

VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“JnanaSangama”, Belgaum -590014, Karnataka.



LAB REPORT on COMPILER DESIGN

Submitted by

NAGALAKSHMAN B S (1BM22CS410)

Under the Guidance of
Prof. Latha R
Assistant Professor,
BMSCE

in partial fulfilment for the award of the degree of
BACHELOR OF ENGINEERING
in
COMPUTER SCIENCE AND ENGINEERING



B.M.S. COLLEGE OF ENGINEERING

(Autonomous Institution under VTU)

BENGALURU-560019

November 2023-February 2024

**B. M. S. College of Engineering,
Bull Temple Road, Bangalore 560019
(Affiliated To Visvesvaraya Technological University, Belgaum)
Department of Computer Science and Engineering**



CERTIFICATE

This is to certify that the Lab work entitled “**Compiler Design**” carried out by **Nagalakshman BS(1BM22CS410)**, who is bonafide student of **B. M. S. College of Engineering**. It is in partial fulfilment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2023-24.

The Lab report has been approved as it satisfies the academic requirements in respect of **Compiler Design- (22CS5PCCPD)** work prescribed for the said degree.

Prof. Latha R
Assistant professor
Department of CSE
BMSCE, Bengaluru

Dr. Jyothi Nayak
Professor and Head
Department of CSE
BMSCE, Bengaluru

B. M. S. COLLEGE OF ENGINEERING
DEPARTMENT OF COMPUTER SCIENCE AND
ENGINEERING



DECLARATION

I, Nagalakshman BS(1BM22CS410), student of 5th Semester, B.E, Department of Computer Science and Engineering, B. M. S. College of Engineering, Bangalore, here by declare that, this lab report entitled " **Compiler Design**" has been carried out by me under the guidance of Prof. Latha R, Assistant Professor, Department of CSE, B. M. S. College of Engineering, Bangalore during the academic semester November-2023-February-2024.

I also declare that to the best of my knowledge and belief, the development reported here is not from part of any other report by any other students.

TABLE OF CONTENTS

Lab No	Title	Page No
1		6-8
1.1	Write a program in LEX to recognize different tokens: Keywords, Identifiers, Constants, Operators and Punctuation symbols.	6
1.2	Write a program in LEX to count the number of characters and digits in a string.	7
	Write a program in LEX to count the number of vowels and consonants in a string.	8
2		9-15
2.1	Write a program in lex to count the number of words in a sentence.	9
2.2	Write a program in lex to demonstrate regular definition.	10
2.3	Write a program in lex to identify tokens in a program by taking input from a file and printing the output on the terminal.	11-12
2.4	Write a program in lex to identify tokens in a program by taking input from a file and printing the output in another file.	13-14
2.5	Write a program in lex to find the length of the input string.	15
3		16-23
3.1	Write a program in LEX to recognize Floating Point Numbers.	16
3.2	Read and input sentence, and check if it is compound or simple. If a sentence has the word- and , or ,but ,because ,if ,then ,nevertheless then it is compound else it is simple.	17
3.3	Write a program to check if the input sentence ends with any of the following punctuation marks (? , fullstop , !)	18-19
3.4	Write a program to read an input sentence and to check if the sentence begins with English articles (A, a,AN,An,THE and The).	20-21
3.5	Lex program to count the number of comment lines (multi line comments or single line) in a program. Read the input from a file called input.txt and print the count in a file called output.txt.	22
3.6	Write a program to read and check if the user entered number is signed or unsigned using appropriate meta character.	23
4		24-36
4.1	Write a LEX program that copies a file, replacing each nonempty sequence of white spaces by a single blank.	24-25
4.2	Write a LEX program to recognize the following tokens over the alphabets {0,1,...,9}	26-36

4.2.1	The set of all string ending in 00.	26
4.2.2	The set of all strings with three consecutive 222's.	27
4.2.3	The set of all string such that every block of five consecutive symbols contains at least two 5's.	28-29
4.2.4	The set of all strings beginning with a 1 which, interpreted as the binary representation of an integer, is congruent to zero modulo 5.	30-31
4.2.5	The set of all strings such that the 10th symbol from the right end is 1.	32
4.2.6	The set of all four digits numbers whose sum is 9.	33-34
4.2.7	The set of all four digital numbers, whose individual digits are in ascending order from left to right.	35-36
5		37-38
5.1	Write a C program to design lexical analysis to recognize any five keywords, identifiers, numbers, operators and punctuations.	37-38
6		39-40
6.1	Write a program to perform recursive descent parsing on the following grammar: S->cAd A->ab a	39-40
7		41-47
7.1	Write a program in YACC to design a suitable grammar for evaluation of arithmetic expression having +, -, * and /.	41-42
7.2	Write a program in YACC to recognize strings of the form $\{(a^n)b, n \geq 5\}$.	43-44
7.3	Write a program in YACC to generate a syntax tree for a given arithmetic expression.	45-47
8		48-49
8.1	Write a program in YACC to convert infix to postfix expression.	48-49
9		50-52
9.1	Write a program in YACC to generate three address code for a given expression.	50-52

Lab 1

1.1 Write a program in LEX to recognize different tokens: Keywords, Identifiers, Constants, Operators and Punctuation symbols.

Code:

```
% {
#include<stdio.h>

% }

%%

printf(for|void|main|while|do|switch|case|int|char|float|double|if|else {printf("%s-keyword\n",yytext);
, {printf("%s-separator\n",yytext);}
; {printf("%s-delimiter\n",yytext);}

[a-zA-Z_][a-zA-Z0-9_]* {printf("%s-Identifier\n",yytext);}

">"|"<"|">="|"<="|"==" {printf("%s- Relational operator\n",yytext);}

"=" {printf("%s-assignment operator\n",yytext);}

[0-9]+ {printf("%s-digit\n",yytext);}

%%

void main()
{
printf("Give an input:\n");

yylex();

}

int yywrap()
{

return 1;

}
```

Output

```
● lakshman@MARVEL:~/codes$ flex lab1a.1
● lakshman@MARVEL:~/codes$ gcc lex.yy.c
○ lakshman@MARVEL:~/codes$ ./a.out
Give an input:
int sum,x=2,y=3,z;
int-keyword
sum-Identifier
,-separator
x-Identifier
=-Assignment operator
2-Digit
,-separator
y-Identifier
=-Assignment operator
3-Digit
,-separator
z-Identifier
;-delimiter
```

1.2 Write a program in LEX to count the number of characters and digits in a string.

Code

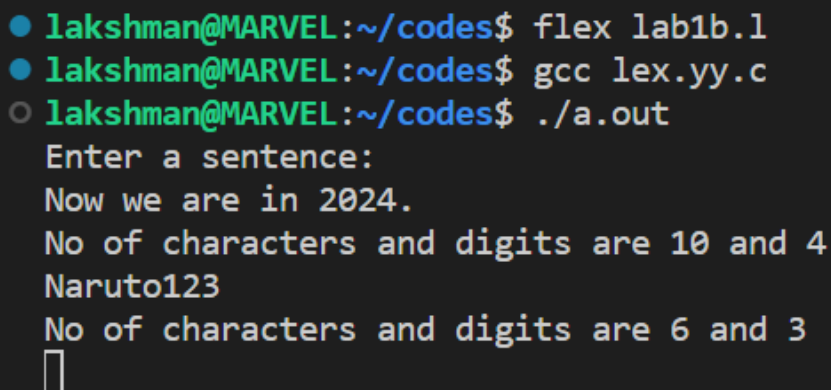
```
% {
#include<stdio.h>
int d=0,c=0;
% }
%%
[a-zA-Z] {c++;}
[0-9] {d++;}
. ;

\n {printf("No of characters and digits are %d and %d\n",c,d),c=0,d=0;}
%%

void main()
{
printf("Enter a sentence:\n");
yylex();
}

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

Output



```
● lakshman@MARVEL:~/codes$ flex lab1b.l
● lakshman@MARVEL:~/codes$ gcc lex.yy.c
○ lakshman@MARVEL:~/codes$ ./a.out
Enter a sentence:
Now we are in 2024.
No of characters and digits are 10 and 4
Naruto123
No of characters and digits are 6 and 3
█
```

1.3 Write a program in LEX to count the number of vowels and consonants in a string.

Code

```
% {  
#include<stdio.h>  
int v=0,c=0;  
% }  
%%  
  
[AEIOUaeiou] {v++;}  
[A-Za-z] {c++;}  
  
\n {printf("No of vowels and consonants are %d and %d\n",v,c),v=0,c=0;}  
%%  
  
void main()  
{  
printf("Enter a sentence:\n");  
yylex();  
}  
  
int yywrap()  
{  
return 1;  
}
```

Output

```
● lakshman@MARVEL:~/codes$ flex lab1c.l  
● lakshman@MARVEL:~/codes$ gcc lex.yy.c  
○ lakshman@MARVEL:~/codes$ ./a.out  
Enter a sentence:  
Computer Science  
No of vowels and consonants are 6 and 9  
Anime  
No of vowels and consonants are 3 and 2  
□
```

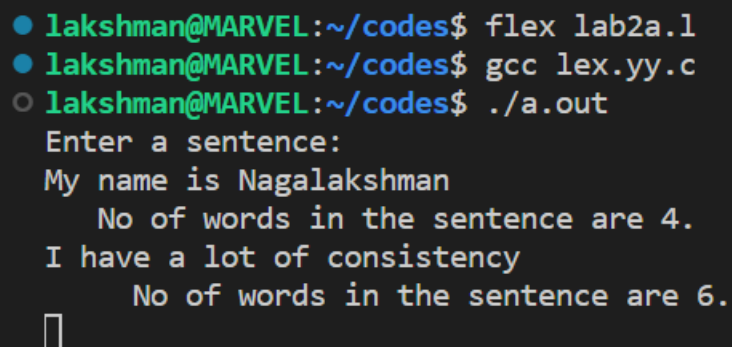

Lab 2

2.1 Write a program in lex to count the number of words in a sentence.

Code

```
% {  
#include<stdio.h>  
  
int words;  
  
% }  
  
%%  
  
[^\t\n ]+ { words++;}  
  
\n {printf("No of words in the sentence are %d.\n",words),words=0;}  
  
%%  
  
void main()  
{  
printf("Enter a sentence:\n");  
yylex();  
}  
  
int yywrap()  
{  
return 1;  
}
```

Output



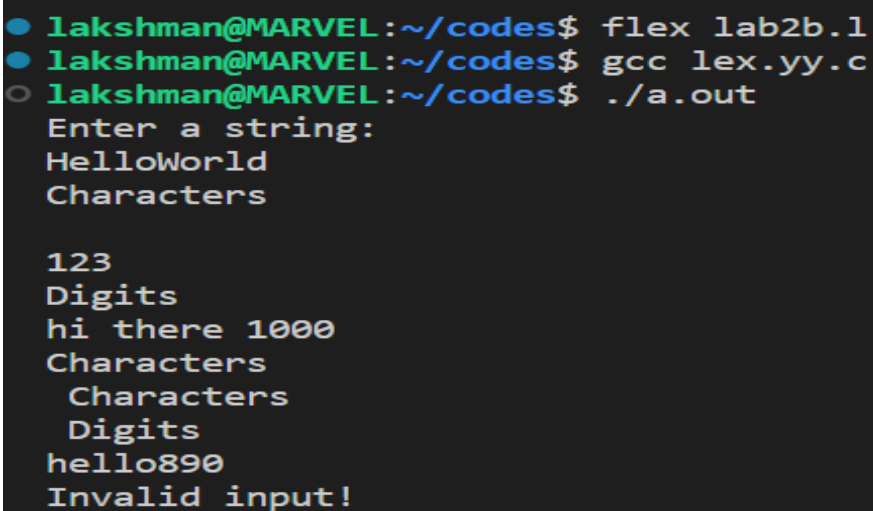
```
● lakshman@MARVEL:~/codes$ flex lab2a.1  
● lakshman@MARVEL:~/codes$ gcc lex.yy.c  
○ lakshman@MARVEL:~/codes$ ./a.out  
Enter a sentence:  
My name is Nagalakshman  
    No of words in the sentence are 4.  
I have a lot of consistency  
    No of words in the sentence are 6.  
□
```

2.2 Write a program in lex to demonstrate regular definition.

Code

```
% {  
#include<stdio.h>  
% }  
  
alpha [a-zA-Z0-9]  
%%  
[a-zA-Z]+ {printf("Characters\n");}  
[0-9]+ {printf("Digits");}  
{alpha}+ {printf("Invalid input!\n");}  
%%  
  
void main()  
{  
printf("Enter a string:\n");  
yylex();  
}  
  
int yywrap()  
{  
return 1;  
}
```

Output



```
● lakshman@MARVEL:~/codes$ flex lab2b.1  
● lakshman@MARVEL:~/codes$ gcc lex.yy.c  
○ lakshman@MARVEL:~/codes$ ./a.out  
Enter a string:  
HelloWorld  
Characters  
  
123  
Digits  
hi there 1000  
Characters  
Characters  
Digits  
hello890  
Invalid input!
```



2.3 Write a program in lex to identify tokens in a program by taking input from a file and printing the output on the terminal.

Code

```
% {  
#include<stdio.h>  
  
% }  
%%  
  
char|int|float {printf("%s is a keyword.\n",yytext);}  
[a-zA-Z][a-zA-Z0-9]* {printf("%s is an identifier.\n",yytext);}  
, {printf("%s is a separator.\n",yytext);}  
; {printf("%s is a delimiter.\n",yytext);}  
"=" {printf("%s is an assignment operator.\n",yytext);}  
"+"|"-"|"*"|"/" {printf("%s is a binary operator.\n",yytext);}  
[0-9]+ {printf("%s is/are digit(s).\n",yytext);}  
  
\n ;  
%%  
  
void main()  
{  
yyin=fopen("input.txt","r");  
yylex();  
fclose(yyin);  
}  
  
int yywrap()  
{  
return 1;  
}
```

Output

input.txt

```
1  int sum,x=2,y=3;
2  sum=x+y;
```

PROBLEMS

OUTPUT

DEBUG CONSOLE

TERMINAL

PORTS

```
● lakshman@MARVEL:~/codes$ flex lab2c.l
● lakshman@MARVEL:~/codes$ gcc lex.yy.c
● lakshman@MARVEL:~/codes$ ./a.out
int is a keyword.
sum is an identifier.
, is a separator.
x is an identifier.
= is an assignment operator.
2 is/are digit(s).
, is a separator.
y is an identifier.
= is an assignment operator.
3 is/are digit(s).
; is a delimiter.
sum is an identifier.
= is an assignment operator.
x is an identifier.
+y is an identifier.
; is a delimiter.
○ lakshman@MARVEL:~/codes$
```

2.4 Write a program in lex to identify tokens in a program by taking input from a file and printing the output in another file.

Code

```
% {  
#include<stdio.h>  
  
% }  
%%  
  
char|int|float { fprintf(yyout,"%s is a keyword.\n",yytext);}  
[a-zA-Z][a-zA-Z0-9]* { fprintf(yyout,"%s is an identifier.\n",yytext);}  
, { fprintf(yyout,"%s is a separator.\n",yytext);}  
; { fprintf(yyout,"%s is a delimiter.\n",yytext);}  
"=" { fprintf(yyout,"%s is an assignment operator.\n",yytext);}  
"+"|"-"|"*"|" "/" { fprintf(yyout,"%s is a binary operator.\n",yytext);}  
[0-9]+ { fprintf(yyout,"%s is/are digit(s).\n",yytext);}  
  
\n ;  
%%  
  
void main()  
{  
yyin=fopen("input.txt","r");  
yyout=fopen("output.txt","w");  
yylex();  
printf("Printed in output.txt\n");  
fclose(yyin);  
fclose(yyout);  
}  
  
int yywrap()  
{  
return 1;  
}
```

Output

input.txt

```
1  int sum,x=2,y=3;
2  sum=x+y;
```

output.txt

```
1  int is a keyword.
2  sum is an identifier.
3  , is a separator.
4  x is an identifier.
5  = is an assignment operator.
6  2 is/are digit(s).
7  , is a separator.
8  y is an identifier.
9  = is an assignment operator.
10 3 is/are digit(s).
11 ; is a delimiter.
12 sum is an identifier.
13 = is an assignment operator.
14 x is an identifier.
15 + is a binary operator.
16 y is an identifier.
17 ; is a delimiter.
18
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

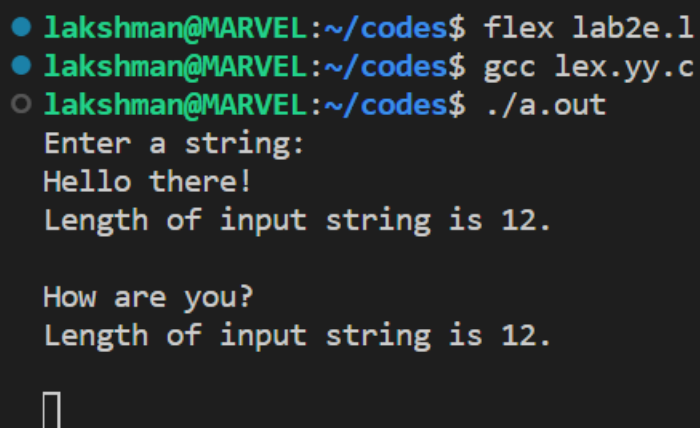
```
● lakshman@MARVEL:~/codes$ flex lab2d.l
● lakshman@MARVEL:~/codes$ gcc lex.yy.c
● lakshman@MARVEL:~/codes$ ./a.out
Printed in output.txt
○ lakshman@MARVEL:~/codes$
```

2.5 Write a program in lex to find the length of the input string.

Code

```
%{  
#include<stdio.h>  
%}  
%%  
[a-zA-Z0-9.,!? \t]+ {printf("Length of input string is %d.\n",yyleng);}   
%%  
void main()  
{  
printf("Enter a string:\n");  
yylex();  
}  
int yywrap()  
{  
return 1;  
}
```

Output



```
● lakshman@MARVEL:~/codes$ flex lab2e.l  
● lakshman@MARVEL:~/codes$ gcc lex.yy.c  
○ lakshman@MARVEL:~/codes$ ./a.out  
Enter a string:  
Hello there!  
Length of input string is 12.  
  
How are you?  
Length of input string is 12.  
█
```

Lab 3

3.1 Write a program in LEX to recognize Floating Point Numbers.

Code

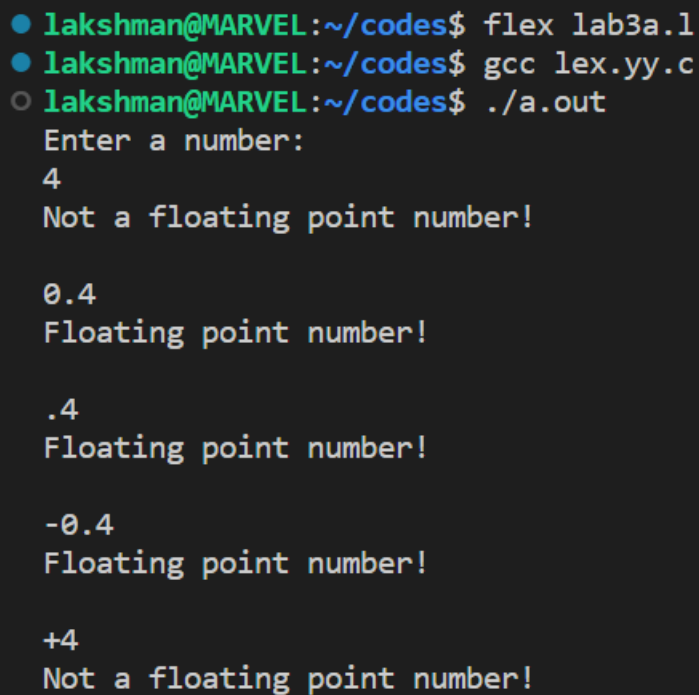
```
% {
#include<stdio.h>
% }
%%

[+-]?[0-9]*[.][0-9][0-9]* {printf("Floating point number!\n");}
[+-]?[0-9][0-9]* {printf("Not a floating point number!\n");}
%%

int yywrap()
{
return 1;
}

void main()
{
printf("Enter a number:\n");
yylex();
}
```

Output



```
● lakshman@MARVEL:~/codes$ flex lab3a.1
● lakshman@MARVEL:~/codes$ gcc lex.yy.c
○ lakshman@MARVEL:~/codes$ ./a.out
Enter a number:
4
Not a floating point number!

0.4
Floating point number!

.4
Floating point number!

-0.4
Floating point number!

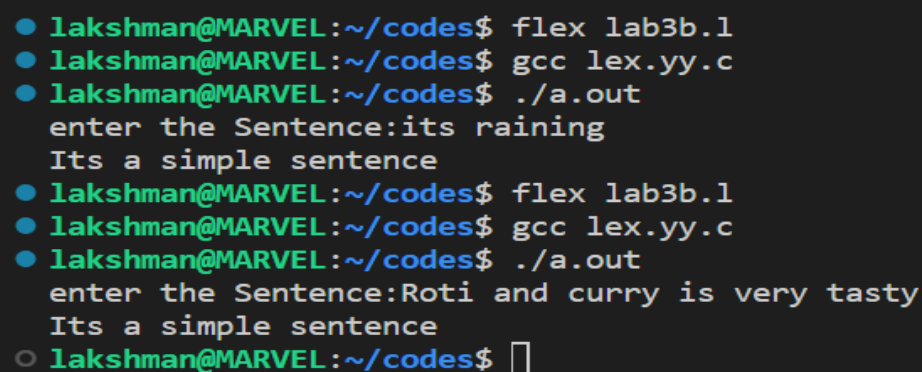
+4
Not a floating point number!
```


3.2 Read and input sentence, and check if it is compound or simple. If a sentence has the word- and , or ,but ,because ,if ,then ,nevertheless then it is compound else it is simple.

Code

```
% {  
#include<stdio.h>  
  
int flag=0;  
  
% }  
%%  
  
if[then|but|because|nevertheless|and|or {flag=1;}  
  
.;  
  
\n {return 0;}  
  
%%  
  
int yywrap()  
{  
return 1;  
}  
  
void main()  
{  
printf("Enter a sentence:\n");  
yylex();  
if(flag==1)  
printf("Compound sentence!\n");  
else  
printf("Simple sentence!\n");  
}
```

Output



```
● lakshman@MARVEL:~/codes$ flex lab3b.l  
● lakshman@MARVEL:~/codes$ gcc lex.yy.c  
● lakshman@MARVEL:~/codes$ ./a.out  
enter the Sentence:its raining  
Its a simple sentence  
● lakshman@MARVEL:~/codes$ flex lab3b.l  
● lakshman@MARVEL:~/codes$ gcc lex.yy.c  
● lakshman@MARVEL:~/codes$ ./a.out  
enter the Sentence:Roti and curry is very tasty  
Its a simple sentence  
○ lakshman@MARVEL:~/codes$
```

3.3 Write a program to check if the input sentence ends with any of the following punctuation marks (? , fullstop , !)

Code

```
% {  
#include<stdio.h>  
int flag=0;  
% }  
%%  
.*[?!|.]$ {flag=1;}  
.* {flag=0;}  
\n {return 0;}  
%%  
int yywrap()  
{  
return 1;  
}  
void main()  
{  
printf("Enter a sentence:\n");  
yylex();  
if(flag==1)  
printf("Ends with a punctuation!\n");  
else  
printf("Does not end with punctuation!\n");  
}
```

Output

```
● lakshman@MARVEL:~/codes$ flex lab3c.l
● lakshman@MARVEL:~/codes$ gcc lex.yy.c
⊗ lakshman@MARVEL:~/codes$ ./a.out
Enter the sentence:
I like bikes.
This sentence ends with punctuation marks
^C
● lakshman@MARVEL:~/codes$ flex lab3c.l
● lakshman@MARVEL:~/codes$ gcc lex.yy.c
⊗ lakshman@MARVEL:~/codes$ ./a.out
Enter the sentence:
Very Excited!
This sentence ends with punctuation marks
^C
● lakshman@MARVEL:~/codes$ flex lab3c.l
● lakshman@MARVEL:~/codes$ gcc lex.yy.c
○ lakshman@MARVEL:~/codes$ ./a.out
Enter the sentence:
Hi
This sentence doesnt ends with punctuation marks
□
```

3.4 Write a program to read an input sentence and to check if the sentence begins with English articles (A, a,AN,An,THE and The).

Code

```
% {  
#include<stdio.h>  
int flag=0;  
% }  
%%  
^(an|An|The|the|A|a)[ " ].* {flag=1;}  
.* {flag=0;}  
\n {return 0;}  
%%  
int yywrap()  
{  
return 1;  
}  
void main()  
{  
printf("Enter a sentence:\n");  
yylex();  
if(flag==1)  
printf("Starts with an article!\n");  
else  
printf("Does not start with an article!\n");  
}
```

Output

```
● lakshman@MARVEL:~/codes$ flex lab3d.l
● lakshman@MARVEL:~/codes$ gcc lex.yy.c
● lakshman@MARVEL:~/codes$ ./a.out
enter the Sentence:Hello there.
This sentence doesn't begins with article
● lakshman@MARVEL:~/codes$ flex lab3d.l
● lakshman@MARVEL:~/codes$ gcc lex.yy.c
● lakshman@MARVEL:~/codes$ ./a.out
enter the Sentence:a car
This sentence begins with article
○ lakshman@MARVEL:~/codes$ █
```

3.5 Lex program to count the number of comment lines (multi line comments or single line) in a program. Read the input from a file called input.txt and print the count in a file called output.txt.

Code

```
%{
#include<stdio.h>

int c=0;

%}

%%

"\\"["^"]*\*+([^\*]["^"]*\*+)*\ / {c++;}

"/".* {c++;}

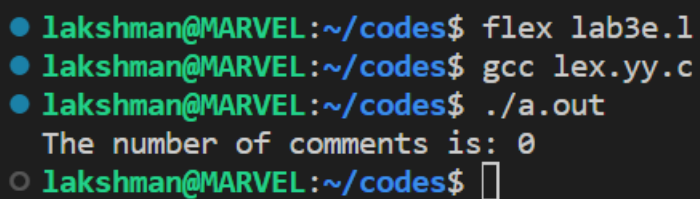
. ECHO;

%%

int yywrap()
{
return 1;
}

void main()
{
yyin=fopen("input.txt","r");
yyout=fopen("output.txt","w");
yylex();
printf("The number of comments are:%d\n",c);
fclose(yyin);
fclose(yyout);
}
```

Output



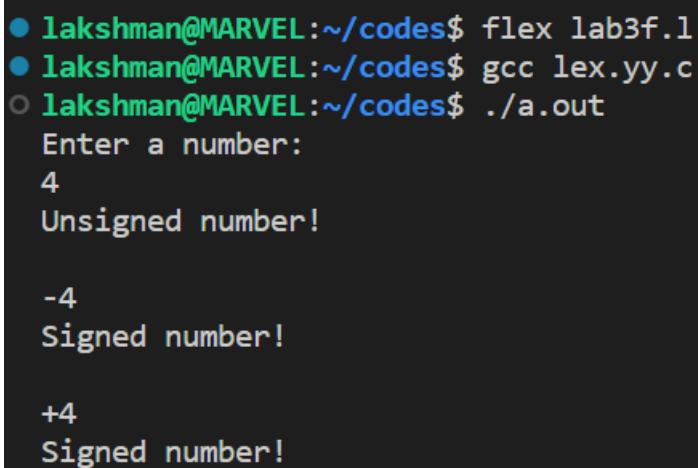
```
● lakshman@MARVEL:~/codes$ flex lab3e.1
● lakshman@MARVEL:~/codes$ gcc lex.yy.c
● lakshman@MARVEL:~/codes$ ./a.out
  The number of comments is: 0
○ lakshman@MARVEL:~/codes$
```

3.6 Write a program to read and check if the user entered number is signed or unsigned using appropriate meta character.

Code

```
%{  
#include<stdio.h>  
%}  
%%  
[+|-][0-9]+ {printf("Signed number!\n");}  
[0-9]+ {printf("Unsigned number!\n");}  
%%  
  
int yywrap()  
{  
return 1;  
}  
  
void main()  
{  
printf("Enter a number:\n");  
yylex();  
}
```

Output



```
● lakshman@MARVEL:~/codes$ flex lab3f.l  
● lakshman@MARVEL:~/codes$ gcc lex.yy.c  
○ lakshman@MARVEL:~/codes$ ./a.out  
Enter a number:  
4  
Unsigned number!  
  
-4  
Signed number!  
  
+4  
Signed number!
```

Lab 4

4.1 Write a LEX program that copies a file, replacing each nonempty sequence of white spaces by a single blank.

Code

```
% {
#include<stdio.h>

% }

%%

[ \t]+ {fprintf(yyout," ");}
.|\\n {fprintf(yyout,"%s",yytext);}

%%

void main()
{
yyin=fopen("text.txt","r");
yyout=fopen("print.txt","w");
yylex();
fclose(yyin);
fclose(yyout);
printf("Printed!\\n");
}

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


Output

```
text.txt
1  Hello      World
2  This is a  lex      program
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

```
● lakshman@MARVEL:~/codes$ flex lab4a.1
● lakshman@MARVEL:~/codes$ gcc lex.yy.c
⊗ lakshman@MARVEL:~/codes$ ./a.out
Printed!
○ lakshman@MARVEL:~/codes$
```

```
print.txt
1  Hello World
2  This is a lex program
```

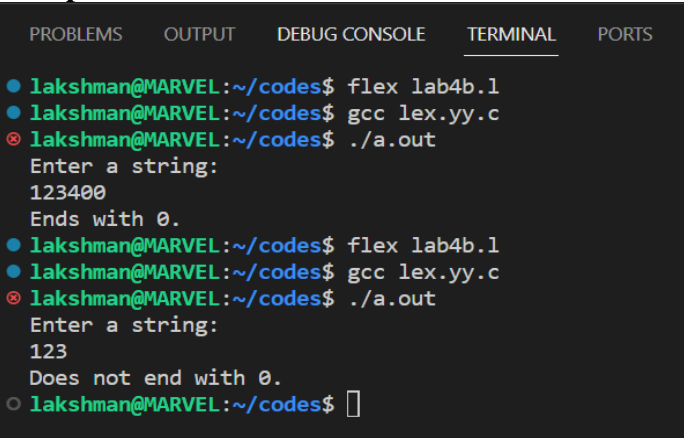
4.2 Write a LEX program to recognize the following tokens over the alphabets {0,1,...,9}

4.2.1 The set of all string ending in 00.

Code

```
%{  
  
#include<stdio.h>  
  
int flag=0;  
  
%}  
  
%%  
  
[0-9]+[00] {flag=1;}  
  
.;  
  
\n {return 0;}  
  
%%  
  
void main()  
{  
  
printf("Enter a string:\n");  
  
yylex();  
  
if(flag==1)  
  
printf("Ends with 0.\n");  
  
else  
  
printf("Does not end with 0.\n");  
  
}  
  
int yywrap()  
{  
  
return 1;  
  
}
```

Output



```
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS  
lakshman@MARVEL:~/codes$ flex lab4b.1  
lakshman@MARVEL:~/codes$ gcc lex.yy.c  
lakshman@MARVEL:~/codes$ ./a.out  
Enter a string:  
123400  
Ends with 0.  
lakshman@MARVEL:~/codes$ flex lab4b.1  
lakshman@MARVEL:~/codes$ gcc lex.yy.c  
lakshman@MARVEL:~/codes$ ./a.out  
Enter a string:  
123  
Does not end with 0.  
lakshman@MARVEL:~/codes$
```

4.2.2 The set of all strings with three consecutive 222's.

Code

```
%{
#include<stdio.h>

int flag=0;

%}

%%

[0-9]*[2][2][2][0-9]* {flag=1;}

.;

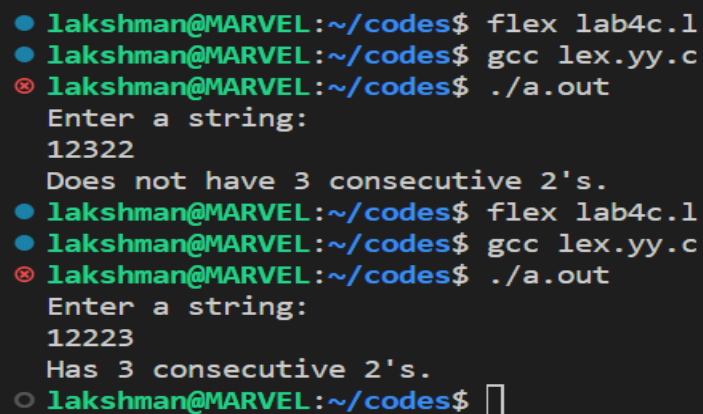
\n {return 0;}

%%

void main()
{
printf("Enter a string:\n");
yylex();
if(flag==1)
printf("Has 3 consecutive 2's.\n");
else
printf("Does not have 3 consecutive 2's.\n");
}

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

Output



```
● lakshman@MARVEL:~/codes$ flex lab4c.1
● lakshman@MARVEL:~/codes$ gcc lex.yy.c
⊗ lakshman@MARVEL:~/codes$ ./a.out
Enter a string:
12322
Does not have 3 consecutive 2's.
● lakshman@MARVEL:~/codes$ flex lab4c.1
● lakshman@MARVEL:~/codes$ gcc lex.yy.c
⊗ lakshman@MARVEL:~/codes$ ./a.out
Enter a string:
12223
Has 3 consecutive 2's.
○ lakshman@MARVEL:~/codes$
```

4.2.3 The set of all string such that every block of five consecutive symbols contains at least two 5's.

Code

```
% {
#include<stdio.h>

int i,count=0,flag;

% }

%%

.{1,5} {flag=0;
for(i=0;i<5;i++)
{
    int c=yytext[i]-'0';
    if(c==5)
    {
        count++;
        if(count==2)
        {
            flag=1;
            break;
        }
    }
}
count=0;
printf("yytext:%s,flag(1 if no of 5 is atleast 2):%d\n",yytext,flag);
if(flag!=1)
{
    printf("Not a valid string!\n");
    return 0;
}
}

\n {return 0;}

%%

void main()
```

```
{  
printf("Enter a string:\n");  
yylex();  
if(flag==1)  
printf("Valid string.\n");  
}  
int yywrap()  
{  
return 1;  
}
```

Output

```
Enter a string:  
1525558566  
yytext:15255,flag(1 if no of 5 is atleast 2):1  
yytext:58566,flag(1 if no of 5 is atleast 2):1  
Valid string.
```

4.2.4 The set of all strings beginning with a 1 which, interpreted as the binary representation of an integer, is congruent to zero modulo 5.

Code

```
% {
#include<stdio.h>

int c,i,flag=1,sum=0,power=1;

% }

%%

^1[01]* {for(i=yytext[0];i<yytext[1];i++)
    {
        c=yytext[i]-'0';
        sum+=c*power;
        power*=2;
    }
    printf("Decimal representation:%d\n",sum);
    if(sum%5!=0)
    {
        printf("Not congruent to modulo 5.\n");
        sum=0;
        power=1;
    }
    else
    {
        printf("Congruent to modulo 5.\n");
        sum=0;
        power=1;
    }
}

.* {printf("Not a binary number.\n");}


\n {return 0;}

%%

void main()
{
printf("Enter a string:\n");
```

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

Output

A terminal window with a dark purple background and light green text. It shows the program's execution: a prompt 'Enter a string:', the input '1010', and the output 'Decimal representation:10' and 'Congruent to modulo 5.'

```
Enter a string:  
1010  
Decimal representation:10  
Congruent to modulo 5.
```

4.2.5 The set of all strings such that the 10th symbol from the right end is 1.

Code

```
%{
#include<stdio.h>

int flag=0;

%}

%%

[0-9]*1[0-9][0-9][0-9][0-9][0-9][0-9][0-9][0-9] {flag=1;}

. ;


\n {return 0;}

%%

void main()
{
printf("Enter a string:\n");
yylex();
if(flag==1)
printf("10th symbol from right is 1.\n");
else
printf("10th symbol from right is not 1.\n");
}

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

Output



```
Enter a string:
11234345236
10th symbol from right is 1.
```


4.2.6 The set of all four digits numbers whose sum is 9.

Code

```
% {
#include<stdio.h>
int sum=0,i,flag=0;
% }
%%
[0-9][0-9][0-9][0-9] {for(i=0;i<yyleng;i++)
    {
        sum+=yytext[i]-'0';
    }
    if(sum==9)
    {
        flag=1;
        sum=0;
    }
    else
    {
        flag=0;
        sum=0;
    }
}
\n {return 0;}
%%
void main()
{
printf("Enter a string:\n");
yylex();
if(flag==1)
printf("The sum of digits is 9.\n");
else
printf("The sum of digits is not 9.\n");
}
int yywrap()
```

```
{  
return 1;  
}
```

Output

```
● lakshman@MARVEL:~/codes$ flex lab4f.1  
● lakshman@MARVEL:~/codes$ gcc lex.yy.c  
⊗ lakshman@MARVEL:~/codes$ ./a.out  
Enter four-digit numbers:  
1234  
1234 is not 9 when added, its digit sum is 10  
^C  
● lakshman@MARVEL:~/codes$ flex lab4f.1  
● lakshman@MARVEL:~/codes$ gcc lex.yy.c  
○ lakshman@MARVEL:~/codes$ ./a.out  
Enter four-digit numbers:  
3303  
3303 is a four-digit number whose sum of digits is 9  
□
```

4.2.7 The set of all four digital numbers, whose individual digits are in ascending order from left to right.

Code

```
% {  
#include<stdio.h>  
  
int c,i,flag=1;  
  
% }  
  
%%  
[0-9][0-9][0-9][0-9] {for(i=0;i<yytext[0];i++)  
    {  
        if(yytext[i]>=yytext[i+1])  
        {  
            flag=0;  
            break;  
        }  
    }  
}  
  
\n {return 0;}  
  
%%  
  
void main()  
{  
printf("Enter a string:\n");  
yylex();  
if(flag==1)  
printf("The digits are in ascending order.\n");  
else  
printf("The digits are not in ascending order.\n");  
}  
  
int yywrap()  
{  
return 1;  
}
```

Output

```
● lakshman@MARVEL:~/codes$ flex lab4e.1
● lakshman@MARVEL:~/codes$ gcc lex.yy.c
⊗ lakshman@MARVEL:~/codes$ ./a.out
Enter a string:
12345
5The digits are in ascending order.
● lakshman@MARVEL:~/codes$ flex lab4e.1
● lakshman@MARVEL:~/codes$ gcc lex.yy.c
⊗ lakshman@MARVEL:~/codes$ ./a.out
Enter a string:
21133
3The digits are not in ascending order.
○ lakshman@MARVEL:~/codes$
```

Lab 5

Write a C program to design lexical analysis to recognize any five keywords, identifiers, numbers, operators and punctuations.

Code

```
#include <stdio.h>

#include <string.h>

#include <ctype.h>

void lexicalAnalyzer(char input_code[]) {

    char *keywords[] = {"if", "else", "while", "for", "return"};

    char *operators[] = {"+", "-", "*", "/", "=", "==", "<", ">", "<=", ">="};

    char *punctuations[] = {"", ";", "(", ")", "{", "}" };

    char *token = strtok(input_code, " \t\n");

    while (token != NULL) {

        if (isdigit(token[0])) {

            printf("Number: %s\n", token);

        } else if (isalpha(token[0]) || token[0] == '_') {

            int isKeyword = 0;

            for (int i = 0; i < sizeof(keywords) / sizeof(keywords[0]); i++) {

                if (strcmp(token, keywords[i]) == 0) {

                    printf("Keyword: %s\n", token);

                    isKeyword = 1;

                    break;

                }

            }

            if (!isKeyword) {

                printf("Identifier: %s\n", token);

            }

        } else if (strchr("+-*/= <>(){} []", token[0]) != NULL) {

            printf("Operator: %s\n", token);

        }

        else if (strchr(" ;", token[0]) != NULL)
```

```

    {
        printf("Punctuation:%s\n",token);
    }

    token = strtok(NULL, " \t\n");
}
}

int main() {
    char input_code[] = "if ( x > 0 ) { return x ; } else { return -x ; }";
    lexicalAnalyzer(input_code);
    return 0;
}

```

Output

```

● lakshman@MARVEL:~/codes$ cc lab5.c
● lakshman@MARVEL:~/codes$ ./a.out
Enter the input string: if
Tokenizing the input:
Keyword: if
● lakshman@MARVEL:~/codes$ cc lab5.c
● lakshman@MARVEL:~/codes$ ./a.out
Enter the input string: ;
Tokenizing the input:
Operator or Punctuation: ;
● lakshman@MARVEL:~/codes$ cc lab5.c
● lakshman@MARVEL:~/codes$ ./a.out
Enter the input string: +
Tokenizing the input:
Operator or Punctuation: +
● lakshman@MARVEL:~/codes$ cc lab5.c
● lakshman@MARVEL:~/codes$ ./a.out
Enter the input string: 1
Tokenizing the input:
Number: 1
● lakshman@MARVEL:~/codes$ cc lab5.c
● lakshman@MARVEL:~/codes$ ./a.out
Enter the input string: a
Tokenizing the input:
Identifier: a
○ lakshman@MARVEL:~/codes$ █

```

Lab 6

Write a program to perform recursive descent parsing on the following grammar:

S->cAd

A->ab | a

Code

```
#include <stdio.h>
#include<stdlib.h>
char input[100];
int ind = 0;
void match(char expected)
{
    if (input[ind] == expected)
    {
        ind++;
    }
}
void A();
void S()
{
    match('c');
    A();
    match('d');
}
void A()
{
    if (input[ind] == 'a')
    {
        printf("Hello\n");
        match('a');
        match('b');
    } /*else if (input[ind] == 'a')
    {
        printf("Hi!\n");
```

```

        match('a');
    }*/
else
{
    printf("Parsing failed.\n", ind);
    exit(1);
}
}

int main() {
    printf("Enter the input string:\n");
    scanf("%s", input);

    S();

    if (input[ind] == '$') {
        printf("Parsing successful.\n");
    } else {
        printf("Parsing failed. Extra characters found.\n");
    }

    return 0;
}

```

Output

```

● lakshman@MARVEL:~/codes$ cc lab6.c
● lakshman@MARVEL:~/codes$ ./a.out
Enter the string: cad

Input          Action
-----
cad            S -> cAd
d              A -> a
EOF            S -> cAd
-----
String is successfully parsed
○ lakshman@MARVEL:~/codes$ █

```


Lab 7

7.1 Write a program in YACC to design a suitable grammar for evaluation of arithmetic expression having +, -, * and /.

Code

LEX

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

YACC

```
%{  
#include<stdio.h>  
#include<stdlib.h>  
int yyerror(const char *s);  
int yylex(void);  
%}  
%token num;  
%left '+' '-'  
%left '*' '/'  
%left ')'   
%left '('
```

```

%%

s:e {printf("Valid expression!\n");
    printf("Result:%d\n",$$);
    exit(0);
}

;

e:e'+e {$$=$1+$3;}
|e'-e {$$=$1-$3;}
|e'*e {$$=$1*$3;}
|e'/e {$$=$1/$3;}
|'(e)' {$$=$2;}
|num {$$=$1;}

;

%%

void main()
{
    printf("Enter an arithmetic expression:\n");
    yyparse();
}

int yyerror(const char *s)
{
    printf("Invalid expression!\n");
    return 0;
}

```

Output

```

Enter an arithmetic expression:
2+3*4
Valid expression!
Result:14

```

```

Enter an arithmetic expression:
2++3-
Invalid expression!

```

7.2 Write a program in YACC to recognize strings of the form $\{(a^n)b, n \geq 5\}$.

Code

LEX

```
%{  
  
#include<stdio.h>  
  
#include<stdlib.h>  
  
#include "y.tab.h"  
  
extern int yylval;  
  
%}  
  
%%  
  
[aA] {yylval=yytext[0];return A;}  
[bB] {yylval=yytext[0];return B;}  
  
\n {return NL;}  
  
. {return yytext[0];}  
  
%%  
  
int yywrap()  
{  
return 1;  
}
```

YACC

```
%{  
  
#include<stdio.h>  
  
#include<stdlib.h>  
  
int yyerror(char *s);  
  
int yylex(void);  
  
%}  
  
%token A  
  
%token B  
  
%token NL  
  
%%  
  
smtr:A A A A S B NL {printf("Parsed using the rule  $(a^n)b, n \geq 5$ . \n Valid String!\n");}  
  
;  
  
S:S A  
  
|
```

```
;
%%
void main()
{
printf("Enter a string!\n");
yyparse();
}
int yyerror(char *s)
{
printf("Invalid String!\n");
return 0;
}
```

Output

```
Enter a string!
aaaaaaab
Parsed using the rule (a^n)b, n>=5.
Valid String!
ab
Invalid String!
```

```
Enter a string!
abc
Invalid String!
```

7.3 Write a program in YACC to generate syntax tree for a given arithmetic expression.

Code

LEX

```
%{  
  
#include<stdio.h>  
  
#include<stdlib.h>  
  
#include "y.tab.h"  
  
extern int yylval;  
  
%}  
  
%%  
  
[0-9]+ { yylval=atoi(yytext);return digit;}  
  
[t] ;  
  
[n] return 0;  
  
. return yytext[0];  
  
%%  
  
int yywrap()  
{  
return 1;  
}
```

YACC

```
%{  
  
#include <math.h>  
  
#include<ctype.h>  
  
#include<stdio.h>  
  
#include<stdlib.h>  
  
#include<string.h>  
  
int yyerror(char *s);  
  
int yylex(void);  
  
struct tree_node  
{  
  
char val[10];  
  
int lc;  
  
int rc;  
  
};
```

```

int ind;

struct tree_node syn_tree[100];

void my_print_tree(int cur_ind);

int mknode(int lc,int rc,char *val);

% }

%token digit

%%

S:E {my_print_tree($1);}

;

E:E'+T {$$=mknode($1,$3,"+");}

|T {$$=$1;}

;

T:T'*F {$$= mknode($1,$3,"*");}

|F {$$=$1;}

;

F:('E') {$$=$2;}

|digit {char buf[10];sprintf(buf,"%d", yylval);$$ = mknode(-1,-1,buf);}

;

%%

int main()

{

ind=0;

printf("Enter an expression:\n");

yyparse();

return 0;

}

int yyerror(char *s)

{

printf("NITW Error\n");

return 0;

}

int mknode(int lc,int rc,char val[10])

{

strcpy(syn_tree[ind].val,val);

```

```

syn_tree[ind].lc = lc;
syn_tree[ind].rc = rc;
ind++;
return ind-1;
}

/*my_print_tree function to print the syntax tree in DLR fashion*/
void my_print_tree(int cur_ind)
{
if(cur_ind==-1) return;
if(syn_tree[cur_ind].lc==-1&&syn_tree[cur_ind].rc==-1)
printf("Digit Node -> Index : %d, Value : %s\n",cur_ind,syn_tree[cur_ind].val);
else
printf("Operator Node -> Index : %d, Value : %s, Left Child Index : %d,Right Child Index : %d\n",cur_ind,syn_tree[cur_ind].val, syn_tree[cur_ind].lc,syn_tree[cur_ind].rc);
my_print_tree(syn_tree[cur_ind].lc);
my_print_tree(syn_tree[cur_ind].rc);
}

```

Output

```

Enter an expression:
2*3+5*4
Operator Node -> Index : 6, Value : +, Left Child Index : 2,Right Child Index : 5
Operator Node -> Index : 2, Value : *, Left Child Index : 0,Right Child Index : 1
Digit Node -> Index : 0, Value : 2
Digit Node -> Index : 1, Value : 3
Operator Node -> Index : 5, Value : *, Left Child Index : 3,Right Child Index : 4
Digit Node -> Index : 3, Value : 5
Digit Node -> Index : 4, Value : 4

```

Lab 8

8.1 Write a program in YACC to convert infix to postfix expression.

Code

LEX

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

YACC

```
% {  
  
#include<stdio.h>  
  
#include<stdlib.h>  
  
int yyerror(const char *s);  
  
int yylex(void);  
  
% }  
  
%token num  
  
%left '+' '-'  
  
%left '*' '/'  
  
%left ')'   
  
%left '('  
  
%right '^'  
  
%%
```



```

s:e {printf("\n");}

;
e:e'+t {printf("+");}
|e'-t {printf("-");}

|t

;
t:t'*h {printf("*");}
|t/'h {printf("/");}

|h

;
h:f^h {printf("^");}

|f

;
f:'(e)

|num {printf("%d", $1);}

;
%%

void main()
{
printf("Enter an infix expression:\n");
yyparse();
}

int yyerror(const char *s)
{
printf("Invalid infix expression!\n");
return 0;
}

```

Output

```

Enter an infix expression:
2+3*8/4^3-3
238*43^/+3-

```

Lab 9

9.1 Write a program in YACC to generate three address code for a given expression.

Code

LEX

```
% {  
#include<stdio.h>  
#include<stdlib.h>  
#include"y.tab.h"  
extern int yylval;  
extern char iden[20];  
%}  
d [0-9]+  
a [a-zA-Z]+  
%%  
{d} { yylval=atoi(yytext); return digit; }  
{a} { strcpy(iden,yytext); yylval=1; return id;}  
[ \t] {;}  
\n return 0;  
. return yytext[0];  
%%  
int yywrap()  
{  
return 1;  
}
```

YACC

```
% {  
#include <math.h>  
#include<ctype.h>  
#include<stdio.h>  
int yyerror(char *s);  
int yylex(void);  
int var_cnt=0;  
char iden[20];
```

```

% }
%token id
%token digit
%%

S:id '=' E { printf("%s=t%d\n",iden,var_cnt-1);}

E:E '+' T { $$=var_cnt; var_cnt++; printf("t%d = t%d + t%d;\n", $$, $1, $3 );}

|E '-' T { $$=var_cnt; var_cnt++; printf("t%d = t%d - t%d;\n", $$, $1, $3 );}

|T { $$=$1;}

;

T:T '*' F { $$=var_cnt; var_cnt++; printf("t%d = t%d * t%d;\n", $$, $1, $3 );}

|T '/' F { $$=var_cnt; var_cnt++; printf("t%d = t%d / t%d;\n", $$, $1, $3 );}

|F { $$=$1;}

;

F:P '^' F { $$=var_cnt; var_cnt++; printf("t%d = t%d ^ t%d;\n", $$, $1, $3 );}

|P { $$ = $1;}

;

P: '(' E ')' { $$=$2;}

|digit { $$=var_cnt; var_cnt++; printf("t%d = %d;\n",$$,$1);}

;

%%

int main()
{
var_cnt=0;
printf("Enter an expression:\n");
yyparse();
return 0;
}

int yyerror(char *s)
{
printf("Invalid expression!");
return 0;
}

```

Output

Enter an expression:

a=2*3/6-4

t0 = 2;

t1 = 3;

t2 = t0 * t1;

t3 = 6;

t4 = t2 / t3;

t5 = 4;

t6 = t4 - t5;

a=t6