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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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 **PRASANNA KUMAR R(1BM21CS138),** 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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Part-A: Implementation of Lexical Analyzer, By using C/C++/Java/Python language and using LEX tool.

PROGRAM 1

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

```
import re
def lexical_analyzer(input_text):
    keywords = ["if", "else", "for", "while", "return"]
    operators = ['+', '-', '*', '/', '=', '==', '!=', '<', '>', '<=', '>=']
    punctuations = [';', ',', '(', ')', '{', '}']
    tokens = []
    # Tokenize the input_text
    words = re.findall(r'\b\w+\b', input_text)
    for word in words:
        if word in keywords:
            tokens.append(("Keyword", word))
        elif re.match(r'^[a-zA-Z_]\w*$', word):
            tokens.append(("Identifier", word))
        elif re.match(r'^[0-9]+$', word):
            tokens.append(("Number", word))
        elif word in operators:
            tokens.append(("Operator", word))
        elif word in punctuations:
            tokens.append(("Punctuation", word))
    return tokens
if __name__ == "__main__":
    input_text = "if x == 5 for i in range(10): print(i); else: print('Not 5')"
```

```
    tokens = lexical_analyzer(input_text)
    print("Token\t\t\tLexeme")
    print("-" * 30)
    for token, lexeme in tokens:
        print(f"{token.ljust(15)}{lexeme}")
```

Output:

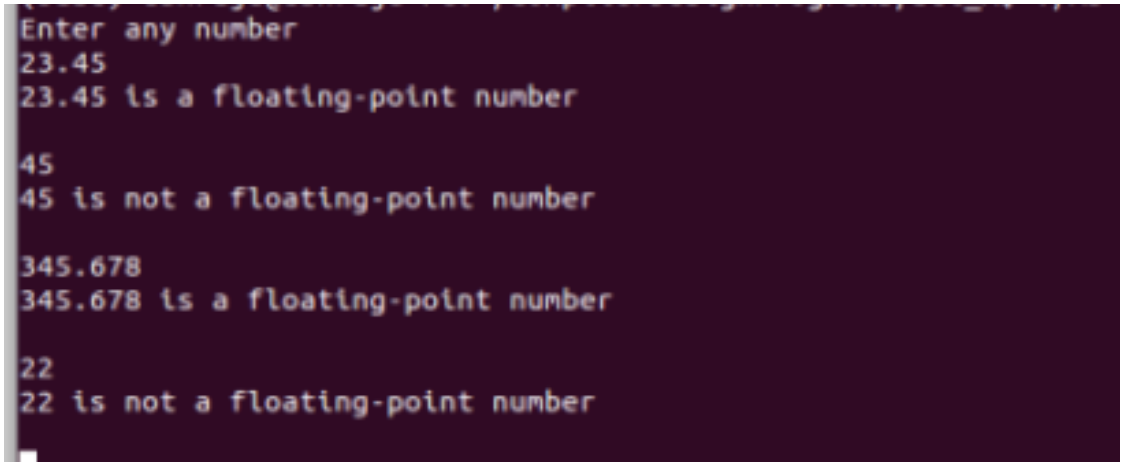
```
Token           Lexeme
------------------------------
Keyword         if
Identifier      x
Number          5
Keyword         for
Identifier      i
Identifier      in
Identifier      range
Number          10
Identifier      print
Identifier      i
Keyword         else
Identifier      print
Identifier      Not
Number          5
```

PROGRAM 2

Write a program in LEX to recognize Floating Point Numbers.

```
%{
  #include<stdio.h>
%}
digit [0-9]
num {digit}+
snum [-+]?{num}
%%
({snum}[.]{num})|({num}[.]{num})|([.]{num})|([-+][.]{num}) {printf("%s is a floating number\n", yytext);}
({snum}|{num}) {printf("%s is not a floating number\n", yytext);}
%%
int yywrap() {
  return 1;
}
int main() {
  printf("Enter a number: ");
  yylex();
  return 0;
}
```

Output:


Enter any number
23.45
23.45 is a floating-point number
45
45 is not a floating-point number
345.678
345.678 is a floating-point number
22
22 is not a floating-point number

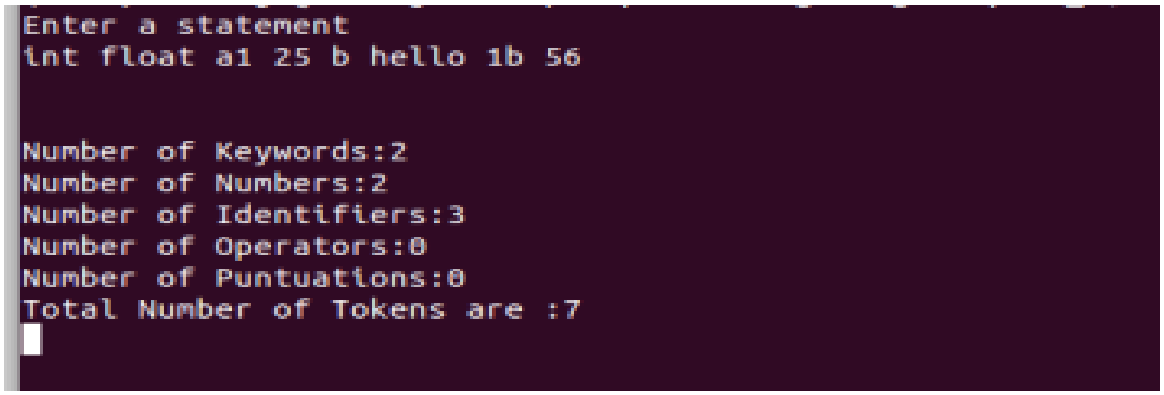
PROGRAM 3

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

```
d [0-9]
a [a-zA-Z]
z [a-zA-Z0-9]
x [.]
%%
int|float|char {x1++;}
{a}{z}* {x2++;}
==|>=|<=|>|< {x3++;}
,|; {x4++;}
[+-]?{d}{d}*({x}{d}{d}*)?({x}{d}*(e[+-]?{d}+)?)? {x5++;}
\n {
  printf("Number of keywords:%d\n", x1);
  printf("Number of Identifiers:%d\n", x2);
  printf("Number of Operators:%d\n", x3);
  printf("Number of punctuation:%d\n", x4);
  printf("Number of constants:%d\n", x5);
  printf("Total number of components:%d\n", x1 + x2 + x3 + x4 + x5);
}
%%
int yywrap() {
  return 1;
}
int main() {
  x1 = x2 = x3 = x4 = x5 = 0;
```

```
  printf("Enter: ");
  yylex();
  return 0;
}
```

Output:



PROGRAM 4

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

```
%{
 #include<stdio.h>
%}
%%
[ ]([ ])* {fprintf(yyout," ");}
([ ])*(\n)([ ])* {fprintf(yyout," ");}
%%
int yywrap()
{
  return 1;
}
int main()
{
  yyin=fopen("filename.txt","r");
  yyout=fopen("filename.txt","w");
  yylex();
  return 0;
}
```

Output:

AS_input.txt

```
Hello,    Friends
Service            to humanity
is
service to              divinity.
If
   you
      don't
           know
              how
                 compiler works,
then
   you don't
know how
                       computer works.
```

AS_output.txt

```
Hello, Friends Service to humanity is service to divinity. If you don't know how compiler works, then
you don't know how computer works.
```

PROGRAM 5

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.

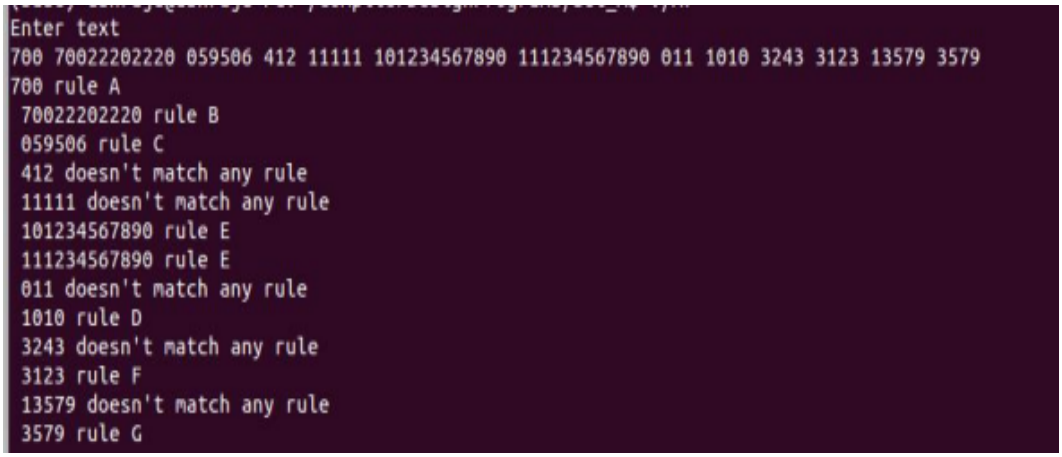
e) The set of all strings such that the 10th symbol from the right end is 1.

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.

```
%{
#include <stdio.h>
%}
digit [0-9]

%%
.*00$       { printf("Token a) String ending in 00: %s\n", yytext); }
.*222.*     { printf("Token b) String with three consecutive 222's: %s\n", yytext); }
[^5]*5[^5]*5[^5]*5[^5]*5[^5]*5[^5]* { printf("Token c) String with every block of five consecutive symbols containing at least two 5's: %s\n", yytext); }
```

```
^1[01]*0[01]*$ { printf("Token d) String beginning with a 1 and congruent to zero modulo 5: %s\n", yytext); }

^.{9}1.*$     { printf("Token e) String with the 10th symbol from the right end being 1: %s\n", yytext); }

^[0-9][0-9][0-9]9$ { printf("Token f) Four-digit numbers whose sum is 9: %s\n", yytext); }

^[0-9][0-9][0-9][0-9]$ { if(yytext[0]<=yytext[1] && yytext[1]<=yytext[2] && yytext[2]<=yytext[3]) printf("Token g) Four-digit numbers with digits in ascending order: %s\n", yytext); }

.|\n

%%

int main() {

   yylex();

   return 0;

}
```

Output:



Part-B: Implementation of Parsers (Syntax Analyzers) Using C/C++/Java/Python language)

PROGRAM 1

Write a program to implement

(a) Recursive Descent Parsing with back tracking (Brute Force Method). S→ cAd , A →ab /a

```
def S(input_str):
    global index
    if index < len(input_str) and input_str[index] == 'c':
        index += 1
        if A(input_str):
            if index < len(input_str) and input_str[index] == 'd':
                index += 1
                return True
    return False
def A(input_str):
    global index
    if index < len(input_str) and input_str[index] == 'a':
        index += 1
        if index < len(input_str) and input_str[index] == 'b':
            index += 1
            return True
```

```
    elif index < len(input_str) and input_str[index] == 'a':
        index += 1
        return True
    return False
def parse(input_str):
    global index
    index = 0
    if S(input_str) and index == len(input_str):
        print("Parsing successful!")
    else:
        print("Parsing failed.")
# Example usage:
input_string =input('Enter a string:')
parse(input_string)
```

Output:

```
Enter string:abd
Parsing failed.
>
```

(b) Recursive Descent Parsing with back tracking (Brute Force Method). S→ cAd , A → a / ab

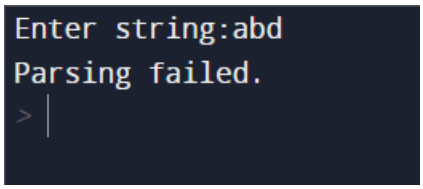
```
def S(input_str):
    global index
    if index < len(input_str) and input_str[index] == 'c':
        index += 1
        if A(input_str):
            if index < len(input_str) and input_str[index] == 'd':
                index += 1
```

```
            return True
    return False

def A(input_str):
    global index
    current_index = index  # Backtrack point
    if index < len(input_str) and input_str[index] == 'a':
        index += 1
        return True
    else:
        index = current_index  # Backtrack
        if index < len(input_str) and input_str[index] == 'a':
            index += 1
            if index < len(input_str) and input_str[index] == 'b':
                index += 1
                return True
    return False

def parse(input_str):
    global index
    index = 0
    if S(input_str) and index == len(input_str):
        print("Parsing successful!")
    else:
        print("Parsing failed.")

# Example usage:
```

input_string = input(‘Enter a string:’)

parse(input_string)

Output:



PROGRAM 2

2. Write a program to implement: Recursive Descent Parsing with back tracking (Brute Force Method).

(a) 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')

2

{
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:

(b)S → aaaSaaa | aa

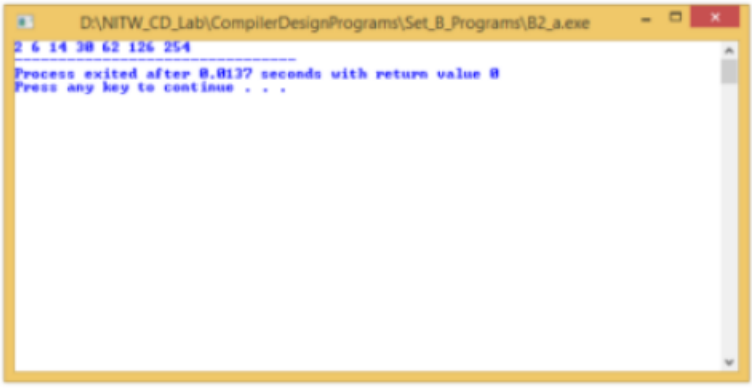
```
#include<bits/stdc++.h>
```

```
using namespace std;
int i;
//??
//tries all possible centres recursively and try to match the
string
int S(char b[],int l)
{
int isave=i;
//match with aa
if(i<l && b[i]=='a')
{
i++;
if(i<l && b[i]=='a')
{
i++;
//match with S recursively
if(S(b,l))
{
//match with aa
if(i<l && b[i]=='a')
{
i++;
if(i<l && b[i]=='a')
{
i++;
return 1;
}
```

```
}
}
}
}
i=isave;
//match with middle aa
if(i<l && b[i]=='a')
{
i++;
if(i<l && b[i]=='a')
{
i++;
return 1;
}
}
return 0;
}
int main()
{

5

i=0;
char a[500];
memset(a,'\0',500);
for(int j=0;j<400;j++)
{
```

```
a[j]='a';
i=0;
if(S(a,j+1) && i==j+1)
{
cout<<j+1<<" ";
}
}
return 0;
}
```

Output:



(c)S → aaaaSaaaa | aa

```
#include<bits/stdc++.h>
using namespace std;
int i;
//??
//checks for grammer S->aaaaSaaaa | aa
//tries all possible centres recursively and try to match the
string
int S(char b[],int l)
{
```

```
int isave=i;
//match with aaaa
if(i<l && b[i]=='a')
{
i++;
if(i<l && b[i]=='a')
{
i++;
if(i<l && b[i]=='a')
{
i++;
if(i<l && b[i]=='a')
{
i++;
//match with S recursively
if(S(b,l))
{
//match with aaaa
if(i<l && b[i]=='a')
{
i++;
if(i<l && b[i]=='a')
{
i++;
if(i<l && b[i]=='a')
{
i++;
```

```
if(i<l &&

b[i]=='a')

{
i++;
return 1;
}
}
}
}
}
}
}
}

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}
i=isave;
//match with middle aa
if(i<l && b[i]=='a')
{
i++;
if(i<l && b[i]=='a')
{
i++;
```
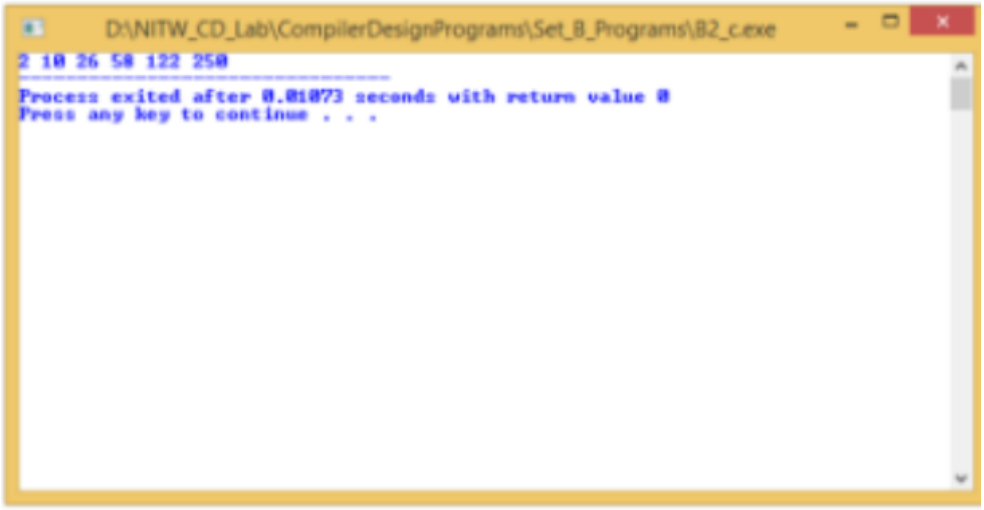

```
return 1;
}
}
return 0;
}
int main()
{
i=0;
char a[500];
memset(a,'\0',500);
for(int j=0;j<400;j++)
{
a[j]='a';
i=0;
if(S(a,j+1) && i==j+1)
{
cout<<j+1<<" ";
}
}
return 0;
}
```

Output:



(d)S → aaaSaaa |aSa | aa

```
#include<bits/stdc++.h>
using namespace std;
int i;
//??
//checks for grammer S->aaaSaaa | aSa | aa
//tries all possible centres recursively and try to match the
string
int S(char b[],int l)
{
int isave=i;
//match with aaa
if(i<l && b[i]=='a')
{
i++;
if(i<l && b[i]=='a')
{
i++;
if(i<l && b[i]=='a')
```

```
{
i++;
//match with S recursively
if(S(b,l))
{
//match with aaa
if(i<l && b[i]=='a')
{
i++;
if(i<l && b[i]=='a')
{
i++;
if(i<l && b[i]=='a')
{
i++;
return 1;
}
}
}
}
}
}
i=isave;
//match with a
if(i<l && b[i]=='a')
{
```

```
i++;
//match with S recursively

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if(S(b,l))
{
//match with a
if(i<l && b[i]=='a')
{
i++;
return 1;
}
}
}
i=isave;
//match with middle aa
if(i<l && b[i]=='a')
{
i++;
if(i<l && b[i]=='a')
{
i++;
return 1;
}
}
return 0;
```
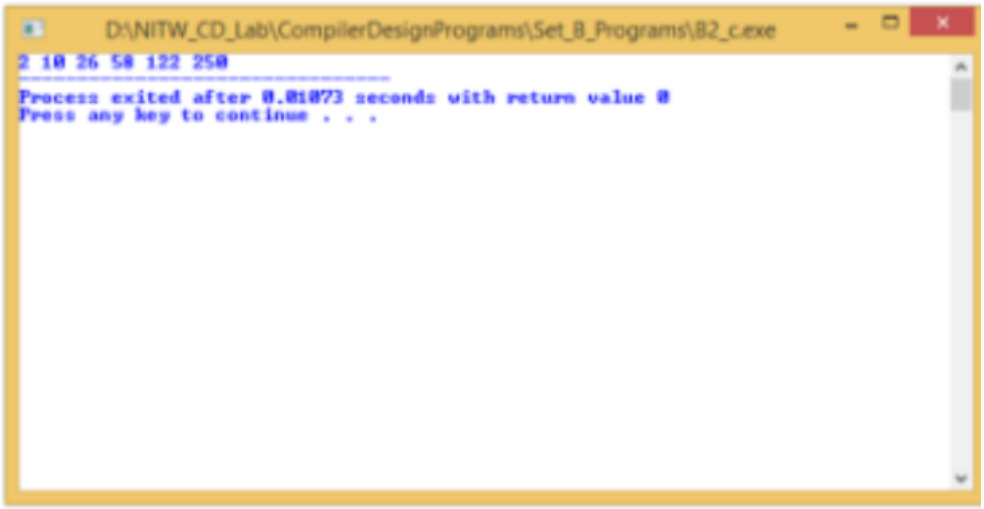

```
}
int main()
{
i=0;
char a[500];
memset(a,'\0',500);
for(int j=0;j<400;j++)
{
a[j]='a';
i=0;
if(S(a,j+1) && i==j+1)
{
cout<<j+1<<" ";
}
}
return 0;
}
```

Output:



Part-C: Syntax Directed Translation using YACC tool

PROGRAM 1

Write a program to design LALR parsing using YACC.

c1.y

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

```
| T '/' P
| P
;
P: F '^' P
| F
;
F: '(' E ')'
 | digit
 ;
%%
int main()
{
 printf("Enter infix expression: ");
 yyparse();
}
yyerror()
{
 printf("NITW Error");
}
```

C1.l

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

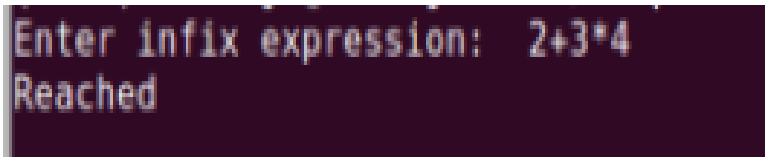
[\t] ;

[\n] return 0;

. return yytext[0];

%%

Output:



PROGRAM 2

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

C2.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 : ");
// calling yyparse function which execute grammer rules and
lex
while(yyparse());
printf("\n");
}
void yyerror(char *s)
{
fprintf(stdout,"\n%s",s);
}
```

C2.l

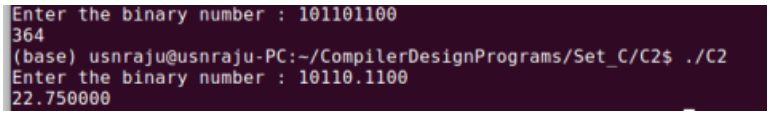
```
%{
#include<stdio.h>
#include<stdlib.h>
#include"y.tab.h"
extern int yylval;
%}
%%
0 {yylval=0;return ZERO;}
1 {yylval=1;return ONE;}
"." {return POINT;}
```

[\t] {;}

\n return 0;

%%

Output:



PROGRAM 3

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

c3.y

```
%{
 #include <stdio.h>
 #include <ctype.h>
 int x[5],y[5],k,j[5],a[5][10],e,w;
%}
%token digit
%%
S : E { printf("\nAnswer : %d\n",$1); }
 ;
E : T { x[e]=$1; } E1 { $$=x[e]; }
 ;
E1 : '+' T { w=x[e]; x[e]=x[e]+$2; printf("Addition Operation %d
and %d : %d\n",w,$2,x[e]); } E1 { $$=x[e]; }
 | '-' T { w=x[e]; x[e]=x[e]-$2; printf("Subtraction Operation
%d and %d : %d\n",w,$2,x[e]); } E1 { $$=x[e]; }
```

```
 | { $$=x[e]; }

 ;

T : Z { y[e]=$1; } T1 { $$=y[e]; }

 ;

T1 : '*' Z { w=y[e]; y[e]=y[e]*$2; printf("Multiplication

Operation of %d and %d : %d\n",w,$2,y[e]); } T1 { $$=y[e]; }

 | { $$=y[e]; }

 ;

Z : F { a[e][j[e]++]=$1; } Z1 { $$=$3; }

 ;

Z1 : '^' Z { $$=$2; }

 | { for(k=j[e]-1;k>0;k--) { w=a[e][k-1]; a[e][k1]=powr(a[e][k-1],a[e][k]); printf("Power Operation
%d ^ %d :

%d\n",w,a[e][k],a[e][k-1]); } $$=a[e][0]; j[e]=0; }

 ;

F : digit { $$=$1; printf("Digit : %d\n",$1); }

 | '(' { e++; } E { e--; } ')' { $$=$3; }

2

 ;

%%

int main()

{

 for(e=0;e<5;e++) { x[e]=y[e]=0; j[e]=0; }

 e=0;

 printf("Enter an expression\n");

 yyparse();

 return 0;

}
```

```
yyerror()
{
 printf("NITW Error");
}
int yywrap()
{
 return 1;
}
int powr(int m,int n)
{
 int ans=1;
 while(n) { ans=ans*m; n--; }
 return ans;
}
```

C3.l

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

Output:

```
Enter an expression
2+3*4
Digit : 2
Digit : 3
Digit : 4
Multiplication Operation of 3 and 4 : 12
Addition Operation 2 and 12 : 14

Answer : 14
```

PROGRAM 4

Use YACC to convert: Infix expression to Postfix expression.

File: C4.y

```
%{
 #include <ctype.h>
 #include<stdio.h>
 #include<stdlib.h>
%}
%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("NITW Error");
}
```

C3.l

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

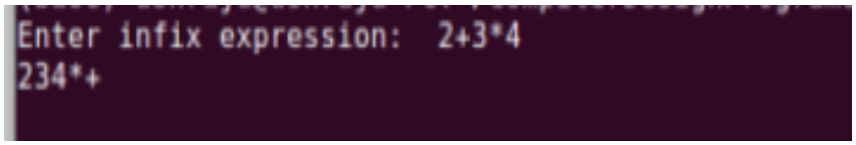
[\t] ;

[\n] return 0;

. return yytext[0];

%%

Output:



PROGRAM 5

Use YACC to generate Syntax tree for a given expression

C3.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 mknode(int lc,int rc,char val[10]);
%}
%token digit
%%
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();
```

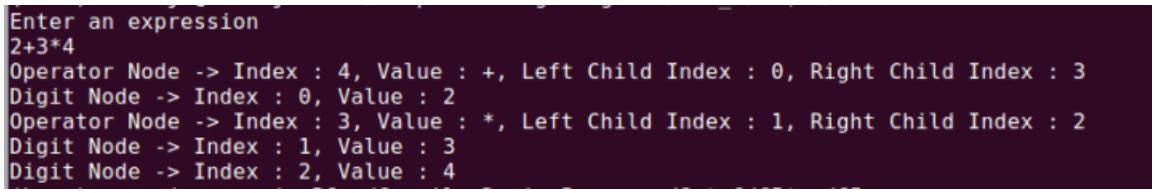
```
return 0;
}
yyerror()
{
printf("NITW Error\n");
}
int mknode(int lc,int rc,char val[10])
{
 strcpy(syn_tree[ind].val,val);
 syn_tree[ind].lc = lc;
 syn_tree[ind].rc = rc;
 ind++;
 return ind-1;
}
void my_print_tree(int cur_ind)
{
 if(cur_ind==-1) return;
 if(syn_tree[cur_ind].lc==-1&&syn_tree[cur_ind].rc==-1)
 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);
```

}

C3.l

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

Output:



PROGRAM 6

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

C4.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); }
;
2
%%
int main()
{
var_cnt=0;
printf("Enter an expression : \n");
yyparse();
return 0;
}
yyerror()
{
printf("NITW Error\n");
}
```

C5.l

```
d [0-9]+
a [a-zA-Z]+
%{
#include<stdio.h>
#include<stdlib.h>
#include"y.tab.h"
extern int yylval;
extern char iden[20];
%}

%%
{d} { yylval=atoi(yytext); return digit; }
{a} { strcpy(iden,yytext); yylval=1; return id; }
[ \t] {;}
\n return 0;
. return yytext[0];
%%
```

Output:

```
Enter an expression :
result=2+3*4
t0 = 2;
t1 = 3;
t2 = 4;
t3 = t1 * t2;
t4 = t0 + t3;
result = t4
```

PROGRAM 7

Use YACC to generate the 3-Address code which contains Arrays.

C7.y

```
%{
 #include <stdio.h>
 #include <bits/stdc++.h>
 #include <ctype.h>
 using namespace std;
 int yylex(void);
 void yyerror(const char *);
 int n,i,j,an,nd[10],dim[10][10],can,r,inter;
 int a[20],c[20],rednum,vn;
 char b[20],name;
 int size_of_datatype,sz;
 int make_variable();
%}
```

```
%token id
%%
/* Final reduction printing. Split LHS and RHS and initiate reduction. */
S : id '=' E ';' { printf("After reduction number %d\n",rednum++); printf("%c =
t%d\n\n",$1,b[$3]-48); }
 ;
/* If a '+' is encountered, split it into two halves and reduce it again. */
/* If it is the last term, reduce it by taking it as T state. */
E : E '+' T { printf("After reduction number %d\n",rednum++);
 i=make_variable(); $$=i; c[i]=vn; b[i]=vn+48; vn++; printf("t%d =
",c[i]); if(a[$1]!=-1){printf("t%d + ",c[$1]);}
 else { printf("%c + ",b[$1]); } if(a[$3]!=-
1){printf("t%d\n",c[$3]);} else { printf("%c\n",b[$3]); } }
 | T { $$=$1; }
 ;
/* T can be either a normal variable. id takes care of variables and if it is an
array, it will move to state L. */
T : id { printf("After reduction number %d\n",rednum++); i=make_variable();
a[i]=-1; b[i]=$1; $$=i; }
 | L { printf("After reduction number %d\n",rednum++); i=make_variable(); $$=i;
c[i]=vn; b[i]=vn+48; vn++;
 printf("t%d = %c[t%d]\n",c[i],name,c[$1]); can++; }
 ;
/* The variable name of the array is received in the token id. */
/* The index of the array can be an expression. Hence, recursively calling E to
reduce the index. */
/* The second term is for multi dimensional arrays. */
```

```
L : id '[' E ']' { printf("After reduction number %d\n",rednum++);
 name=$1; r=0; i=make_variable(); $$=i; c[i]=vn; b[i]=vn+48;
vn++; printf("t%d = ",c[i]); if(a[$3]!=-1){printf("t%d",c[$3]);}
 else { printf("%c",b[$3]); }
2
 if(r+1!=nd[can]) { printf(" *
%d",size_of_datatype*dim[can][nd[can]-1-r]); }
 else { printf(" * %d",size_of_datatype); } r++; printf("\n");
}
 | L '[' E ']' { printf("After reduction number %d\n",rednum++);
 //inter=make_variable();
inter=vn++; printf("t%d = ",inter); if(a[$3]!=-
1){printf("t%d",c[$3]);} else { printf("%c",b[$3]); }
 if(r+1!=nd[can]) { printf(" *
%d",size_of_datatype*dim[can][nd[can]-1-r]); } else { printf(" *
%d",size_of_datatype); }
 r++; printf("\n");
i=make_variable(); $$=i; c[i]=vn; b[i]=vn+48; vn++;
printf("t%d = t%d + t%d\n",c[i],c[$1],inter);
 }
 ;
%%
int main()
{
 rednum=1; vn=1;
 printf("Enter size of data type : \n");
 scanf("%d",&size_of_datatype);
```

```
 printf("Enter no of arrays : \n");
 scanf("%d",&an);
 int y,l;
 for(y=0;y<an;y++)
 {
 printf("Enter no of dimension of %d array : \n",y+1);
 scanf("%d",&nd[y]);
 printf("Enter dimensions of %d array : \n",y+1);
 for(l=0;l<nd[y];l++)
 {
 scanf("%d",&dim[y][l]);
 }
 }
 //an=1; nd[0]=2; dim[0][0]=2; dim[0][1]=3;
 can=0;
 int x=0;
 for(x=0;x<20;x++) { a[i]=0; }
 n=1;
 printf("Enter Expression ending with Semicolon\n");
 cin.ignore();
 yyparse();
 return 0;
}
int make_variable()
{
 return n++;
}
```

```
void yyerror(const char *str)
3
{
 printf("NITW Error occuring\n");
}
int yywrap()
{
 return 1;
}
```

C7.l

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

 #include <stdlib.h>
%}
d[0-9]
c[a-z]
extern char yylval;
/*
 Rules:
 If an alphabet from a to z is matched, it is sent as a token.
 If a tab character is encountered, nothing is done.
 If a new line character is encountered, code stops running.
 For anything else, the first character of the matched word is
sent as token.
*/
```

%%

{c} { yylval=yytext[0]; return(id); }

[\t] ;

[\n] return 0;

. return yytext[0];

%%

Output: