LAB MANUAL

of

Compiler Design Laboratory (CSE606)

Bachelor of Technology (CSE)

By

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Sr No.	Experiment Title
1	a. Write a program to recognize strings starts with ‘a’ over {a, b}. b. Write a program to recognize strings end with ‘a’. c. Write a program to recognize strings end with ‘ab’. Take the input from text file. d. Write a program to recognize strings contains ‘ab’. Take the input from text file.
2	a. Write a program to recognize the valid identifiers. b. Write a program to recognize the valid operators. c. Write a program to recognize the valid number. d. Write a program to recognize the valid comments. e. Write a program to implement Lexical Analyzer.
3	To Study about Lexical Analyzer Generator (LEX) and Flex(Fast Lexical Analyzer)
4	Implement following programs using Lex. a. Write a Lex program to take input from text file and count no of characters, no. of lines & no. of words. b. Write a Lex program to take input from text file and count number of vowels and consonants. c. Write a Lex program to print out all numbers from the given file. d. Write a Lex program which adds line numbers to the given file and display the same into different file. e. Write a Lex program to printout all markup tags and HTML comments in file.
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. b. Write a Lex program to recognize keywords, identifiers, operators, numbers, special symbols, literals from a given C program.
6	Program to implement Recursive Descent Parsing in C.
7	a. To Study about Yet Another Compiler-Compiler(YACC).

	b. Create Yacc and Lex specification files to recognizes arithmetic expressions involving +, -, * and / . c. Create Yacc and Lex specification files are used to generate a calculator which accepts integer type arguments. d. Create Yacc and Lex specification files are used to convert infix expression to postfix expression.

Practical 1

AIM:

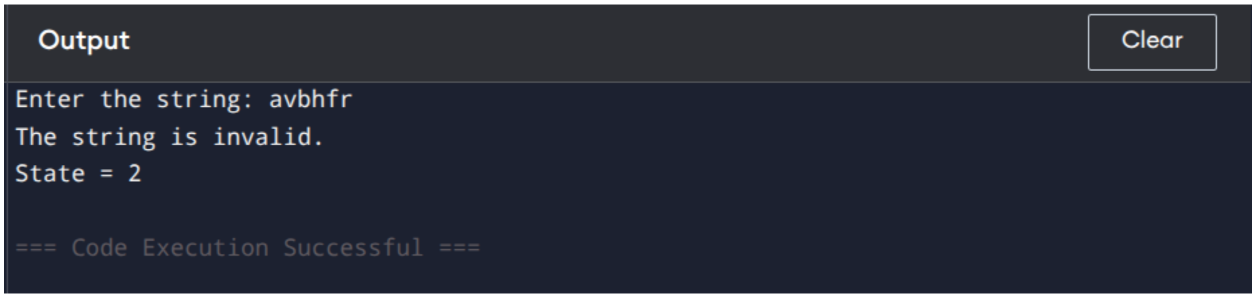
a. Write a program to recognize strings starts with ‘a’ over {a, b}.
b. Write a program to recognize strings end with ‘a’.
c. Write a program to recognize strings end with ‘ab’. Take the input from text file.
d. Write a program to recognize strings contains ‘ab’. Take the input from text file.

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

CODE:

```
//strings starts with 'a' over {a, b}.

#include<stdio.h>

int main(){

    char input[100];

    int state = 0, i=0;

    printf("Enter the string: ");

    scanf("%s",input);

    while(input[i]!='\0'){

    switch(state){

        case 0:

            if(input[i]=='a') state = 1;
            else state = 2;
            break;
        case 1:
            if(input[i]=='a' || input[i]=='b') state=1;
            else state =2;
            break;
        case 2:
            state = 2;
            break;
        }
        i++;
    }
    if(state=='0'){
        printf("The string is invalid.");
        printf("\nState = %d",state);
    }
    else if(state==1){
        printf("The string is valid.");
        printf("\nState = %d",state);
    }
    else if(state==2){
        printf("The string is invalid.");
        printf("\nState = %d",state);
    }
    else {
    }
    return 0;
}
```

OUTPUT:



Output

```
Enter the string: avbhfr
The string is invalid.
State = 2

=== Code Execution Successful ===
```

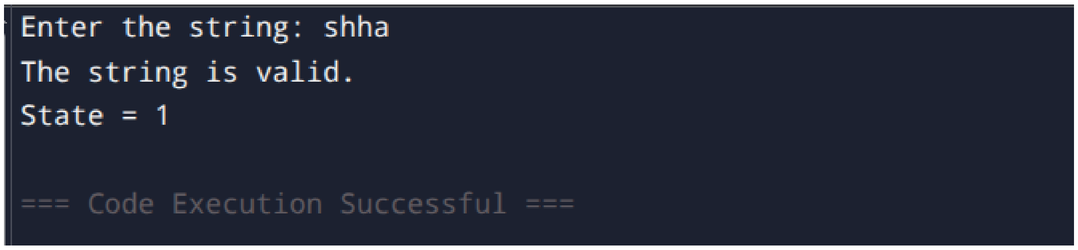
b. Write a program to recognize strings end with ‘a’.

CODE:

```
//strings end with 'a'.
#include<stdio.h>
int main(){
        char input[100];
        int state = 0, i=0;
        printf("Enter 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==0){
        printf("The string is invalid.");
        printf("\nState = %d",state);
    }
    else if(state==1){
        printf("The string is valid.");
        printf("\nState = %d",state);
    }
    else {
    }
    return 0;
}
```

OUTPUT:



```
Enter the string: shha
The string is valid.
State = 1

=== Code Execution Successful ===
```

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

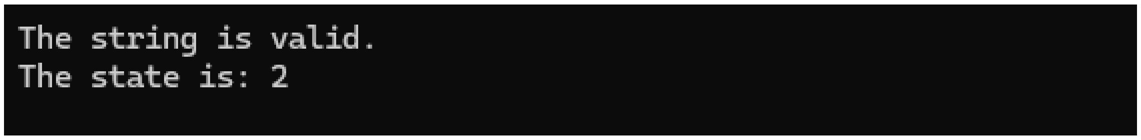
CODE:

```
//string ends with ab and take input from a file.
#include <stdio.h>

int main() {
    char input[100];
    int state = 0, i = 0;
    FILE *file; // File pointer

    file = fopen("input.txt", "r");
    if (file == NULL) {
        printf("Error: Could not open file.\n");
        return 1;
    }
```

```
if (fgets(input, sizeof(input), file) == NULL) {
    printf("Error: Could not read from file or file is empty.\n");
    fclose(file);
    return 1;
}

fclose(file);

// Removing newline character, if present
for (i = 0; input[i] != '\0'; i++) {
    if (input[i] == '\n') {
        input[i] = '\0';
        break;
    }
}

i = 0; // Reset index for processing the string

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

if (state == 0) {
    printf("String is invalid.\n");
    printf("The state is: %d\n", state);
} else if (state == 1) {
    printf("The string is invalid.\n");
    printf("The state is: %d\n", state);
} else if (state == 2) {
    printf("The string is valid.\n");
    printf("The state is: %d\n", state);
}
```

```
    return 0;
}
```

OUTPUT:



```
The string is valid.
The state is: 2
```

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

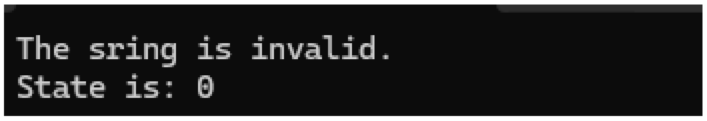
CODE:

```
//sting contains ab, and takes input from a file.
#include<stdio.h>
int main(){
char input[100];
int state=0,i=0;
FILE *file;
file=fopen("input1.txt","r");
if(file==NULL){
printf("Error: Couldn't open the file.\n");
return 1;
}
if(fgets(input,sizeof(input),file)==NULL){
printf("Error: Could not read from file or file is empty.\n");
        fclose(file);
        return 1;
}
fclose(file);
```

```
// Removing newline character, if present
    for (i = 0; input[i] != '\0'; i++) {
        if (input[i] == '\n') {
            input[i] = '\0';
            break;
        }
    }

    i = 0; // Reset index for processing the string
/*printf("Enter 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 = 0;
else state = 0;
break;
case 1:
if(input[i]=='a') state = 1;
else if(input[i]=='b') state =2;
else state = 0;
break;
case 2:
if(input[i]=='a' || input[i]=='b') state = 2;
else state = 2;
break;
}
i++;
}
if(state==0){
```

```
printf("The sring is invalid.");
printf("\nState is: %d",state);
}
else if(state==1){
printf("The sring is invalid.");
printf("\nState is: %d",state);
}
else if(state==2){
printf("The sring is valid.");
printf("\nState is: %d",state);
}
else{
}
return 0;
}
```

OUTPUT:



```
The sring is invalid.
State is: 0
```

Practical 2

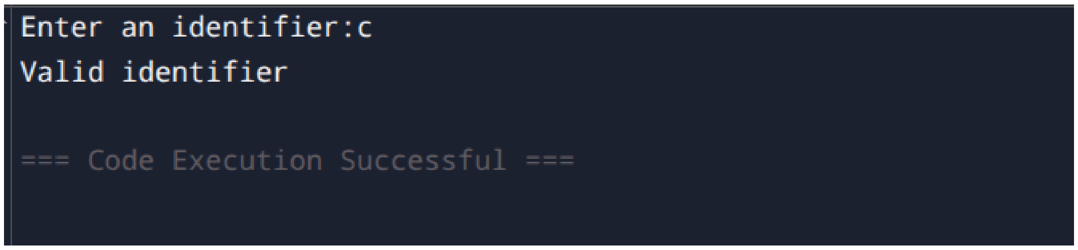
AIM:

a. Write a program to recognize the valid identifiers.
b. Write a program to recognize the valid operators.
c. Write a program to recognize the valid number.
d. Write a program to recognize the valid comments.
e. Write a program to implement Lexical Analyzer.

a. Write a program to recognize the valid identifiers.
CODE:

```
#include <stdio.h>

#include <ctype.h>

int main()

{

char a[10];

int flag, i=1;



printf("Enter an identifier:");

scanf("%s",&a);

if(isalpha(a[0])){

flag = 1; // If the first character is an alphabet, set flag = 1 (indicating a valid start).



}
else

printf("invalid identifier");

while (a[i] != '\0') {

        if (!isalnum(a[i]) && a[i] != '_') {

            flag = 0;

            break;

        }

        i++;

    }


if(flag == 1){

printf("Valid identifier");

}

//getch();

}
```

OUTPUT:



```
Enter an identifier:c
Valid identifier

=== Code Execution Successful ===
```

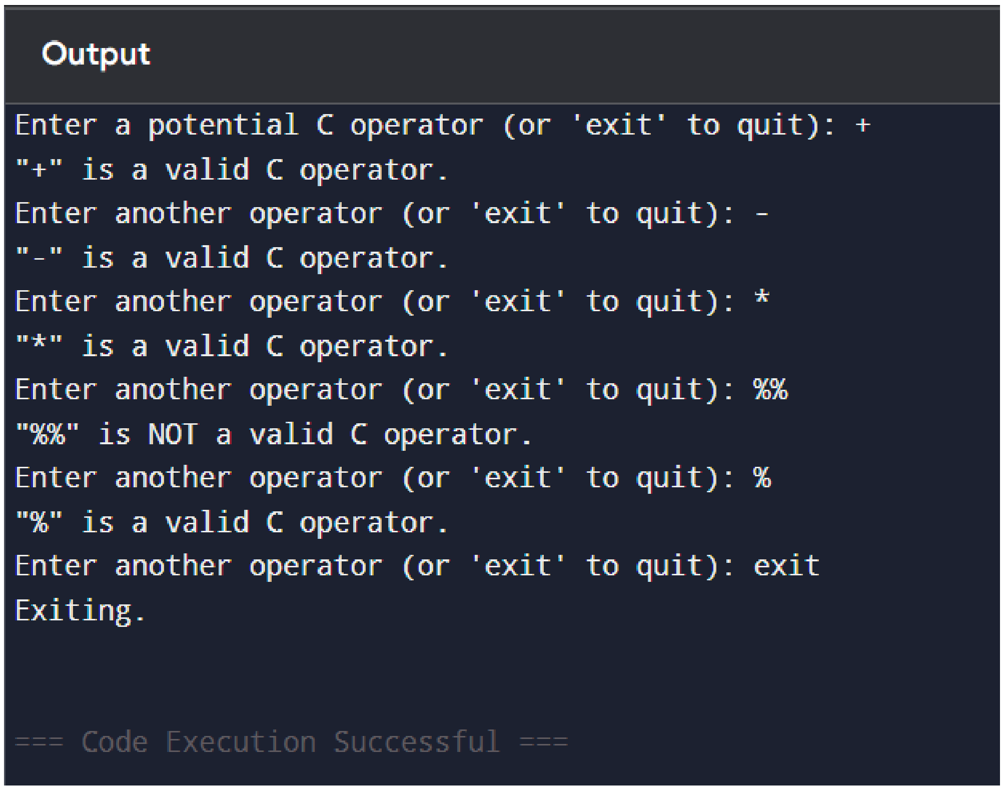
b. Write a program to recognize the valid operators.

CODE:

```
//to recognize the valid operators

#include <stdio.h>

#include <string.h>

#include <stdbool.h>


int main() {

   char input[50];

   const char *validOperators[] = {

      "+", "-", "*", "/", "%",  // Arithmetic

      "=", "+=", "-=", "*=", "/=", "%=", // Assignment

      "==", "!=", ">", "<", ">=", "<=", // Relational

      "&&", "||", "!", // Logical

      "&", "|", "^", "~", "<<", ">>", // Bitwise

      "++", "--", // Increment/Decrement

      ",", ".", "->", // Structure/Union member access

      "(", ")", "[", "]", "{", "}", // Parentheses, brackets, braces

      "?", ":", // Ternary operator

      "sizeof", // Unary operator

      "->", "." // Pointer-to-member operators (less common)

   };
```

```
int numOperators = sizeof(validOperators) / sizeof(validOperators[0]);
printf("Enter a potential C operator (or 'exit' to quit): ");
while (1) {
    scanf("%49s", input);
    if (strcmp(input, "exit") == 0) {
        break;
    }
    bool found = false;
    int i = 0; // Initialize loop counter
    while (i < numOperators) { // While loop
        switch (strcmp(input, validOperators[i])) { // Switch statement
            case 0: // Match found
                found = true;
                i = numOperators; // A way to break the while loop
                break;
            default: // No match, go to next operator
                i++;
                break;
        }
    }
    if (found) {
        printf("\"%s\" is a valid C operator.\n", input);
        } else {
            printf("\"%s\" is NOT a valid C operator.\n", input);
        }
        printf("Enter another operator (or 'exit' to quit): ");
    }
    printf("Exiting.\n");
    return 0;
}
```

OUTPUT:



Output

```
Enter a potential C operator (or 'exit' to quit): +
"+" is a valid C operator.
Enter another operator (or 'exit' to quit): -
"-" is a valid C operator.
Enter another operator (or 'exit' to quit): *
"*" is a valid C operator.
Enter another operator (or 'exit' to quit): %%
"%%" is NOT a valid C operator.
Enter another operator (or 'exit' to quit): %
"%" is a valid C operator.
Enter another operator (or 'exit' to quit): exit
Exiting.


=== Code Execution Successful ===
```

c. Write a program to recognize the valid number.

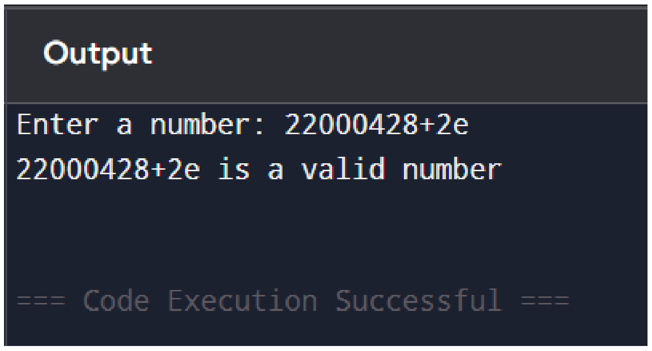
CODE:

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

void check_valid_number(char *input) {
    int state = 0, i = 0;
    char lexeme[100];

    while (input[i] != '\0') {
        char c = input[i];

        switch (state) {
            case 0:
                if (isdigit(c)) {
                    state = 1;  // Transition to integer state
                } else if (c == '.') {
                    state = 2;  // Starts with a dot, expecting digits
                } else {
                    printf("Invalid number: %s\n", input);
                    return;
                }
                break;

            case 1:  // Integer state
                if (isdigit(c)) {
                    state = 1;
                } else if (c == '.') {
                    state = 3;  // Transition to decimal part
                } else if (c == 'E' || c == 'e') {
                    state = 5;  // Transition to exponent part
                } else {
                    printf("%s is a valid number\n", input);
                    return;
                }
                break;
```

```
case 2:  // Starts with a dot
    if (isdigit(c)) {
        state = 3;
    } else {
        printf("Invalid number: %s\n", input);
        return;
    }
    break;

case 3:  // Decimal part
    if (isdigit(c)) {
        state = 3;
    } else if (c == 'E' || c == 'e') {
        state = 5;
    } else {
        printf("%s is a valid number\n", input);
        return;
    }
    break;

case 5:  // Exponent part
    if (c == '+' || c == '-') {
        state = 6;
    } else if (isdigit(c)) {
        state = 7;
    } else {
        printf("Invalid number: %s\n", input);
        return;
    }
    break;

case 6:  // Sign after exponent
    if (isdigit(c)) {
        state = 7;
    } else {
        printf("Invalid number: %s\n", input);
        return;
    }
    break;
```

```
            case 7:  // Digits after exponent
                if (isdigit(c)) {
                    state = 7;
                } else {
                    printf("%s is a valid number\n", input);
                    return;
                }
                break;
        }
        i++;
    }

    // If loop exits normally, check if we ended in a valid state
    if (state == 1 || state == 3 || state == 7) {
        printf("%s is a valid number\n", input);
    } else {
        printf("Invalid number: %s\n", input);
    }
}

int main() {
    char input[100];

    printf("Enter a number: ");
    scanf("%s", input);

    check_valid_number(input);

    return 0;
}
```

OUTPUT:



```
Enter a number: 22000428+2e
22000428+2e is a valid number


=== Code Execution Successful ===
```

d. Write a program to recognize the valid comments.

CODE:

```
//accept only comments single line and multiline both.
#include<stdio.h>
int main(){

    char input[100];
    int state =0, i=0;
    FILE *file;

    file = fopen("input3.txt","r");
    if(file==NULL){
        printf("Error: Couldn't open the file.\n");
        return 1;
    }

    if(fgets(input,sizeof(input),file)==NULL){
        printf("Error: Couldn't read the file or file is empty.");
        fclose(file);
        return 1;
    }
    fclose(file);

    for (i = 0; input[i] != '\0'; i++) {
  if (input[i] == '\n') {
```

```
            input[i] = '\0';
            break;
        }
    }

    i = 0;

            while(input[i]!='\0'){
                    switch(state){
                            case 0:
                                    if(input[i]=='/')state = 1;
                                    else state =3;
                                    break;
                            case 1:
                                    if(input[i]=='/') state=2;
                                    else if(input[i]=='*') state =4;
                                    else state=3;
                                    break;
                            case 2:
                                    state = 2;
                                    break;
                            case 3:
                                    state =3;
                                    break;
                            case 4:
                                    if(input[i]='*')state=5;
                                    else state=4;
```

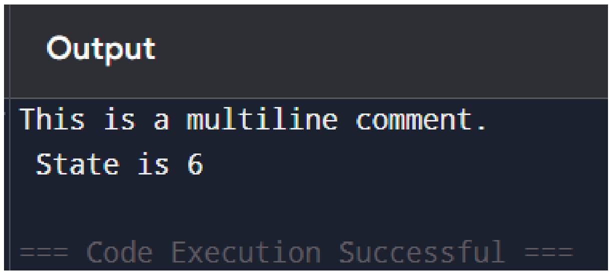
```
                break;
            case 5:
                if(input[i]=='/') state =6;
                else state = 4;
                break;
            case 6:
                state = 3;
                break;
        }
        i++;
    }
    if(state==0){
        printf("This is not a comment.");
        printf("\nState is %d",state);
    }
    else if(state==1){
        printf("This is not a comment.");
        printf("\nState is %d",state);
    }
    else if(state==2){
        printf("This is a single line comment.");
        printf("\nState is %d",state);
    }
    else if(state==3){
        printf("This is not a comment.");
        printf("\nState is %d",state);
    }
```

```
        else if(state==4){
                printf("This is not a comment.");
                printf("\nState is %d",state);
        }
        else if(state==5){
                printf("This is not a comment.");
                printf("\nState is %d",state);
        }
        else if(state==6){
                printf("This is a multiline comment.");
                printf("\nState is %d",state);
        }
        return 0;
}
```

input3.txt:

```
/*My Name is Nishil and This a comment */
```

OUTPUT:



Output

```
This is a multiline comment.
 State is 6


=== Code Execution Successful ===
```

e. Write a program to implement Lexical Analyzer.

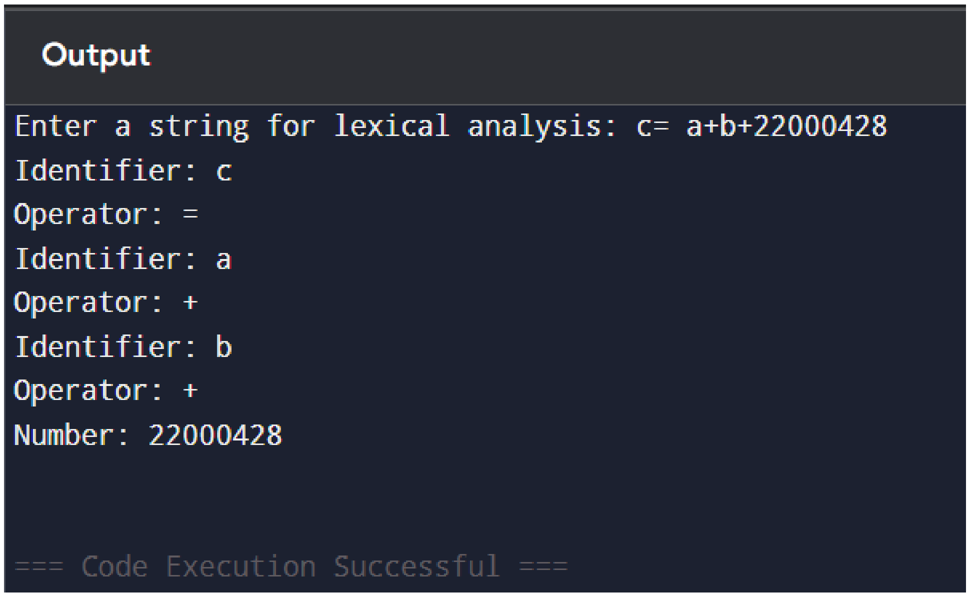
CODE:

```
#include <stdio.h>

#include <ctype.h>

#include <string.h>


// List of keywords

const char *keywords[] = {"int", "float", "if", "else", "while", "return", "for", "do", "switch",
"case"};

#define NUM_KEYWORDS (sizeof(keywords) / sizeof(keywords[0]))


// Function to check if a string is a keyword

int isKeyword(char *str) {

int i;

    for (i = 0; i < NUM_KEYWORDS; i++) {

        if (strcmp(str, keywords[i]) == 0)

            return 1;

    }

    return 0;

}


// Function to check if a character is an operator
```

```
int isOperator(char ch) {
    char operators[] = "+-*/=<>!&|";
    int i;
    for (i = 0; operators[i] != '\0'; i++) {
        if (ch == operators[i])
            return 1;
    }
    return 0;
}

void lexicalAnalyzer(char *input) {
    int i = 0;
    char token[50];
    int tokenIndex = 0;

    while (input[i] != '\0') {
        if (isspace(input[i])) {
            i++;
            continue;
        }

        if (isalpha(input[i])) { // Identifiers and Keywords
            tokenIndex = 0;
            while (isalnum(input[i])) {
                token[tokenIndex++] = input[i++];
            }
            token[tokenIndex] = '\0';
            if (isKeyword(token)) {
                printf("Keyword: %s\n", token);
            } else {
                printf("Identifier: %s\n", token);
            }
        }
        else if (isdigit(input[i])) { // Numbers
            tokenIndex = 0;
            while (isdigit(input[i])) {
                token[tokenIndex++] = input[i++];
            }
            token[tokenIndex] = '\0';
            printf("Number: %s\n", token);
        }
        else if (isOperator(input[i])) { // Operators
            printf("Operator: %c\n", input[i]);
            i++;
        }
        else { // Special characters
```

```
            printf("Special Symbol: %c\n", input[i]);
            i++;
        }
    }
}


int main() {
    char input[100];
    printf("Enter a string for lexical analysis: ");
    fgets(input, sizeof(input), stdin);
    lexicalAnalyzer(input);
    return 0;
}
```

OUTPUT:



Output

```
Enter a string for lexical analysis: c= a+b+22000428
Identifier: c
Operator: =
Identifier: a
Operator: +
Identifier: b
Operator: +
Number: 22000428


=== Code Execution Successful ===
```

Practical 3

AIM:

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

1. Lexical Analyzer Generator (LEX)

LEX is a classic UNIX-based tool used to create lexical analyzers. It uses regular expressions to define token patterns and generates C code capable of recognizing these patterns.

How LEX Works:

LEX programs are divided into three parts:

1. Definition Section
   - Includes C headers and global variable declarations.
2. Rules Section
   - Contains regular expressions paired with corresponding actions (in C code). Each pattern represents a token.
3. User Code Section (optional)
   - Contains helper functions and the main() function.

Compilation Steps:

1. Write your code in a .l file.
2. Run lex filename.l to generate the C source file lex.yy.c.
3. Compile the generated C file using gcc lex.yy.c -o output.
4. Run the resulting executable to analyze the input and print tokens.

Sample LEX Code:

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

```
%%
[0-9]+    { printf("Number: %s\n", yytext); }
[a-zA-Z]+ { printf("Identifier: %s\n", yytext); }
.         { printf("Special Character: %s\n", yytext); }
%%

int main() {
   yylex(); // Start token scanning
   return 0;
}
int yywrap() { return 1; }
```

How to Execute:

```
lex file.l
gcc lex.yy.c -o output
./output < input.txt
```

2. Flex (Fast Lexical Analyzer)

FLEX is a modern, faster, and open-source alternative to LEX. It’s widely adopted due to its enhanced performance and extended functionality. Like LEX, it generates a lex.yy.c file, but the internal engine is more optimized.

Notable Features of FLEX:

- Faster token scanning due to optimized deterministic finite automata (DFA).
- Compatible with LEX syntax and structure.
- Provides advanced options like debugging and performance analysis.

Sample FLEX Code:

(Same as LEX program above)

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

%%
```

```
[0-9]+    { printf("Number: %s\n", yytext); }
[a-zA-Z]+ { printf("Identifier: %s\n", yytext); }
.         { printf("Special Character: %s\n", yytext); }
%%

int main() {
    yylex(); // Start scanning input
    return 0;
}
int yywrap() { return 1; }
```

To Compile and Run:

```
flex file.l
gcc lex.yy.c -o output
./output < input.txt
```

LEX vs FLEX: A Quick Comparison

Feature	LEX	FLEX
Speed	Slower	Much faster
Platform Support	Traditional UNIX	Cross-platform (GNU-based)
Debugging	Basic	Rich debugging tools
Optimization	Limited	Efficient and optimized DFA

Conclusion

- Both LEX and FLEX streamline the process of building lexical analyzers.
- FLEX is the more powerful and widely used tool today due to its speed and flexibility.
- These tools are essential in compiler design, scripting language interpreters, and other text-processing applications where tokenization is required.

Practical 4

AIM:

Implement following programs using Lex.

e) **Write a Lex program to take input from text file and count no of characters, no. of lines & no. of words.**
e) **Write a Lex program to take input from text file and count number of vowels and consonants.**
e) **Write a Lex program to print out all numbers from the given file.**
e) **Write a Lex program which adds line numbers to the given file and display the same into different file.**
e) **Write a Lex program to printout all markup tags and HTML comments in file.**

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

Lex CODE:

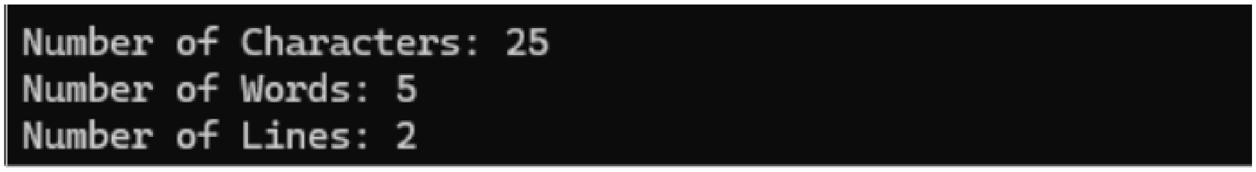
```
%{
#include <stdio.h>
int char_count = 0, word_count = 0, line_count = 0;
%}

%%

\n          { line_count++; char_count++; }
[^\n\t ]+   { word_count++; char_count += yyleng; }
.           { char_count++; }
```

```
%%

int main() {
    yylex();
    printf("\nNumber of Characters: %d", char_count);
    printf("\nNumber of Words: %d", word_count);
    printf("\nNumber of Lines: %d\n", line_count);
    return 0;
}

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

Input.txt:

```
Hello World!
Lex is fun.
```

Compile and run:



```
Number of Characters: 25
Number of Words: 5
Number of Lines: 2
```

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

Lex Code

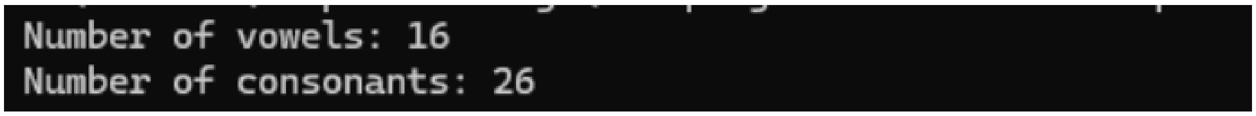
```
%{
   int vowels = 0;
   int consonants = 0;
   FILE *yyin;
%}

%%

[aeiouAEIOU]    { vowels++; }
[a-zA-Z]        { consonants++; }
.|\n            { /* Ignore other characters */ }

%%
int yywrap() {
   return 1;
}



int main(int argc, char *argv[]) {
   if (argc < 2) {
      printf("Usage: %s input2.txt\n", argv[0]);
      return 1;
   }
```

```
    FILE *file = fopen(argv[1], "r");
    if (!file) {
        printf("Cannot open file %s\n", argv[1]);
        return 1;
    }

    yyin = file;
    yylex();

    printf("Number of vowels: %d\n", vowels);
    printf("Number of consonants: %d\n", consonants);

    fclose(file);
    return 0;
}
```

Input.txt:

The quick brown fox jumps past dry land.

Compile and run:



```
Number of vowels: 16
Number of consonants: 26
```

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

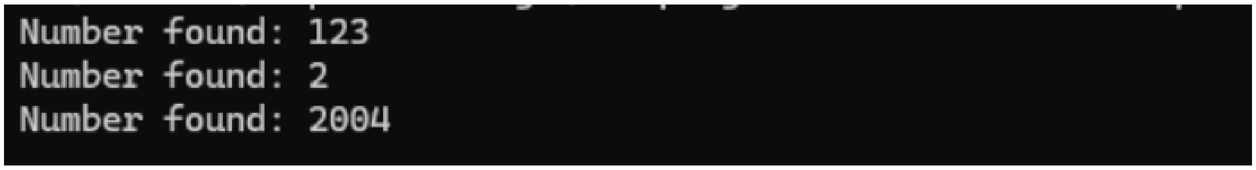
Lex Code

```
%{
#include <stdio.h>
%}
%%
[0-9]+(\.[0-9]+)?    { printf("Number found: %s\n", yytext); }
.|\n                 { /* Ignore all other characters */ }

%%
int yywrap() {
   return 1;
}
int main() {
   yylex();  // Start the lexical analysis
   return 0;
}
```

Input.txt:

```
Test 1234.
2 codes
Born in 2004.
```

Compile and run:



```
Number found: 123
Number found: 2
Number found: 2004
```

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

Lex Code

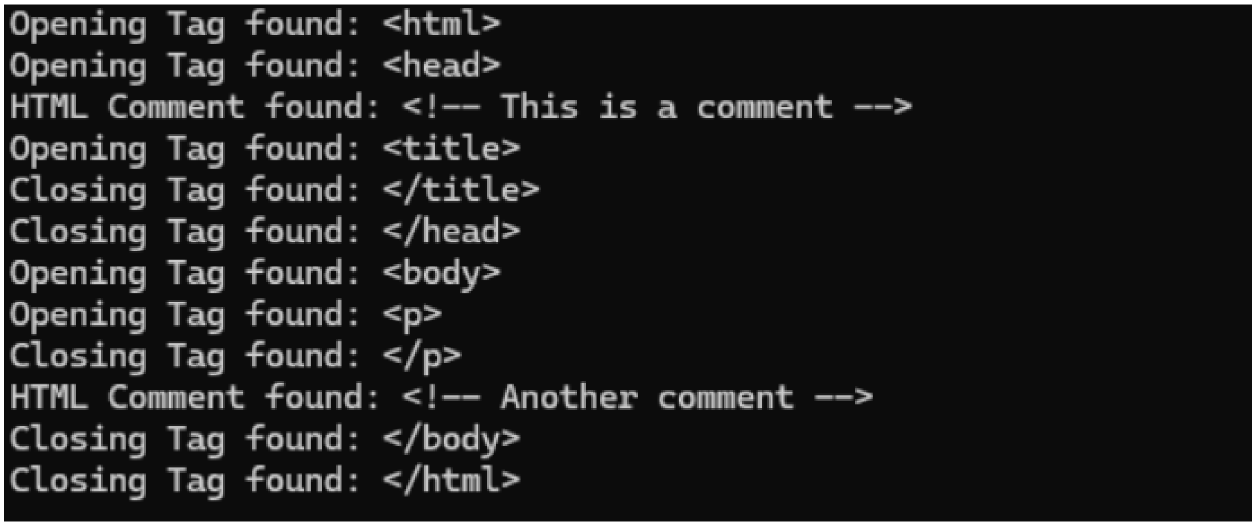
```
%{
#include <stdio.h>
%}

%%

"<!--"([^>]|[\n])*"-->"          { printf("HTML Comment found: %s\n", yytext); }
"<"[a-zA-Z][a-zA-Z0-9]*">"       { printf("Opening Tag found: %s\n", yytext); }
"</"[a-zA-Z][a-zA-Z0-9]*">"      { printf("Closing Tag found: %s\n", yytext); }
"<"[a-zA-Z][^>]*"/>"             { printf("Self-closing Tag found: %s\n", yytext); }

.|\n                             { /* Ignore other content */ }

%%

int yywrap() { return 1; }

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

input.html:

```
<html>
```

```
<head>
<!-- This is a comment -->
<title>Page Title</title>
</head>
<body>
<p>Welcome to the page!</p>
<!-- Another comment -->
</body>
</html>
```

Compile and run:



```
Opening Tag found: <html>
Opening Tag found: <head>
HTML Comment found: <!-- This is a comment -->
Opening Tag found: <title>
Closing Tag found: </title>
Closing Tag found: </head>
Opening Tag found: <body>
Opening Tag found: <p>
Closing Tag found: </p>
HTML Comment found: <!-- Another comment -->
Closing Tag found: </body>
Closing Tag found: </html>
```

Practical 5

AIM:

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

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.**

CODE:

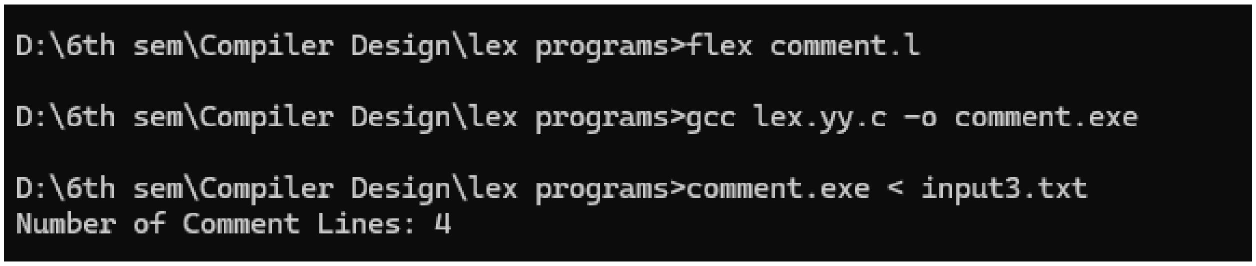
```
%{
#include <stdio.h>
#include <stdlib.h>
int comment_count = 0;
%}

%%
\/\/.*      { comment_count++; }  // Single-line comments
\/\*[^*]*\*+([^/*][^*]*\*+)*\/  { comment_count++; } // Multi-line comments
.|\n       { /* Ignore all characters, since we are not writing to a file */ }
%%

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

```
int main() {
    yyin = stdin;  // Read input from standard input (CMD)
    yylex();

    printf("Number of Comment Lines: %d\n", comment_count);
    return 0;
}
```

input.txt:

```
#include <stdio.h>

/* This is a multi-line comment
   explaining the main function */
int main() {
    // This is a single-line comment
    printf("Hello, World!\n"); // Print statement
    return 0; /* Return statement */
}
```

Compile and run:



```
D:\6th sem\Compiler Design\lex programs>flex comment.l

D:\6th sem\Compiler Design\lex programs>gcc lex.yy.c -o comment.exe

D:\6th sem\Compiler Design\lex programs>comment.exe < input3.txt
Number of Comment Lines: 4
```

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

CODE:

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

DIGIT       [0-9]
LETTER      [a-zA-Z]
IDENTIFIER  {LETTER}({LETTER}|{DIGIT})*
NUMBER      {DIGIT}+(\.{DIGIT}+)?
OPERATOR    [+\-*/%=><|&!]
SPECIAL     [(){}[\];,]
LITERAL     \"(\\.|[^"\\])*\"

%%

"auto"      { printf("Keyword: %s\n", yytext); }
"break"     { printf("Keyword: %s\n", yytext); }
"case"      { printf("Keyword: %s\n", yytext); }
"char"      { printf("Keyword: %s\n", yytext); }
"const"     { printf("Keyword: %s\n", yytext); }
"continue"  { printf("Keyword: %s\n", yytext); }
"default"   { printf("Keyword: %s\n", yytext); }
"do"        { printf("Keyword: %s\n", yytext); }
"double"    { printf("Keyword: %s\n", yytext); }
```

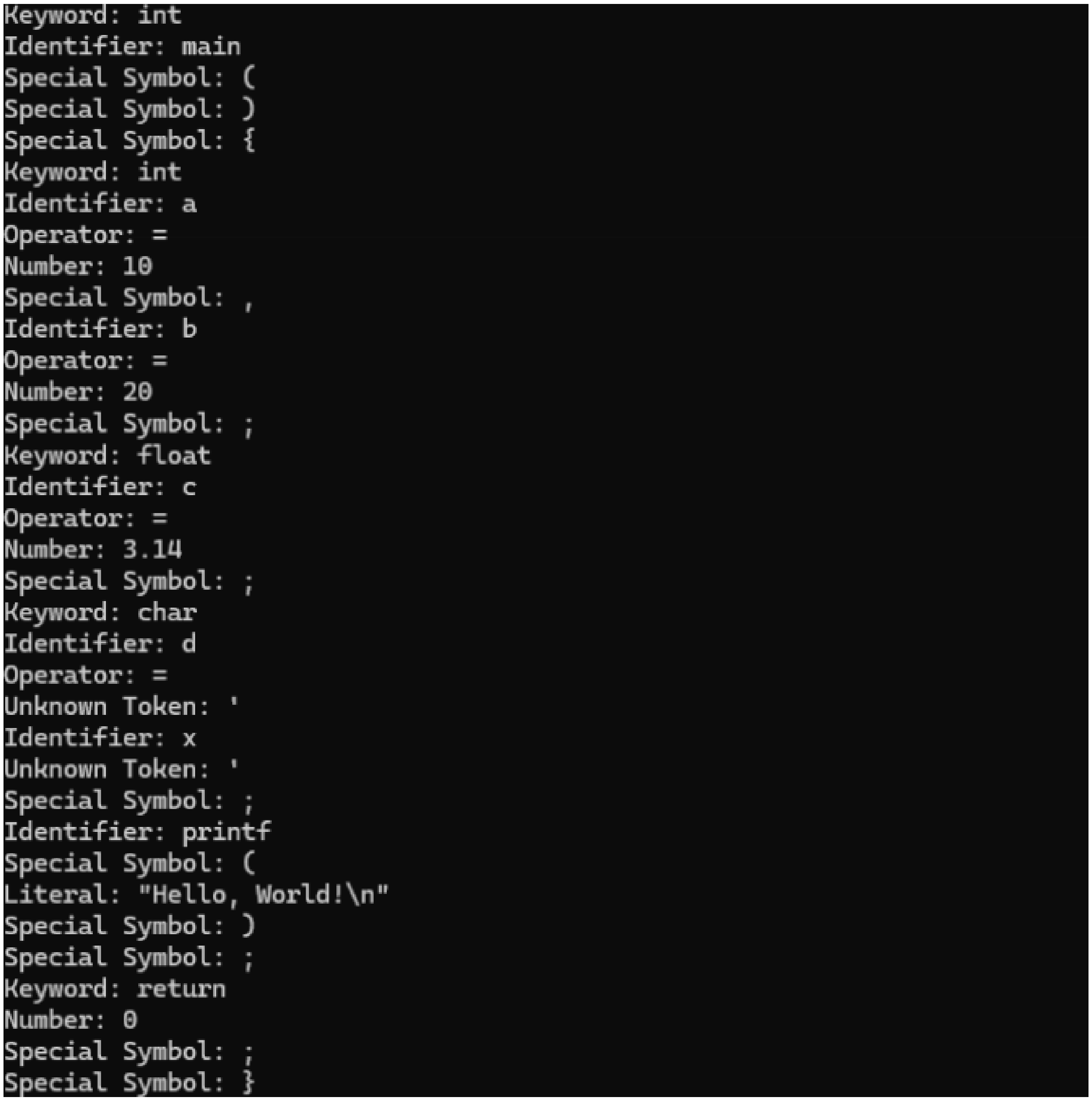
```
"else"      { printf("Keyword: %s\n", yytext); }
"enum"      { printf("Keyword: %s\n", yytext); }
"extern"    { printf("Keyword: %s\n", yytext); }
"float"     { printf("Keyword: %s\n", yytext); }
"for"       { printf("Keyword: %s\n", yytext); }
"goto"      { printf("Keyword: %s\n", yytext); }
"if"        { printf("Keyword: %s\n", yytext); }
"int"       { printf("Keyword: %s\n", yytext); }
"long"      { printf("Keyword: %s\n", yytext); }
"register"  { printf("Keyword: %s\n", yytext); }
"return"    { printf("Keyword: %s\n", yytext); }
"short"     { printf("Keyword: %s\n", yytext); }
"signed"    { printf("Keyword: %s\n", yytext); }
"sizeof"    { printf("Keyword: %s\n", yytext); }
"static"    { printf("Keyword: %s\n", yytext); }
"struct"    { printf("Keyword: %s\n", yytext); }
"switch"    { printf("Keyword: %s\n", yytext); }
"typedef"   { printf("Keyword: %s\n", yytext); }
"union"     { printf("Keyword: %s\n", yytext); }
"unsigned"  { printf("Keyword: %s\n", yytext); }
"void"      { printf("Keyword: %s\n", yytext); }
"volatile"  { printf("Keyword: %s\n", yytext); }
"while"     { printf("Keyword: %s\n", yytext); }

{IDENTIFIER}   { printf("Identifier: %s\n", yytext); }
{NUMBER}       { printf("Number: %s\n", yytext); }
{OPERATOR}     { printf("Operator: %s\n", yytext); }
{SPECIAL}      { printf("Special Symbol: %s\n", yytext); }
```

```
{LITERAL}      { printf("Literal: %s\n", yytext); }

[ \t\n]        { /* Ignore whitespace and newlines */ }

.              { printf("Unknown Token: %s\n", yytext); }

%%

int yywrap() {
    return 1;
}

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

input.txt:

```
int main() {
    int a = 10, b = 20;
    float c = 3.14;
    char d = 'x';
    printf("Hello, World!\n");

    return 0;
}
```

Compile and run:



```
Keyword: int
Identifier: main
Special Symbol: (
Special Symbol: )
Special Symbol: {
Keyword: int
Identifier: a
Operator: =
Number: 10
Special Symbol: ,
Identifier: b
Operator: =
Number: 20
Special Symbol: ;
Keyword: float
Identifier: c
Operator: =
Number: 3.14
Special Symbol: ;
Keyword: char
Identifier: d
Operator: =
Unknown Token: '
Identifier: x
Unknown Token: '
Special Symbol: ;
Identifier: printf
Special Symbol: (
Literal: "Hello, World!\n"
Special Symbol: )
Special Symbol: ;
Keyword: return
Number: 0
Special Symbol: ;
Special Symbol: }
```

Practical 6

AIM: Program to implement Recursive Descent Parsing in C.

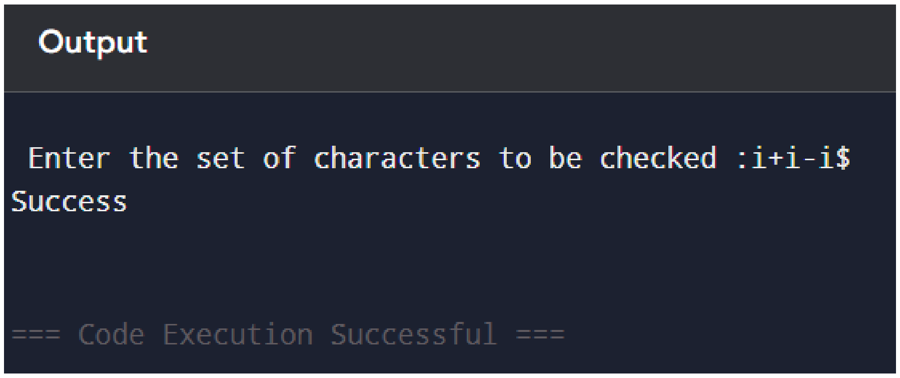
CODE:

```
#include<stdio.h>

#include<stdlib.h>

/*

E-> iE_

E_-> +iE_ / -iE_ / epsilon

*/

char s[20];

int i=1;

char l;

int match(char t)

{

    if(l==t){

        l=s[i];

        i++; }

    else{

       printf("Sytax error");

       exit(1);}

}

int E_()
```

```
{
   if(l=='+'){
       match('+');
       match('i');
       E_(); }
   else  if(l=='-'){
       match('-');
       match('i');
       E_(); }
   else
       return(1);
}
int E()
{
   if(l=='i'){
       match('i');
       E_(); }
}

int main()
{
   printf("\n Enter the set of characters to be checked :");
   scanf("%s",&s);
```

```
    l=s[0];

    E();

    if(l=='$')

    {

        printf("Success \n");

    }

    else{

        printf("syntax error");

    }

    return 0;

}
```

OUTPUT:



```
Output

 Enter the set of characters to be checked :i+i-i$
Success


=== Code Execution Successful ===
```

Practical 7

AIM:

a. **To Study about Yet Another Compiler-Compiler(YACC).**
b. **Create Yacc and Lex specification files to recognizes arithmetic expressions involving +, -, * and / .**
c. **Create Yacc and Lex specification files are used to generate a calculator which accepts integer type arguments.**
d. **Create Yacc and Lex specification files are used to convert infix expression to postfix expression.**

a. To Study about Yet Another Compiler-Compiler(YACC).

Introduction:

YACC stands for **Yet Another Compiler-Compiler**. It is a tool developed by Stephen C. Johnson at Bell Labs in the 1970s and is widely used for generating **parsers**—key components in compilers and interpreters. YACC automates the process of writing the syntax analysis (parsing) phase of a compiler by taking a grammar specification and generating C code to parse that grammar.

Purpose and Functionality:

YACC is designed to work with context-free grammars (CFGs) described in **Backus-Naur Form (BNF)** or a similar notation. These grammars define the syntactic structure of programming languages. YACC processes this grammar and produces a **parser**, specifically an **LALR(1)** parser (Look-Ahead Left-to-Right, Rightmost derivation with 1 lookahead symbol), which is efficient and suitable for many programming languages.
It is typically used in combination with **Lex**, a lexical analyzer generator. Lex handles the tokenization (lexical analysis) phase, while YACC handles parsing and syntax analysis.

Structure of a YACC Program:

A YACC program is divided into three sections, separated by %%:

1. **Declarations** – Includes token declarations, C header files, and definitions.
2. **Grammar Rules** – Context-free grammar rules with associated C code (actions).
3. **User Subroutines** – Additional C code, such as helper functions or the main() function.

Example:

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

%token NUMBER

%%
expr: expr '+' term   { printf("Addition\n"); }
    | term            ;

term: NUMBER          { printf("Number: %d\n", yylval); }
    ;
%%

int main() {
    yyparse();
    return 0;
}
```

How YACC Works:

1. **Input:** A grammar file (.y) describing the syntax and semantic actions.
2. **Parser Generation:** YACC generates a C file (usually y.tab.c) which implements the parser.
3. **Compilation:** This generated file is compiled along with a lexical analyzer (from Lex or hand-written).

4. **Execution:** The final executable parses input according to the specified grammar.

Features and Advantages:

- **Automates Parser Construction:** Reduces manual effort in writing complex parsing code.
- **Error Recovery:** Built-in mechanisms for syntax error detection and recovery.
- **C Integration:** Allows embedding C code within grammar rules to perform actions during parsing.
- **Modularity:** Works cleanly with Lex for a complete front-end compiler setup.

Applications of YACC:

- Developing **compilers** for new programming languages.
- Creating **interpreters** and **domain-specific languages (DSLs)**.
- Building **command processors**, **configuration file parsers**, and **scripting engines**.
- Educational purposes in compiler design courses.

Conclusion:

YACC is a powerful tool in the domain of compiler construction. By generating efficient parsers from formal grammar specifications, it simplifies the development of compilers and interpreters. Despite being several decades old, YACC and its modern variants (like Bison for GNU) are still widely used and form the foundation for many real-world programming language implementations.

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

Lex CODE:

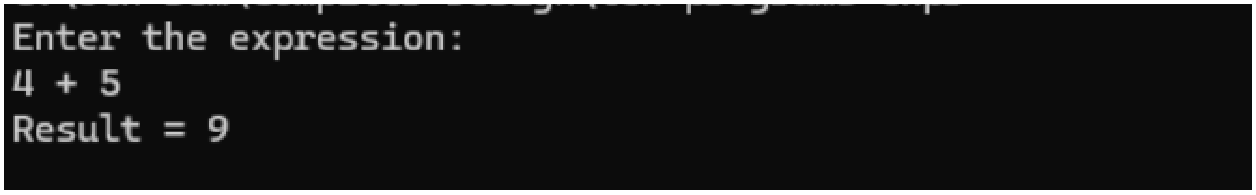
```
%{
   #include "expr.tab.h"
   #include <stdlib.h>
%}

%%

[0-9]+        { yylval.ival = atoi(yytext); return NUMBER; }
[a-zA-Z]+     { yylval.ival = 0; return ID; }
[ \t]+        ; // skip whitespace
\n            { return '\n'; }
.             { return yytext[0]; }

%%

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

YACC CODE:

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

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

%union {
    int ival;
}

%token <ival> NUMBER
%token <ival> ID
```

```
%type <ival> E

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

%%

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

E:
    E '+' E     { $$ = $1 + $3; }
  | E '-' E     { $$ = $1 - $3; }
  | E '*' E     { $$ = $1 * $3; }
  | E '/' E     { $$ = $1 / $3; }
  | '-' E       { $$ = -$2; }
  | '(' E ')'   { $$ = $2; }
  | NUMBER      { $$ = $1; }
  | ID          { $$ = $1; }
  ;

%%

int main(void) {
    printf("Enter the expression:\n");
    yyparse();
    return 0;
}

void yyerror(const char *s) {
    fprintf(stderr, "Error: %s\n", s);
}
```

OUTPUT:



```
Enter the expression:
4 + 5
Result = 9
```

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

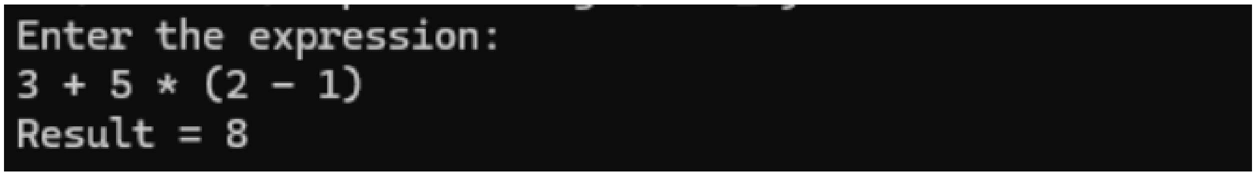
Lex CODE:

```
%{
#include <stdlib.h>
void yyerror(char *);
#include "sample.tab.h"
%}
%%
[0-9]+  {yylval = atoi(yytext); return NUM;}
[-+*\n] {return *yytext;}
[ \t] ; { }
. yyerror("invalid character");
%%
int yywrap() {
 return 0;
}
```

YACC CODE:

```
%{
 #include<stdio.h>
 int yylex(void);
 void yyerror(char *);
%}
%token NUM
%%
S : E '\n' { printf("%d\n", $1); return(0); }
E : E '+' T {$$ =$1 + $3; }
  | E '-' T {$$ = $1 - $3; }
  | T       {$$ = $1; }
T : T '*' F {$$ = $1 * $3; }
  | F          {$$ = $1; }
F: NUM      {$$ = $1; }
%%
void yyerror(char *s) {
 printf("%s\n", s);
}
int main() {
 yyparse();
 return 0;
}
```

OUTPUT:



```
Enter the expression:
3 + 5 * (2 - 1)
Result = 8
```

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

Lex CODE:

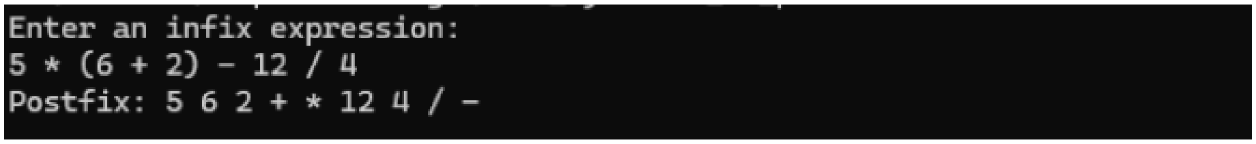
```
%{
#include "infix_to_postfix.tab.h"
#include <stdlib.h>
#include <string.h>
%}

DIGIT   [0-9]
WS      [ \t\r]+

%%

{DIGIT}+    {
                yylval.str = strdup(yytext);
                return NUMBER;
            }
"("         { return '('; }
")"         { return ')'; }
"+"         { return '+'; }
"-"         { return '-'; }
"*"         { return '*'; }
"/"         { return '/'; }
{WS}        { /* skip whitespace */ }
\n          { return '\n'; }
.           { return yytext[0]; }
```

```
%%

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

YACC CODE:

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

// custom asprintf implementation for Windows
int asprintf(char **strp, const char *fmt, ...) {
    va_list args;
    va_start(args, fmt);
    int size = vsnprintf(NULL, 0, fmt, args);
    va_end(args);

    if (size < 0) return -1;

    *strp = (char *)malloc(size + 1);
    if (!*strp) return -1;

    va_start(args, fmt);
    vsnprintf(*strp, size + 1, fmt, args);
    va_end(args);
    return size;
}

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

%union {
    char *str;
}

%token <str> NUMBER
%left '+' '-'
%left '*' '/'
%token '(' ')'

%type <str> expr

%%

input:
    /* empty */
    | input expr '\n' {
        printf("Postfix: %s\n", $2);
        free($2);
    }
    ;

expr:
      NUMBER               { $$ = strdup($1); free($1); }
    | expr '+' expr        { asprintf(&$$, "%s %s +", $1, $3); free($1); free($3); }
    | expr '-' expr        { asprintf(&$$, "%s %s -", $1, $3); free($1); free($3); }
    | expr '*' expr        { asprintf(&$$, "%s %s *", $1, $3); free($1); free($3); }
    | expr '/' expr        { asprintf(&$$, "%s %s /", $1, $3); free($1); free($3); }
    | '(' expr ')'        { $$ = $2; }
    ;

%%

void yyerror(const char *s) {
    fprintf(stderr, "Error: %s\n", s);
}

int main() {
    printf("Enter an infix expression:\n");
    yyparse();
    return 0;
}
```

OUTPUT:



```
Enter an infix expression:
5 * (6 + 2) - 12 / 4
Postfix: 5 6 2 + * 12 4 / -
```