
expr: NUM { printf("Expression: %d\n", $1); }
```

```
    | expr EQ expr { printf("Expression: %d == %d\n", $1, $3); }
    | expr NEQ expr { printf("Expression: %d != %d\n", $1, $3); }
    | expr LT expr { printf("Expression: %d < %d\n", $1, $3); }
    | expr GT expr { printf("Expression: %d > %d\n", $1, $3); }
    | expr LTE expr { printf("Expression: %d <= %d\n", $1, $3); }
    | expr GTE expr { printf("Expression: %d >= %d\n", $1, $3); }
    ;
%%
int main() {
    yyparse();
    if(valid)
    {
            printf("Sucess");
    }
    return 0;
}
void yyerror(const char *s) {
    valid=0;
    printf("Error: %s\n", s);
}
```

OUTPUT:

```
nikki@nikki-VirtualBox:~$ gedit relational.l
nikki@nikki-VirtualBox:~$ gedit relational.y
nikki@nikki-VirtualBox:~$ lex relational.l
nikki@nikki-VirtualBox:~$ yacc -d relational.y
relational.y:18 parser name defined to default :"parse"
nikki@nikki-VirtualBox:~$ gcc lex.yy.c y.tab.c -w
nikki@nikki-VirtualBox:~$ ./a.out
3=5
Expression: 3
Error: parse error
```

```
nikki@nikki-VirtualBox:~$ gedit relational.l
nikki@nikki-VirtualBox:~$ gedit relational.y
nikki@nikki-VirtualBox:~$ lex relational.l
nikki@nikki-VirtualBox:~$ yacc -d relational.y
relational.y:18 parser name defined to default :"parse"
nikki@nikki-VirtualBox:~$ gcc lex.yy.c y.tab.c -w
nikki@nikki-VirtualBox:~$ ./a.out
3==5
Expression: 3
Expression: 5
Expression: 3 == 5
Success
```

CONCLUSION:

By executing the above program, we have successfully implemented Yacc program to check for relational operator.

EXPERIMENT NUMBER – 26

AIM: To improve code with the help of optimization techniques

DESCRIPTION: In this program, we try to implement a program to improve code with the help of any one of the optimization techniques

ALGORITHM:
Step-1: Start
Step-2: Start by defining the structures for op and pr with l and r as members, representing left and right sides of an assignment statement.
Step-3: Take input for the number of values n.
Step-4: Loop through n times and take input for left and right sides of the assignment statements, storing them in the op structure.
Step-5: Print the intermediate code by looping through op and displaying l and r values.
Step-6: Perform dead code elimination by looping through op and checking if the l value is present in the r value of other op structures. If present, store it in pr structure.
Step-7: Print the result of dead code elimination by looping through pr and displaying l and r values.
Step-8: Perform common expression elimination by looping through pr and checking if the r value of one pr structure is a substring of r value of other pr structures. If present, replace the common expression with the l value of the first pr structure.
Step-9: Print the result of common expression elimination by looping through pr and displaying l and r values.
Step-10: Finally, eliminate redundant assignments by looping through pr and checking for duplicate assignments with same l and r values. If found, mark the l value as '\0'.
Print the optimized code by looping through pr and displaying l and r values, excluding the ones with l value as '\0'.
Step-11: Stop.

PROGRAM:
```
#include<stdio.h>
#include<string.h>
struct op
{
	char l;
	char r[20];
}op[10],pr[10];
void main()
{
	int a,i,k,j,n,z=0,m,q;
	char *p,*l;
	char temp,t;
	char *tem;
	printf("Enter the Number of Values:");
	scanf("%d",&n);
	for(i=0;i<n;i++)
```

```
{
	printf("left: ");
	scanf(" %c",&op[i].l);
	printf("right: ");
	scanf(" %s",&op[i].r);
}
printf("Intermediate Code\n") ;
for(i=0;i<n;i++)
{
	printf("%c=",op[i].l);
	printf("%s\n",op[i].r);
}
for(i=0;i<n-1;i++)
{
	temp=op[i].l;
	for(j=0;j<n;j++)
	{
		p=strchr(op[j].r,temp);
		if(p)
		{
			pr[z].l=op[i].l;
			strcpy(pr[z].r,op[i].r);
			z++;
		}
	}
}
pr[z].l=op[n-1].l;
strcpy(pr[z].r,op[n-1].r);
z++;
printf("\nAfter Dead Code Elimination\n");
for(k=0;k<z;k++)
{
	printf("%c\t=",pr[k].l);
	printf("%s\n",pr[k].r);
}
for(m=0;m<z;m++)
{
	tem=pr[m].r;
	for(j=m+1;j<z;j++)
	{
		p=strstr(tem,pr[j].r);
		if(p)
		{
			t=pr[j].l;
			pr[j].l=pr[m].l;
			for(i=0;i<z;i++)
			{
```

```
                                        l=strchr(pr[i].r,t) ;
                                        if(l)
                                        {
                                                a=l-pr[i].r;
                                                printf("pos: %d\n",a);
                                                pr[i].r[a]=pr[m].l;
                                        }
                                }
                        }
                }
        }
        printf("Eliminate Common Expression\n");
        for(i=0;i<z;i++)
        {
                printf("%c\t=",pr[i].l);
                printf("%s\n",pr[i].r);
        }
        for(i=0;i<z;i++)
        {
                for(j=i+1;j<z;j++)
                {
                        q=strcmp(pr[i].r,pr[j].r);
                        if((pr[i].l==pr[j].l)&&!q)
                        {
                                pr[i].l='\0';
                        }
                }
        }
        printf("Optimized Code\n");
        for(i=0;i<z;i++)
        {
                if(pr[i].l!='\0')
                {
                        printf("%c=",pr[i].l);
                        printf("%s\n",pr[i].r);
                }
        }
}
```

OUTPUT:

```
Enter the Number of Values:5
left: a
right: 9
left: b
right: c+d
left: e
right: c+d
left: f
right: b+e
left: r
right: f
Intermediate Code
a=9
b=c+d
e=c+d
f=b+e
r=f

After Dead Code Elimination
b       =c+d
e       =c+d
f       =b+e
r       =f
pos: 2
Eliminate Common Expression
b       =c+d
b       =c+d
f       =b+b
r       =f
Optimized Code
b=c+d
f=b+b
r=f

--------------------------------
Process exited after 23.39 seconds with return value 4
Press any key to continue . . .
```

CONCLUSION:

By executing the above program, we have successfully implemented Optimization techniques

EXPERIMENT NUMBER – 27

AIM: To implement a standalone Scanner without lex tool. (Tokenization-by constructing DFA of lexical analyzer)

DESCRIPTION: This is a program in C language that implements a DFA (Deterministic Finite Automaton) for the lexical analysis of an input file. The program identifies the keywords, constants, and relational operators present in the file.

ALGORITHM:
Step-1: Initialize the state to 0 and the flag to 0.
Step-2: Read the input file character by character until the end of file is reached.
Step-3: Based on the current state and the input character, transition to the next state.
Step-4: If a final state is reached, output the corresponding token (keyword, constant, or relational operator) and transition back to state 0.
Step-5: If the end of file is reached, set the flag to 1 and exit the loop.
Step-6: Close the input file.

PROGRAM:
```
#include<stdio.h>
#include<stdlib.h>
#include<string.h>
#include<ctype.h>
void main()
{
   int state=0,flag=0,i,p=0,id=0;
   char
ch,word[20],kw[20][20]={"int","float","char","long","double","if","else","for","while","void",
"do","switch","case","break"};
   FILE *f;
   f=fopen("input.txt","r");
   while(flag!=1)
   {
      switch(state)
      {
         case 0:
            ch=fgetc(f);
            if(isalnum(ch))
               if(isalpha(ch))
                  state=11;
               else
                  state=13;
            else if(ch=='<')
               state=1;
            else if(ch=='>')
               state=4;
            else if(ch=='!')
```

```
            state=7;
        else if(ch=='=')
            state=9;
        break;
    case 1:
        ch=fgetc(f);
        if(ch=='=')
            state=2;
        else
            state=3;
        break;
    case 2:
        printf("\n'<=' is a relational operator.");
        state=0;
        break;
    case 3:
        fseek(f,-1,SEEK_CUR);
        printf("\n'<' is a relational operator.");
        state=0;
        break;
    case 4:
        ch=fgetc(f);
        if(ch=='=')
            state=5;
        else
            state=6;
        break;
    case 5:
        printf("\n'>=' is a relational operator.");
        state=0;
        break;
    case 6:
        fseek(f,-1,SEEK_CUR);
        printf("\n'>' is a relational operator.");
        state=0;
        break;
    case 7:
        ch=fgetc(f);
        if(ch=='=')
            state=8;
        else
        {
            fseek(f,-1,SEEK_CUR);
            state=0;
        }
        break;
    case 8:
```

```
    printf("\n'!=' is a relational operator.");
    state=0;
    break;
case 9:
    ch=fgetc(f);
    if(ch=='=')
        state=8;
    else
    {
        fseek(f,-1,SEEK_CUR);
        state=0;
    }
    break;
case 10:
    printf("\n'==' is a relational operator.");
    state=0;
    break;
case 11:
    word[p++]=ch;
    while(isalnum(ch=fgetc(f)))
        word[p++]=ch;
    fseek(f,-1,SEEK_CUR);
    word[p]='\0';
    state=12;
    p=0;
    break;
case 12:
    for(i=0;i<14;i++)
        if(strcmp(kw[i],word)==0)
        {
            printf("\n%s is a keyword.",word);
            id=1;
            break;
        }
    if(id==0)
        printf("\n%s is an identifier.",word);
    state=0;
    id=0;
    break;
case 13:
    word[p++]=ch;
    while(isdigit(ch=fgetc(f)))
        word[p++]=ch;
    fseek(f,-1,SEEK_CUR);
    word[p]='\0';
    state=14;
    p=0;
```

```
            break;
        case 14:
            printf("\n%s is a constant.",word);
            state=0;
            break;
        default:
            break;
    }
    if(ch==EOF)
        flag=1;
  }
  fclose(f);
}
```

input.txt:

int i = 1;

OUTPUT:

```
int is a keyword.
i is an identifier.
1 is a constant.
--------------------------------
Process exited after 0.02435 seconds with return value 0
Press any key to continue . . .
```

CONCLUSION:

By executing the above program, we have successfully implemented a standalone Scanner without lex tool. (Tokenization-by constructing DFA of lexical analyzer).

EXPERIMENT NUMBER – 28

AIM: To implement a parser for small language.

DESCRIPTION: In this program, we try to implement a parser for LISP language.

ALGORITHM:
Step 1: Start by defining the grammar rules of the language that the parser will be parsing.
Step 2: Create a lexical analyzer (also known as a lexer or scanner) that will read in the input code and tokenize it according to the grammar rules.
Step 3: Create a parser that will use the tokens generated by the lexer to construct a parse tree. The parse tree represents the structural relationship between the different parts of the code.
Step 4: Use a stack-based approach to parse the input code. The parser will push the tokens onto the stack and use a set of rules to determine how to reduce the input code into a parse tree.
Step 5: Implement error handling mechanisms to detect and recover from syntax errors in the input code.
Step 6: Once the parse tree has been constructed, the parser may do additional processing to generate intermediate code or perform semantic analysis.
Step 7: Finally, the parser may output the result of its processing in some form, such as machine code or a high-level representation of the input code.

PROGRAM:
```
def generate_AST(string):
 number_symbols = ['0', '1', '2', '3', '4', '5', '6', '7', '8', '9', '.', '-']
 ind = 1
 arr_to_return = []
 while ind < len(string):
  char = string[ind]
  if char == "(":
   open_cnt = 1
   closed_cnt = 0
   sub_str = "("
   for c in string[ind + 1:]:
    if c == "(": open_cnt += 1
    if c == ")": closed_cnt += 1
    sub_str += c
    if open_cnt == closed_cnt: break
   arr_to_return.append(generate_AST(sub_str))
   ind += len(sub_str)
  elif char == " " or char == ")":
   ind += 1
  else:
   stop_ind = string.find(" ", ind)
   if stop_ind == -1:
    stop_ind = string.find(")", ind)
```

```
    s = string[ind:stop_ind]
    if all(x in number_symbols for x in list(s)):
      if s.find('-', 1) == -1:
        num = float(s)
        arr_to_return.append(num)
    else:
      arr_to_return.append(s)
    ind = stop_ind + 1
  return arr_to_return


if __name__ == "__main__":
  ip = "(first (list -1.5 (+ 2 3) 9))" # lisp
  print("Input(LISP):", ip)
  print("Output (AST):", generate_AST(ip))
```

OUTPUT:

```
● ~/.../lab/cd-lablast ᛋ  python lisp_ast.py
  Input(LISP): (first (list -1.5 (+ 2 3) 9))
  Output (AST): ['first', ['list', -1.5, ['+', 2.0, 3.0], 9.0]]
```

CONCLUSION:
By executing the above program, we have successfully implemented a parser for small language.