Lab Manual

Of

Compiler Design

LABORATORY

,

Bachelor of Technology (CSE)

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

Input:

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){s

        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:

```
Enter the string: abbaaabbba
The string is valid.
State = 1
--------------------------------
Process exited after 10.31 seconds with return value 0
Press any key to continue . . .
```

```
Enter the string: baaababaa
The string is invalid.
State = 2
--------------------------------
Process exited after 4.691 seconds with return value 0
Press any key to continue . . .
```

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: fgkjgsfgj
The string is invalid.
State = 0
--------------------------------
Process exited after 4.58 seconds with return value 0
Press any key to continue . . .
```

```
Enter the string: fjefjefajaa
The string is valid.
State = 1
--------------------------------
Process exited after 4.391 seconds with return value 0
Press any key to continue . . .
```

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

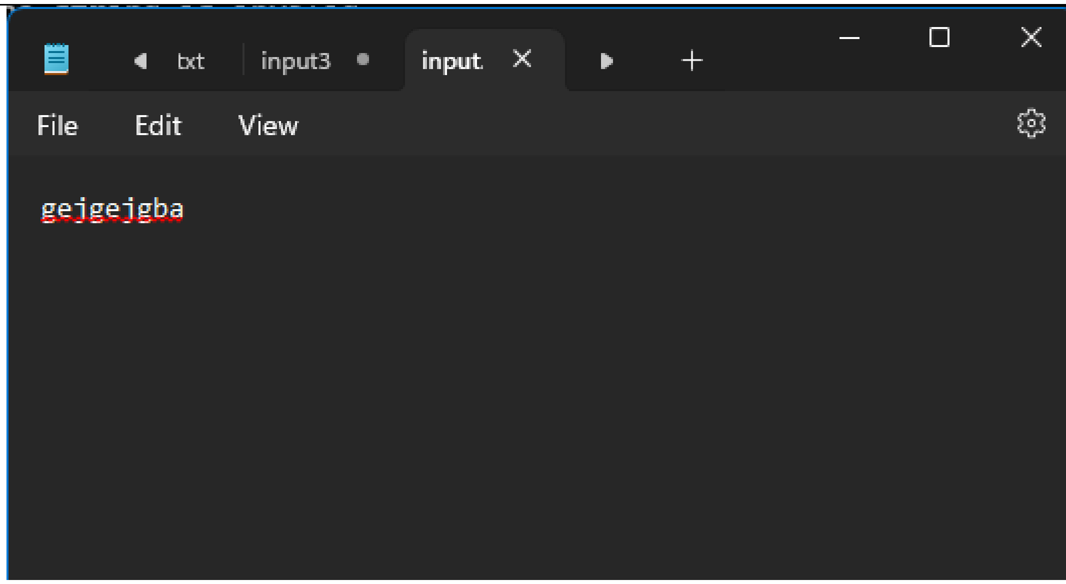
Code:

```
//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;
    }
```

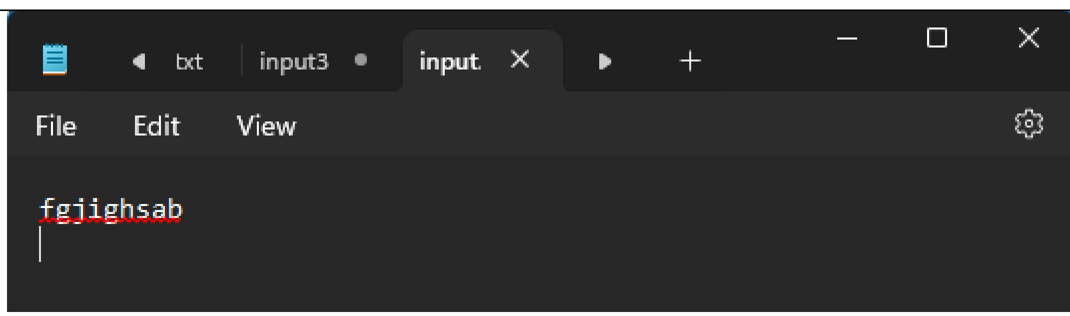
```
    fclose(file);

    // 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 invalid.
The state is: 1

--------------------------------
Process exited after 0.07688 seconds with return value 0
Press any key to continue . . .
```




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

--------------------------------
Process exited after 0.08925 seconds with return value 0
Press any key to continue . . .
```

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

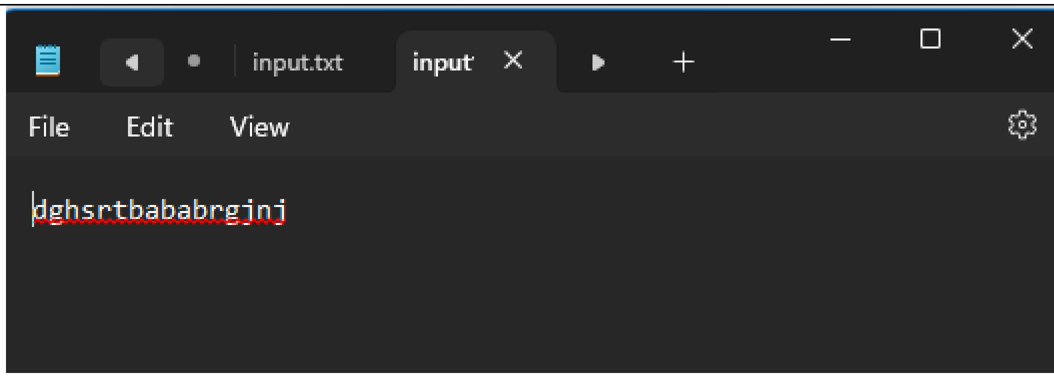
Code:

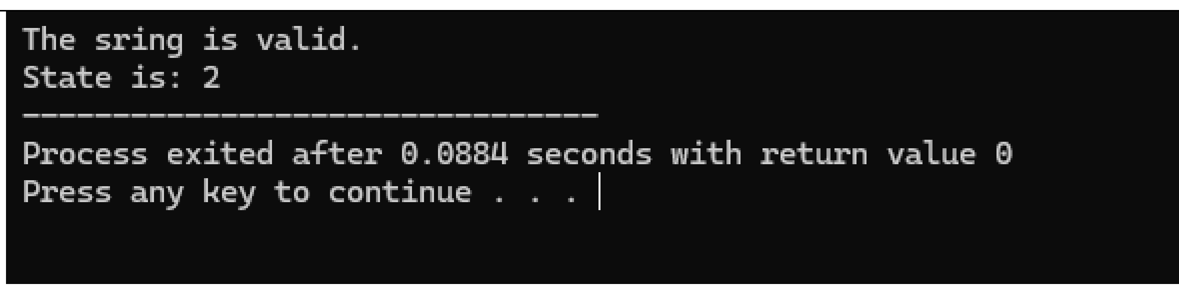
```
//sting contains ab, and takes input from a file.
#include<stdio.h>
int main(){

    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;
    }
  }
```

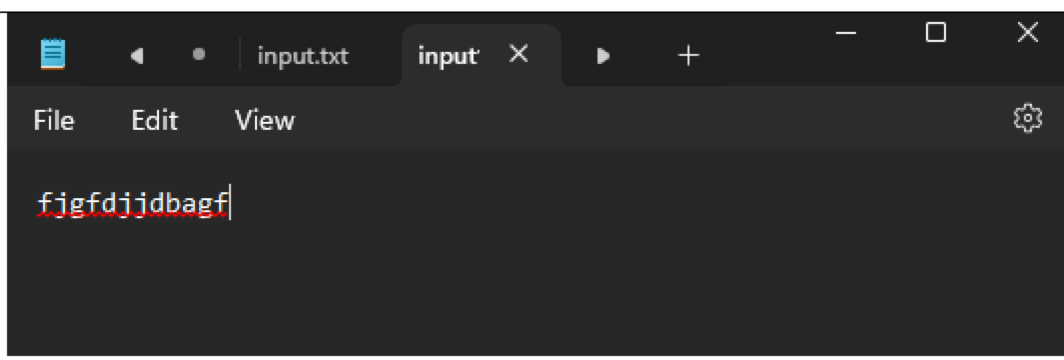
```
i = 0; // Reset index for processing the string

    /*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
--------------------------------
Process exited after 0.08277 seconds with return value 0
Press any key to continue . . .
```

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.

Input:

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();
}
```

```
Enter an identifier:firstName
Valid identifier
--------------------------------
Process exited after 51.49 seconds with return value 0
Press any key to continue . . .
```

```
Enter an identifier:1firstName
invalid identifier
--------------------------------
Process exited after 20.1 seconds with return value 0
Press any key to continue . . .
```

b) Write a program to recognize the valid operators.

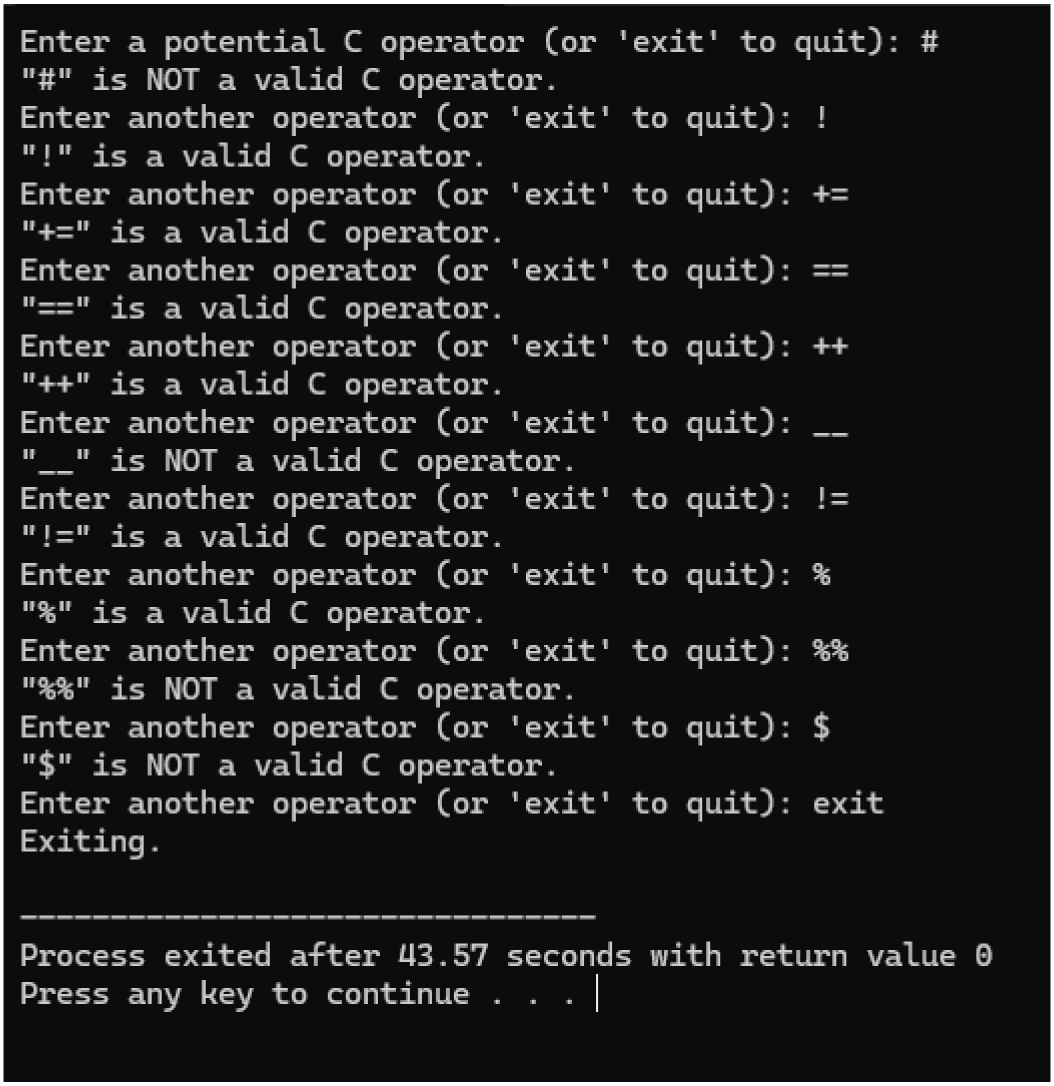
Code:

```
//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;

}
```



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

--------------------------------
Process exited after 43.57 seconds with return value 0
Press any key to continue . . .
```

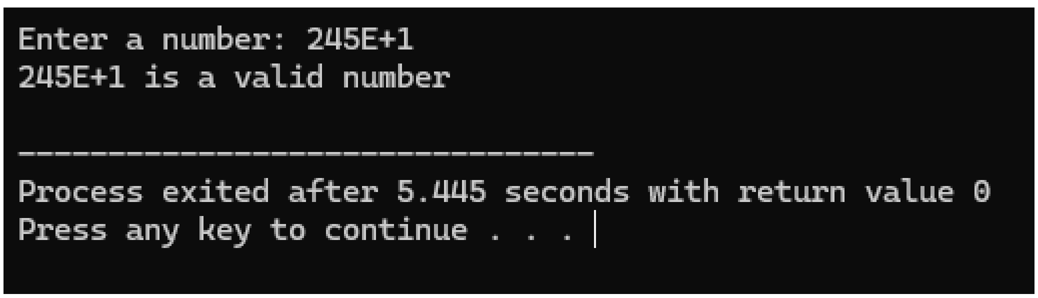
c) Write a program to recognize the valid number.

Code:

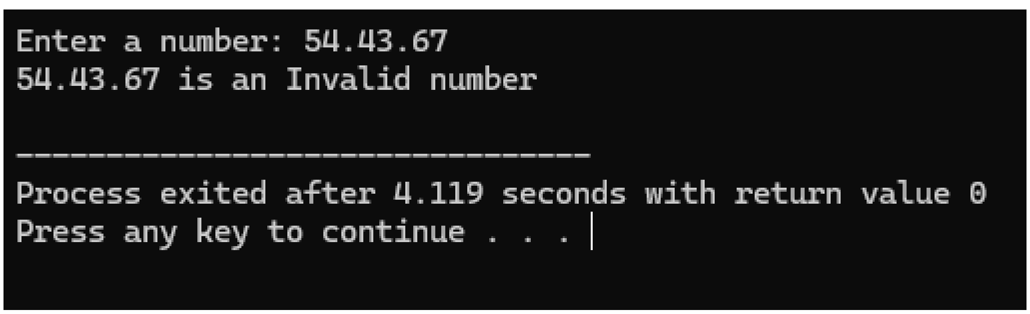
```
#include <stdio.h>
#include <ctype.h>
#include <string.h>

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;
}
```



```
Enter a number: 245E+1
245E+1 is a valid number

--------------------------------
Process exited after 5.445 seconds with return value 0
Press any key to continue . . .
```



```
Enter a number: 54.43.67
54.43.67 is an Invalid number

--------------------------------
Process exited after 4.119 seconds with return value 0
Press any key to continue . . .
```

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:

```
/*dsjdbhsdbf *gdgsdg *dfd */
```

```
This is a multiline comment.
State is 6
--------------------------------
Process exited after 0.1017 seconds with return value 0
Press any key to continue . . .
```

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;
}
```

```
Enter a string for lexical analysis: int x = 10 + y;
Keyword: int
Identifier: x
Operator: =
Number: 10
Operator: +
Identifier: y
Special Symbol: ;

--------------------------------
Process exited after 12.3 seconds with return value 0
Press any key to continue . . .
```

Practical 3

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

Introduction:

A Lexical Analyzer converts an input stream (source code) into a sequence of tokens, which are then used by the parser in a compiler. Lex and Flex are tools designed for this purpose.

1. Lexical Analyzer Generator (LEX)

LEX is a tool used to generate lexical analyzers. It takes a set of **regular expressions** (token patterns) as input and produces a C program that can identify these tokens.

Working of LEX:

1. **Specification File:**
   A LEX program consists of three sections:
   - **Definition Section:** Declare header files and global variables.
   - **Rules Section:** Define token patterns using regular expressions.
   - **C Code Section:** Additional helper functions (optional).
2. **Compilation Process:**
   - The **LEX file (.l)** is compiled using lex to generate lex.yy.c.
   - The lex.yy.c file is compiled with a C compiler (gcc lex.yy.c -o output).
   - The executable processes input and tokenizes it.

Example LEX Program:

```
%{

#include <stdio.h>

%}
```

```
%%
[0-9]+    { printf("Number: %s\n", yytext); }
[a-zA-Z]+ { printf("Identifier: %s\n", yytext); }
.         { printf("Special Symbol: %s\n", yytext); }
%%
int main() {
    yylex();
    return 0;
}
int yywrap() { return 1; }
```

Commands to Run:

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

2. Fast Lexical Analyzer (FLEX)

Flex is an improved and faster version of **Lex**. It provides better performance and extended functionality.

Key Features of FLEX:

- Works similarly to **Lex**, but faster.
- Generates a more optimized lex.yy.c.

- Supports additional options like debugging and performance tuning.

Example FLEX Program:

(Same structure as LEX)

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


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


int main() {
   yylex();
   return 0;
}
int yywrap() { return 1; }
```

Commands to Run:

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

Comparison: LEX vs FLEX

Feature	LEX	FLEX
Speed	Slower	Faster
Compatibility	Traditional UNIX tool	GNU version, supports more platforms
Debugging	Limited	More debugging options
Performance	Basic optimization	Highly optimized DFA

Conclusion:

- Lex and Flex automate the creation of lexical analyzers.
- Flex is an enhanced version of Lex and is more commonly used today.
- These tools simplify token generation in compiler design.

Practical 4

Aim: 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.

Input:

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

Lex code: (count.l)

```
%{
#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;
}
```

Input2.txt code:

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

Compile and run:

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

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

D:\6th sem\Compiler Design\lex programs>count.exe < input2.txt

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 [count1.l]

```
%{
    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;
}
```

Input2.txt Code:

```
Hello World!
Lex is fun.
123
Vaidehi Hirani born on 2nd oct. 2004
```

Compile and run:

```
D:\6th sem\Compiler Design\lex programs>flex count1.l

D:\6th sem\Compiler Design\lex programs>gcc lex.yy.c -o count1.exe

D:\6th sem\Compiler Design\lex programs>count1.exe input2.txt
Number of vowels: 16
Number of consonants: 26
```

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

Lex Code [numbers.l]

```
%{
#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;
}
```

Input2.txt Code:

```
Hello World!
Lex is fun.
123
Vaidehi Hirani born on 2nd oct. 2004
```

Compile and run:

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

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

D:\6th sem\Compiler Design\lex programs>numbers.exe < input2.txt
Number found: 123
Number found: 2
Number found: 2004
```

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

Lex Code [tags_comments.l]

```
%{
#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;
```

}

input3.html code:

```
<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:

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

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

D:\6th sem\Compiler Design\lex programs>tags_comments.exe < input3.html
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.

Input:

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.

comment.l

```
%{
#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;
}
```

input3.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.

tokenizer.l

```
%{
```

```
#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;
}
```

input4.txt

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

    return 0;
}
```

Compile and run:

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

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

D:\6th sem\Compiler Design\lex programs>tokenizer.exe < input4.txt
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 <string.h>

#define SUCCESS 1

#define FAILED 0

// Function prototypes

int E(), Edash(), T(), Tdash(), F();

const char *cursor;

char string[64];

int main()

{

    puts("Enter the string");

    scanf("%s", string); // Read input from the user

    cursor = string;

    puts("");

    puts("Input          Action");

    puts("--------------------------------");

    // Call the starting non-terminal E

    if (E() && *cursor == '\0')

    { // If parsing is successful and the cursor has reached the end

        puts("--------------------------------");
```

```
        puts("String is successfully parsed");
        return 0;
    }
    else
    {
        puts("--------------------------------");
        puts("Error in parsing String");
        return 1;
    }
}
// Grammar rule: E -> T E'
int E()
{
    printf("%-16s E -> T E'\n", cursor);
    if (T())
    { // Call non-terminal T
        if (Edash())
        { // Call non-terminal E'
            return SUCCESS;
        }
        else
        {
            return FAILED;
```

```
        }
    }
    else
    {
        return FAILED;
    }
}
// Grammar rule: E' -> + T E' | $
int Edash()
{
    if (*cursor == '+')
    {
        printf("%-16s E' -> + T E'\n", cursor);
        cursor++;

        if (T())
        { // Call non-terminal T
            if (Edash())
            { // Call non-terminal E'
                return SUCCESS;
            }
            else
            {
```

```
                return FAILED;
            }
        }
        else
        {
            return FAILED;
        }
    }
    else
    {
        printf("%-16s E' -> $\n", cursor);
        return SUCCESS;
    }
}
// Grammar rule: T -> F T'
int T()
{
    printf("%-16s T -> F T'\n", cursor);
    if (F())
    { // Call non-terminal F
        if (Tdash())
        { // Call non-terminal T'
            return SUCCESS;
```

```
        }
        else
        {
            return FAILED;
        }
    }
    else
    {
        return FAILED;
    }
}

// Grammar rule: T' -> * F T' | $
int Tdash()
{
    if (*cursor == '*')
    {
        printf("%-16s T' -> * F T'\n", cursor);
        cursor++;

        if (F())
        { // Call non-terminal F
            if (Tdash())
```

```
            { // Call non-terminal T'
                return SUCCESS;
            }
            else
            {
                return FAILED;
            }
        }
        else
        {
            return FAILED;
        }
    }
    else
    {
        printf("%-16s T' -> $\n", cursor);
        return SUCCESS;
    }
}
// Grammar rule: F -> ( E ) | i
int F()
{
    if (*cursor == '(')
```

```
    {
        printf("%-16s F -> ( E )\n", cursor);
        cursor++;
        if (E())
        { // Call non-terminal E
            if (*cursor == ')')
            {
                cursor++;
                return SUCCESS;
            }
            else
            {
                return FAILED;
            }
        }
        else
        {
            return FAILED;
        }
    }
    else if (*cursor == 'i')
    {
        printf("%-16s F -> i\n", cursor);
```

```
        cursor++;

        return SUCCESS;

    }

    else

    {

        return FAILED;

    }

}
```

Output:

```
Enter the string
i+i$

Input           Action
--------------------------------
i+i$              E -> T E'
i+i$              T -> F T'
i+i$              F -> i
+i$               T' -> $
+i$               E' -> + T E'
i$                T -> F T'
i$                F -> i
$                 T' -> $
$                 E' -> $
--------------------------------
Error in parsing String

--------------------------------
Process exited after 8.433 seconds with return value 1
Press any key to continue . . .
```

```
Enter the string
i + i $

Input          Action
--------------------------------
i                E -> T E'
i                T -> F T'
i                F -> i
                 T' -> $
                 E' -> $
--------------------------------
String is successfully parsed

--------------------------------
Process exited after 4.121 seconds with return value 0
Press any key to continue . . .
```

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.

Code:

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

What is YACC?

- YACC (Yet Another Compiler-Compiler) is a tool used in compiler design to generate parsers. It helps you build the syntax analysis part of a compiler.
- It was developed by Stephen C. Johnson at AT&T Bell Labs.

Why is YACC used?

- Writing a parser manually (like recursive descent) is complex and error-prone.
- YACC automates this by generating C code for the parser from a grammar specification.
- It works well with lex, the lexical analyzer generator.

How does YACC work?

- You write a grammar using BNF (Backus-Naur Form) or similar syntax.
- You assign semantic actions to grammar rules (using C code).
- YACC generates a parser in C that uses a bottom-up parsing algorithm (usually LALR(1)).
- The parser works with lex to analyze tokens.

Structure of a YACC file

A YACC source file has three sections, separated by %%:

```
%{
   // Declarations (C code, headers)
%}

%token ID NUM // Token definitions

%%

E : E '+' T   { printf("Adding\n"); }
  | T         { /* do nothing */ }
  ;

T : T '*' F   { printf("Multiplying\n"); }
  | F         { /* do nothing */ }
  ;

F : '(' E ')'
  | ID
  | NUM
  ;

%%

// Additional C code (main function etc.)
```

YACC and LEX Integration

- LEX handles scanning/tokenizing (splits input into tokens).
- YACC handles parsing (checks if token sequence is valid as per grammar).
- They work together to build front ends for compilers.

Advantages of YACC

- Speeds up parser development.
- Helps build robust parsers for programming languages.
- Well-suited for formal language processing tasks.

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

expr.l 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;
}
```

expr.y 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:

```
C:\6th sem\Compiler Design\lex programs>bison -d expr.y

C:\6th sem\Compiler Design\lex programs>flex expr.l

C:\6th sem\Compiler Design\lex programs>gcc -o expr expr.tab.c lex.yy.c

C:\6th sem\Compiler Design\lex programs>expr
Enter the expression:
4+5*(3-1)
Result = 14
```

```
C:\6th sem\Compiler Design\lex programs>bison -d expr.y

C:\6th sem\Compiler Design\lex programs>flex expr.l

C:\6th sem\Compiler Design\lex programs>gcc -o expr expr.tab.c lex.yy.c

C:\6th sem\Compiler Design\lex programs>expr
Enter the expression:
4 + 5
Result = 9

C:\6th sem\Compiler Design\lex programs>bison -d expr.y

C:\6th sem\Compiler Design\lex programs>flex expr.l

C:\6th sem\Compiler Design\lex programs>gcc -o expr expr.tab.c lex.yy.c

C:\6th sem\Compiler Design\lex programs>expr
Enter the expression:
5 +
Error: syntax error
```

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

calc.l code:

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

%%

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

```
%%

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

calc.y code:

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

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

%union {
    int ival;
}

%token <ival> NUMBER
%type <ival> expr

%left '+' '-'
%left '*' '/'
%start input

%%

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

```
expr:
    expr '+' expr   { $$ = $1 + $3; }
  | expr '-' expr   { $$ = $1 - $3; }
  | expr '*' expr   { $$ = $1 * $3; }
  | expr '/' expr   {
                      if ($3 == 0) {
                        yyerror("Division by zero");
                        YYABORT; // Exit the parsing process immediately
                      } else {
                        $$ = $1 / $3;
                      }
                    }
  | '(' expr ')'    { $$ = $2; }
  | NUMBER          { $$ = $1; }
  ;

%%

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

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

Output:

```
C:\6th sem\Compiler Design\calc_my>bison -d calc.y

C:\6th sem\Compiler Design\calc_my>flex calc.l

C:\6th sem\Compiler Design\calc_my>gcc -o calc calc.tab.c lex.yy.c

C:\6th sem\Compiler Design\calc_my>calc
Enter the expression:
3 + 5 * (2 - 1)
Result = 8
```

```
C:\6th sem\Compiler Design\calc_my>bison -d calc.y

C:\6th sem\Compiler Design\calc_my>flex calc.l

C:\6th sem\Compiler Design\calc_my>gcc -o calc calc.tab.c lex.yy.c

C:\6th sem\Compiler Design\calc_my>calc
Enter the expression:
8 / 0
Error: Division by zero
```

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

infix_to_postfix.l 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;
}
```

infix_to_postfix.y 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:

```
C:\6th sem\Compiler Design\calc_my>bison -d infix_to_postfix.y

C:\6th sem\Compiler Design\calc_my>flex infix_to_postfix.l

C:\6th sem\Compiler Design\calc_my>gcc -o infix_to_postfix infix_to_postfix.tab.c lex.yy.c

C:\6th sem\Compiler Design\calc_my>infix_to_postfix
Enter an infix expression:
5 * (6 + 2) - 12 / 4
Postfix: 5 6 2 + * 12 4 / -
```

```
C:\6th sem\Compiler Design\calc_my>bison -d infix_to_postfix.y

C:\6th sem\Compiler Design\calc_my>flex infix_to_postfix.l

C:\6th sem\Compiler Design\calc_my>gcc -o infix_to_postfix infix_to_postfix.tab.c lex.yy.c

C:\6th sem\Compiler Design\calc_my>infix_to_postfix
Enter an infix expression:
8 + 3 / - 2
Error: syntax error
```