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“JnanaSangama”, Belgaum -590014, Karnataka.



LAB REPORT

on

COMPILER DESIGN

Submitted by

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in partial fulfillment 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)

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CERTIFICATE

This is to certify that the Lab work entitled “Compiler Design” carried out by **ROHITH U (1BM21CS170)**, who is bonafide student of **B. M. S. College of Engineering**. It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2023. The Lab report has been approved as it satisfies the academic requirements in respect of a **Compiler Design course (21CS5PCCPD)**work prescribed for the said degree.

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Experiment No :01

Aim of the program

Write a program to design Lexical Analyzer in C/C++/Java/Python Language (to recognize any five keywords, identifiers, numbers, operators and punctuations)

Program

```
def analyze_input(input_text):  
    keywords = ["char", "float", "bool", "int", "for", "break", "continue"]  
    punctuation = [".", "!", ";", "?"]  
    operators = ["+", "-", "*", "/", "%", "="]  
  
    keys, ids, nums, ops, punct = 0, 0, 0, 0, 0  
  
    for i in input_text.split():  
        if i in keywords:  
            if keys < 5:  
                print(f'{i} is a keyword!\n')  
                keys += 1  
        elif i in punctuation:  
            if punct < 5:  
                print(f'{i} is a punctuation!\n')  
                punct += 1  
        elif i in operators:  
            if ops < 5:  
                print(f'{i} is an operator!\n')
```

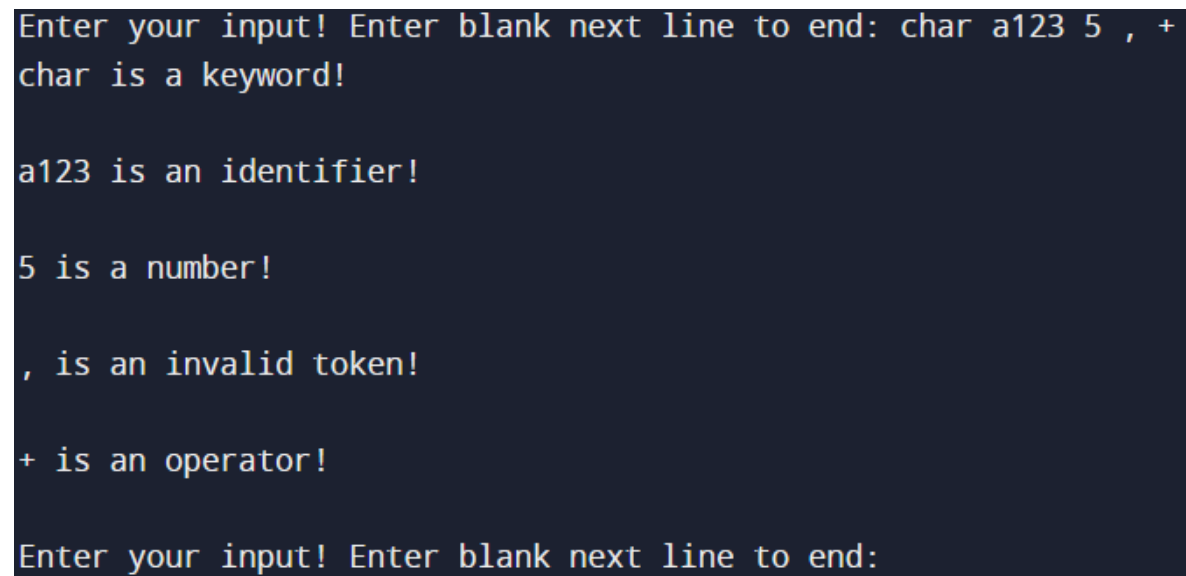
```
        ops += 1
elif i.isnumeric():
    if nums < 5:
        print(f'{i} is a number!\n')
        nums += 1
else:
    if ids < 5:
        flag = False
        if i[0].isalpha() or i[0] == '_':
            flag = True
        for j in i[1:]:
            if j in operators or j in punctuation:
                print(f'{i} is an invalid token!\n')
                flag = False
                break
        if flag:
            print(f'{i} is an identifier!\n')
            ids += 1
    else:
        print(f'{i} is an invalid token!\n')
```

```
while True:
```

```
    user_input = input("Enter your input! Enter blank next line to end: ")
    if not user_input.strip():
        break
```

```
analyze_input(user_input)
```

Output – Screen shot



```
Enter your input! Enter blank next line to end: char a123 5 , +  
char is a keyword!  
  
a123 is an identifier!  
  
5 is a number!  
  
, is an invalid token!  
  
+ is an operator!  
  
Enter your input! Enter blank next line to end:
```

Experiment No :02

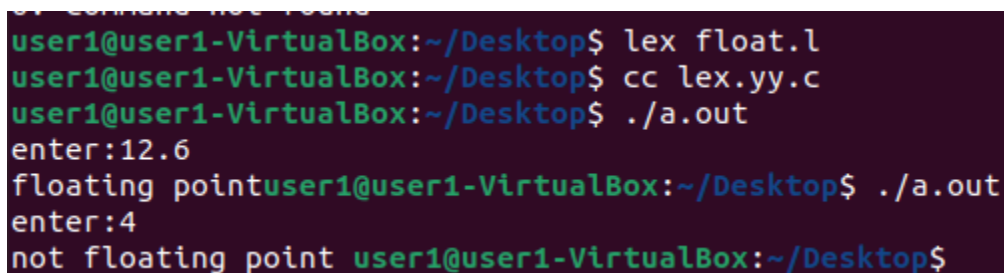
Aim of the program

Write a program in LEX to recognize Floating Point Numbers.

Program

```
%{
#include<stdio.h>
int flag=0;
%}
alpha[a-zA-Z]
digit[0-9]
decimal[.]
%%
[+|-]?({digit})*{decimal}({digit})* { flag=1;}
{alpha}({alpha})({digit})* {printf("invalid number ");}
\n return 0;
%%
int yywrap(){
int main(){
printf("enter :");
yylex();
if(flag==1){ printf("floating point number");}
else{printf(" not a floating point number");}
}
}
```

Output – Screen shot



```
user1@user1-VirtualBox:~/Desktop$ lex float.l
user1@user1-VirtualBox:~/Desktop$ cc lex.yy.c
user1@user1-VirtualBox:~/Desktop$ ./a.out
enter:12.6
floating pointuser1@user1-VirtualBox:~/Desktop$ ./a.out
enter:4
not floating point user1@user1-VirtualBox:~/Desktop$
```


Experiment No :03

Aim of the program

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

Program

```
% {  
#include<stdio.h>  
int x1=0,x2=0,x3=0,x4=0;  
% }  
alpha[a-zA-Z]  
digit[0-9]  
d[.]  
%%  
int|float|char { x1++;}  
{ digit}+ {x2++;}  
[<|>|=|<=|>|=|=] {x3++;}  
{ alpha}({ digit}|{ alpha})* {x4++;}  
\n {  
printf("\nkey:%d",x1);  
printf("\nconst:%d",x2);  
printf("\noperator:%d",x3);  
printf("\nidentifier:%d",x4);  
}
```

%%

```
int yywrap(){ }
```

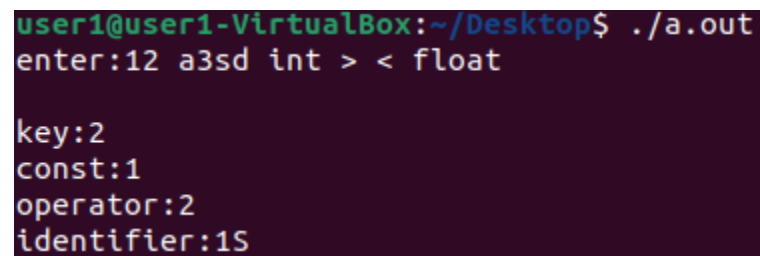
```
int main(){
```

```
printf("enter:");
```

```
yylex();
```

```
}
```

Output – Screen shot



```
user1@user1-VirtualBox:~/Desktop$ ./a.out
enter:12 a3sd int > < float

key:2
const:1
operator:2
identifier:1S
```

Experiment No :04

Aim of the program

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

Program

```
% {  
#include<stdio.h>  
% }  
%%  
  
[ ]([ ])* {fprintf(yyout," ");}  
([ ]*(\n)([ ])* {fprintf(yyout," ");}  
%%  
  
int yywrap(){ }  
int main(){  
printf("running");  
yyin=fopen("txt","r");  
yyout=fopen("txto","w");  
yylex();  
}
```

Output – Screen shot

1 hi friend happy new year welcome to 2024 .

Experiment No :05

Aim of the program

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

- a) The set of all string ending in 00.
- b) The set of all strings with three consecutive 222's.
- c) The set of all string such that every block of five consecutive symbols contains at least two 5's.
- d) The set of all strings beginning with a 1 which, interpreted as the binary representation of an integer, is congruent to zero modulo 5.
- e) The set of all strings such that the 10th symbol from the right end is 1.
- f) The set of all four digits numbers whose sum is 9
- g) The set of all four digital numbers, whose individual digits are in ascending order from left to right.

Program

```
% {  
#include<stdio.h>  
  
int x1=0,x2=0,x3=0,x4=0;  
  
% }  
  
alpha[a-zA-Z]  
digit[0-9]  
  
d[.]  
  
%%  
  
({digit})*00 {printf("\n%s rule A",yytext);}  
({digit})*222({digit})* {printf("\n%s rule B",yytext);}
```

$(1(0)*(11|01)(01*01|00*10(0)*(11|1))*0)(1|10(0)*(11|01)(01*01|00*10(0)*(11|1))*10)*$ {printf("\n%s rule D",yytext);}

$(\{digit\})^*1\{digit\}\{9\}$ {printf("\n%s rule E",yytext);}

$\{digit\}\{4\}$ {

int sum=0;

for(int i=0;i<4;i++){

sum=sum+yytext[i]-48;

}

if(sum==9) {printf("\n%s rule F",yytext);}

sum=1;

for(int j=0;j<3;j++){

if(yytext[j]>yytext[j+1]) sum=0;

}

if(sum==1) {printf("\n%s rule G",yytext);}

}

$\{d\}^*$ {int i=0; int c=0;

if(yyvaleng<5) {break;}

for(i=0;i<5;i++) {

if(yytext[i]=='5') c++;

}

if(c<2) {break;}

```
else{

for(;i<yyleng;i++){
if(yytext[i-5]=='5') c--;
if(yytext[i]=='5') c++;
if(c<2) break;

}
if(i==yyleng) {printf("\n %s rule C",yytext);}
}

}

%%
```

```
int yywrap(){ }
int main(){
printf("enter:");
yylex();
}
```

Output – Screen shot

```
enter: ^C
user1@user1-VirtualBox: ~/Desktop$ lex p05.l
user1@user1-VirtualBox: ~/Desktop$ cc lex.yy.c
user1@user1-VirtualBox: ~/Desktop$ ./a.out
enter: 100 122233 1000000001 1010 1234 2205

100 rule A
122233 rule B
1000000001 rule E
1010 rule D
1234 rule G
2205 rule F
```


Part-B:

Experiment No :01

Aim of the program

1. Write a program to implement

(a) Recursive Descent Parsing with back tracking (Brute Force Method).

$S \rightarrow cAd$, $A \rightarrow ab / a$

(b) Recursive Descent Parsing with back tracking (Brute Force Method).

$S \rightarrow cAd$, $A \rightarrow a / ab$

Program

```
#include<stdio.h>
#include<conio.h>
#include<string.h>
int A();
char str[15];
int isave,curr_ptr=0;
int main(void)
{
    //clrscr();
    printf("1.S->cAd\n2.A->ab/a\n");
    printf("this is parser for the above grammar:\n");
    printf("Enter any string:");
    scanf("%s",str);
    while(curr_ptr<strlen(str))
    {
        //S has only one immediate derivation which is cAd
        //match with c
        if (str[curr_ptr]=='c')
        {
            curr_ptr++;
            //call function to match A
            if (A()) //checking the productions of A->ab/a
            {
                curr_ptr++;
```

```

//match d
if (str[curr_ptr]=='d' && str[curr_ptr+1]=='\0')
{
//success
printf("string is accepted by the grammar");
getch();
return 1;
}
else break;
}
else break;
}
else break;
}
//incase any of them fail to match return negatively.
printf("string is not accepted by the grammar");
//getch();
return 0;
}
int A() //sub function A()
{
isave=curr_ptr;

if (str[curr_ptr]=='a')
{
curr_ptr++;
if(str[curr_ptr]=='b')
return 1;
}
curr_ptr=isave; //return to start
//check if a is matched and return accordingly.
if(str[curr_ptr]=='a')
return 1;
else
return 0;
}

```

Output – Screen shot

```
1.S->cAd
2.A->ab/a
this is parser for the above grammar:
Enter any string:cdd
string is not accepted by the grammar
```

```
1.S->cAd
2.A->ab/a
this is parser for the above grammar:
Enter any string:cabd
string is accepted by the grammar
```

Experiment No :02

Aim of the program

Use YACC to Convert Binary to Decimal (including fractional numbers)

Program

p.y

```
% {
```

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

```
#include<stdlib.h>
```

```
#include<math.h>
```

```
void yyerror(char *s);
```

```
float x = 0;
```

```
% }
```

```
%token ZERO ONE POINT
```

```
% %
```

```
L: X POINT Y {printf("%f", $1+x);}
```

```
| X {printf("%d", $$);}
```

```
X: X B {$$=$1*2+$2;}
```

```
| B {$$=$1;}
```

```
Y: B Y {x=$1*0.5+x*0.5;}
```

```
| {;}
```

```
B:ZERO {$$=$1;}
```

```
|ONE {$$=$1;};
```

```
% %
```

```
int main()
{
printf("Enter the binary number : ");

while(yyvsparse());
printf("\n");
}
```

```
void yyerror(char *s)
{
fprintf(stdout,"\n%s",s);
}
```

p.l

```
% {
```

```
#include<stdio.h>
#include<stdlib.h>
#include"y.tab.h"
```

```
extern int yylval;
% }
```

```
% %
```

```
0 {yylval=0;return ZERO;}
```

```
1 {yylval=1;return ONE;}
```

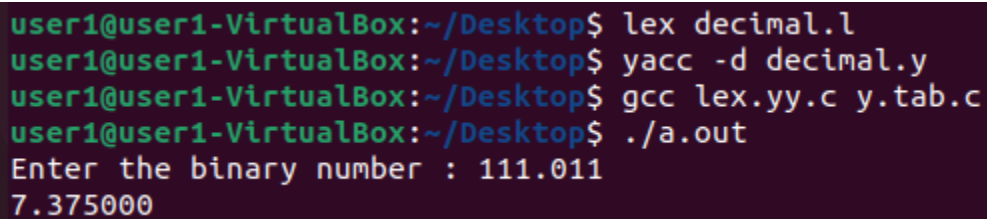
```
". " {return POINT;}
```

```
[ \t] {;}
```

```
\n return 0;
```

```
% %
```

Output – Screen shot



```
user1@user1-VirtualBox:~/Desktop$ lex decimal.l
user1@user1-VirtualBox:~/Desktop$ yacc -d decimal.y
user1@user1-VirtualBox:~/Desktop$ gcc lex.yy.c y.tab.c
user1@user1-VirtualBox:~/Desktop$ ./a.out
Enter the binary number : 111.011
7.375000
```

Experiment No :03

Aim of the program

Use YACC to implement, evaluator for arithmetic expressions (Desktop calculator)

Program

p.y

```
%{
```

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

```
    int flag=0;
```

```
int yylex();
```

```
int yyerror();
```

```
%}
```

```
%token NUMBER
```

```
%left '+' '-'
```

```
%left '*' '/'
```

```
%left '%'
```

```
%right '^'
```

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

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

| NUMBER {$$=$1;}

;

%%

void main()

{

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

    yyparse();

    if(flag==0)

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

```



```

}

int yyerror()

{

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

    flag=1;
    return 0;
}

```

P.I

```

%{

#include<stdio.h>

#include "y.tab.h"

extern int yylval;

}%

%%

[0-9]+ {

    yylval=atoi(yytext);

    return NUMBER;

}

[\t] ;

```

```
[n] return 0;

. return yytext[0];

%%

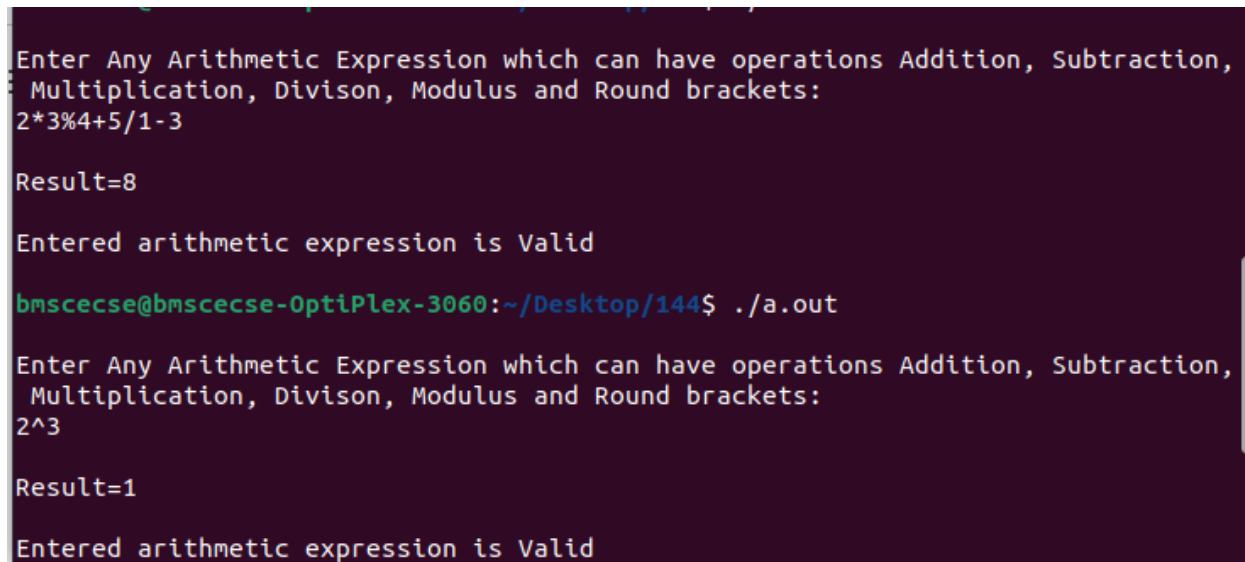
int yywrap()

{

return 1;

}
```

Output – Screen shot



```
Enter Any Arithmetic Expression which can have operations Addition, Subtraction,
Multiplication, Divison, Modulus and Round brackets:
2*3%4+5/1-3

Result=8

Entered arithmetic expression is Valid

bmscecse@bmscecse-OptiPlex-3060:~/Desktop/144$ ./a.out

Enter Any Arithmetic Expression which can have operations Addition, Subtraction,
Multiplication, Divison, Modulus and Round brackets:
2^3

Result=1

Entered arithmetic expression is Valid
```

Experiment No :04

Aim of the program

Use YACC to convert: Infix expression to Postfix expression.

Program

p.y

```
% {
```

```
#include <ctype.h>
```

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

```
#include<stdlib.h>
```

```
int yylex();
```

```
% }
```

```
%token digit
```

```
% %
```

```
S: E {printf("\n\n");}
```

```
;
```

```
E: E '+' T { printf ("+" );}
```

```
| E '-' T { printf ("-");}
```

```
| T
```

```
;
```

```
T: T '*' P { printf ("*");}
```

```
| T '/' P { printf ("/");}
```

```
| P
```

;

P: F '^' P { printf ("^");}

| F

;

F: '(' E ')'

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

;

%%

int main()

{

printf("Enter infix expression: ");

yyparse();

}

yyerror()

{

printf("Error");

}

p.l

% {

#include "y.tab.h"

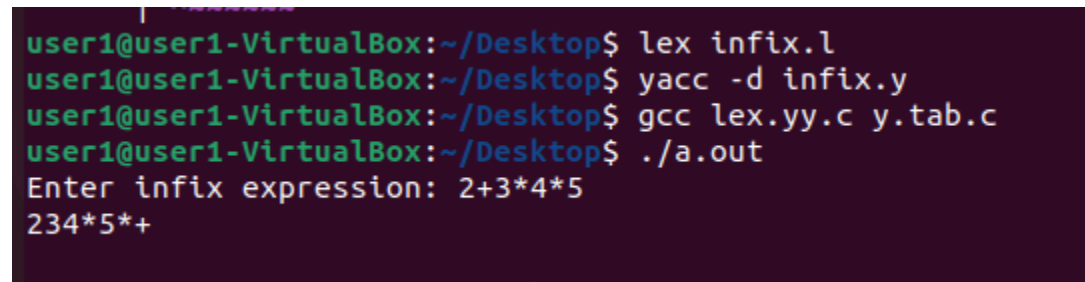
```
extern int yylval;
% }
% %

[0-9]+ {yylval=atoi(yytext); return digit;}

[\t] ;

[\n] return 0;
. return yytext[0];
% %
```

Output – Screen shot



```
user1@user1-VirtualBox:~/Desktop$ lex infix.l
user1@user1-VirtualBox:~/Desktop$ yacc -d infix.y
user1@user1-VirtualBox:~/Desktop$ gcc lex.yy.c y.tab.c
user1@user1-VirtualBox:~/Desktop$ ./a.out
Enter infix expression: 2+3*4*5
234*5*+
```

Experiment No :05

Aim of the program

Use YACC to generate Syntax tree for a given expression

Program

p.y

```
%{
#include<math.h>
#include<ctype.h>
#include<stdio.h>
#include<stdlib.h>
#include<string.h>
#include "y.tab.h"

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, const char *val);

int yylex(void);
void yyerror(const char *s);
%}

%token digit
%%
/* print the tree after evaluating E */
S: E { my_print_tree($1); }
;

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

```
| T { $$= $1; }  
;
```

```
T: T '*' F { $$= mknnode($1, $3, "**"); }  
| T '/' F { $$= mknnode($1, $3, "/"); }  
| F { $$= $1; }  
;
```

```
F: P '^' F { $$= mknnode($1, $3, "^"); }  
| P { $$= $1; }  
;
```

```
P: '(' E ')' { $$= $2; }  
| digit { char buf[10]; sprintf(buf, "%d", yylval); $$= mknnode(-1, -1, buf); }  
%%
```

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

```
void yyerror(const char *s) {  
    printf("NITW Error: %s\n", s);  
}
```

```
int mknnode(int lc, int rc, const char *val) {  
    strcpy(syn_tree[ind].val, val);  
    syn_tree[ind].lc = lc;  
    syn_tree[ind].rc = rc;  
    ind++;  
    return ind-1;  
}
```

```
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);
    }

```

p.l

```

%{
#include "y.tab.h"
%}
%%
[0-9]+ { yylval=atoi(yytext); return digit; }
[t] ;
[\n] return 0;
. return yytext[0];
%%

```

Output – Screen shot

```

user1@user1-VirtualBox:~/Desktop$ lex syntax.l
user1@user1-VirtualBox:~/Desktop$ yacc -d syntax.y
user1@user1-VirtualBox:~/Desktop$ gcc lex.yy.c y.tab.c
user1@user1-VirtualBox:~/Desktop$ ./a.out
Enter an expression
8*9/3
Operator Node -> Index: 4, Value: /, Left Child Index: 2, Right Child Index: 3
Operator Node -> Index: 2, Value: *, Left Child Index: 0, Right Child Index: 1
Digit Node -> Index: 0, Value: 8
Digit Node -> Index: 1, Value: 9
Digit Node -> Index: 3, Value: 3
user1@user1-VirtualBox:~/Desktop$

```


Aim of the program

Use YACC to generate 3-Address code for a given expression

Program

p.y

```
% {  
#include <math.h>  
#include <ctype.h>  
#include <stdio.h>  
int var_cnt=0;  
char iden[20];  
% }  
%token digit  
%token id  
%%  
  
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;
```

```
}
```

```
yyerror()
```

```
{
```

```
printf("NITW Error\n");
```

```
}
```

p.l

```
% {  
  
#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];  
%%
```

Output – Screen shot

```
user1@user1-VirtualBox:~/Desktop$ lex code3.l
user1@user1-VirtualBox:~/Desktop$ yacc -d code3.y
user1@user1-VirtualBox:~/Desktop$ gcc lex.yy.c y.tab.c
user1@user1-VirtualBox:~/Desktop$ ./a.out
Enter an expression :
result=2+3*4
t0 = 2;
t1 = 3;
t2 = 4;
t3 = t1 * t2;
t4 = t0 + t3;
result = t4
```