VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

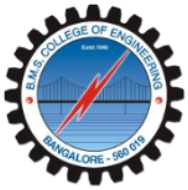
LAB REPORT
on

Compiler Design (22CS5PCCPD)

Submitted by

Ananya Aithal (1BM21CS259)

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



B.M.S. COLLEGE OF ENGINEERING
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CERTIFICATE

This is to certify that the Lab work entitled "Compiler Design" carried out by **Ananya Aithal (1BM21CS259),** who is a 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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Part-A

Experiment 1

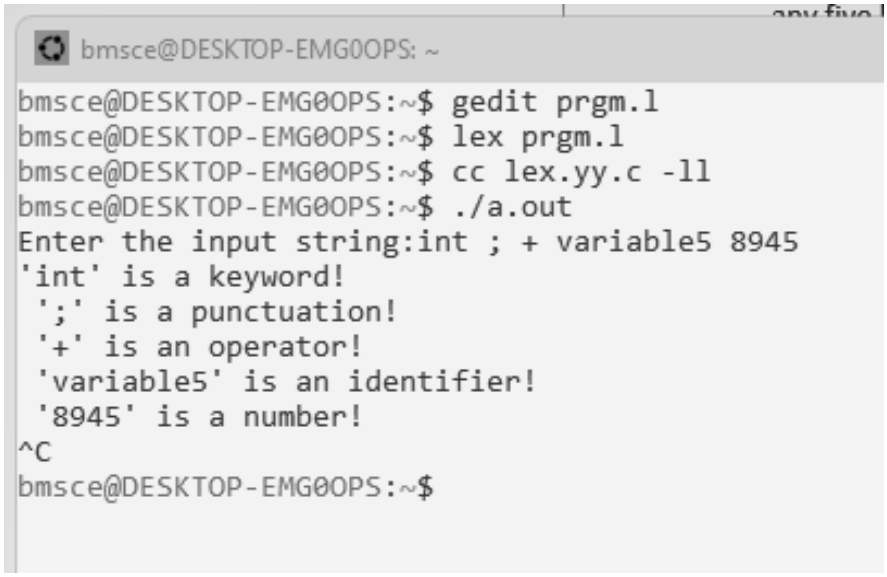
Aim

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

Program

```
%option noyywrap
%{
#include<stdio.h>
%}
%%
int|float|double|void|public {printf("'%s' is a keyword!\n",yytext);}
[0-9]+ {printf("'%s' is a number!\n",yytext);}
[+-/*^] {printf("'%s' is an operator!\n",yytext);}
[;"",.<] {printf("'%s' is a punctuation!\n",yytext);}
[0-9a-zA-Z_]+ {printf("'%s' is an identifier!\n",yytext);}
[\n\t] /* Ignore*/
%%
int main()
{
  printf("Enter the input string:");
  yylex();
  return 0;
}
```

Output



Experiment 2

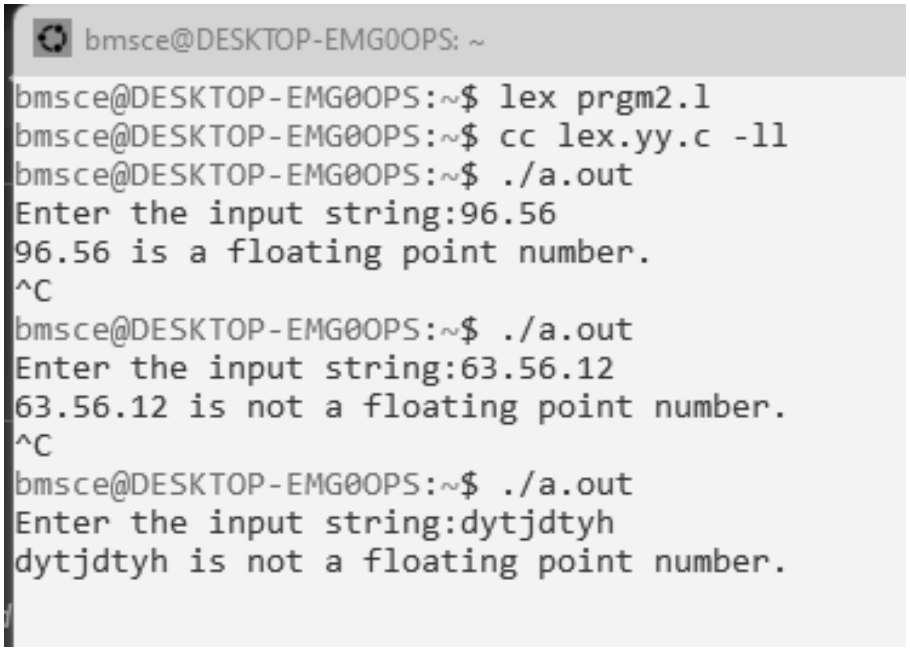
Aim

Write a program in LEX to recognize Floating Point Numbers.

Program

```
%option noyywrap
%{
#include<stdio.h>
%}
%%
[0-9]+\.?[0-9]+ {printf("%s is a floating point number.",yytext);}
[a-zA-Z.0-9]+ {printf("%s is not a floating point number.",yytext);}
[\n\t] /* Ignore*/
%%
int main()
{
  printf("Enter the input string:");
  yylex();
  return 0;

}
```

Output



Experiment 3

Aim

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

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

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

Experiment 4

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

```
hi friend happy new year welcome to 2024 .
```

```
hi friend happy new year welcome to 2024 .
```

Experiment 5

Aim

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);}
}
{digit}* {int i=0; int c=0;
if(yyleng<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

```
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 1

Aim

Write a program to implement:
(a) Recursive Descent Parsing with backtracking (Brute Force Method). S→ cAd , A →ab /a
(b) Recursive Descent Parsing with backtracking (Brute Force Method). S→ cAd , A → 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

```
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 2

Aim

Write a program to implement: Recursive Descent Parsing with back tracking
(Brute Force Method)
(a)S = aaSaa |aa
(b)S = aaaSaaa |aa
(c)S = aaaaSaaaa |aa
(d)S = aaaSaaa aa | aSa |aa

Program

B2.cpp

```
/* S->aaSaa | aa */
#include<bits/stdc++.h>
using namespace std;
int curr;
//??
int S(char b[],int l)
{
//match with aa
char prod[20];
int isave=curr;
strcpy(prod,"aaSaa");
if(curr<l && b[curr]=='a')
{
curr++;
if(curr<l && b[curr]=='a')
{
curr++;
//recursive call to match S
if(S(b,l))
{
if(curr<l && b[curr]=='a')
{
curr++;
if(curr<l && b[curr]=='a')
{
curr++;
return 1; } } } } }
//match with aa
strcpy(prod,"aa");
```

```
curr=isave;
if(curr<l && b[curr]=='a')
{
curr++;
if(curr<l && b[curr]=='a')
{ curr++;
return 1; } }
return 0; }
int main() {
curr=0;
char a[500];
cout<<"Enter the string : ";
cin.getline(a,500,'\n');
int l=strlen(a);
cout<<"length = "<<l<<endl;
if(S(a,l) && curr==l)
{
cout<<"Accepted\n";
}
else
{
cout<<"Not Accepted\n";
}
return 0;
}
```

Output

Part-C
Experiment 1

Aim

Use YACC to construct a LALR parser.

Program

a.y

```
%{
#include <stdio.h>
%}
%token NUM
%token ADD SUB MUL DIV
%%
expression: expression ADD term
        | expression SUB term
        | term
        ;
term: term MUL factor
   | term DIV factor
   | factor
   ;
factor: NUM
     | '(' expression ')'
     ;
%%
#include "lex.yy.c"
int main() {
   yyparse();
   return 0;
}
int yyerror(const char *msg) {
   fprintf(stderr, "Error: %s\n", msg);
   return 1;
}
```

a.l

```
%{
#include "y.tab.h"
%}
%%
```

```
[0-9]+ {
    yylval = atoi(yytext);
    return NUM;
}
[-+*/()]\|\n {
    return yytext[0];
}
[ \t] {
    // Ignore whitespace
}
. {fprintf(stderr, "Unexpected character: %s\n", yytext);}
%%
int yywrap() {
    return 1;
}
```

Output

```
lex calculator.l
yacc -d calculator.y
gcc lex.yy.c y.tab.c -o calculator_parser
./calculator_parser
```

```
3 + 5 * ( 4 - 2 )
```

```
13
```

Experiment 2

Aim

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(yyparse());
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

```
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 3

Aim

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

Program

p.y

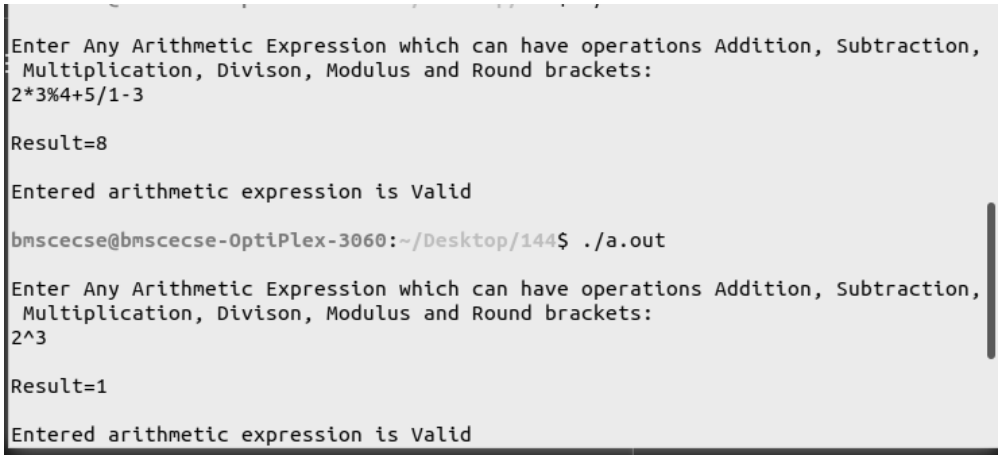
```
%{
#include<stdio.h>
int flag=0;
int yylex();
int yyerror();
%}
%token NUMBER
%left '+' '-'
%left '*' '/'
%left '%'
%right '^'
%left '(' ')'
%%
ArithmeticExpression: E{
  printf("\nResult=%d\n",$$);
   return 0;
          }
E:E'+'E {$$=$1+$3;}
 |E'-'E {$$=$1-$3;}
 |E'*'E {$$=$1*$3;}
 |E'/'E {$$=$1/$3;}
 |E'%'E {$$=$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.l

```
%{
#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



Experiment 4

Aim

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

```
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 5

Aim

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

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

P: '(' 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;
}

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

int mknode(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

```
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$
```

Experiment 6

Aim

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("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

```
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
```