

VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“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
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Department of Computer Science and Engineering**

CERTIFICATE



This is to certify that the Lab work entitled “**COMPILER DESIGN**” carried out by **G RAKSHITHA(1BM21CS258)**, 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 2023-24. The Lab report has been approved as it satisfies the academic requirements in respect of **Compiler Design Lab - (22CS5PCCPD)** work prescribed for the said degree.

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DECLARATION

I, G. Rakshitha (IBM21CS258), student of 5th Semester, B.E, Department of Computer Science and Engineering, B. M. S. College of Engineering, Bangalore, hereby declare that, this lab report entitled " **Compiler Design**" has been carried out by me under the guidance of Prof. 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. Write a Lex program to find whether the given input character is valid or invalid.

```
%option noyywrap

%{

#include<stdio.h>

%}

%%

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

[+-] {printf("operator:%s\n",yytext);}

[ \t\n] { /*ignore whitespaces and newline*/}

[a-zA-Z]* {printf("invalid character:%s\n",yytext);}

%%

int main()

{

printf("Enter the input: ");

yylex();

return 0;

}
```

OUTPUT

```
Enter the input: xyz
invalid character:xyz
█
```

2. Write a lex program to count number of characters in given input string.

```
%{  
#include<stdio.h>  
  
int c=0;  
  
%}  
  
%%  
  
[a-zA-Z0-9]+ {c++;}  
  
\n {printf("The count is %d",c);}  
  
%%  
  
int yywrap()  
{  
}  
  
int main()  
{  
printf("Enter the sentence : ");  
yylex();  
return 0;  
}
```

OUTPUT

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

3. Write a Lex program to count number of vowels and consonants in a sentence.

```
%{  
  
#include  
  
<stdio.h>  
  
int  
  
vow_cou  
  
nt = 0;  
  
int  
  
const_co  
  
unt = 0;  
  
%}  
  
%%  
  
[aeiouAE  
IOU] {  
vow_cou  
nt++; }  
  
[a-zA-Z]  
  
{  
const_co  
unt++; }  
  
\n  
  
{  
printf("Vo  
wels  
count
```



```
is=%d,
```

```
Consona
```

```
nts count
```

```
is=%d\n",
```

```
vow_cou
```

```
nt,
```

```
const_co
```

```
unt); }
```

```
.
```

```
/* Ignore
```

```
any other
```

```
character
```

```
s */
```

```
%%
```

```
int main()
```

```
{
```

```
printf("En
```

```
ter the
```

```
string of
```

```
vowels
```

```
and
```

```
consona
```

```
nts: ");
```

```
yylex();
```

```
    return
```

```
0;
```

```
}
```

```
int
```

```
yywrap()
```

```
{
```

```
    return
```

```
1; /*
```

```
Indicate
```

```
that
```

```
we've
```

```
reached
```

```
the end
```

```
of input */
```

```
}OUTPUT
```


```
T
```

```
Enter the string of vowels and consonants: Good Morning  
Vowels count is=4, Consonants count is=7
```

4. Write a lex program to check whether input is digit or not.

```
% {  
  
#include<stdio.h>  
  
#include<stdlib.h>  
  
% }  
  
%%  
  
^[0-9]* printf("digit");  
^[^0-9][0-9]*[a-zA-Z] printf("not a digit");  
  
.;  
  
%%  
  
int yywrap()  
{  
}  
  
int main()  
{  
    yylex();  
    return 0;  
}
```

OUTPUT




```
7a  
not a digit  
7  
digit  
█
```

5. Write a lex program to check whether the given number is even or odd.

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

OUTPUT:



```
8  
Even  
31  
Odd  
|
```

6. Write a lex program to check whether a number is Prime or not.

```
% {  
  
    #include<stdio.h>  
  
    #include<stdlib.h>  
  
    int flag,c,j;  
% }  
  
%%  
  
[0-9]+ {c=atoi(yytext);  
    if(c==2)  
    {  
        printf("\n Prime number");  
    }  
    else if(c==0 || c==1)  
    {  
        printf("\n Not a Prime number");  
    }  
    else  
    {  
        for(j=2;j<c;j++)
```

```
    {  
    if(c%j==0)  
        flag=1;  
    }  
    if(flag==1)  
        printf("\n Not a prime number");  
    else if(flag==0)  
        printf("\n Prime number");  
    }  
}
```

%%


int yywrap()

```
{  
}
```

int main()

```
{  
    yylex();  
    return 0;  
}
```

OUTPUT



```
13  
    Prime number  
6  
    Not a prime number  
█
```

7.i) Write a lex program to recognize a) identifier

b) keyword-int and float

c) anything else as invalid tokens

% {

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

```
% }
```

```
alpha[a-zA-Z]
```

```
digit[0-9]
```

```
% %
```

```
(float|int) {printf("\nkeyword");}
```

```
{ alpha } ( { digit } | { alpha } ) * {printf("\nidentifier");}
```

```
{ digit } ( { digit } | { alpha } ) * {printf("\ninvalid token");}
```

```
% %
```

```
int yywrap()
```

```
{
```

```
}
```

```
int main()
```

```
{
```

```
yylex();
```

```
return 0;
```

```
}
```

OUTPUT:

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

7. ii) Write a lex program to identify a) identifiers

b) keyword-int and float

c) anything else as invalid tokens


Read these from a text file.

```
% {  
  
    #include<stdio.h>  
  
    char fname[25];  
  
% }  
  
alpha[a-zA-Z]  
digit[0-9]  
  
%%  
  
(float|int) {printf("\nkeyword");}  
  
{ alpha } ( { digit } | { alpha } ) * {printf("\nidentifier");}  
  
{ digit } ( { digit } | { alpha } ) * {printf("\ninvalid token");}  
  
%%  
  
int yywrap()  
  
}  
  
int main()  
  
{
```



```
printf("enter filename");  
scanf("%s",fname);  
yyin=fopen(fname,"r");  
yylex();  
return 0;  
fclose(yyin);  
}
```

OUTPUT




```
enter filenameinput.txt  
keyword  
identifier;
```

8. 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

```
%{  
#include <stdio.h>  
  
int cc=0;  
  
%}  
  
%x CMNT  
  
%%  
  
"/" {BEGIN CMNT;}  
  
<CMNT>. ;
```

```
<CMNT>"/" {BEGIN 0; cc++;}  
  
%%  
  
int yywrap() { }  
  
int main(int argc, char *argv[])  
{  
if(argc!=3)  
{  
printf("Usage : %s <scr_file> <dest_file>\n",argv[0]);  
return 0;  
}  
yyin=fopen(argv[1],"r");  
yyout=fopen(argv[2],"w");  
yylex();  
printf("\nNumber of multiline comments = %d\n",cc);  
return 0;  
}
```

OUTPUT



```
Number of multiline comments = 2
```

9. Write a program in LEX to recognize Floating Point Numbers. Check for all the following input cases

```
%{  
  
#include<stdio.h>  
  
int cnt=0;  
  
%}  
  
sign [+|-]  
  
num [0-9]  
  
dot [.]  
  
%%  
  
{sign}?{num}*{dot}{num}* {printf("Floating point no.");cnt=1;}  
  
{sign}?{num}* {printf("Not Floating point no.");cnt=1;}  
  
%%  
  
int yywrap()  
  
{ }  
  
int main()  
{  
    yylex();  
  
    if(cnt==0){  
  
        printf("Not floating pnt no.");  
    }  
    return 0;  
  
}
```

OUTPUT

```
-67.5  
Floating point no.  
-93  
Not Floating point no.  
█
```

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

```
%{  
  
#include<stdio.h>  
  
int cnt=0;  
  
%}  
  
sign [+|-]  
  
num [0-9]  
  
dot [.]  
  
%%  
  
{sign}{num}*{dot}*{num}* {printf("Signed no.");cnt=1;}  
  
{num}*{dot}*{num}* {printf("Unsigned no.");cnt=1;}  
  
%%  
  
int yywrap()  
  
{  
  
}  
  
int main()  
  
{  
  
yylex();  
  
if(cnt==0){  
  
printf("Not floating pnt no.");  
  
}  
  
return 0;  
  
}
```

OUTPUT

```
+67
Signed no.
89
Unsigned no.

```

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

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

int cnt=0;

%}

punc [?|,|.|!]

chars [a-z|A-Z|0-9|" "\t]

%%

{chars}*{punc} {printf("Sentence ends with punc");}

{chars}* {printf("Sentence does not end with punc");}

%%

int yywrap()

{

}

int main()

{
```

```
yylex();  
  
return 0;  
  
}
```

OUTPUT

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

12.a) Write a Lex program to find an article(a,an,the).

```
%{  
  
#include<stdio.h>  
  
int cnt=0;  
  
%}  
  
chars [a-z|A-Z|0-9]  
  
check [A|a|AN|An|THE|The]  
  
%%  
  
{check}+{chars}* {printf("Begins with %s",yytext);} {chars}* {printf("Invalid");}  
  
%%  
  
int yywrap()  
  
{  
  
}  
  
int main()  
  
{  
  
yylex();  
  
return 0;
```

}

12. b). Write a program in LEX to recognize different tokens: Keywords, Identifiers, Constants, Operators and Punctuations?

```
% {  
  
#include<stdio.h>  
  
int cnt=0;  
  
% }  
  
letter [a-zA-Z]  
  
digit [0-9]  
  
punc [!|,|.]  
  
oper [ + | * | - | / | % ]  
  
boole [true|false]  
  
%%  
  
{ digit }+ | { digit } * . { digit } + { printf("Constants");}  
  
int|float { printf("Keyword");}  
  
{ letter } ( { digit } | { letter } ) * { printf("Identifiers");}  
  
{ oper } { printf("Operator");}  
  
{ punc } { printf("Punctuator");}
```

```
% %
```

```
int yywrap()
```

```
{
```

```
}
```

```
int main()
```

```
{
```

```
yylex();
```

```
return 0;
```

```
}
```

OUTPUT

```
a
Identifiers
25
Constants
int
Keyword
!
Punctuator
+
Operator
hello!
IdentifiersPunctuator
□
```


12 c).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.**

```
% {  
  
#include<stdio.h>  
  
int flag=0,i;  
  
% }  
  
  
letter [a-zA-Z]  
  
digit [0-9]  
  
A [0-9]  
  
punc [!,|.|]  
  
oper [+|*|-|/|%]  
  
boole [true|false]  
  
%%  
  
{ digit }*00 {printf("Ending with 00");}  
  
{ digit }*222{ digit }* {printf("Consecutive 222");}  
  
{ A }{ A }{ A }{ A }{ A } {  
  
flag=0;  
  
for(i=0;i<yy leng;i++){  
  
if(yytext[i]=='5'){  
  
flag=flag+1;
```

```

    }

}

if(flag>=2){

printf("Success");

}

else{

printf("Failure");

}

}

%%

int yywrap()

{

}

int main()

{

yylex();

return 0;

}

```

OUTPUT

```

1200
Ending with 00
122233
Consecutive 222
12535
Success

```

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

```
d[0-9]
```

```
% {
```

```
/* d is for recognising digits */
```

```
int c1=0,c2=0,c3=0,c4=0,c5=0,c6=0,c7=0;
```

```
/* c1 to c7 are counters for rules a1 to a7 */
```

```
% }
```

```
% %
```

```
(({d})*00 { c1++; printf("%s rule A\n",yytext);}
```

```
(({d})222({d})) { c2++; printf("%s rule B\n",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) {
```

```
c4++;
```

```
printf("%s rule D\n",yytext);
```

```
}
```

```
(({d})*1{d}{9} {
```

```
c5++; printf("%s rule E\n",yytext);
```

```
}
```

```
(({d})* {
```

```
int i,c=0;
```

```
if(yytext[5])
```

```
{
```

```
printf("%s doesn't match any rule\n",yytext);
```

```
}  
  
else  
  
{  
  
for(i=0;i<5;i++) { if(yytext[i]=='5') {  
  
c++; } }  
  
if(c>=2)  
  
{  
  
for(;i<yyleng;i++)  
  
{  
  
if(yytext[i-5]=='5') {  
  
c--; }  
  
if(yytext[i]=='5') { c++;  
  
}  
  
if(c<2) { printf("%s doesn't match any rule\n",yytext);  
  
break; }  
  
}  
  
if(yyleng==i)  
  
{  
  
printf("%s ruleC\n",yytext); c3++; }  
  
}  
  
else  
  
{  
  
printf("%s doesn't match any rule\n",yytext);
```

```

}

}

}

%%

int yywrap()

{

}

int main()

{

printf("Enter text\n");

yylex();

printf("Total number of tokens matching rules are : \n");

printf("Rule A : %d \n",c1);

printf("Rule B : %d \n",c2);

printf("Rule C : %d \n",c3);

printf("Rule D : %d \n",c4);

printf("Rule E : %d \n",c5);

return 0;

}

```

OUTPUT:

```

Enter text
1000
1000 rule A

122200
122200 rule A

12223
12223 rule B

1253533535
1253533535 rule E

12535
12535 ruleC

```

13. Write a Program to design Lexical Analyzer in C/C++/Java/python language(to recognize any five keywords,identifiers,numbers,operators and punctuation)

```
kwd=['int','float','char','if','else']

oper=['+','-','*','/','%']

punct=['.','(',')','!']

def func():

    txt=input("Enter text")

    txt=txt.split()

    for token in txt:

        if token in kwd:

            print(token + "is keyword")

        elif (token in oper):

            print(token + "is operator")

        elif(token in punct): print(token + "is punctuator")
        elif(token.isnumeric()): print(token + "is number")
        elif(not token[0].isnumeric()): print(token + "is identifier")
        else:
            print(token + "is not valid identifier") func()
```

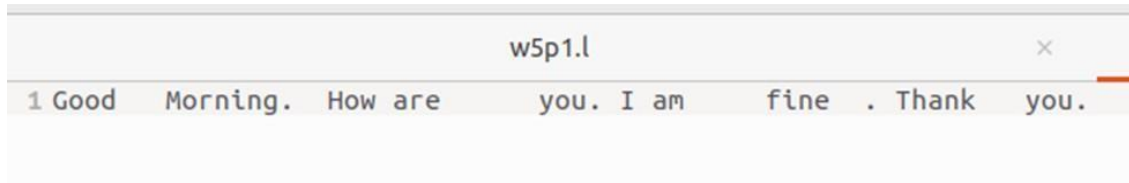
OUTPUT

```
Enter textHello int 123 . +
Hellois identifier
intis keyword
123is number
.is punctuator
+is operator
```

14. Write a Lex Program that copies a file, replacing each nonempty sequence of whitespaces by a single blank.

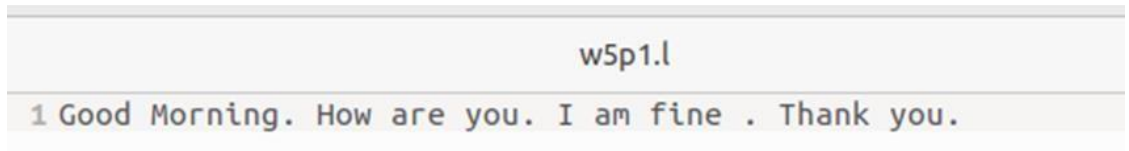
```
% {  
  
#include<stdio.h>  
  
% }  
  
%%  
[\\t" "]+ fprintf(yyout," ");  
.\\n fprintf(yyout,"%s",yytext);  
  
%%  
  
int yywrap()  
{  
return 1;  
}  
  
int main(void)  
{  
yyin=fopen("input1.txt","r");  
yyout=fopen("output.txt","w");  
yylex();  
return 0;  
}
```

Input.txt



A screenshot of a text editor window titled "w5p1.l". The window has a light gray title bar with a close button (X) on the right. The text inside the editor is "1 Good Morning. How are you. I am fine . Thank you." The text is displayed in a monospaced font with a light gray background. The first line is highlighted with a light gray background.

Output.txt



A screenshot of a text editor window titled "w5p1.l". The window has a light gray title bar with a close button (X) on the right. The text inside the editor is "1 Good Morning. How are you. I am fine . Thank you." The text is displayed in a monospaced font with a light gray background. The first line is highlighted with a light gray background.

15 a) Design a suitable grammar for evaluation of arithmetic expression having + and – operators.

+ has least priority and it is left associative

- has higher priority and is right associative

lex

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

yacc

```
% {  
  
#include<stdio.h>  
  
% }  
  
%token NUM  
  
%left '+'  
  
%right '-'
```

```

%%

expr:e {printf("Valid Expression\n"); printf ("Result: %d\n",$$); return 0;}

e:e'+e {$$=$1+$3;}

|e-'e {$$=$1-$3;}

| NUM      {$$=$1;}

;

%%

int main()

{

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

yyparse();

return 0;

}

int yyerror()

{

printf("\nInvalid expression\n");

return 0;

}

```

OUTPUT

```

Enter an arithmetic expression
5-2+3-6
Valid Expression
Result: 0

```

15 b) Design a suitable grammar for evaluation of arithmetic expression having + , - , * , / , % , ^ operators.

^ having highest priority and right associative

% having second highest priority and left associative

*** , / have third highest priority and left associative**

+ , - having least priority and left associative

```
% {  
  
#include "y.tab.h"  
  
% }  
  
%%  
  
[0-9]+ {yylval=atoi(yytext); return NUM;}  
  
[\t]    ;  
  
\n      return 0;  
  
.       return yytext[0];  
  
%%  
  
int yywrap()  
{  
  
}  
  
% {  
  
#include<stdio.h>  
  
% }  
  
%token NUM  
  
%left '+' '-'  
  
%left '*' '/' '%'
```

%right '^'

%%

expr: e { printf("Valid expression\n"); printf("Result: %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 {

 int result = 1;

 for (int i = 0; i < \$3; i++) {

 result *= \$1;

 }

 \$\$ = result;

 }

| NUM { \$\$ = \$1; }

;

%%

int main()

{

 printf("\nEnter an arithmetic expression:\n");

 yyparse();

 return 0;

```
}
```

```
int yyerror()
```

```
{
```

```
    printf("\nInvalid expression\n");
```

```
    return 0;
```

```
}
```

OUTPUT

```
Enter an arithmetic expression:
1+2*3%1^2
Valid expression
Result: 1
```

16.a)Program to recognize the grammar (anb, $n \geq 5$).

Hint : $S \rightarrow aaaaaEb$

$E \rightarrow aE \mid \epsilon$

p2.1

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

```
%%
```

```
[aA] {return A;}
```

```
[bB] {return B;}
```

```

\n {return NL;}

. {return yytext[0];}

%%

int yywrap()
{
    return 1;
}

p2.y

%{

#include<stdio.h>

#include<stdlib.h>

%}

%token A B NL

%%

stmt: A A A A A S B NL {printf("valid string\n"); exit(0);}

;

S: S A

| ;

%%

int yyerror(char *msg)
{
    printf("invalid string\n");

    exit(0);
}

```

```

}

main()

{

printf("enter the string\n");

yyparse();

}

```

OUTPUT:

```

enter the string
aaaaaab
valid string

```

16 .b)Program to recognize strings ‘aaab’, ‘abbb’, ‘ab’ and ‘a’ using the grammar (anbn, n>= 0).

Hint : $S \rightarrow aSb \mid \epsilon$

P3.1

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

```
%%
```

```
[aA] {return A;}
```

```
[bB] {return B;}
```

```
\n {return NL;}
```

```
. {return yytext[0];}
```

```
%%
```

```
int yywrap() {
```

```
return 1; }
```

P3.y

```
% {
```

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

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

```
% }
```

```
%token A B NL
```

```
%%
```

```
stmt: S NL {printf("valid string\n"); exit(0);}
```

```
;
```

```
S: A S B
```

```
| ;
```

```
%%
```

```
int yyerror(char *msg)
```

```
{
```

```
    printf("invalid string\n");
```

```
    exit(0);
```

```
}
```

```
main()
```

```
{
```

```
    printf("enter the string\n");
```

```
    yyparse();
```

```
}
```


OUTPUT

```
enter the string
abb
invalid string
```

16 c) Write a YACC program to accept strings with exactly one a where $\Sigma=\{a,b\}$

P4.l

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

P4.y

```
% {
#include<stdio.h>
#include<stdlib.h>
% }
%token A B NL
%%
stmt: S NL {printf("valid string\n"); exit(0);}
;
S: B S
| A X ;

X : B X |
;
%%
int yyerror(char *msg)
{
    printf("invalid string\n");
    exit(0);
}
main()
{
    printf("enter the string\n");
    yyparse();
}
```

OUTPUT

```
enter the string
aabb
invalid string
```

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

S->cAd,A>ab/a

```
#include <stdio.h>

int index = 0;

int parse_A(char input_str[]) {
    int current_index = index;
    if (input_str[index] == 'a') {
        index++;
        if (input_str[index] == 'b') {
            index++;
            return 1;
        } else {
            // Backtrack
            index = current_index;
            return 0;
        }
    } else if (input_str[index] == 'a') {
        index++;
        return 1;
    }
    return 0;
}
```

```
}
```

```
int parse_S(char input_str[]) {
```

```
    if (input_str[index] == 'c') {
```

```
        index++;
```

```
        if (parse_A(input_str)) {
```

```
            if (input_str[index] == 'd') {
```

```
                index++;
```

```
                return 1;
```

```
            }
```

```
        }
```

```
    }
```

```
    return 0;
```

```
}
```

```
void recursive_descent_parser(char input_str[]) {
```

```
    index = 0;
```

```
    if (parse_S(input_str) && input_str[index] == '\0') {
```

```
        printf("Parsing successful.\n");
```

```
    } else {
```

```
        printf("Parsing failed.\n");
```

```
    }
```

```
}
```

```

int main() {

    char input_string[] = "cabdc";

    recursive_descent_parser(input_string);

    return 0;

}

```

OUTPUT

```

main.c:12:5: warning: built-in function 'index' declared as non-function [-Wbuiltin-declaration-mismatch]
   12 | int index = 0;
      |     ^~~~~
Parsing failed.

```

```

main.c:12:5: warning: built-in function 'index' declared as non-function [-Wbuiltin-declaration-mismatch]
   12 | int index = 0;
      |     ^~~~~
Parsing successful.

```

18. Write a Yacc program to generate syntax tree for a given arithmetic expression

p1.l

```

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

```

```
{  
}
```

p1.y

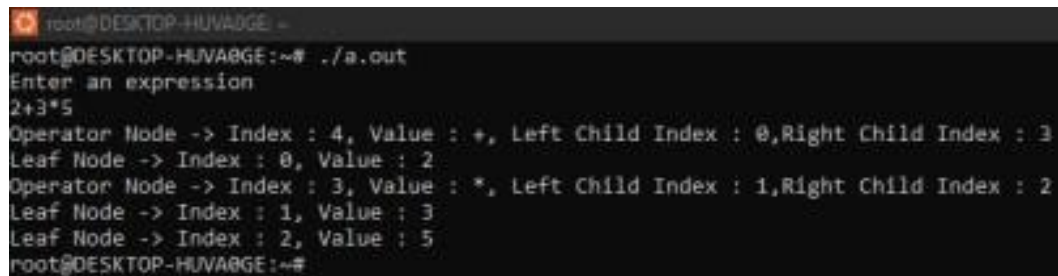
```
% {  
#include <math.h>  
#include <ctype.h>  
#include <stdio.h>  
#include <stdlib.h>  
#include <string.h>  
struct tree_node  
{  
char val[10];  
int lc;  
int rc;  
};  
int ind;  
struct tree_node syn_tree[100];  
void my_print_tree(int cur_ind);  
int mknnode(int lc,int rc,char val[10]);  
% }  
%token digit  
%%  
S:E { my_print_tree($1); }  
;  
E:E'+T { $$= mknnode($1,$3,"+"); ; }  
|T { $$=$1; }  
;  
T:T'*F { $$= mknnode($1,$3,"*"); ; }  
|F { $$=$1 ; }  
;  
F:('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;  
}  
int yyerror()  
{  
printf("NITW Error\n");  
}
```

```

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



```

root@DESKTOP-HUVA0GE: ~
root@DESKTOP-HUVA0GE:~# ./a.out
Enter an expression
2+3*5
Operator Node -> Index : 4, Value : +, Left Child Index : 0,Right Child Index : 3
Leaf Node -> Index : 0, Value : 2
Operator Node -> Index : 3, Value : *, Left Child Index : 1,Right Child Index : 2
Leaf Node -> Index : 1, Value : 3
Leaf Node -> Index : 2, Value : 5
root@DESKTOP-HUVA0GE:~#

```

19. Use YACC to convert: Infix expression to Postfix expression.

p4.l

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

p4.y

```
% {  
#include <ctype.h>  
#include<stdio.h>  
#include<stdlib.h>  
% }  
%token digit  
%%  
S: E {printf("\n\n");}  
;  
E: E '+' T { printf ("+" );}  
| T  
;  
T: T '*' F { printf ("*");}  
| F
```

```

;
F: '(' E ')'
| digit {printf("%d", $1);}
;
%%

int main()
{
printf("Enter infix expression: ");
yyparse();
}

yyerror()
{
printf("Error");
}

```

OUTPUT

```

root@DESKTOP-HUNVAGE:~# lex p4.l
root@DESKTOP-HUNVAGE:~# yacc p4.y
root@DESKTOP-HUNVAGE:~# gcc lex.yy.c y.tab.c
y.tab.c: In function 'yyparse':
y.tab.c:1019:16: warning: implicit declaration of function 'yylex' [-Wimplicit-function-declaration]
 1019 |     yychar = yylex ();
      |                ^~~~~
y.tab.c:1178:7: warning: implicit declaration of function 'yyerror'; did you mean 'yyerrok'? [-Wimplicit-function-declaration]
 1178 |     yyerror (YY_("syntax error"));
      |     ^~~~~~
      |     yyerrok
p4.y: At top level:
p4.y:28:1: warning: return type defaults to 'int' [-Wimplicit-int]
   28 | yyerror()
      | ^~~~~~
root@DESKTOP-HUNVAGE:~# ./a.out
Enter infix expression: 2+8*3+4
263*+4+

```


20. Modify the program so as to include operators such as / , - , ^ as per their arithmetic associativity and precedence

```
% {
#include <ctype.h>
#include<stdio.h>
#include<stdlib.h>
% }
%token digit
%left '+' '-'
%left '*' '/'
%right '^'
%%
S: E {printf("\n\n");}
;
E: E '+' T { printf ("+" );}
|E '-' T { printf ("-");}
| T
;
T: T '*' G { printf ("*");}
|T '/' G{ printf ("/");}
| G
;
G: G '^' F { printf ("^");}
|F
;
F: '(' E ')'
| digit {printf("%d", $1);}
;
%%
int main()
{
printf("Enter infix expression: ");
yyparse();
}
yyerror()
{
printf("Error");
}
}
```

OUTPUT

```
y.tab.c: In function 'yyparse':
y.tab.c:1223:16: warning: implicit declaration of function 'yylex' [-Wimplicit-f
unction-declaration]
 1223 |         yychar = yylex ();
      |                ^~~~~~
y.tab.c:1392:7: warning: implicit declaration of function 'yyerror'; did you mea
n 'yyerrok'? [-Wimplicit-function-declaration]
 1392 |         yyerror (YY_("syntax error"));
      |         ^~~~~~
      |         yyerrok
p4.y: At top level:
p4.y:30:1: warning: return type defaults to 'int' [-Wimplicit-int]
   30 |     yyerror()
      |     ^~~~~~
bmsce@bmsce-OptiPlex-3060:~/Desktop/1BM21CS205$ ./a.out
Enter infix expression: 2^3+4^5
23^45^+
```

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

```
%{

/* Definition section */

#include<stdio.h>

#include "y.tab.h"

extern int yylval;

}%

/* Rule Section */

%%

[0-9]+ {

    yylval=atoi(yytext);

    return NUMBER
```

```

    }

    [\t] ;

    [\n] return 0;

    return yytext[0];

%%

int yywrap()

{

    return 1;

}

token NUMBER

%left '+' '-'

%left '*' '/' '%'

%left '(' ')'

/* Rule Section */

%%

ArithmeticExpression: E{

    printf("\nResult=%d\n", $$);

    return 0;

};

E:E+'E' {$$=$1+$3;}

|E-'E' {$$=$1-$3;}

|E'*'E {$$=$1*$3;}

```

```
|E/'E' {$$=$1/$3;}
```

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

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

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

```
;
```

```
%%
```

```
//driver code
```

```
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("\nEnter arithmetic expression is Valid\n\n");
```

```
}
```

```
void yyerror()
```

```
{
```

```
    printf("\nEnter arithmetic expression is Invalid\n\n");
```

```
    flag=1;
```

```
}
```

OUTPUT

```
Enter Any Arithmetic Expression which can have operations Addition, Subtraction, Multiplication, Division, Modulus and Round brackets:  
1+2*3  
Result=7  
Entered arithmetic expression is Valid
```

22.YACC to generate 3-Adress code for given expression.

```
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];

%%

int yywrap()

{

}
```

P.y

%{

#include <math.h>

#include<ctype.h>

#include<stdio.h>

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;

}

yyerror()

{

printf("error");

}

```

OUTPUT

```

bmscecse@bmscecse-OptiPlex-3060:~/Documents/18M21CS253$ ./a.out
Enter an expression :
a=3*5+4
t0 = 3;
t1 = 5;
t2 = t0 * t1;
t3 = 4;
t4 = t2 + t3;
a=t4

```