LAB MANUAL

of

Compiler Design Laboratory

(CSE606)

Bachelor of Technology (CSE)

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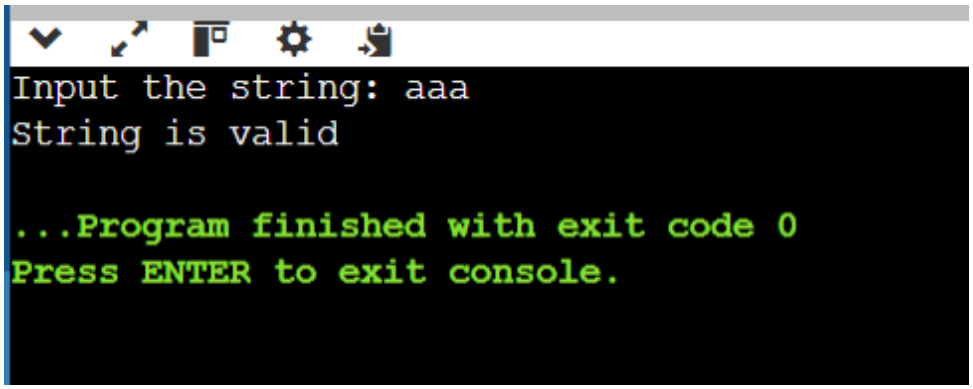
EXPERIMENT 1

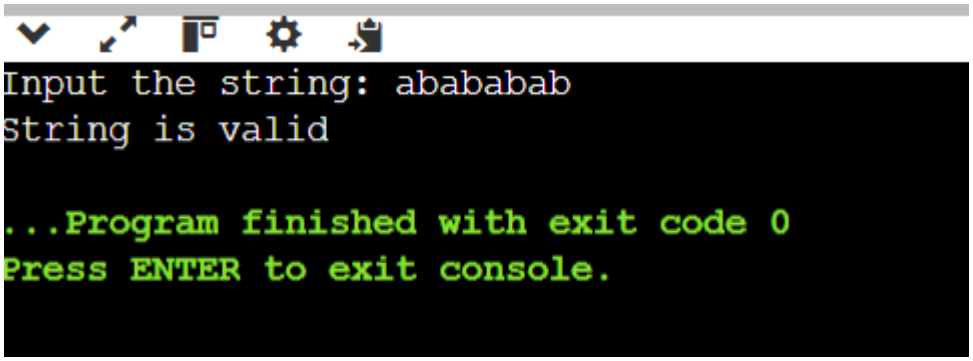
a)
Write a program to recognize strings starts with ‘a’ over {a, b}.

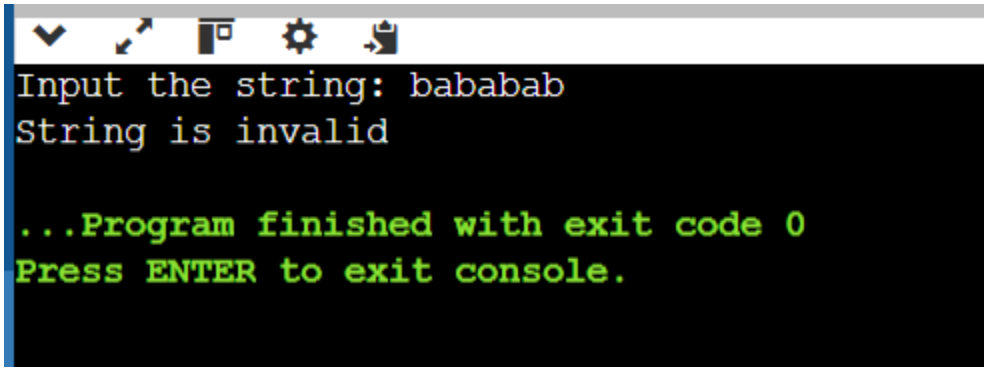
SOURCE CODE:

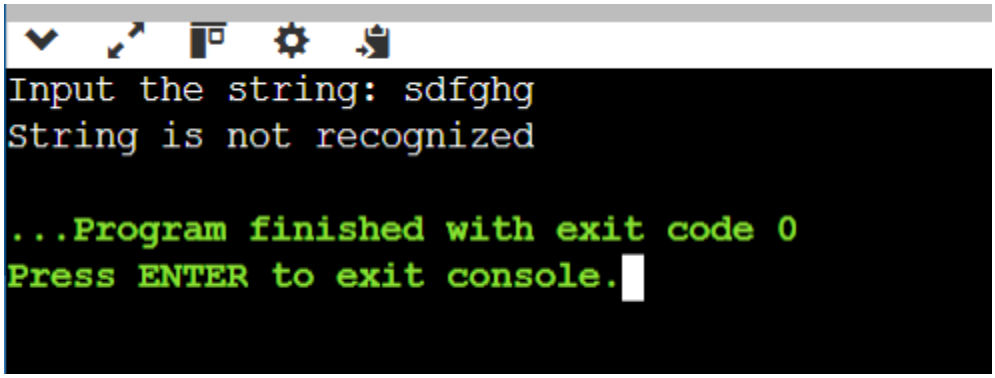
```c
#include <stdio.h>

int main(){
   char input[10];
   int i=0, state=0;
   printf("Input the string: ");
   scanf("%s", input);

   while(input[i]!='\0'){
       switch(state) {
           case 0:
               if(input[i]=='a') state = 1;
               else if (input[i] == 'b') state = 2;
               else state = 3;
               break;

           case 1:
               if (input[i] == 'a' || input[i] == 'b') state = 1;
               else state = 3;
               break;

           case 2:
               if (input[i] == 'a' || input[i] == 'b') state = 2;
               else state = 3;
               break;

           case 3:
               state = 3;
               break;
       }

       i++;
   }

   if (state==1) printf("String is valid");
   else if (state==2 || state==0) printf("String is invalid");
   else if (state==3) printf("String is not recognized");
   return 0;
}
```

OUTPUT:


Input the string: aaa
String is valid
...Program finished with exit code 0
Press ENTER to exit console.


Input the string: abababab
String is valid
...Program finished with exit code 0
Press ENTER to exit console.


Input the string: bababab
String is invalid
...Program finished with exit code 0
Press ENTER to exit console.

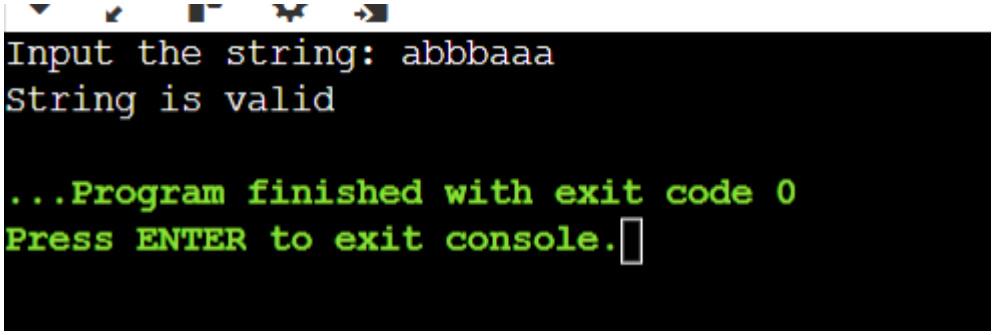

Input the string: sdfghg
String is not recognized
...Program finished with exit code 0
Press ENTER to exit console.

b)
Write a program to recognize strings end with ‘a’.

SOURCE CODE:

```c
#include <stdio.h>

int main(){
   char input[10];
   int i=0, state=0;
   printf("Input the string: ");
   scanf("%s", input);

   while(input[i]!='\0'){
       switch(state) {
           case 0:
               if(input[i]=='a') state = 1;
               else state = 0;
               break;

           case 1:
               if (input[i] == 'a') state = 1;
               else state = 0;
               break;

       }

       i++;
   }

   if (state==1) printf("String is valid");
   else if (state==0) printf("String is invalid");
   return 0;
}
```

OUTPUT:



```
Input the string: babbaaaa
String is valid

...Program finished with exit code 0
Press ENTER to exit console.
```

```
Input the string: abbbbbb
String is invalid

...Program finished with exit code 0
Press ENTER to exit console.
```

```
Input the string: fdghjn
String is invalid

...Program finished with exit code 0
Press ENTER to exit console.
```

c)

Write a program to recognize strings end with ‘ab’. Take the input from text file.

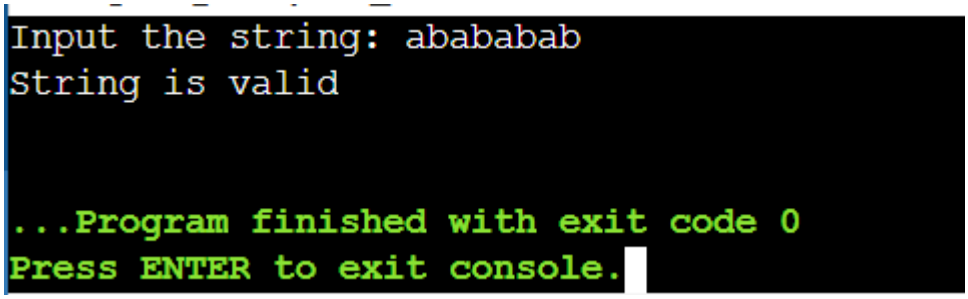
SOURCE CODE:

```c
#include <stdio.h>

int main(){
   char input[10];
   int i=0, state=0;
   printf("Input the string: ");
   scanf("%s", input);

   int len = strlen(input);

   if (len >= 2 && input[len - 2] == 'a' && input[len - 1] == 'b') {
       printf("String is valid\n");
   } else {
       printf("String is invalid\n");
   }

   return 0;
}
```

OUTPUT:

```
Input the string: dgfhab
String is valid


...Program finished with exit code 0
Press ENTER to exit console.
```

```
Input the string: gsfdghb
String is invalid


...Program finished with exit code 0
Press ENTER to exit console.
```


Input the string: abababab
String is valid
...Program finished with exit code 0
Press ENTER to exit console.

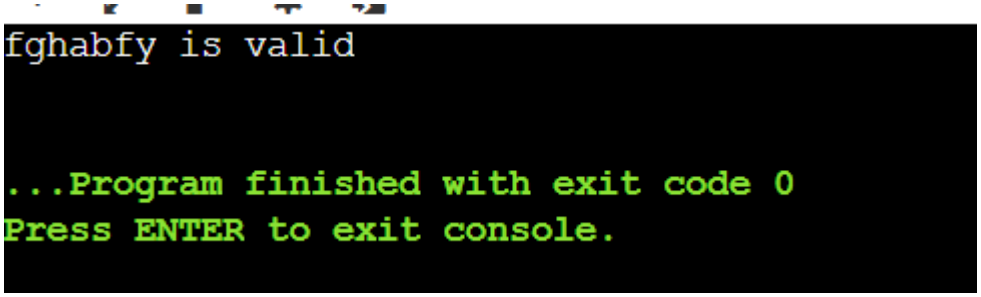
d)

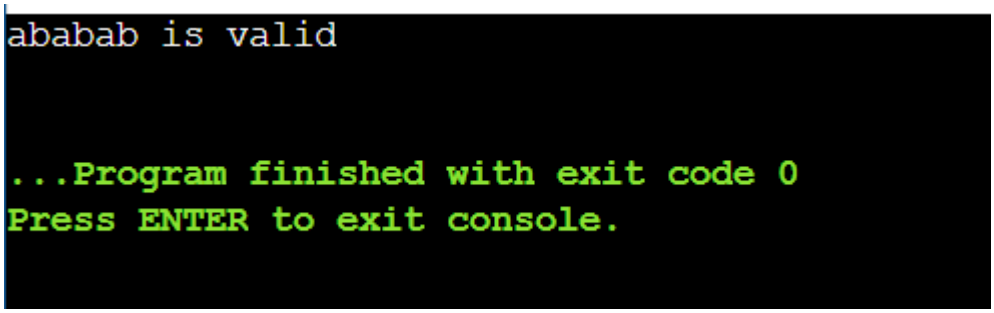
Write a program to recognize strings contains ‘ab’. Take the input from text file.

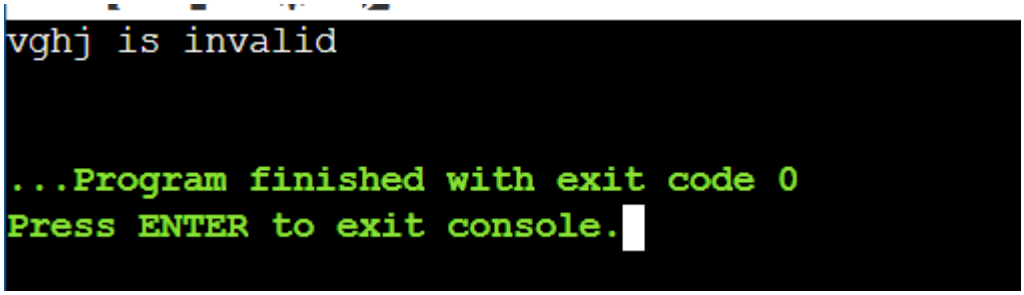
SOURCE CODE:

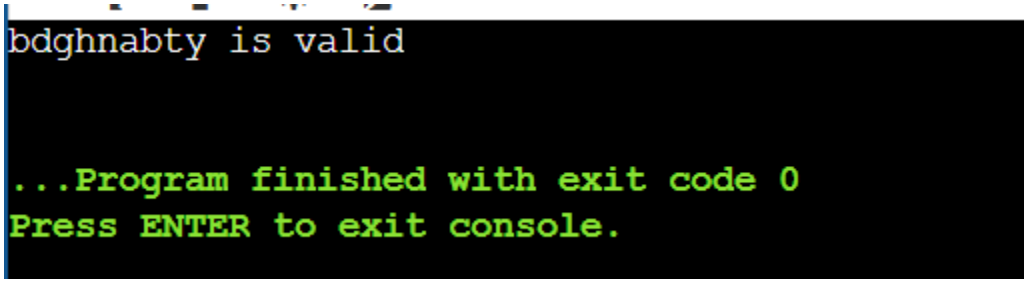
```c
#include <stdio.h>
#include <string.h>

int main() {
    char input[100];
    FILE *file = fopen("input.txt", "r");

    if (file == NULL) {
        printf("Error opening file!\n");
        return 1;
    }

    fscanf(file, "%s", input);
    fclose(file);

    if (strstr(input, "ab") != NULL) {
        printf("%s is valid\n",input);
    } else {
        printf("%s is invalid\n",input);
    }

    return 0;
}
```

OUTPUT:




ababab is valid
...Program finished with exit code 0
Press ENTER to exit console.


vghj is invalid
...Program finished with exit code 0
Press ENTER to exit console.


bdghnabty is valid
...Program finished with exit code 0
Press ENTER to exit console.

EXPERIMENT 2

a)

Write a program to recognize the valid identifiers and keywords

SOURCE CODE:

Input.txt:

if

else

my_var

1variable

_underscore

class

def

function_name

99bottles

helloWorld

int

float

__init__

try

except

lambda

whileTrue

True

False

None

CODE:

```
def is_valid_identifier(token):
    state = 0
    for char in token:
        if state == 0:
            if char.isalpha() or char == '_':
                state = 1
            else:
                return False
        elif state == 1:
            if char.isalnum() or char == '_':
                state = 1
            else:
                return False
    return state == 1

def is_keyword(token):
    keywords = {"if", "else", "while", "return", "for", "def", "class",
"import", "from", "as", "with", "try", "except", "finally", "raise", "lambda",
"pass", "break", "continue", "in", "not", "or", "and", "is", "None", "True",
"False", "global", "nonlocal", "assert", "yield"}
    return token in keywords

def tokenize_and_check(input_string):
    tokens = input_string.split()
    results = []
    for token in tokens:
        identifier = is_valid_identifier(token)
        keyword_check = is_keyword(token)
        status = "Both Identifier and Keyword" if identifier and keyword_check
else \
                 "Valid Identifier" if identifier else \
                 "Keyword" if keyword_check else "Invalid"
        results.append((token, status))

    return results

if __name__ == "__main__":
    with open("input.txt", "r") as file:
        input_string = file.read().strip()

    results = tokenize_and_check(input_string)

    with open("output.txt", "w") as file:
```

```
        file.write("Tokenized Output:\n")
        for token, status in results:
            file.write(f"Token: '{token}', Status: {status}\n")

    print("\nTokenized Output:")
    for token, status in results:
        print(f"Token: '{token}', Status: {status}")
```

OUTPUT:

```
Tokenized Output:
Token: 'if', Status: Both Identifier and Keyword
Token: 'else', Status: Both Identifier and Keyword
Token: 'my_var', Status: Valid Identifier
Token: '1variable', Status: Invalid
Token: '_underscore', Status: Valid Identifier
Token: 'class', Status: Both Identifier and Keyword
Token: 'def', Status: Both Identifier and Keyword
Token: 'function_name', Status: Valid Identifier
Token: '99bottles', Status: Invalid
Token: 'helloWorld', Status: Valid Identifier
Token: 'int', Status: Valid Identifier
Token: 'float', Status: Valid Identifier
Token: '__init__', Status: Valid Identifier
Token: 'try', Status: Both Identifier and Keyword
Token: 'except', Status: Both Identifier and Keyword
Token: 'lambda', Status: Both Identifier and Keyword
Token: 'whileTrue', Status: Valid Identifier
Token: 'True', Status: Both Identifier and Keyword
Token: 'False', Status: Both Identifier and Keyword
Token: 'None', Status: Both Identifier and Keyword
```

b)

Write a program to recognize the valid operators.

SOURCE CODE:

```
operators = {'+', '-', '*', '/', '%', '=', '==', '!=', '>', '<', '>=', '<='}

def is_identifier(token):
    return token.isalnum() and not token.isdigit()

expression = input("Enter a string: ")

for char in expression:
    if char in operators:
        print(f"{char} is an operator.")
    elif char.isalnum():
        print(f"{char} is an identifier.")
```

OUTPUT:

```
Enter a string: a+b-c=e*q
a is an identifier.
+ is an operator.
b is an identifier.
- is an operator.
c is an identifier.
= is an operator.
e is an identifier.
* is an operator.
q is an identifier.
```

c)

Write a program to recognize the valid number.

SOURCE CODE:

Numbers.txt:

123

-456.78

3.14159

1E10

-2.5e-3

+100

abc

12.34.56

E45

1.2.3

CODE:

```
def is_valid_number_fsm(number: str) -> bool:
    state = 'a'
    for char in number:
        if state == 'a':
            if char in '+-':
                state = 'h'
            elif char.isdigit():
                state = 'b'
            else:
                return False
        elif state == 'h':
            if char.isdigit():
                state = 'b'
            else:
                return False
        elif state == 'b':
            if char.isdigit():
                state = 'b'
            elif char == '.':
                state = 'c'
            elif char in 'Ee':
```

```
                state = 'e'
            else:
                return False
        elif state == 'c':
            if char.isdigit():
                state = 'd'
            else:
                return False
        elif state == 'd':
            if char.isdigit():
                state = 'd'
            elif char in 'Ee':
                state = 'e'
            else:
                return False
        elif state == 'e':
            if char in '+-':
                state = 'f'
            elif char.isdigit():
                state = 'g'
            else:
                return False
        elif state == 'f':
            if char.isdigit():
                state = 'g'
            else:
                return False
        elif state == 'g':
            if char.isdigit():
                state = 'g'
            else:
                return False
    return state in {'b', 'd', 'g'}

if __name__ == "__main__":
    try:
        with open("numbers.txt", "r") as file:
            for line in file:
                number = line.strip()
                print(f"'{number}' is a valid number:
{is_valid_number_fsm(number)}")
    except FileNotFoundError:
        print("Error: 'numbers.txt' file not found.")
```

OUTPUT:


'123' is a valid number: True
'-456.78' is a valid number: True
'3.14159' is a valid number: True
'1E10' is a valid number: True
'-2.5e-3' is a valid number: True
'+100' is a valid number: True
'abc' is a valid number: False
'12.34.56' is a valid number: False
'E45' is a valid number: False
'1.2.3' is a valid number: False

d)

Write a program to recognize the valid comments

SOURCE CODE:

Comments.txt:

Hello World

// This is a single-line comment

/* This is a multi-line comment */

Not a comment

/* Unclosed comment

CODE:

```
def is_valid_comment(line: str) -> bool:
    state = 'start'
    i = 0
    while i < len(line):
        char = line[i]

        if state == 'start':
            if char == '/':
                state = 'slash'
            else:
                return False

        elif state == 'slash':
            if char == '/':
                return True
            elif char == '*':
                state = 'multi_line'
            else:
                return False

        elif state == 'multi_line':
            if char == '*':
                state = 'multi_line_end'

        elif state == 'multi_line_end':
            if char == '/':
                return True
            elif char != '*':
                state = 'multi_line'
```

```
        i += 1

    return state == 'multi_line_end'

if __name__ == "__main__":
    try:
        with open("comments.txt", "r") as file:
            for line in file:
                line = line.strip()
                print(f"'{line}' is a valid comment:
{is_valid_comment(line)}")
    except FileNotFoundError:
        print("Error: 'comments.txt' file not found.")
```

OUTPUT:

```
'Hello World' is a valid comment: False
'// This is a single-line comment' is a valid comment: True
'/* This is a multi-line comment */' is a valid comment: True
'Not a comment' is a valid comment: False
'/* Unclosed comment' is a valid comment: False
```

e)

Program to implement Lexical Analyzer.

SOURCE CODE:

Input2.txt:

```
// This is a single-line comment
/* This is
  a multi-line comment */
int main() {
   int a = 10;
   float b = 3.14;
   char c = 'A';
   if (a < b) {
      a = a + 1;
   }
   return 0;
}
```

CODE:

```
def check(lexeme):
    keywords = {"auto", "break", "case", "char", "const", "continue",
"default", "do",
                "double", "else", "enum", "extern", "float", "for", "goto",
"if",
                "inline", "int", "long", "register", "restrict", "return",
"short", "signed",
                "sizeof", "static", "struct", "switch", "typedef", "union",
"unsigned", "void", "volatile", "while"}
    if lexeme in keywords:
        print(f"{lexeme} is a keyword")
    else:
        print(f"{lexeme} is an identifier")

def lexer(filename):
    try:
        with open(filename, "r") as f:
            buffer = f.read()
```

```
    except FileNotFoundError:
        print("Error opening file")
        return

    state = 0
    lexeme = ""
    f = 0
    while f < len(buffer):
        c = buffer[f]
        if state == 0:
            if c.isalpha() or c == '_':
                state = 1
                lexeme += c
            elif c.isdigit():
                state = 13
                lexeme += c
            elif c == '/':
                state = 11
            elif c in " \t\n":
                state = 0
            elif c in ";,+-*/%=<>(){}[]":
                print(f"{c} is a symbol")
                state = 0
            else:
                state = 0
        elif state == 1:
            if c.isalnum() or c == '_':
                lexeme += c
            else:
                check(lexeme)
                lexeme = ""
                state = 0
                f -= 1
        elif state == 11:
            if c == '/':
                while f < len(buffer) and buffer[f] != '\n':
                    f += 1
                state = 0
            elif c == '*':
                f += 1
                while f < len(buffer) - 1 and not (buffer[f] == '*' and
buffer[f + 1] == '/'):
                    f += 1
                f += 2
                state = 0
            else:
                print("/ is an operator")
                state = 0
```

```
            f -= 1
        elif state == 13:
            if c.isdigit():
                lexeme += c
            elif c == '.':
                state = 14
                lexeme += c
            elif c in "Ee":
                state = 16
                lexeme += c
            else:
                print(f"{lexeme} is a valid integer")
                lexeme = ""
                state = 0
                f -= 1
        elif state == 14:
            if c.isdigit():
                lexeme += c
                state = 15
            else:
                print("Error: Invalid floating point format")
                lexeme = ""
                state = 0
        elif state == 15:
            if c.isdigit():
                lexeme += c
            elif c in "Ee":
                state = 16
                lexeme += c
            else:
                print(f"{lexeme} is a valid floating point number")
                lexeme = ""
                state = 0
                f -= 1
        elif state == 16:
            if c in "+-":
                state = 17
                lexeme += c
            elif c.isdigit():
                state = 18
                lexeme += c
            else:
                print("Error: Invalid scientific notation")
                lexeme = ""
                state = 0
        elif state == 17:
            if c.isdigit():
                state = 18
```

```
        lexeme += c
            else:
                print("Error: Invalid exponent format")
                lexeme = ""
                state = 0
        elif state == 18:
            if c.isdigit():
                lexeme += c
            else:
                print(f"{lexeme} is a valid scientific notation number")
                lexeme = ""
                state = 0
                f -= 1
        f += 1

lexer("input2.txt")
```

OUTPUT:

```
int is a keyword
main is an identifier
( is a symbol
) is a symbol
{ is a symbol
int is a keyword
a is an identifier
= is a symbol
10 is a valid integer
; is a symbol
float is a keyword
b is an identifier
= is a symbol
3.14 is a valid floating point number
; is a symbol
char is a keyword
c is an identifier
= is a symbol
A is an identifier
; is a symbol
if is a keyword
( is a symbol
a is an identifier
< is a symbol
b is an identifier
) is a symbol
```

```
{ is a symbol
a is an identifier
= is a symbol
a is an identifier
+ is a symbol
1 is a valid integer
; is a symbol
} is a symbol
return is a keyword
0 is a valid integer
; is a symbol
} is a symbol
```

EXPERIMENT 3

To Study about Lexical Analyzer Generator (LEX) and Flex(Fast Lexical Analyzer)

DESCRIPTION:

Lexical analysis is the first phase of a compiler, responsible for converting source code into tokens. This phase is automated using **Lexical Analyzer Generators** like **LEX** and **Flex**.

LEX (Lexical Analyzer Generator)

LEX is a tool used for **generating lexical analyzers** in compiler design. It helps in pattern recognition and tokenizing input text using **regular expressions**. LEX works by defining patterns and corresponding actions in a .l file, which is then processed to generate a C-based scanner.

Key Features of LEX:

- Uses **regular expressions** to match patterns in input text.
- Generates **lex.yy.c**, a C program implementing the scanner.
- Can be compiled using a C compiler to produce an executable lexer.
- Works with **YACC (Yet Another Compiler Compiler)** to build full-fledged compilers.

Working of LEX:

1. **Specification:** The user writes a .l file containing regular expressions and C actions.
2. **Processing:** The lex command processes the .l file and generates lex.yy.c.
3. **Compilation:** The lex.yy.c is compiled with gcc to create an executable scanner.
4. **Execution:** The scanner reads input, matches patterns, and executes the corresponding actions.

Flex (Fast Lexical Analyzer)

Flex is an **enhanced and faster version of LEX**, designed for improved performance and portability. It follows the same working mechanism as LEX but generates more **efficient** and **optimized** C code.

Key Features of Flex:

- Faster and more efficient than LEX.
- Uses **longest match rule** over first match rule.
- Generates **lex.yy.c**, similar to LEX but optimized for better performance.
- Works seamlessly on **Linux, Unix, and Windows** with the required dependencies.

Working of Flex:

1. **Write a `` file** with pattern definitions and C-based actions.
2. **Use the `` command** to generate lex.yy.c.
3. **Compile the file** using gcc.
4. **Run the executable**, which scans the input and processes tokens.

Differences Between LEX and Flex

Feature	LEX	Flex
Speed	Slower	Faster
Portability	Limited	Widely used in Linux & Unix
Memory Usage	Higher	Optimized
Output File	lex.yy.c	lex.yy.c
Default Action	Returns first match	Returns longest match

Procedure

1. Create a .l file (e.g., lexer.l) containing regular expressions and C code.
2. Use the flex command to generate lex.yy.c.
3. Compile the generated C file using GCC.
4. Run the executable and provide input for analysis.

Example Code (LEX/Flex Program)

```
%{
#include <stdio.h>
%}
%%
[0-9]+      { printf("NUMBER\n"); }
[a-zA-Z]+   { printf("IDENTIFIER\n"); }
.           { printf("SPECIAL CHARACTER\n"); }
```

```
%%
int main() {
   yylex();
   return 0;
}
```

Conclusion

LEX and Flex are powerful tools for lexical analysis in compilers. They help automate **tokenization** using **regular expressions** and **C functions**, making lexical analysis efficient.

EXPERIMENT 4

a)

Write a Lex program to take input from text file and count no of characters, no. of lines & no. of words.

SOURCE CODE:

input.txt:

Hello

Good Morning

This is my lex program

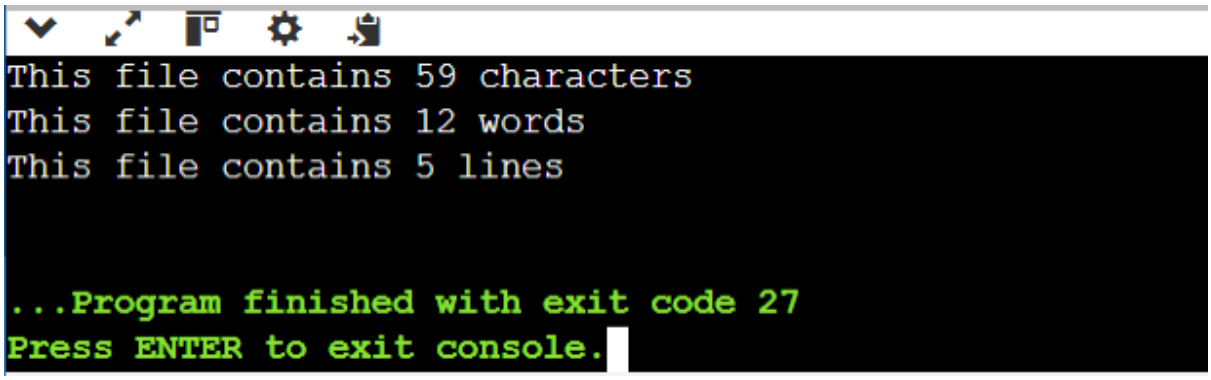
123456 677 34.676

56e56

sample.l:

```
%{
#include<stdio.h>
int char_count=0, word_count=0, line_count=0;
%}
%%
\n  {line_count++;word_count++;}
[\t ]+  word_count++;
. char_count++;
%%
void main(){
yyin=fopen("input.txt","r");
yylex();
printf("This file contains %d characters\n", char_count);
printf("This file contains %d words\n", word_count);
printf("This file contains %d lines\n", line_count);
}
int yywrap(){ return(1);}
```

OUTPUT:


This file contains 59 characters
This file contains 12 words
This file contains 5 lines
...Program finished with exit code 27
Press ENTER to exit console.

b)

Write a Lex program to take input from text file and count number of vowels and consonants.

SOURCE CODE:

input.txt:

Hello

Good Morning

This is my lex program

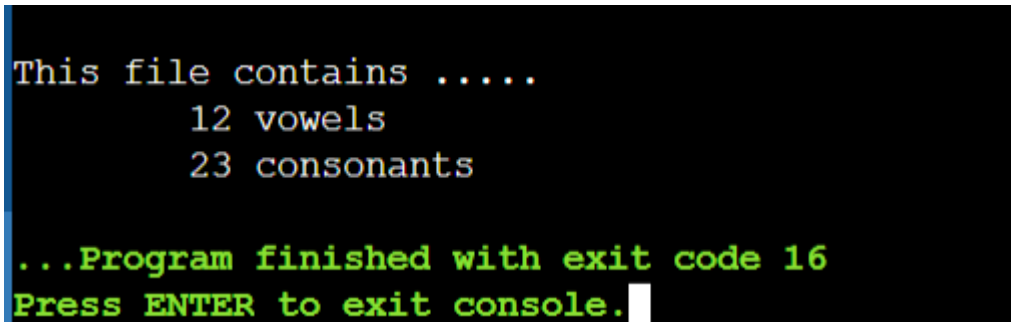
123456 677 34.676

56e56

d2.l:

```
%{
#include<stdio.h>
int consonants=0, vowels=0;
%}
%%
[aeiouAEIOU] {vowels++;}
[a-zA-Z] {consonants++;}
. ;
%%
void main(){
yyin=fopen("input.txt","r");
yylex();
printf("This file contains .....");
printf("\n\t%d vowels ",vowels);
printf("\n\t%d consonants ",consonants);
return 0;
}
int yywrap(){ return(1);}
```

OUTPUT:


This file contains .....
12 vowels
23 consonants
...Program finished with exit code 16
Press ENTER to exit console.

c)

Write a Lex program to print out all numbers from the given file.

SOURCE CODE:

input.txt:

Hello

Good Morning

This is my lex program

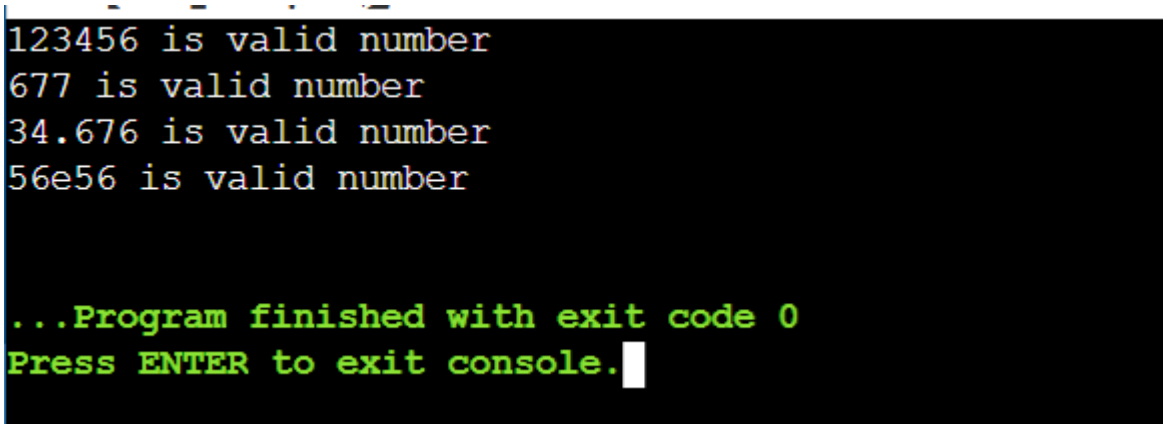
123456 677 34.676

56e56

d3.l:

```
%{
#include<stdio.h>
%}
digits [0-9]+
%%
digits(\.digits)?([eE][+-]?digits)? printf("%s is valid number\n", yytext);
\n ;
. ;
%%
void main(){
yyin=fopen("input.txt","r");
yylex();

}
int yywrap(){ return(1);}
```

OUTPUT:


123456 is valid number
677 is valid number
34.676 is valid number
56e56 is valid number
...Program finished with exit code 0
Press ENTER to exit console.

d)

Write a Lex program which adds line numbers to the given file and display the same into different file.

SOURCE CODE:

input.txt

Hello

Good Morning

This is my lex program

123456 677 34.676

56e56

d4.l:

```
%{
int line_number = 1;
%}
%%
.* {fprintf(yyout, "%d: %s",line_number,yytext);line_number++;}

%%
void main(){
yyin=fopen("input.txt","r");
yyout=fopen("op.txt","w");
yylex();
printf("done");
return 0;
}
int yywrap(){ return(1);}
```

OUTPUT:

```
d4.1: In function 'main':
d4.1:13:8: warning: 'return' with a value, in function returning void
d4.1:8:6: note: declared here
done

...Program finished with exit code 4
Press ENTER to exit console.
```

main.c | input.txt | op.txt

```
1: Hello
2: Good Morning
3: This is my lex program
4: 123456 677 34.676
5: 56e56
6
```

e)

Write a Lex program to printout all markup tags and HTML comments in file.

SOURCE CODE:

input.txt:

<html>

<head> Heer </head>

<body>

<!-- iehhfjs 122 -->

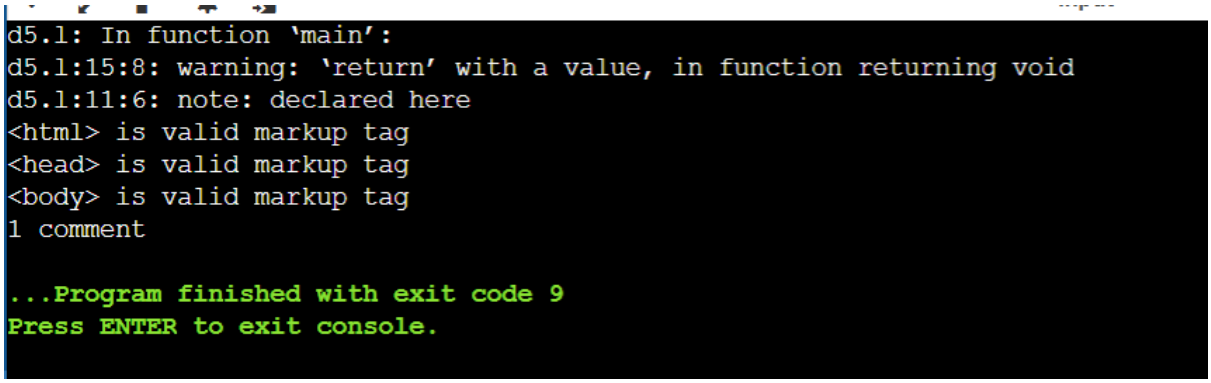
</body>

</html>

d5.l:

```
%{
#include<stdio.h>
int num = 0;
%}
%%
\<[a-zA-z0-9]+">" printf("%s is valid markup tag \n",yytext);
"<!--"(.|\n)*"-->" num++;
\n ;
. ;
%%
void main(){
yyin=fopen("input.txt","r");
yylex();
printf("%d comment", num);
return 0;
}
int yywrap(){ return(1);}
```

OUTPUT:


d5.1: In function 'main':
d5.1:15:8: warning: 'return' with a value, in function returning void
d5.1:11:6: note: declared here
<html> is valid markup tag
<head> is valid markup tag
<body> is valid markup tag
1 comment
...Program finished with exit code 9
Press ENTER to exit console.

Experiment 5

a)

Write a Lex program to count the number of C comment lines from a given C program. Also eliminate them and copy that program into separate file.

Sample code:

```c
#include <stdio.h>

// This is a single-line comment
int main() {
    int a = 5; /* Inline multi-line
                  comment */
    int b = 10; // Another comment
    printf("Sum = %d\n", a + b);
    /* Entire
       block
       comment */
    return 0;
}
```

Lex Code:

```
%{
#include <stdio.h>
int comment_count = 0;
FILE *out;
%}

%%
"//".*                          { comment_count++; /* skip single-line comment */ }
"/*"([^*]|\*+[^*/])*\*+"/"      { comment_count++; /* skip multi-line comment */ }
.|\n                           { fputc(yytext[0], out); }
%%

int main() {
    FILE *in = fopen("sample_input.c", "r");
    if (!in) {
        perror("Input file error");
        return 1;
    }
    out = fopen("cleaned_output.c", "w");
    if (!out) {
        perror("Output file error");
        return 1;
    }
    yyin = in;
    yylex();
    fclose(in);
    fclose(out);
    printf("Total comments removed: %d\n", comment_count);
    return 0;
}

int yywrap() {
    return 1;
}
```

Output:

```
#include <stdio.h>


int main() {
    int a = 5;
    int b = 10;
    printf("Sum = %d\n", a + b);

    return 0;
}
```

b)

Write a Lex program to recognize keywords, identifiers, operators, numbers, special symbols, literals from a given C program.

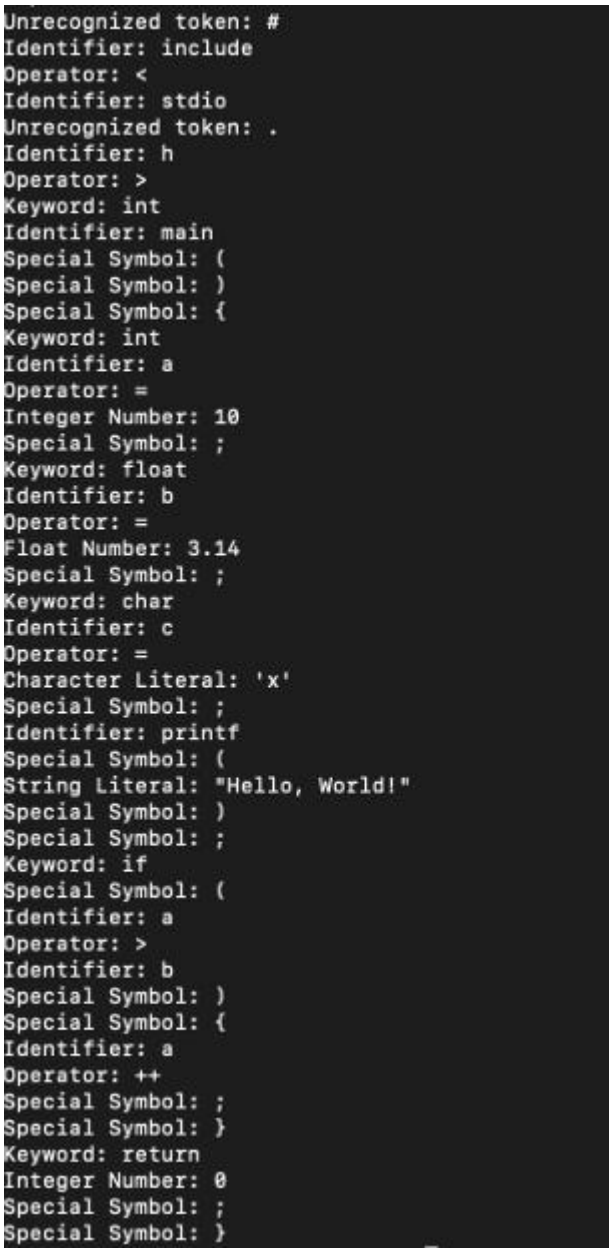
Sample Code:

```c
#include <stdio.h>

int main() {
    int a = 10;
    float b = 3.14;
    char c = 'x';
    printf("Hello, World!");
    if (a > b) {
        a++;
    }
    return 0;
}
```

Lex code:

```
 %{
#include <stdio.h>
%}
digit       [0-9]
alpha       [a-zA-Z]
id
          {alpha}({alpha}|{digit})*
int_const   {digit}+
float_const {digit}+"."{digit}+
string_lit  \"([^\\\"]|\\.)*\"
char_lit    \'([^\\\']|\\.)\'
%%
"auto"|"break"|"case"|"char"|"const"|"continue"|"default"|"do"|"double"|"else"
|"enum"|"
 extern"|"float"|"for"|"goto"|"if"|"inline"|"int"|"long"|"register"|"restrict"
|"return"|"short
 "|"signed"|"sizeof"|"static"|"struct"|"switch"|"typedef"|"union"|"unsigned"|"
void"|"volatil
 e"|"while"    { printf("Keyword: %s\n", yytext); }
{id}                { printf("Identifier: %s\n", yytext); }
"=="|"!="|"<="|">="|"&&"|"||"|"++"|"--"|"+"|"-"|"*"|"/"|"="|"<"|">"
{ printf("Operator: %s\n", yytext); }
{float_const}       { printf("Float Number: %s\n", yytext); }
{int_const}         { printf("Integer Number: %s\n", yytext); }
{string_lit}        { printf("String Literal: %s\n", yytext); }
{char_lit}          { printf("Character Literal: %s\n", yytext); }
[{}();,]            { printf("Special Symbol: %s\n", yytext); }
[ \t\n]+
            { /* skip whitespace */ }
.                   { printf("Unrecognized token: %s\n", yytext); }
%%
int main() {
    yyin = fopen("sample_input.c", "r");
    if (!yyin) {
        perror("Could not open file");
        return 1;
    }
    yylex();
    fclose(yyin);
    return 0;
}
int yywrap() {
    return 1;
}
```

Output:


Unrecognized token: #
Identifier: include
Operator: <
Identifier: stdio
Unrecognized token: .
Identifier: h
Operator: >
Keyword: int
Identifier: main
Special Symbol: (
Special Symbol:)
Special Symbol: {
Keyword: int
Identifier: a
Operator: =
Integer Number: 10
Special Symbol: ;
Keyword: float
Identifier: b
Operator: =
Float Number: 3.14
Special Symbol: ;
Keyword: char
Identifier: c
Operator: =
Character Literal: 'x'
Special Symbol: ;
Identifier: printf
Special Symbol: (
String Literal: "Hello, World!"
Special Symbol:)
Special Symbol: ;
Keyword: if
Special Symbol: (
Identifier: a
Operator: >
Identifier: b
Special Symbol:)
Special Symbol: {
Identifier: a
Operator: ++
Special Symbol: ;
Special Symbol: }
Keyword: return
Integer Number: 0
Special Symbol: ;
Special Symbol: }

Experiment 6

Aim: Program to implement Recursive Descent Parsing in C.

Grammar:

E -> i E'

E' -> + i E' | ε

Code:

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

const char *input;
int pos = 0;

void E();
void Eprime();

void error() {
    printf("❌ Syntax Error at position %d\n", pos);
    exit(1);
}

void match(char expected) {
    if (input[pos] == expected) {
        pos++;
    } else {
        error();
    }
}

void E() {
    if (input[pos] == 'i') {
        match('i');
        Eprime();
    } else {
        error();
    }
}

void Eprime() {
    if (input[pos] == '+') {
```

```
        match('+');
        if (input[pos] == 'i') {
            match('i');
            Eprime();
        } else {
            error();
        }
    }
    // else epsilon production: do nothing
}

int main() {
    char str[100];
    printf("Enter the input string (end with $): ");
    scanf("%s", str);
    input = str;

    E();

    if (input[pos] == '$') {
        printf("☑ Parsing successful.\n");
    } else {
        error();
    }

    return 0;
}
```

Experiment 7

A. Create Yacc and Lex specification files to recognises arithmetic expressions involving +, -, * and / .

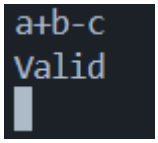
Lex.l

```
%{
#include "yacc.tab.h"
#include <stdlib.h>
#include <string.h>
%}

%%
[0-9]+                  { yylval = atoi(yytext); return NUMBER; }
[a-zA-Z_][a-zA-Z0-9_]*  { return IDENTIFIER; }
[+\-*/]                 { return yytext[0]; }
\n                      { return '\n'; }
[ \t]                   ;
.                       { return 0; }
%%

int yywrap() { return 1; }
```

yacc.y

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

int yylex(void);
int yyerror(char *s);
%}

%token NUMBER IDENTIFIER

%left '+' '-'
%left '*' '/'

%%
stmt: expr '\n' { printf("Valid\n"); }
    ;

expr: expr '+' expr
    | expr '-' expr
    | expr '*' expr
    | expr '/' expr
    | NUMBER
    | IDENTIFIER
    ;
%%

int main() {
    return yyparse();
}

int yyerror(char *s) {
    printf("Invalid\n");
    return 0;
}
```

Output:



B. Create Yacc and Lex specification files are used to generate a calculator which accepts integer type arguments.

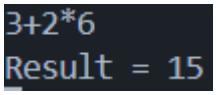
Lex.l

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

%%
[0-9]+      { yylval = atoi(yytext); return NUMBER; }
[+\-*/\n]   { return yytext[0]; }
[ \t]       ;
%%

int yywrap() { return 1; }

```

yacc.y

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

int yylex(void);
int yyerror(char *s);
%}

%token NUMBER

%left '+' '-'
%left '*' '/'

%%
stmt: expr '\n' { printf("Result = %d\n", $1); }
    ;

expr: expr '+' expr { $$ = $1 + $3; }
    | expr '-' expr { $$ = $1 - $3; }
    | expr '*' expr { $$ = $1 * $3; }
    | expr '/' expr {
        if ($3 == 0) {
            printf("Error: Divide by zero\n");
            exit(1);
        }
        $$ = $1 / $3;
      }
    | NUMBER
    ;
%%

int main() {
    return yyparse();
}

int yyerror(char *s) {
    printf("Error: %s\n", s);
    return 0;
}
```

Output:


3+2*6
Result = 15

C. Create Yacc and Lex specification files are used to convert infix expression to postfix expression.

Lex.l

```
%{
#include "yacc.tab.h"
#include <stdlib.h>
#include <string.h>
%}

%%
[0-9]+                  { yylval.num = atoi(yytext); return NUMBER; }
[a-zA-Z_][a-zA-Z0-9_]*  { yylval.id = strdup(yytext); return IDENTIFIER; }
[+\-*/()\n]             { return yytext[0]; }
[ \t]+                  ;
.                       { printf("Invalid character: %s\n", yytext); return -1; }
%%

int yywrap() { return 1; }

```

yacc.y

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

int yylex(void);
int yyerror(char *s);
%}

%union {
    int num;
    char* id;
}

%token <num> NUMBER
%token <id> IDENTIFIER

%%
stmt: expr '\n' { printf("\n"); }
    ;

expr: expr '+' term   { printf("+ "); }
    | expr '-' term   { printf("- "); }
    | term
    ;

term: term '*' factor { printf("* "); }
    | term '/' factor { printf("/ "); }
    | factor
    ;

factor: '(' expr ')'
      | NUMBER        { printf("%d ", $1); }
      | IDENTIFIER    { printf("%s ", $1); free($1); }
      ;
%%

int main() {
    return yyparse();
}

int yyerror(char *s) {
    fprintf(stderr, "Error: %s\n", s);
    return 0;
}

```

Output: