VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT

on

COMPILER DESIGN

Submitted by

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Under the Guidance of

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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

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B. M. S. College of Engineering,

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(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 **Namya R D (1BM21CS111)** , 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
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B. M. S. COLLEGE OF ENGINEERING

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

DECLARATION

I, Namya R D (1BM21CS111), 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.

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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

```
Namya$ lex Week1_identifyKeywords.l
Namya$ gcc lex.yy.c
Namya$ ./a.out
Give an input:
int sum = 0, x = 23, number = 342;
int-keyword
 sum-Identifier
 =-assignment operator
 0-digit
,-separator
 x-Identifier
 =-assignment operator
 23-digit
,-separator
 number-Identifier
 =-assignment operator
 342-digit
;-delimiter
```

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

```
Namya$ lex Week1_NoOfDigChar.l
Namya$ gcc lex.yy.c
Namya$ ./a.out
Enter a sentence:
I was born during December
No of characters and digits are 22 and 0
Most used password is 123456
No of characters and digits are 18 and 6
```

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

```
Namya$ lex Week1_NoOfConsonantsVowels.l
Namya$ gcc lex.yy.c
Namya$ ./a.out
Enter a sentence:
Current course is Compiler Design
    No of vowels and consonants are 11 and 18
```

Lab 2

2.1Write 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

```
Namya$ lex Week2_NoOfWords.l
Namya$ gcc lex.yy.c
Namya$ ./a.out
Enter a sentence:
This a test case to identify the number of words
         No of words in the sentence are 10.
Another test
 No of words in the sentence are 2.
```

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

```
Namya$ lex Week2_RegularDef.l
Namya$ gcc lex.yy.c
Namya$ ./a.out
Enter a string:
Testcase
Characters

2024
Digits
Testcase3
Invalid input!
```

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

```
Namya$ cat input.txt
int sum = 0, x = 23, y = 43;
sum = x + y;
Namya$ lex Week2_FileInput.l
Namya$ gcc lex.yy.c
Namya$ ./a.out
int is a keyword.
 sum is an identifier.
 = is an assignment operator.
 0 is/are digit(s).
, is a separator.
 x is an identifier.
 = is an assignment operator.
 23 is/are digit(s).
, is a separator.
 y is an identifier.
 = is an assignment operator.
 43 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

```
Namya$ cat input.txt
int sum = 0, x = 23, y = 43;
sum = x + y;
Namya$
Namya$ lex Week2_fileInputFileOutput.l
Namya$ gcc lex.yy.c
Namya$ ./a.out
Printed in output.txt
Namya$
Namya$
Namya$ cat output.txt
int is a keyword.
 sum is an identifier.
 = is an assignment operator.
 0 is/are digit(s).
, is a separator.
 x is an identifier.
 = is an assignment operator.
 23 is/are digit(s).
, is a separator.
 y is an identifier.
 = is an assignment operator.
 43 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.
```

2.5 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

```
Namya$ lex Week2_lengthofString.l
Namya$ gcc lex.yy.c
Namya$ ./a.out
Enter a string:
This is an example of a string
Length of input string is 30.

Hello world
Length of input string is 11.
```

Lab 3

3.1 Write a program in LEX to recognize Floating Point Numbers.

Code

```
%{
#include<stdio.h>
%}
%%
[+-]?[0-9]*[.][0-9][0-9]* {printf("Floating point number!\n");};
[+-]?[0-9][0-9]* {printf("Not a floating point number!\n");};
%%
int yywrap()
{ return 1; }
void main()
{
printf("Enter a number:\n");
yylex(); }
```

Output

```
Namya$ lex Week3_floatingPtOrNot.l
Namya$ gcc lex.yy.c
Namya$ ./a.out
Enter a number:
543
Not a floating point number!

.3445
Floating point number!

234.45
Floating point number!
```

3.2 Read and input sentence, and check if it is compound or simple. If a sentence has the word- and , or ,but ,because ,if ,then ,nevertheless then it is compound else it is simple.

Code

```
%{

#include<stdio.h> int

flag=0;

%} %%

if|then|but|because|nevertheless|and|or {flag=1;}

. ;

\n {return 0;}

%%

int yywrap()

{ return 1;

} void

main()

{

printf("Enter a sentence:\n");

yylex(); if(flag==1)

printf("Compound sentence!\n"); else

printf("Simple sentence!\n");

}
```

Output

```
Namya$ lex Week3_compoundOrSimple.l
Namya$ gcc lex.yy.c
Namya$ ./a.out
Enter a sentence:
This is an example of a sentence
Simple sentence!
Namya$ ./a.out
Enter a sentence:
she is good at singing and swimming
Compound sentence!
Namya$
```

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

Code

```
%{
#include<stdio.h> int
flag=0;
%}
%%
.*[?|!|.]$ {flag=1;}
.* {flag=0;}
\n {return 0;}
%%
int yywrap()
{ return 1;
} void
main()
{
printf("Enter a sentence:\n");
yylex(); if(flag==1)
printf("Ends with a punctuation!\n"); else
printf("Does not end with punctuation!\n");
}
```

Output

```
Namya$ lex Week3_endsWithPunc.l
Namya$ gcc lex.yy.c
Namya$ ./a.out
Enter a sentence:
Hello World!
Ends with a punctuation!
Namya$ ./a.out
Enter a sentence:
This is a period
Does not end with punctuation!
```

3.4 Write a program to read an input sentence and to check if the sentence begins with English articles (A, a,AN,An,THE and The).

Code

```
%{
#include<stdio.h> int
flag=0;
%}
%%
^(an|An|The|the|A|a)[" "].* {flag=1;}
.* {flag=0;}
\n {return 0;}
%%
int yywrap()
{ return 1;
} void
main()
{
printf("Enter a sentence:\n");
yylex(); if(flag==1)
printf("Starts with an article!\n"); else
printf("Does not start with an article!\n");
}
```

Output

```
Namya$ lex Week3_startsWithArticle.l
Namya$ gcc lex.yy.c
Namya$ ./a.out
Enter a sentence:
This is not a person
Does not start with an article!
Namya$ ./a.out
Enter a sentence:
The class starts at nine
Starts with an article!
```

3.5 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.

Code

```
%{
#include<stdio.h> int
c=0;
%}
%%
"\/\*"[^*]*\*+([^/*][^*]*\*+)*\/ {c++;}
"//".* {c++;}
. ECHO;
%%
int yywrap()
{ return 1;
} void
main()
{
yyin=fopen("input.txt","r");
yyout=fopen("output.txt","w"); yylex();
printf("The number of comments are:%d\n",c);
fclose(yyin); fclose(yyout); }
```

Output

```
Namya$ cat input.txt
//This is a comment
/* This is a multi-line comment*/
int x = 34;
Namya$
Namya$
Namya$ lex Week3_comments.l
Namya$ gcc lex.yy.c
Namya$ ./a.out
The number of comments are:2
```

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

Code

```
%{
#include<stdio.h>
%}
%%
[+|-][0-9]+ {printf("Signed number!\n");}
[0-9]+ {printf("Unsigned number!\n");}
%%
int yywrap()
{ return 1;
} void
main()
{
printf("Enter a number:\n");
yylex(); }
```

Output

```
Namya$ lex Week3_signedOrNot.l
Namya$ gcc lex.yy.c
Namya$ ./a.out
Enter a number:
2343
Unsigned number!

-3434
Signed number!

+2334
Signed number!
```

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

```
Namya$ cat text.txt
This    is         a              line
This is           also     a     line
Namya$
Namya$
Namya$ lex Week4_ReplaceSpaces.l
Namya$ gcc lex.yy.c
Namya$ ./a.out
Printed!
Namya$
Namya$
Namya$ cat print.txt
This is a line
This is also a line
```

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

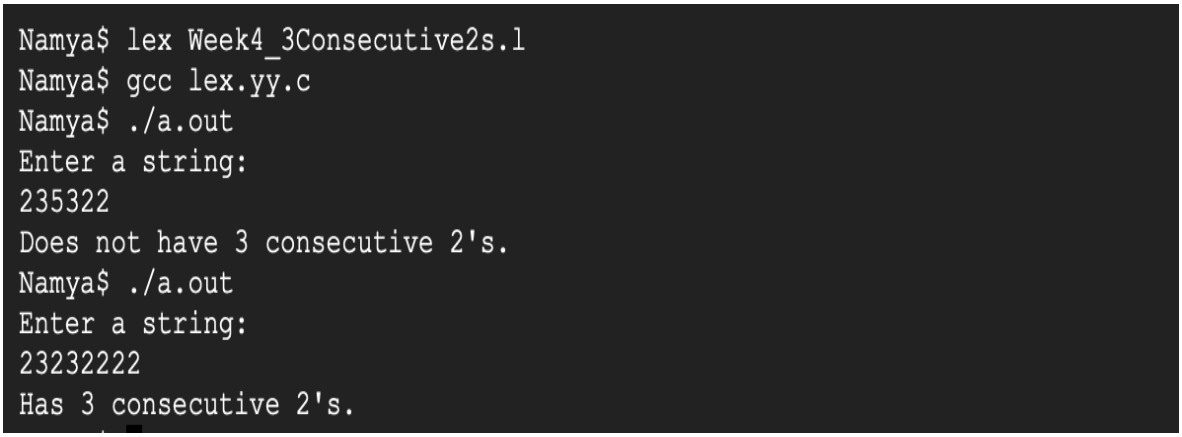
```
Namya$ lex Week4_EndsWith0.l
Namya$ gcc lex.yy.c
Namya$ ./a.out
Enter a string:
2398430
Ends with 0.
Namya$ ./a.out
Enter a string:
asdf
Does not end with 0.
```

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

```
Namya$ ./a.out
Enter a string:
154353455235
yytext:15435,flag(1 if no of 5 is atleast 2):1
yytext:34552,flag(1 if no of 5 is atleast 2):1
yytext:35,flag(1 if no of 5 is atleast 2):0
Not a valid string!
Namya$ ./a.out
Enter a string:
1234567890
yytext:12345,flag(1 if no of 5 is atleast 2):0
Not a valid string!
Namya$ ./a.out
Enter a string:
12345767891
yytext:12345,flag(1 if no of 5 is atleast 2):0
Not a valid string!
```

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

```
Namya$ lex Week4_BinRepCongruentTo5.l
Namya$ gcc lex.yy.c
Namya$ ./a.out
Enter a string:
1001
Decimal representation:9
Not congruent to modulo 5.
Namya$ ./a.out
Enter a string:
10101
Decimal representation:21
Not congruent to modulo 5.
Namya$ ./a.out
Enter a string:
101
Decimal representation:5
Congruent to modulo 5.
Namya$ ./a.out
Enter a string:
234
Not a binary number.
```

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

```
Namya$ lex Week4_TenthSymbolIs1.l
Namya$ gcc lex.yy.c
Namya$ ./a.out
Enter a string:
3245257546
10th symbol from right is not 1.
Namya$ ./a.out
Enter a string:
1135769375
10th symbol from right is 1.
```

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

```
Namya$ lex Week4_SumEqualTo9.l
Namya$ gcc lex.yy.c
Namya$ ./a.out
Enter a string:
2356
The sum of digits is not 9.
Namya$ ./a.out
Enter a string:
1242
The sum of digits is 9.
```

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

```
Namya$ lex Week4_DigAscOrder.l
Namya$ gcc lex.yy.c
Namya$ ./a.out
Enter a string:
1256
The digits are in ascending order.
Namya$ ./a.out
Enter a string:
4578
The digits are in ascending order.
Namya$ ./a.out
Enter a string:
5472
The digits are not in ascending order.
```

Lab 5

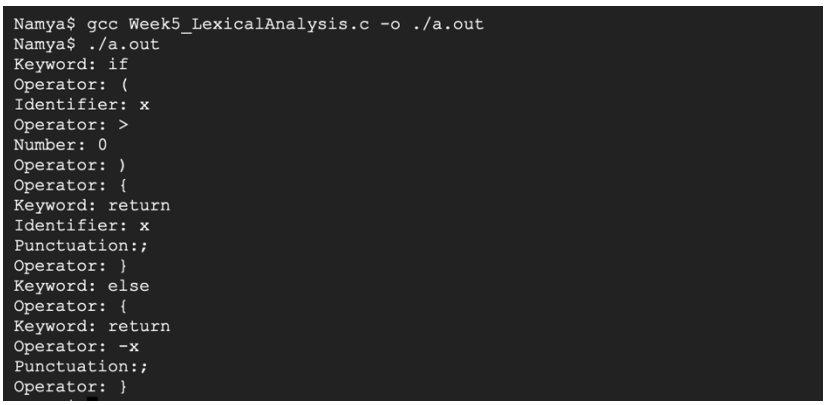
Write a C program to design lexical analysis to recognize any five keywords, identifiers, numbers, operators and punctuations.

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

```
Namya$ gcc Week6_RecursiveDescent.c
Namya$ ./a.out
Enter the input string:
cad$
Hello
Parsing successful.
Namya$ ./a.out
Enter the input string:
cadd$
Hello
Parsing failed. Extra characters found.
Namya$ ./a.out
Enter the input string:
cabd$
Hello
Parsing successful.
```

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

```
Namya$ lex Week7_yacc_calci.l
Namya$ yacc Week7_yacc_calci.y
Namya$ yacc -d Week7_yacc_calci.y
Namya$ gcc lex.yy.c y.tab.c
Namya$ ./a.out
Enter an arithmetic expression:
2+3*3
Valid expression!
Result:11
Namya$ ./a.out
Enter an arithmetic expression:
++23-2
Invalid expression!
```

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

```
Namya$ lex Week7_yacc_StringMatch.l
Namya$ yacc Week7_yacc_StringMatch.y
Namya$ yacc -d Week7_yacc_StringMatch.y
Namya$ gcc lex.yy.c y.tab.c
Namya$ ./a.out
Enter a string!
aaaaab
Parsed using the rule (a^n)b, n>=5.
Valid String!
asdf
Invalid String!
```

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

```
Namya$ lex Week7_yacc_SyntaxTree.l
Namya$ yacc Week7_yacc_SyntaxTree.y
Namya$ yacc -d Week7_yacc_SyntaxTree.y
Namya$ gcc lex.yy.c y.tab.c
Namya$ ./a.out
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

```
Namya$ lex Week8_yacc_InfixToPostfix.l
Namya$ yacc Week8_yacc_InfixToPostfix.y
Namya$ yacc -d Week8_yacc_InfixToPostfix.y
Namya$ gcc lex.yy.c y.tab.c
Namya$ ./a.out
Enter an infix expression:
2+3*8/4^3-3
238*43^/+3-
```

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

```
Namya$ lex Week9_AddressCode.l
Namya$ yacc Week9_AddressCode.y
Namya$ yacc -d  Week9_AddressCode.y
Namya$ gcc lex.yy.c y.tab.c
Namya$ ./a.out
Enter an expression:
a=2*3/6-4
t0 = 2;
t1 = 3;
t2 = t0 * t1;
t3 = 6;
t4 = t2 / t3;
t5 = 4;
t6 = t4 - t5;
a=t6
```