

# **VISVESVARAYA TECHNOLOGICAL UNIVERSITY**

“JnanaSangama”, Belgaum -590014, Karnataka.



## **LAB REPORT**

**on**

## **COMPILER DESIGN**

*Submitted by*

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*Under the Guidance of*

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*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 **M Ananta Naga Rajesh (1BM21CS098)**, 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.

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***DECLARATION***

I, M Ananta Naga Rajesh (1BM21CS098), 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 Prameetha Pai, 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.

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### Course outcomes:

CO1	Apply the fundamental concepts for the various phases of compiler design.
CO2	Analyse the syntax and semantic concepts of a compiler.
CO3	Design various types of parsers and Address code generation.
CO4	Implement compiler principles, methodologies using lex, yacc tools.

## 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



```
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

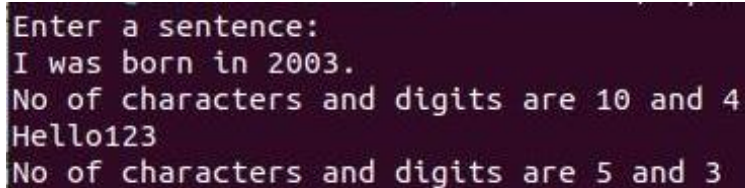
```
%{
#include<stdio.h>
int d=0,c=0;
%}
%%
[a-zA-Z] {c++;}
[0-9] {d++;}
. ;

\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

A screenshot of a terminal window with a dark background and light-colored text. It shows the execution of the LEX program. The user enters "I was born in 2003." and the program outputs "No of characters and digits are 10 and 4". Then the user enters "Hello123" and the program outputs "No of characters and digits are 5 and 3".

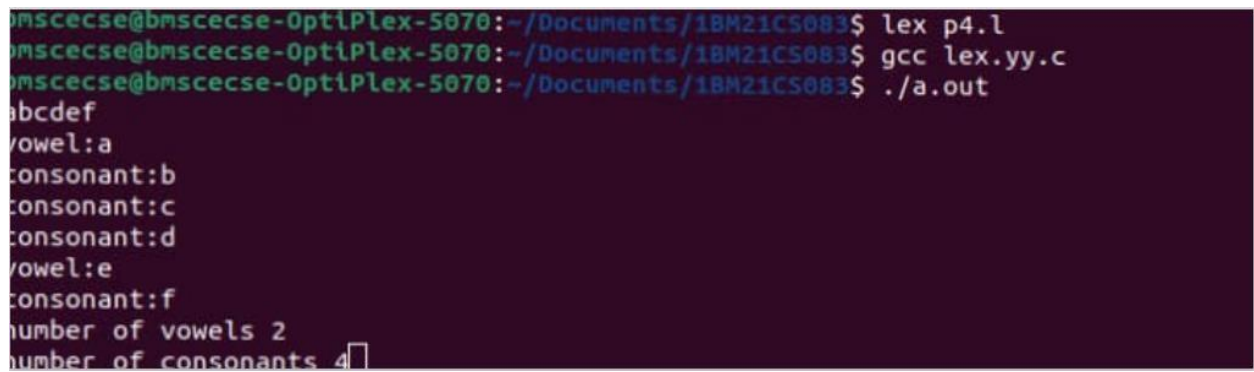
```
Enter a sentence:
I was born in 2003.
No of characters and digits are 10 and 4
Hello123
No of characters and digits are 5 and 3
```

### 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



```
mscecse@mscecse-OptiPlex-5070:~/Documents/IBM21CS083$ lex p4.l  
mscecse@mscecse-OptiPlex-5070:~/Documents/IBM21CS083$ gcc lex.yy.c  
mscecse@mscecse-OptiPlex-5070:~/Documents/IBM21CS083$ ./a.out  
abcdef  
vowel:a  
consonant:b  
consonant:c  
consonant:d  
vowel:e  
consonant:f  
number of vowels 2  
number of consonants 4
```

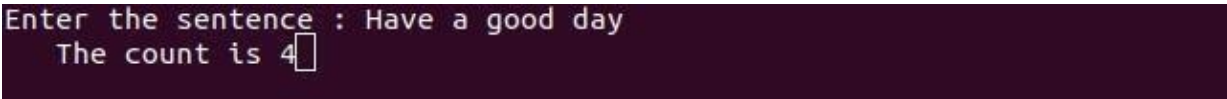


## 2.1 Write a program in lex to count the number of words in a sentence.

### Code

```
% {  
#include<stdio.h>  
  
int words;  
  
% }  
%%  
[^\t\n ]+ { words++;}  
  
\n {printf("The count is %d.\n",words),words=0;}  
  
%%  
  
void main()  
{  
printf("Enter the  
sentence:\n");yylex();  
}  
  
int yywrap()  
{  
return 1;  
}
```

### Output

A screenshot of a terminal window with a dark purple background. It shows the program's output: "Enter the sentence : Have a good day" followed by "The count is 4" and a cursor. The text is in a light-colored monospace font.


```
Enter the sentence : Have a good day  
The count is 4
```

## 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



```
Enter a string:  
HelloWorld  
Characters  
  
1234  
Digits  
Hello123  
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);}

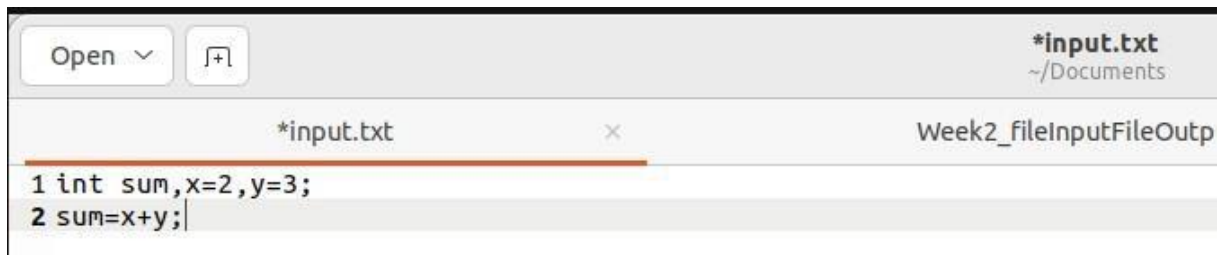
\n ;

%%

void main()
{
yyin=fopen("input.txt","r");
yylex();
fclose(yyin);
}

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

## Output



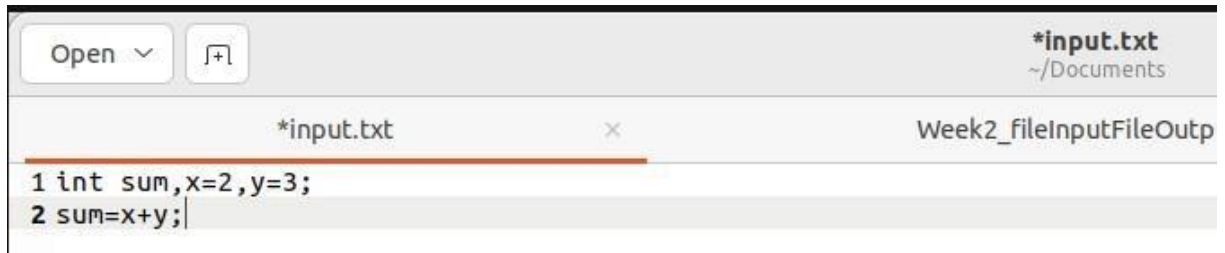
```
int
keyword
var
identifier
8b
invalid token
□
```

## 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

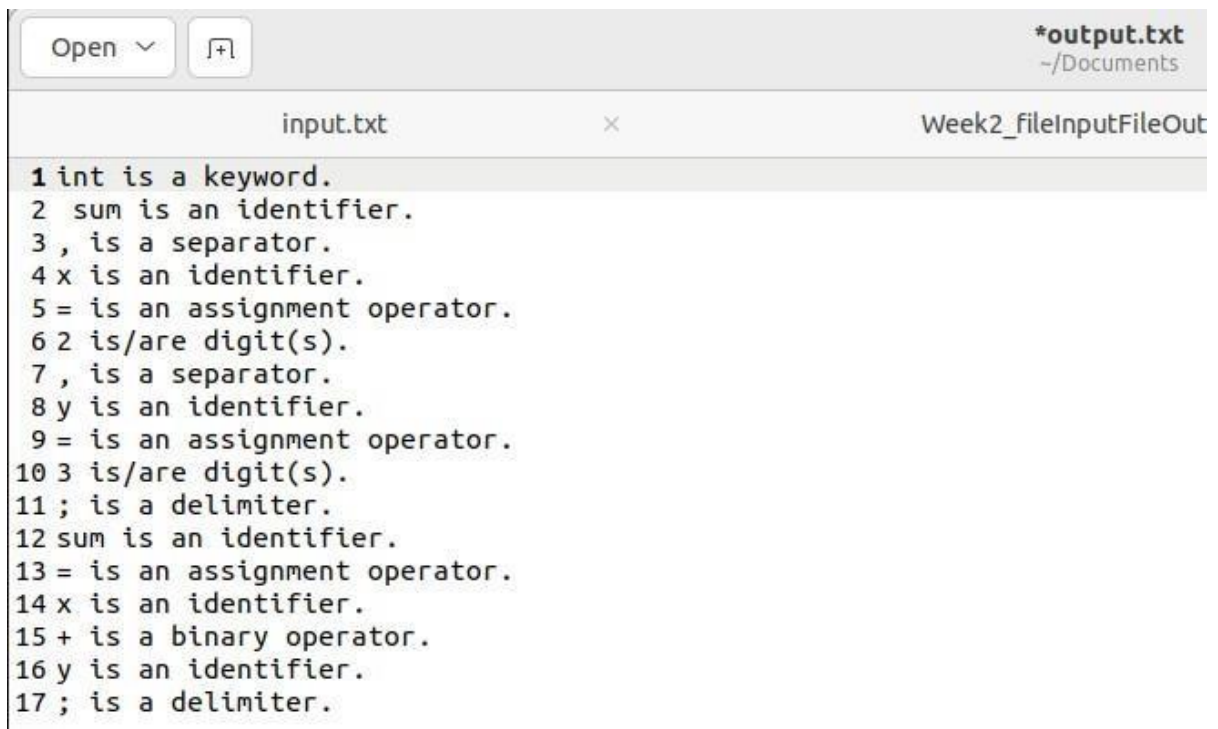
```
% {  
#include<stdio.h>  
% }  
%%  
  
char|int|float { fprintf(yyout,"%s is a keyword.\n",yytext);}  
[a-zA-Z][a-zA-Z0-9]* { fprintf(yyout,"%s is an identifier.\n",yytext);}  
, { fprintf(yyout,"%s is a separator.\n",yytext);}  
; { fprintf(yyout,"%s is a delimiter.\n",yytext);}  
"=" { fprintf(yyout,"%s 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



The screenshot shows an IDE window titled `*input.txt` with the path `~/Documents`. The window contains two lines of C code:

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



The screenshot shows an IDE window titled `*output.txt` with the path `~/Documents`. The window contains 17 lines of output text, each corresponding to a token in the input code:

```
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.
```

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

### Code

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

%}

%%

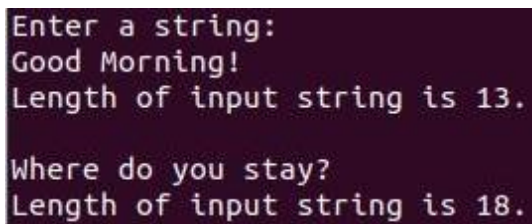
[a-zA-Z0-9.,!? \t]+ {printf("Length of input string is %d.\n",yyleng);}

%%

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

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

### Output

A screenshot of a terminal window with a dark background and light-colored text. It shows the output of the program for two different inputs. The first input is "Good Morning!" and the output is "Length of input string is 13.". The second input is "Where do you stay?" and the output is "Length of input string is 18.".

```
Enter a string:
Good Morning!
Length of input string is 13.

Where do you stay?
Length of input string is 18.
```

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

#### Code

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

%}

%%

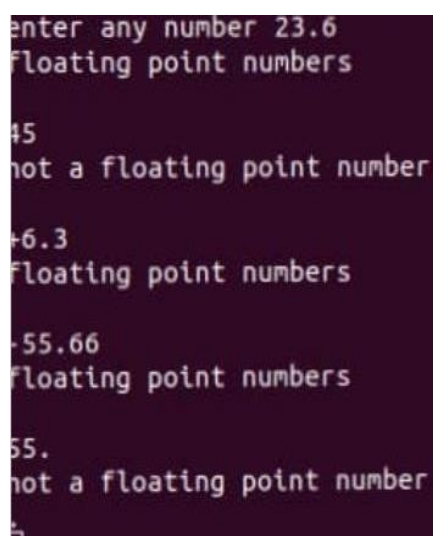
[+-]?[0-9]*[.][0-9][0-9]* {printf("Floating point number!\n");}
[+-]?[0-9][0-9]* {printf("Not a floating point number!\n");}

%%

int yywrap()
{
return 1;
}

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

#### Output



```
enter any number 23.6
floating point numbers

45
not a floating point number

+6.3
floating point numbers

+55.66
floating point numbers

55.
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)

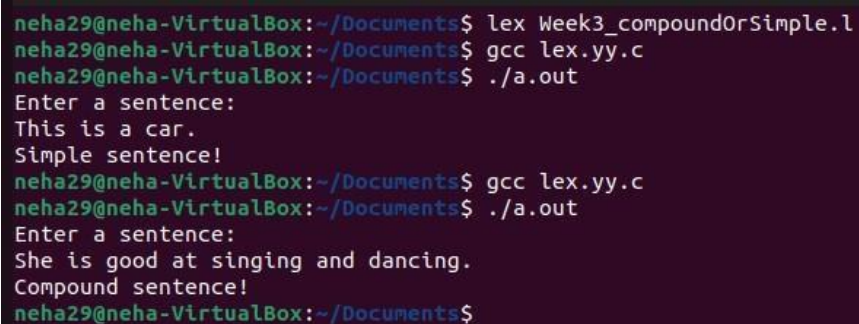
printf("Compound sentence!\n");

else

printf("Simple sentence!\n");

}
```

### Output



```
neha29@neha-VirtualBox:~/Documents$ lex Week3_compoundOrSimple.l
neha29@neha-VirtualBox:~/Documents$ gcc lex.yy.c
neha29@neha-VirtualBox:~/Documents$ ./a.out
Enter a sentence:
This is a car.
Simple sentence!
neha29@neha-VirtualBox:~/Documents$ gcc lex.yy.c
neha29@neha-VirtualBox:~/Documents$ ./a.out
Enter a sentence:
She is good at singing and dancing.
Compound sentence!
neha29@neha-VirtualBox:~/Documents$
```

### 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

```
Hello
Sentence does not end with punc
Hello hi.
Sentence ends with punc
□
```

### 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

```
Enter a sentence:
This is a good idea.
Does not start with an article!
neha29@neha-VirtualBox:~/Documents$ gcc lex.yy.c
neha29@neha-VirtualBox:~/Documents$ ./a.out
Enter a sentence:
Amazing experience!
Does not start with an article!
neha29@neha-VirtualBox:~/Documents$ gcc lex.yy.c
neha29@neha-VirtualBox:~/Documents$ ./a.out
Enter a sentence:
The sun rises in the east.
Starts with an article!
neha29@neha-VirtualBox:~/Documents$ gcc lex.yy.c
neha29@neha-VirtualBox:~/Documents$ ./a.out
Enter a sentence:
An apple a day keeps the doctor away.
Starts with an article!
neha29@neha-VirtualBox:~/Documents$ gcc lex.yy.c
neha29@neha-VirtualBox:~/Documents$ ./a.out
Enter a sentence:
A book is lying on the table.
Starts with an article!
```

### 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++;}

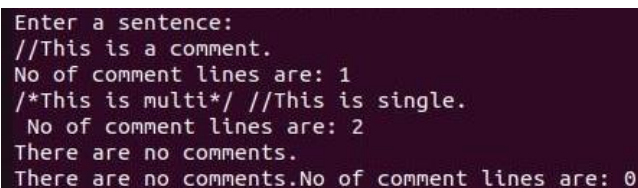
. ECHO;

%%

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

A screenshot of a terminal window with a dark background and light-colored text. It shows the output of the Lex program for three different input sentences. The first sentence is a single-line comment, resulting in a count of 1. The second sentence is a multi-line comment, resulting in a count of 2. The third sentence contains no comments, resulting in a count of 0.


```
Enter a sentence:
//This is a comment.
No of comment lines are: 1
/*This is multi*/ //This is single.
No of comment lines are: 2
There are no comments.
There are no comments.No of comment lines are: 0
```

### 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



```
Enter a number:  
123  
Unsigned number!  
  
-123  
Signed number!  
  
+123  
Signed number!
```

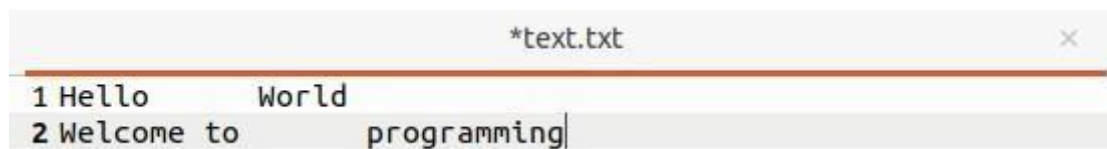
## Lab 4

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

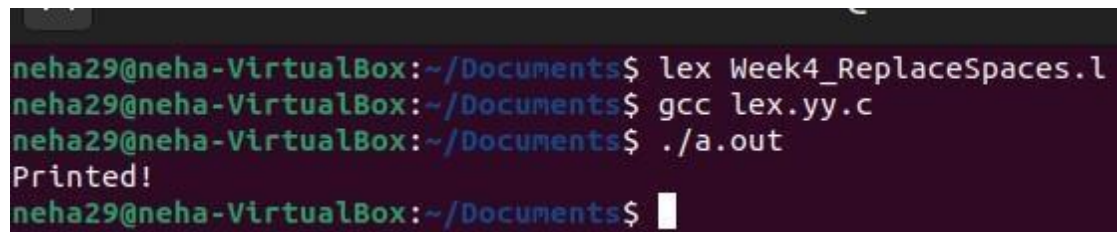
### Code

```
% {  
#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;  
}
```

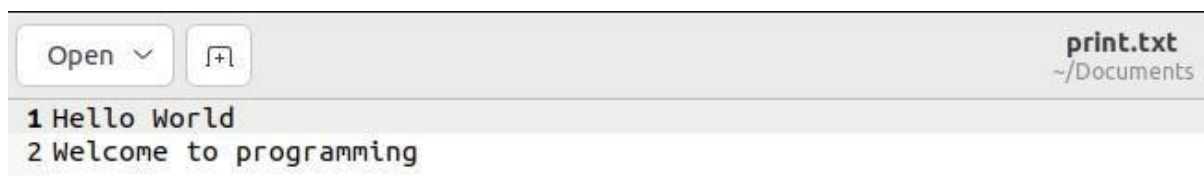
## Output



```
*text.txt
1 Hello World
2 Welcome to programming
```



```
neha29@neha-VirtualBox:~/Documents$ lex Week4_ReplaceSpaces.l
neha29@neha-VirtualBox:~/Documents$ gcc lex.yy.c
neha29@neha-VirtualBox:~/Documents$ ./a.out
Printed!
neha29@neha-VirtualBox:~/Documents$
```



```
print.txt
~/Documents
1 Hello World
2 Welcome to programming
```



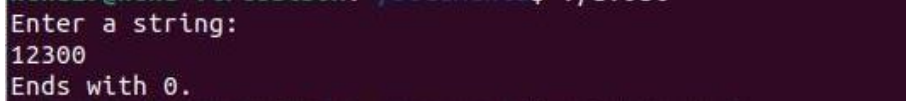
## 4.2 Write a LEX program to recognize the following tokens over the alphabets {0,1,...,9}

### 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




```
Enter a string:  
12300  
Ends with 0.
```

### 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



```
Enter a string:  
2322  
Does not have 3 consecutive 2's.
```

### 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.
neha29@neha-VirtualBox:~/Documents$ gcc lex.yy.c
neha29@neha-VirtualBox:~/Documents$ ./a.out
Enter a string:
12345455
yytext:12345,flag(1 if no of 5 is atleast 2):0
Not a valid string!
neha29@neha-VirtualBox:~/Documents$ gcc lex.yy.c
neha29@neha-VirtualBox:~/Documents$ ./a.out
Enter a string:
5432512345
yytext:54325,flag(1 if no of 5 is atleast 2):1
yytext:12345,flag(1 if no of 5 is atleast 2):0
Not a 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");}

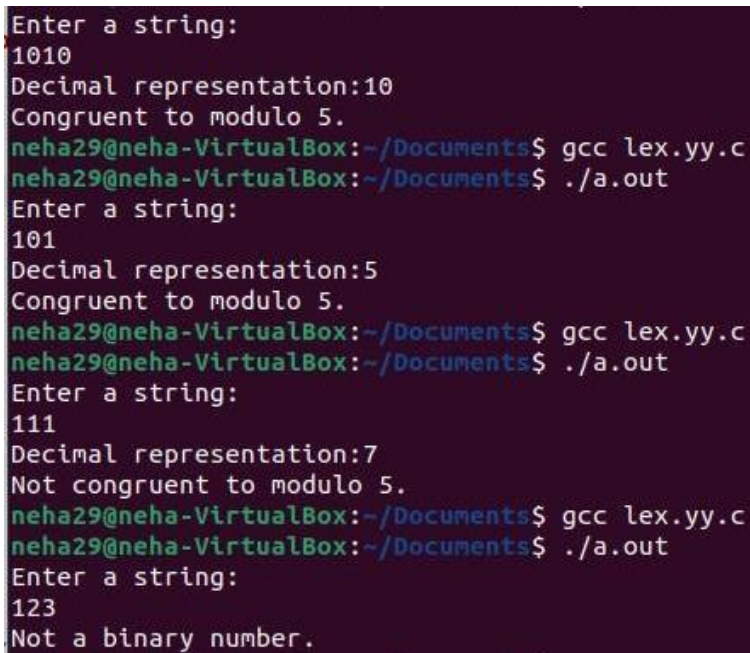
\n {return 0;}

%%

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

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

## Output



```
Enter a string:  
1010  
Decimal representation:10  
Congruent to modulo 5.  
neha29@neha-VirtualBox:~/Documents$ gcc lex.yy.c  
neha29@neha-VirtualBox:~/Documents$ ./a.out  
Enter a string:  
101  
Decimal representation:5  
Congruent to modulo 5.  
neha29@neha-VirtualBox:~/Documents$ gcc lex.yy.c  
neha29@neha-VirtualBox:~/Documents$ ./a.out  
Enter a string:  
111  
Decimal representation:7  
Not congruent to modulo 5.  
neha29@neha-VirtualBox:~/Documents$ gcc lex.yy.c  
neha29@neha-VirtualBox:~/Documents$ ./a.out  
Enter a string:  
123  
Not a binary number.
```

#### 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.
neha29@neha-VirtualBox:~/Documents$ gcc lex.yy.c
neha29@neha-VirtualBox:~/Documents$ ./a.out
Enter a string:
23123456123
10th symbol from right is not 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

```
Enter a string:  
6300  
The sum of digits is 9.  
neha29@neha-VirtualBox:~/Documents$ gcc lex.yy.c  
neha29@neha-VirtualBox:~/Documents$ ./a.out  
Enter a string:  
3331  
The sum of digits is not 9.  
neha29@neha-VirtualBox:~/Documents$ gcc lex.yy.c  
neha29@neha-VirtualBox:~/Documents$ ./a.out  
Enter a string:  
2340  
The 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<yyleng-1;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

```
Enter a string:
1235
The digits are in ascending order.
neha29@neha-VirtualBox:~/Documents$ gcc lex.yy.c
neha29@neha-VirtualBox:~/Documents$ ./a.out
Enter a string:
1243
The digits are not in ascending order.
```

**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

```

PS C:\Users\neha2\OneDrive\Documents\CD_lab_Practice> cd
lysis } ; if ($?) { .\Week5_lexicalAnalysis }
Keyword: if
Operator: (
Identifier: x
Operator: >
Number: 0
Operator: )
Operator: {
Keyword: return
Identifier: x
Punctuation;;
Operator: }
Keyword: else
Operator: {
Keyword: return
Operator: -x
Punctuation;;
Operator: }

```

**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

```

recursive_descent.c: In function 'A':
recursive_descent.c:33:16: warning: too many arguments for format [-Wformat-extra-args]
   33 |         printf("Parsing failed.\n", ind);
      |         ~~~~~^
msc@msc-HP-Elite-Tower-600-G9-Desktop-PC:~/Documents$ ^C
msc@msc-HP-Elite-Tower-600-G9-Desktop-PC:~/Documents$ ^C
msc@msc-HP-Elite-Tower-600-G9-Desktop-PC:~/Documents$ gcc -o recursive_descent recursive_descent.c
recursive_descent.c: In function 'A':
recursive_descent.c:33:16: warning: too many arguments for format [-Wformat-extra-args]
   33 |         printf("Parsing failed.\n", ind);
      |         ~~~~~^
msc@msc-HP-Elite-Tower-600-G9-Desktop-PC:~/Documents$ ./recursive_descent
Enter the input string:
aa
ello
arsing failed. Extra characters found.
msc@msc-HP-Elite-Tower-600-G9-Desktop-PC:~/Documents$ ./recursive_descent
Enter the input string:
aaad$
ello
arsing failed. Extra characters found.
msc@msc-HP-Elite-Tower-600-G9-Desktop-PC:~/Documents$ ./recursive_descent
Enter the input string:
abb$
ello
arsing successful.
msc@msc-HP-Elite-Tower-600-G9-Desktop-PC:~/Documents$ ./recursive_descent
Enter the input string:
aaad$
ello
arsing failed. Extra characters found.
msc@msc-HP-Elite-Tower-600-G9-Desktop-PC:~/Documents$ ./recursive_descent
Enter the input string:
abb$
ello
arsing successful.
msc@msc-HP-Elite-Tower-600-G9-Desktop-PC:~/Documents$ ./recursive_descent
Enter the input string:
aaad$
ello
arsing failed. Extra characters found.
msc@msc-HP-Elite-Tower-600-G9-Desktop-PC:~/Documents$

```

## 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
neha29@neha-VirtualBox:~/Documents/Lex_Programs$ gcc lex.yy.c y.tab.c
neha29@neha-VirtualBox:~/Documents/Lex_Programs$ ./a.out
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  $(a^n)b, n \geq 5$ . 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

```

mscecse@bmscecse-OptiPlex-5070:~/Documents/1BM21CS083$ lex anbn.L
mscecse@bmscecse-OptiPlex-5070:~/Documents/1BM21CS083$ yacc -d anbn.y
mscecse@bmscecse-OptiPlex-5070:~/Documents/1BM21CS083$ gcc lex.yy.c y.tab.c
mscecse@bmscecse-OptiPlex-5070:~/Documents/1BM21CS083$ ./a.out
Enter a string!
abb$
Invalid String!
mscecse@bmscecse-OptiPlex-5070:~/Documents/1BM21CS083$ ./a.out
Enter a string!
abb
Invalid String!
mscecse@bmscecse-OptiPlex-5070:~/Documents/1BM21CS083$ ./a.out
Enter a string!
aaab
Invalid String!
mscecse@bmscecse-OptiPlex-5070:~/Documents/1BM21CS083$ ./a.out
Enter a string!
aaaaab
Parsed using the rule (a^n)b, n>=5.
Valid String!
aaaaaaabb
Invalid String!
mscecse@bmscecse-OptiPlex-5070:~/Documents/1BM21CS083$ 

```

### 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

```

bmscecse@bmscecse-HP-Elite-Tower-600-G9-Desktop-PC:~/Documents$ ./a.out
Enter an expression
4+6*9
Operator Node -> Index : 4, Value : +, Left Child Index : 0,Right Child Index : 3
Digit Node -> Index : 0, Value : 4
Operator Node -> Index : 3, Value : *, Left Child Index : 1,Right Child Index : 2
Digit Node -> Index : 1, Value : 6
Digit Node -> Index : 2, Value : 9
bmscecse@bmscecse-HP-Elite-Tower-600-G9-Desktop-PC:~/Documents$ █

```

## 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)

{

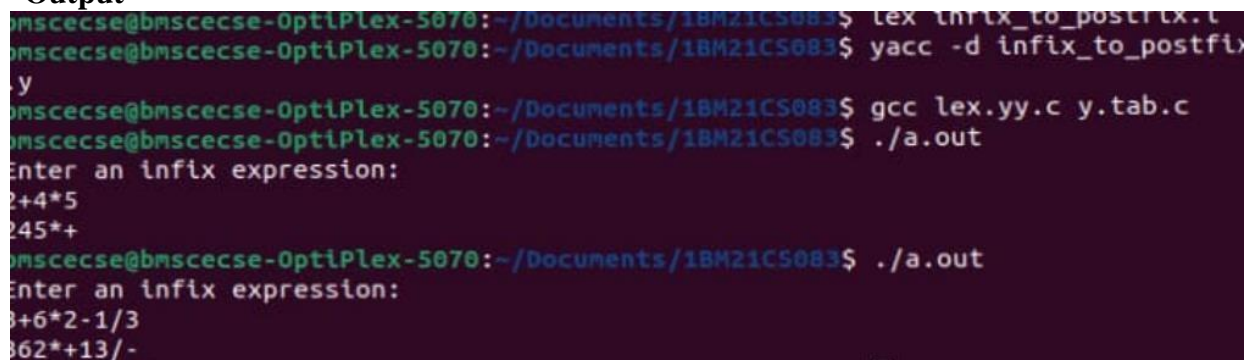
printf("Invalid infix expression!\n");

return 0;

}

```

## Output



```

bmscecse@bmscecse-OptiPlex-5070:~/Documents/1BM21CS083$ lex infix_to_postfix.l
bmscecse@bmscecse-OptiPlex-5070:~/Documents/1BM21CS083$ yacc -d infix_to_postfix.y
bmscecse@bmscecse-OptiPlex-5070:~/Documents/1BM21CS083$ gcc lex.yy.c y.tab.c
bmscecse@bmscecse-OptiPlex-5070:~/Documents/1BM21CS083$ ./a.out
Enter an infix expression:
2+4*5
245*+
bmscecse@bmscecse-OptiPlex-5070:~/Documents/1BM21CS083$ ./a.out
Enter an infix expression:
3+6*2-1/3
362*+13/-

```



## 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
```