VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT

on

COMPILER DESIGN

Submitted by

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(1BM21CS106)

Under the Guidance of

Prof. Prameetha Pai

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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)

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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 **Mohammad Faraz Mahmud (1BM21CS106)** , 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.

Prof. Prameetha Pai	Dr. Jyothi Nayak
Assistant professor	Professor and Head
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B. M. S. COLLEGE OF ENGINEERING

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

DECLARATION

I, Mohammad Faraz Mahmud (1BM21CS106), 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 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.

TABLE OF CONTENTS

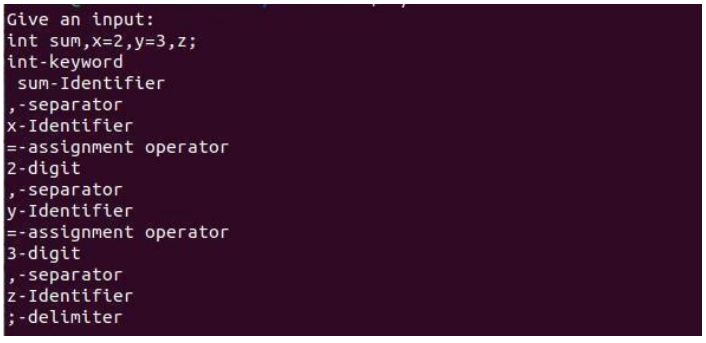
Lab 1

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



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

```
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

```
Enter a sentence:
Compiler design
 No of vowels and consonants are 5 and 9
This is a book
   No of vowels and consonants are 5 and 6
```

Lab 2

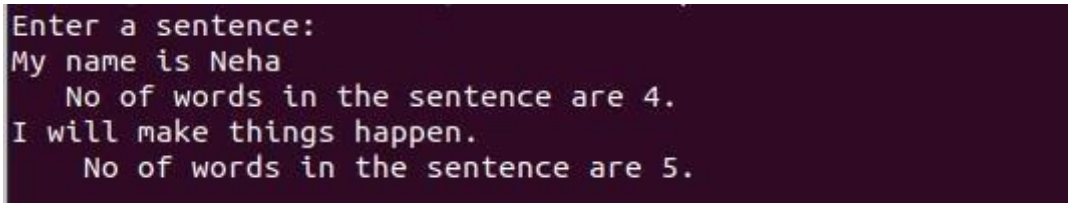
2.1 Write a program in lex to count the number of words in a sentence.

Code

```
%{
#include<stdio.h> int
words;
%}
%%
[^\t\n ]+ {words++;}
\n {printf("No of words in the sentence are %d.\n",words),words=0;}
```

```
%%
void main() {
printf("Enter a sentence:\n");
yylex(); } int yywrap() {
return 1;
}
```

Output



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

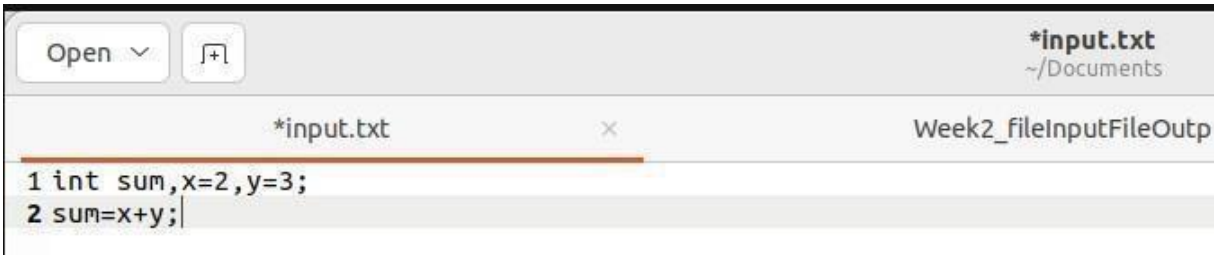
2.3 Write a program in lex to identify tokens in a program by taking input from a file and printing the output on the terminal.

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



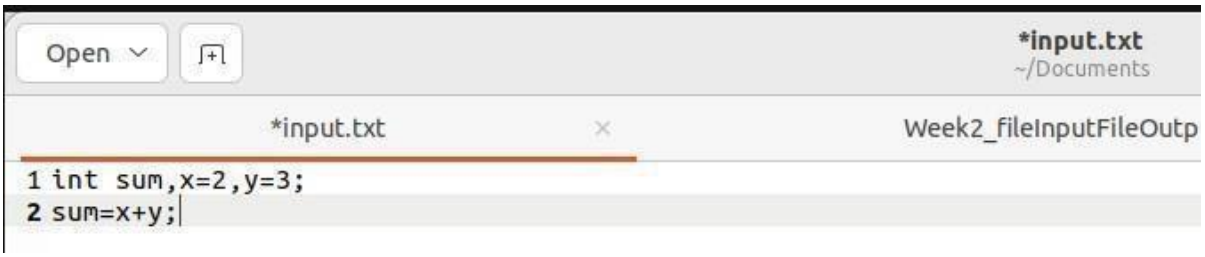

```
int is a keyword.
 sum is an identifier.
, is a separator.
x is an identifier.
= is an assignment operator.
2 is/are digit(s).
, is a separator.
y is an identifier.
= is an assignment operator.
3 is/are digit(s).
; is a delimiter.
sum is an identifier.
= is an assignment operator.
x is an identifier.
+ is a binary operator.
y is an identifier.
; is a delimiter.
```

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.

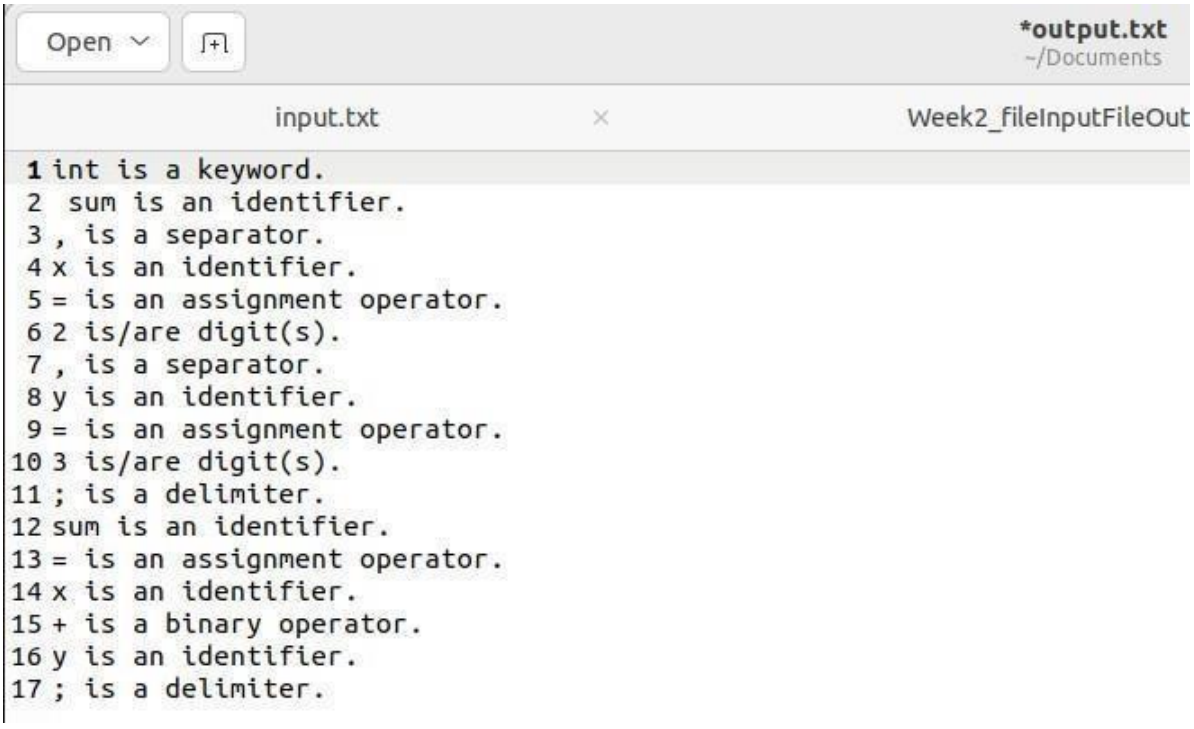
Code

```
%{
#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




```
Printed in output.txt
```

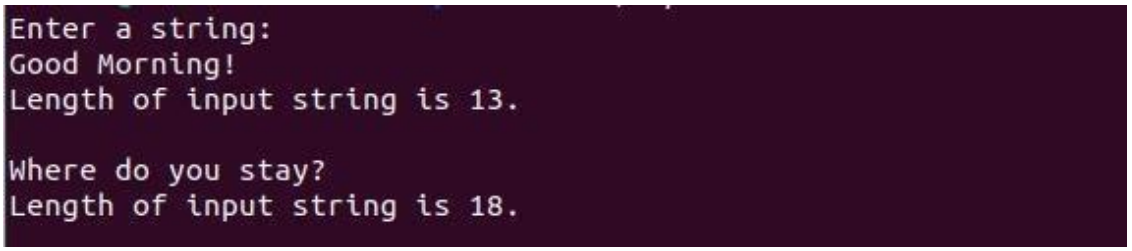


2.5 Write a program in lex to find the length of the input string.

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



Lab 3

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

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.
```

```
Enter a string:
145
Does not end 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

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

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=yyleng-1;i>=0;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.
```

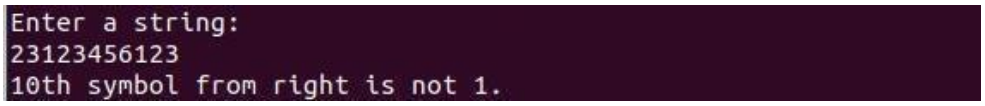
```
Enter a string:
101
Decimal representation:5
Congruent to modulo 5.
```

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][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



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

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.
```

```
Enter a string:
1243
The digits are not in ascending order.
```

Lab 5

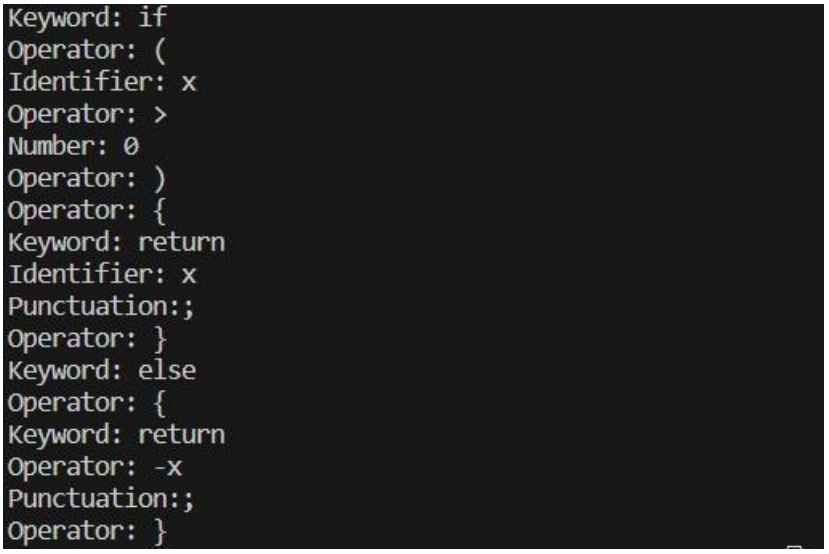
Write a C program to design lexical analysis to recognize any five keywords, identifiers, numbers, operators and punctuations.

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



Lab 6

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

```
Enter a string:
cad$
Valid string!
```

```
Enter a string:
cabd$
Valid string!
```

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
```

7.2 Write a program in YACC to recognize strings of the form {(a^n)b , n>=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 A S B NL {printf("Parsed using the rule (a^n)b, n>=5.\nValid String!\n");}
;
S:S A
|
```

```
;
%%
void main() {
printf("Enter a string!\n");
yyparse(); } int
yyerror(char *s) {
printf("Invalid String!\n");
return 0; }
```

Output

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

```
Enter an expression:
2*3+5*4
Operator Node -> Index : 6, Value : +, Left Child Index : 2,Right Child Index : 5
Operator Node -> Index : 2, Value : *, Left Child Index : 0,Right Child Index : 1
Digit Node -> Index : 0, Value : 2
Digit Node -> Index : 1, Value : 3
Operator Node -> Index : 5, Value : *, Left Child Index : 3,Right Child Index : 4
Digit Node -> Index : 3, Value : 5
Digit Node -> Index : 4, Value : 4
```

Lab 8

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

Lab 9

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