SCHOOL OF ENGINEERING & TECHNOLOGY

BACHELOR OF TECHNOLOGY

COMPILER DESIGN

6TH SEMESTER

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

Laboratory Manual

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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.

Q1 a Write a program to recognize strings starts with ‘a’ over {a, b}.

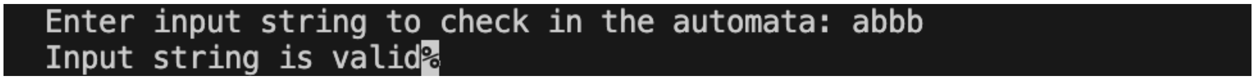
Code:

```
#include<stdio.h>


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



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

```
    case 1:
    if (input[i] == 'a' || input[i] == 'b')
    {
        /* code */
        state = 1;
    }
    else
    {

        state = 3;
    }
    break;

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

    case 3:
    state = 3;
}
```

```
        i++;
    }
    if(state == 1) printf("Input string is valid");
    else if(state == 2 || state == 0) printf("Input string is not valid");
    else if(state == 3) printf("String is not recogized");

    return 0;
}
```

Output:



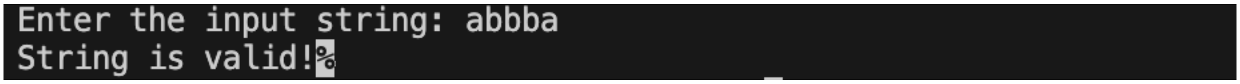
```
Enter input string to check in the automata: abbb
Input string is valid%
```

Q1 b Write a program to recognize strings end with ‘a’.

Code:

```
#include<stdio.h>

int main() {
    char input[10];
    int state=0, i=0;

    printf("Enter the input 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("String is invalid!");
  else printf("String is valid!");

return 0;
}
```

Output:



```
Enter the input string: abbba
String is valid!%
```

Q1 c Write a program to recognize strings end with ‘ab’. Take the input from text file.

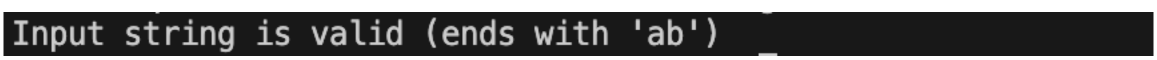
Code:

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

int main() {
  char input[100];
  int i = 0, state = 0;
```

```
// Open the file for reading
FILE *file = fopen("input.txt", "r");
if (file == NULL) {
   printf("Error: Could not open file.\n");
   return 1;
}

// Read the string from the file
fscanf(file, "%s", input);
fclose(file); // Close the file after reading

// DFA logic to check if the string ends with "ab"
while (input[i] != '\0') {
   switch (state) {
      case 0:
         if (input[i] == 'a') {
            state = 1;
         } else if (input[i] == 'b') {
            state = 0;
         } else {
            state = 3; // Invalid character
         }
         break;

      case 1:
         if (input[i] == 'b') {
            state = 2;
         } else if (input[i] == 'a') {
            state = 1;
```

```
                } else {
                    state = 3;
                }
                break;

            case 2:
                if (input[i] == 'a') {
                    state = 1;
                } else if (input[i] == 'b') {
                    state = 0;
                } else {
                    state = 3;
                }
                break;
            case 3:
                state = 3;
                break;
        }
        i++;
    }
    // Final check: only accept if last two characters were 'a' followed by 'b'
    if (state == 2) {
        printf("Input string is valid (ends with 'ab')\n");
    } else {
        printf("Input string is not valid (does not end with 'ab')\n");
    }

    return 0;
}
```

Output:



```
Input string is valid (ends with 'ab')
```

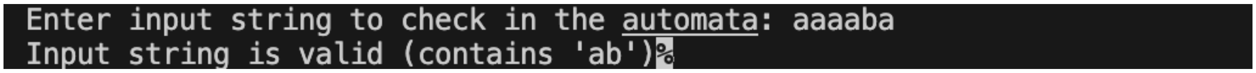
Q1 d Write a program to recognize strings contains ‘ab’. Take the input from text file.

Code:

```
#include <stdio.h>


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


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

```
            case 1:
                if (input[i] == 'b') {
                    state = 2; // Transition to final state on "ab"
                } else if (input[i] == 'a') {
                    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 == 2) {
        printf("Input string is valid (contains 'ab')");
    } else {
        printf("Input string is not valid (does not contain 'ab')");
    }
    return 0;
}
```

Output:



```
Enter input string to check in the automata: aaaaba
Input string is valid (contains 'ab')%
```

2

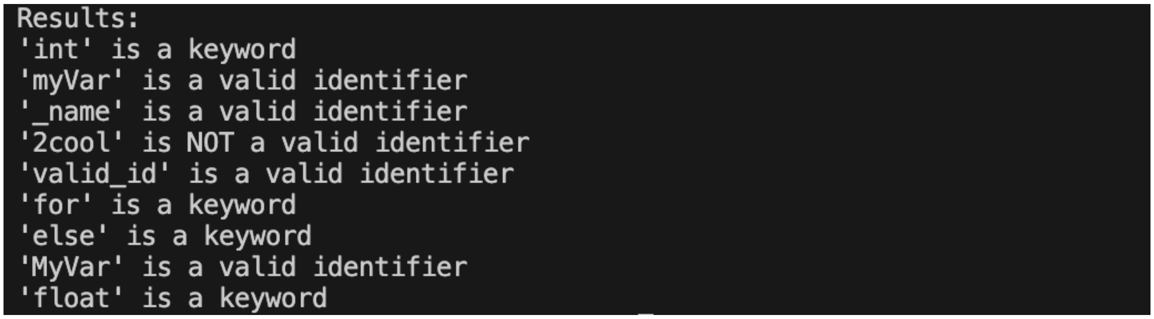
a) **Write a program to recognize the valid identifiers and keywords.**

Code:

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

int isKeyword(char *str) {
   char *keywords[] = {"int","float","char","double","return","if","else","for","while"};
   int numKeywords = sizeof(keywords) / sizeof(keywords[0]);

   for (int i = 0; i < numKeywords; i++) {
      if (strcmp(str, keywords[i]) == 0)
         return 1;
   }
   return 0;
}


int isValidIdentifier(char *str) {
   if (!isalpha(str[0]) && str[0] != '_')
```

```
        return 0;

    for (int i = 1; str[i] != '\0'; i++) {
        if (!isalnum(str[i]) && str[i] != '_')
            return 0;
    }

    return 1;
}

int main() {
    FILE *file;
    char filename[] = "input2a.txt";
    char word[100];
    int index = 0;
    char ch;

    file = fopen(filename, "r");
    if (file == NULL) {
        perror("Error opening file");
        return 1;
    }

    printf("Results:\n");

    while ((ch = fgetc(file)) != EOF) {
        if (isalnum(ch) || ch == '_') {
            word[index++] = ch;
        } else if (index > 0) {
            word[index] = '\0';
            if (isKeyword(word))
                printf("'%s' is a keyword\n", word);
            else if (isValidIdentifier(word))
                printf("'%s' is a valid identifier\n", word);
            else
                printf("'%s' is NOT a valid identifier\n", word);

            index = 0;  // Reset for next word
        }
    }

    // Handle last word if file doesn't end with whitespace
    if (index > 0) {
        word[index] = '\0';

        if (isKeyword(word))
            printf("'%s' is a keyword\n", word);
        else if (isValidIdentifier(word))
            printf("'%s' is a valid identifier\n", word);
        else
            printf("'%s' is NOT a valid identifier\n", word);
    }

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

Output:



```
Results:
'int' is a keyword
'myVar' is a valid identifier
'_name' is a valid identifier
'2cool' is NOT a valid identifier
'valid_id' is a valid identifier
'for' is a keyword
'else' is a keyword
'MyVar' is a valid identifier
'float' is a keyword
```

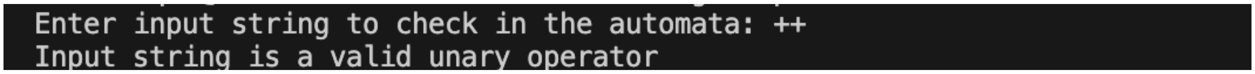
b) Write a program to recognize the valid operators.

Code:

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

int main() {
    char input[10];
    int i = 0;

    printf("Enter input string to check in the automata: ");
    scanf("%s", input);

    int state = 50;

    while (input[i] != '\0') {
        switch (state) {
            case 50:
                if (input[i] == '+') {
                    if (input[i + 1] == '+') state = 100;
    else if (input[i + 1] == '=') state = 101;

    else if (input[i + 1] == '\0' || input[i + 1] == ' ') state = 102;

    else state = -1;

}

else if (input[i] == '-') {

    if (input[i + 1] == '-') state = 103;

    else if (input[i + 1] == '=') state = 104;

    else if (input[i + 1] == '\0' || input[i + 1] == ' ') state = 105;

    else state = -1;

}

else if (input[i] == '*') {

    if (input[i + 1] == '=') state = 107;

    else if (input[i + 1] == '\0' || input[i + 1] == ' ') state = 108;

    else state = -1;

}

else if (input[i] == '/') {

    if (input[i + 1] == '=') state = 109;

    else if (input[i + 1] == '\0' || input[i + 1] == ' ') state = 110;

    else state = -1;

}

else if (input[i] == '%') {

    if (input[i + 1] == '=') state = 111;

    else if (input[i + 1] == '\0' || input[i + 1] == ' ') state = 112;

    else state = -1;

}

else if (input[i] == '=') {

    if (input[i + 1] == '=') state = 119;

    else if (input[i + 1] == '\0' || input[i + 1] == ' ') state = 120;

    else state = -1;

}
```

```
            else {
                state = -1;
            }
            break;
        }
        i++;
    }

    if (state == 100 || state == 103)
        printf("Input string is a valid unary operator\n");
    else if (state == 102 || state == 105 || state == 108 || state == 110 || state == 112)
        printf("Input string is a valid arithmetic operator\n");
    else if (state == 119)
        printf("Input string is a valid relational operator\n");
    else if (state == 101 || state == 104 || state == 107 || state == 109 || state == 111 || state == 120)
        printf("Input string is a valid assignment operator\n");
    else
        printf("Invalid input\n");

    return 0;
}
```

Output:



```
Enter input string to check in the automata: ++
Input string is a valid unary operator
```

c) Write a program to recognize the valid number.

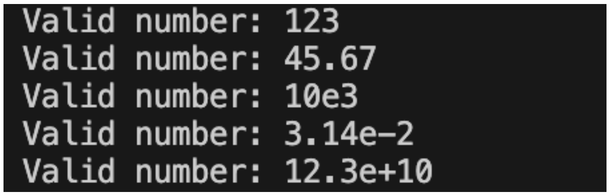
Code:

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

```
#include <ctype.h>

#include <string.h>


int main() {

    FILE *file;

    char filename[] = "number.txt";

    char ch;

    int state = 0;

    int valid_found = 0;

    char word[100];

    int index = 0;


    file = fopen(filename, "r");

    if (file == NULL) {

        perror("Error opening file");

        return 1;

    }


    while ((ch = fgetc(file)) != EOF) {

        switch (state) {

            case 0:

                if (isdigit(ch)) {

                    word[index++] = ch;

                    state = 1;

                } else if (ch == ' ' || ch == '\n' || ch == '\t') {

                    // ignore whitespace

                } else {

                    index = 0;

                    state = 0;

                }
                break;

            case 1:
                if (isdigit(ch)) {
                    word[index++] = ch;
                    state = 1;
                } else if (ch == '.') {
                    word[index++] = ch;
                    state = 2;
                } else if (ch == 'E' || ch == 'e') {
                    word[index++] = ch;
                    state = 4;
                } else {
                    word[index] = '\0';
                    printf("Valid number: %s\n", word);
                    valid_found = 1;
                    index = 0;
                    state = 0;
                    ungetc(ch, file); // put back the extra character
                }
                break;

            case 2:
                if (isdigit(ch)) {
                    word[index++] = ch;
                    state = 3;
                } else {
                    index = 0;
                    state = 0;
                }
                break;

            case 3:
                if (isdigit(ch)) {
                    word[index++] = ch;
                    state = 3;
                } else if (ch == 'E' || ch == 'e') {
                    word[index++] = ch;
                    state = 4;
                } else {
                    word[index] = '\0';
                    printf("Valid number: %s\n", word);
                    valid_found = 1;
                    index = 0;
                    state = 0;
                    ungetc(ch, file);
                }
                break;

            case 4:
                if (ch == '+' || ch == '-') {
                    word[index++] = ch;
                    state = 5;
                } else if (isdigit(ch)) {
                    word[index++] = ch;
                    state = 6;
                } else {
                    index = 0;
                    state = 0;
                }
```

```
            break;

        case 5:
            if (isdigit(ch)) {
                word[index++] = ch;
                state = 6;
            } else {
                index = 0;
                state = 0;
            }
            break;

        case 6:
            if (isdigit(ch)) {
                word[index++] = ch;
                state = 6;
            } else {
                word[index] = '\0';
                printf("Valid number: %s\n", word);
                valid_found = 1;
                index = 0;
                state = 0;
                ungetc(ch, file);
            }
            break;
    }
}

// Handle if file ends directly after a number
if ((state == 1 || state == 3 || state == 6) && index > 0) {
        word[index] = '\0';

        printf("Valid number: %s\n", word);

        valid_found = 1;

    }


    fclose(file);


    if (!valid_found) {

        printf("No valid number found.\n");

    }


    return 0;

}
```

Output:



```
Valid number: 123
Valid number: 45.67
Valid number: 10e3
Valid number: 3.14e-2
Valid number: 12.3e+10
```

d) Write a program to recognize the valid comments.

Code:

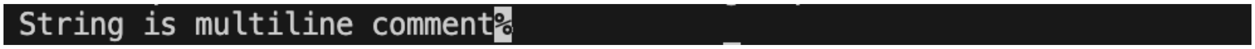
```
// Write a program to the comment in the code


#include<stdio.h>
```

```
int main() {
    FILE *file;
    char filename[] = "comment.txt";
    char ch;
    int state=0,i=0;

    file = fopen(filename, "r");

    if (file == NULL) {
        perror("Error opening file");
        return 1;
    }

    while ((ch = fgetc(file)) != EOF) {
      switch(state) {
            case 0:
                if(ch=='/') state=1;
                else state=2;
                break;
            case 1:
                if(ch=='/') state=3;
                else if (ch=='*')
                {
                    state=4;
                }

                else
                {
                    state=2;
                }
```

```
         break;
      case 2:
         state=2;
         break;
      case 3:
         state=3;
         break;
      case 4:
         if(ch=='*') state=5;
         else state=4;
         break;
      case 5:
         if(ch=='/') state=6;
         else state=4;
         break;
      case 6:
         state=2;
         break;


   }
   i++;
}

if(state == 1) printf("Input string is invalid");
else if(state == 2 || state == 0) printf("Input string is not any comment");
else if(state == 3) printf("String is single line comment");
else if(state == 4 || state==5) printf("String is not a valid comment");
else if(state == 6) printf("String is multiline comment");
```

```
return 0;
}
```

Output:



```
String is multiline comment%
```

e) **Program to implement Lexical Analyzer.**

Code:

```
// Program to implement Lexical Analyzer


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

#define BUFFER_SIZE 1000

void check(char *lexeme);

void main() {
   FILE *f1;
   char buffer[BUFFER_SIZE], lexeme[50];
   char c;
   int f = 0, state = 0, i = 0;

   f1 = fopen("input.txt", "r");
   if (!f1) {
      printf("Error opening file.\n");
      return;
```

```
}

int bytesRead = fread(buffer, sizeof(char), BUFFER_SIZE - 1, f1);
buffer[bytesRead] = '\0'; // Null terminate
fclose(f1);

while (buffer[f] != '\0') {
    switch (state) {
        case 0:
            c = buffer[f];

            if (isalpha(c) || c == '_') {
                state = 1;  // Identifier or Keyword
                lexeme[i++] = c;
            }
            else if (isdigit(c)) {
                state = 13;  // Number
                lexeme[i++] = c;
            }
            else if (c == '/') {
                state = 11;  // Potential comment
            }
            else if (c == ';' || c == ',' || c == '{' || c == '}' || c == '(' || c == ')') {
                printf(" %c is a symbol\n", c);
            }
            else if (strchr("+-*/=<>!&|", c)) {
                state = 20;  // Operator
                lexeme[i++] = c;
            }
            break;
```

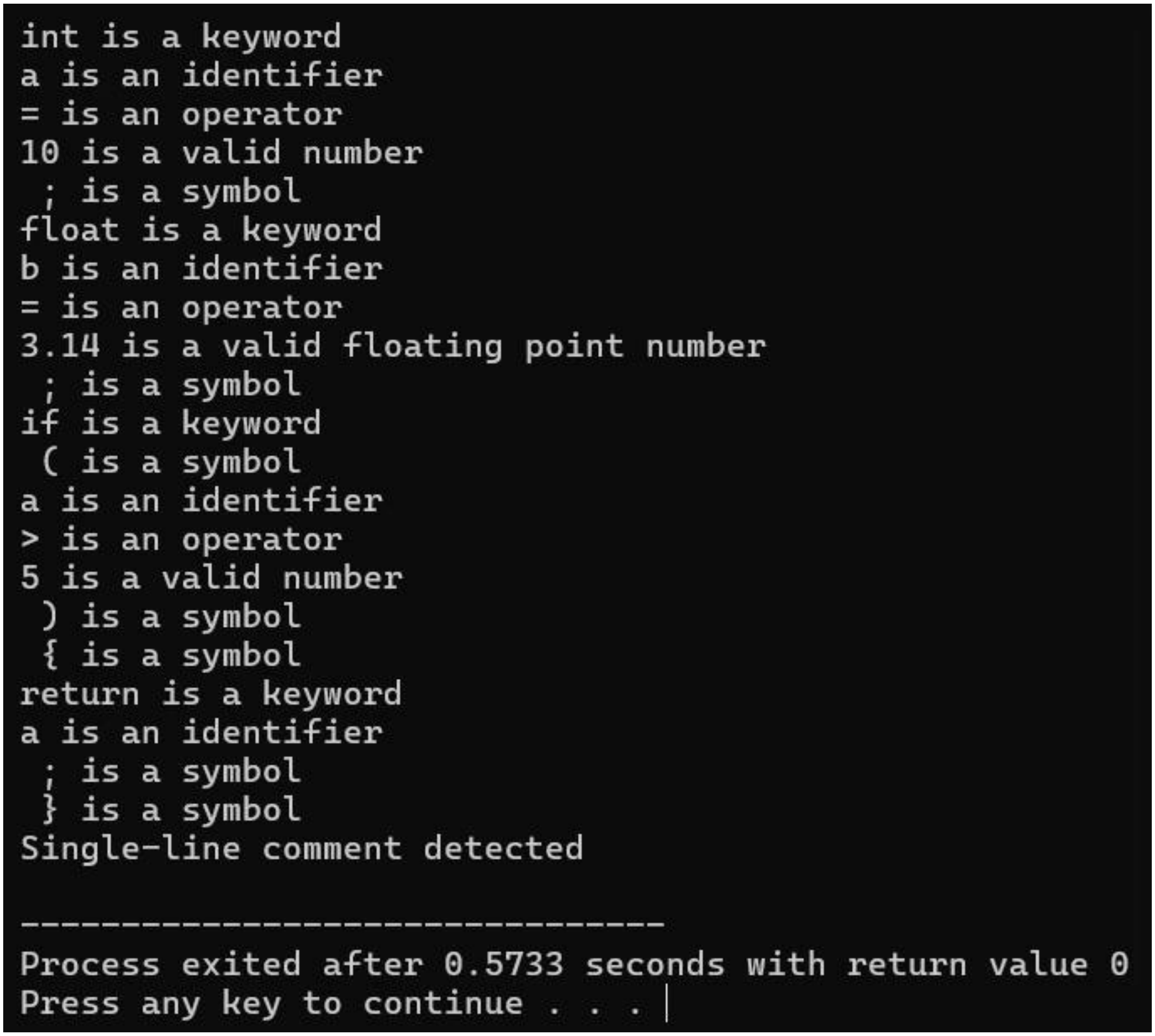
```
case 1:
  c = buffer[f];
  if (isalnum(c) || c == '_') {
    lexeme[i++] = c;
  } else {
    lexeme[i] = '\0';
    check(lexeme);
    i = 0;
    state = 0;
    f--;
  }
  break;

case 11:
  c = buffer[f];
  if (c == '/') {
    while (buffer[f] != '\n' && buffer[f] != '\0') f++;
    printf("Single-line comment detected\n");
  }
  else if (c == '*') {
    f++;
    while (buffer[f] != '\0' && !(buffer[f] == '*' && buffer[f + 1] == '/')) f++;
    f += 2;
    printf("Multi-line comment detected\n");
  }
  else {
    printf("/ is an operator\n");
    f--;
  }
```

```
    state = 0;
    break;

case 13:
    c = buffer[f];
    if (isdigit(c)) {
        lexeme[i++] = c;
    } else if (c == '.') {
        state = 14;
        lexeme[i++] = c;
    } else if (c == 'E' || c == 'e') {
        state = 16;
        lexeme[i++] = c;
    } else {
        lexeme[i] = '\0';
        printf("%s is a valid number\n", lexeme);
        i = 0;
        state = 0;
        f--;
    }
    break;

case 14:
    c = buffer[f];
    if (isdigit(c)) {
        lexeme[i++] = c;
    } else if (c == 'E' || c == 'e') {
        state = 16;
        lexeme[i++] = c;
    } else {
        lexeme[i] = '\0';
        printf("%s is a valid floating point number\n", lexeme);
        i = 0;
        state = 0;
        f--;
    }
    break;

case 16:
    c = buffer[f];
    if (isdigit(c) || c == '+' || c == '-') {
        state = 17;
        lexeme[i++] = c;
    } else {
        lexeme[i] = '\0';
        printf("%s is a valid number\n", lexeme);
        i = 0;
        state = 0;
        f--;
    }
    break;

case 17:
    c = buffer[f];
    if (isdigit(c)) {
        lexeme[i++] = c;
    } else {
        lexeme[i] = '\0';
        printf("%s is a valid scientific notation number\n", lexeme);
        i = 0;
```

```
                    state = 0;
                    f--;
                }
                break;

            case 20:
                c = buffer[f];
                if ((lexeme[0] == '=' && c == '=') ||
                    (lexeme[0] == '!' && c == '=') ||
                    (lexeme[0] == '>' && c == '=') ||
                    (lexeme[0] == '<' && c == '=') ||
                    (lexeme[0] == '&' && c == '&') ||
                    (lexeme[0] == '|' && c == '|')) {
                    lexeme[i++] = c;
                    lexeme[i] = '\0';
                    printf("%s is an operator\n", lexeme);
                    i = 0;
                    state = 0;
                } else {
                    lexeme[i] = '\0';
                    printf("%s is an operator\n", lexeme);
                    i = 0;
                    state = 0;
                    f--;
                }
                break;
        }
        f++;
    }
}
```

```
void check(char *lexeme) {
    char *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"
    };

    for (int i = 0; i < 32; i++) {
        if (strcmp(lexeme, keywords[i]) == 0) {
            printf("%s is a keyword\n", lexeme);
            return;
        }
    }
    printf("%s is an identifier\n", lexeme);
}
```

Output:



```
int is a keyword
a is an identifier
= is an operator
10 is a valid number
 ; is a symbol
float is a keyword
b is an identifier
= is an operator
3.14 is a valid floating point number
 ; is a symbol
if is a keyword
 ( is a symbol
a is an identifier
> is an operator
5 is a valid number
 ) is a symbol
 { is a symbol
return is a keyword
a is an identifier
 ; is a symbol
 } is a symbol
Single-line comment detected

--------------------------------
Process exited after 0.5733 seconds with return value 0
Press any key to continue . . .
```

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

A **Lexical Analyzer** (or scanner/tokenizer) is a part of a compiler that:

- Reads the input source code (text file)
- Breaks it into **tokens** (smallest meaningful units like keywords, identifiers, numbers, symbols, etc.)
- Removes white spaces and comments
- Sends tokens to the **parser** for syntax analysis

Strcture of Lex

```
%{
 // C declarations (optional)
%}


%%
// Rules section
pattern1    action1
pattern2    action2
%%
// Additional C code (optional)
```

How lex works:

- Write a `.l` file with patterns and actions.
- Run `lex file.l` – it creates a C file `lex.yy.c`.
- Compile with `gcc lex.yy.c -lfl` (link with LEX/FLEX library).
- Run the output program with your input.

Flex -Flex stands for Fast Lexical Analyzer.It is an improved, faster version of LEX.Works similarly to LEX but is more flexible and efficient.Compatible with LEX programs.

4

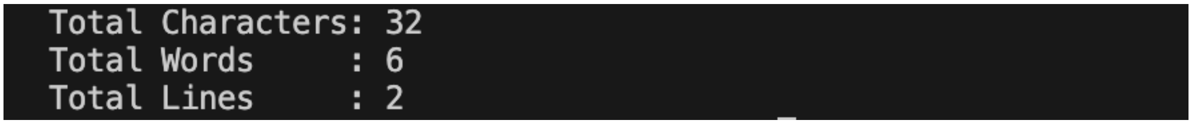
a. Write a Lex program to take input from text file and count no of characters, no. of lines & no. of words.

Code:

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


int char_count = 0;
int word_count = 0;
int line_count = 0;
%}


%%


[^\n\t ]+     { word_count++; char_count += yyleng; }  // Count words + their characters
[\n]         { line_count++; char_count++; }         // Count lines and newline characters
[ \t]        { char_count++; }                     // Count spaces and tabs
.            { char_count++; }                     // Count other characters (punctuation etc.)


%%


int yywrap() {
   return 1;
}


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

```
    yyin = file;   // Set input source for Lex
    yylex();       // Start scanning

    fclose(file);  // Close file after scanning

    // Print results
    printf("Total Characters: %d\n", char_count);
    printf("Total Words     : %d\n", word_count);
    printf("Total Lines     : %d\n", line_count);

    return 0;
}
```

Output:

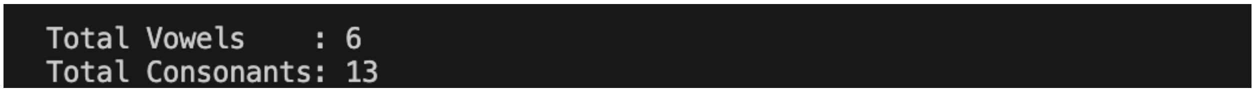


```
Total Characters: 32
Total Words     : 6
Total Lines     : 2
```

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

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

int countv = 0;
int countc = 0;
%}

%%
[aeiouAEIOU] { countv++; }
[bcdfghjklmnpqrstvwxyzBCDFGHJKLMNPQRSTVWXYZ] { countc++; }
. ; // Ignore all other characters
%%

int yywrap() {
  return 1;
}

int main() {
  FILE *file = fopen("input.txt", "r");
  if (!file) {
    printf("Could not open input.txt\n");
    return 1;
  }
  yyin = file;
  yylex();
  fclose(file);
  printf("Total Vowels    : %d\n", countv);
  printf("Total Consonants: %d\n", countc);
  return 0;
}
```

Output:



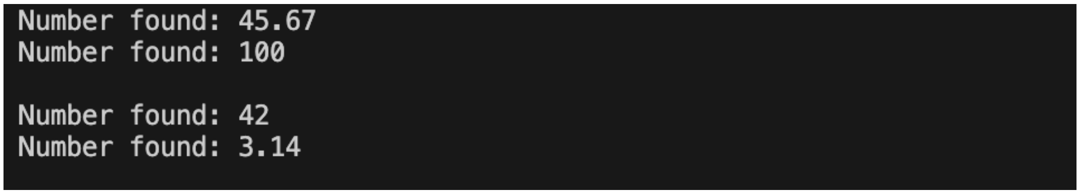
```
Total Vowels    : 6
Total Consonants: 13
```

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

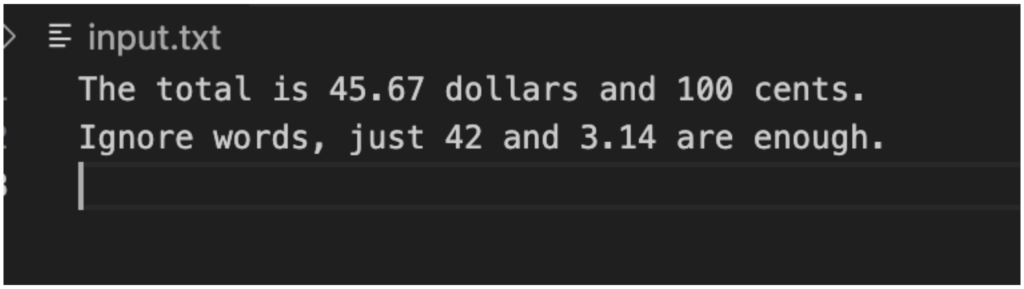
```
%{
#include <stdio.h>
%}
```

```
%%
[0-9]+(\.[0-9]+)?([eE][+-]?[0-9]+)?     { printf("Number found: %s\n", yytext); }

.                   ; // Ignore all other characters
%%

int yywrap() {
   return 1;
}

int main() {
   yyin = fopen("input.txt", "r");
   if (!yyin) {
      printf("Error opening input.txt\n");
      return 1;
   }

   yylex(); // Start scanning
   fclose(yyin);
   return 0;
}
```

Output:



```
Number found: 45.67
Number found: 100

Number found: 42
Number found: 3.14
```



```
The total is 45.67 dollars and 100 cents.
Ignore words, just 42 and 3.14 are enough.
```

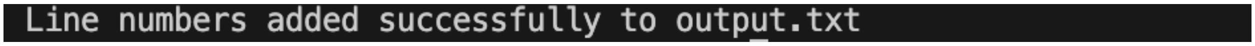
d. Write a Lex program that adds line numbers to the given file and displays the same into a different file.

Code:

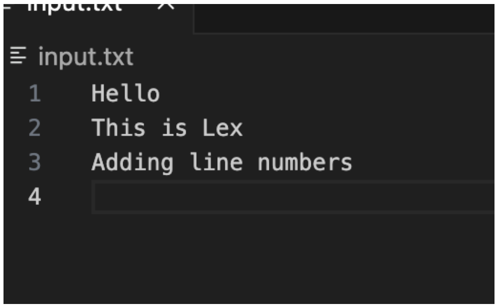
```
%{
```

```
#include <stdio.h>
int line_number = 1;
FILE *out;
%}

%%

^.*\n      {
               fprintf(out, "%d: %s", line_number++, yytext);
           }

.|\n       {
               // For any characters missed (like last line without newline)
               fprintf(out, "%d: %s\n", line_number++, yytext);
           }

%%

int yywrap() {
    return 1;
}

int main() {
    FILE *in = fopen("input.txt", "r");
    out = fopen("output.txt", "w");

    if (!in || !out) {
        printf("Error opening files!\n");
        return 1;
    }
    yyin = in;

    yylex();


    fclose(in);

    fclose(out);


    printf("Line numbers added successfully to output.txt\n");

    return 0;

}
```

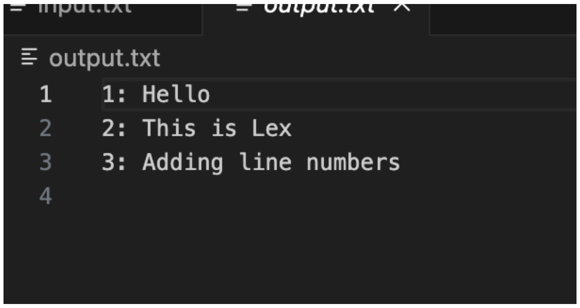
Output:



```
Line numbers added successfully to output.txt
```



```
input.txt
Hello
This is Lex
Adding line numbers

```

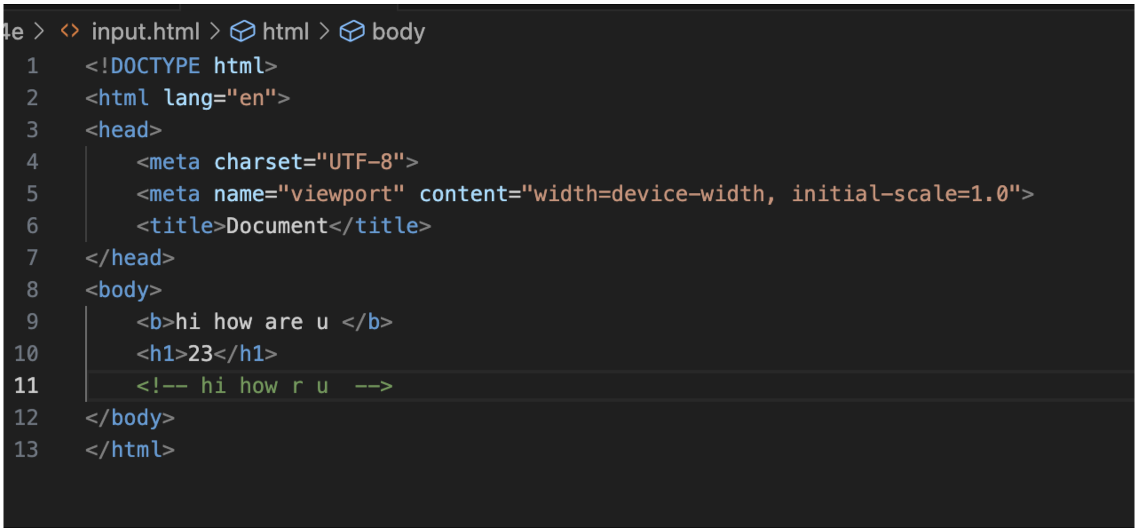


```
output.txt
1: Hello
2: This is Lex
3: Adding line numbers

```

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

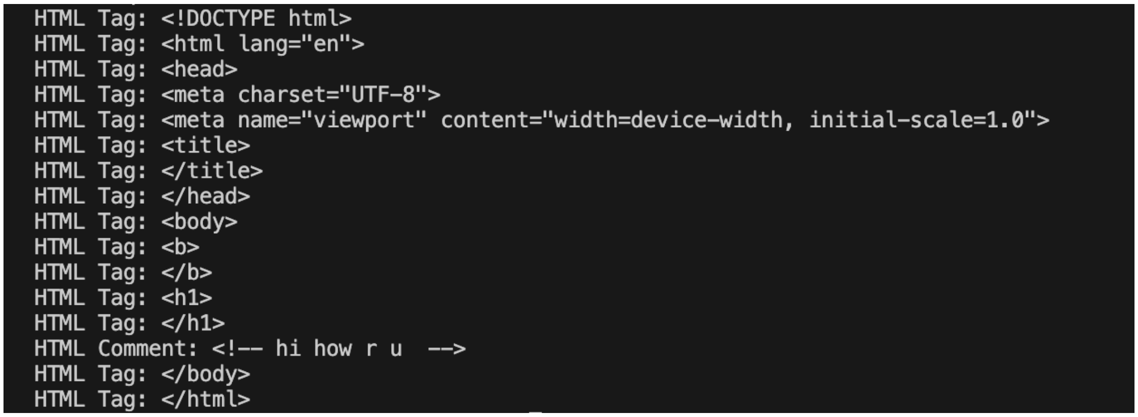
```
%{

#include <stdio.h>

%}
```

```
%%
"<!--"([^<]|"<"[^!]|"<!"[^\-]|"<!-"[^-])*"-->"    { printf("HTML Comment: %s\n", yytext); }

\<[^>]*\>                           { printf("HTML Tag: %s\n", yytext); }

.|\n                            ; // Ignore everything else
%%

int yywrap() {
    return 1;
}

int main() {
    yyin = fopen("input.html", "r");
    if (!yyin) {
        printf("Error opening input.html\n");
        return 1;
    }

    yylex();  // start scanning
    fclose(yyin);
    return 0;
}
```



```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Document</title>
</head>
<body>
    <b>hi how are u </b>
    <h1>23</h1>
    <!-- hi how r u  -->
</body>
</html>
```

Output:



```
HTML Tag: <!DOCTYPE html>
HTML Tag: <html lang="en">
HTML Tag: <head>
HTML Tag: <meta charset="UTF-8">
HTML Tag: <meta name="viewport" content="width=device-width, initial-scale=1.0">
HTML Tag: <title>
HTML Tag: </title>
HTML Tag: </head>
HTML Tag: <body>
HTML Tag: <b>
HTML Tag: </b>
HTML Tag: <h1>
HTML Tag: </h1>
HTML Comment: <!-- hi how r u  -->
HTML Tag: </body>
HTML Tag: </html>
```

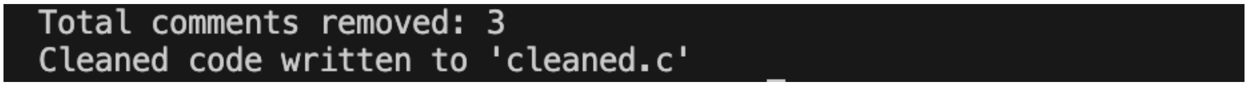
5.

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.

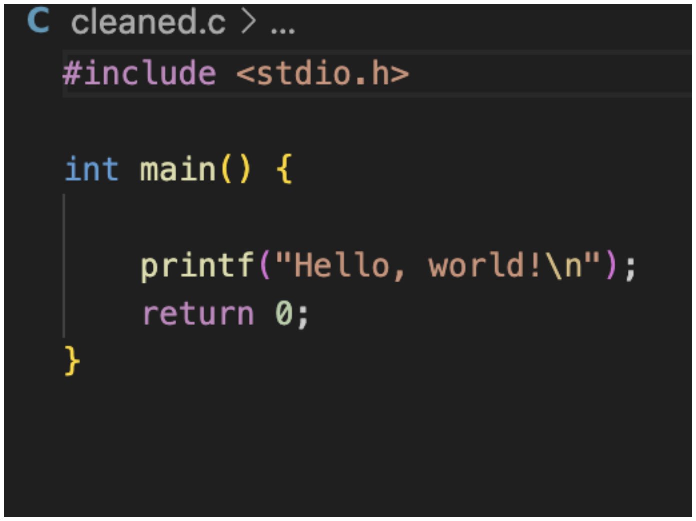
Code:

```
%{

#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); } // Copy other content


%%


int yywrap() {

   return 1;
}


int main() {
   FILE *in = fopen("source.c", "r");
   out = fopen("cleaned.c", "w");


   if (!in || !out) {
       printf("Error opening file(s)\n");
       return 1;
   }


   yyin = in;
   yylex();


   fclose(in);
   fclose(out);


   printf("Total comments removed: %d\n", comment_count);
   printf("Cleaned code written to 'cleaned.c'\n");
   return 0;
}
```

Output:



```
Total comments removed: 3
Cleaned code written to 'cleaned.c'
```



cleaned.c > ...

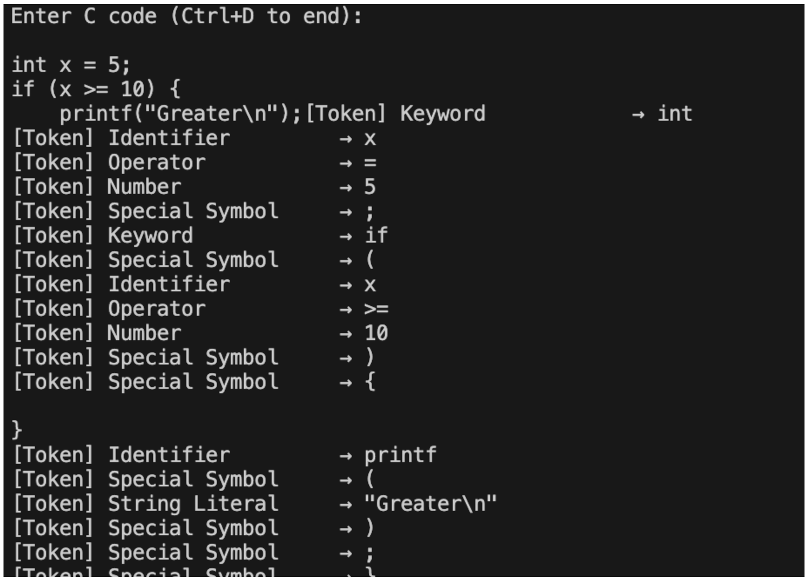
```c
#include <stdio.h>

int main() {

    printf("Hello, world!\n");
    return 0;
}
```

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

Code:

```
%{

#include <stdio.h>

#include <string.h>


// List of C keywords

char *keywords[] = {

   "auto","break","case","char","const","continue","default","do","double","else",

   "enum","extern","float","for","goto","if","int","long","register","return",

   "short","signed","sizeof","static","struct","switch","typedef","union",

   "unsigned","void","volatile","while"

};


int isKeyword(char *str) {
    for (int i = 0; i < sizeof(keywords)/sizeof(char*); i++) {
        if (strcmp(str, keywords[i]) == 0)
            return 1;
    }
    return 0;
}
%}

%option noyywrap

%%
[0-9]+(\.[0-9]+)?      { printf("[Token] %-18s → %s\n", "Number", yytext); }
[a-zA-Z_][a-zA-Z0-9_]* {
                        if (isKeyword(yytext))
                            printf("[Token] %-18s → %s\n", "Keyword", yytext);
                        else
                            printf("[Token] %-18s → %s\n", "Identifier", yytext);
                      }
"++"|"--"|"+"|"-"|"=="|"="|"<="|">="|"!="|"&&"|"||"|"*"|"/"|"%"  { printf("[Token] %-18s → %s\n",
"Operator", yytext); }
[\[\]\{\}\(\),;\.:]    { printf("[Token] %-18s → %s\n", "Special Symbol", yytext); }
\'([^\\\n]|(\\.))\'    { printf("[Token] %-18s → %s\n", "Char Literal", yytext); }
\"([^\\\n]|(\\.))*\"   { printf("[Token] %-18s → %s\n", "String Literal", yytext); }
[ \t\n]+              ;  // Skip whitespace
.                     { printf("[Token] %-18s → %s\n", "Unknown", yytext); }
%%

int main() {
    printf("Enter C code (Ctrl+D to end):\n\n");
    yylex();
    return 0;

}
```

Output:



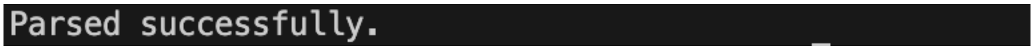
```
Enter C code (Ctrl+D to end):

int x = 5;
if (x >= 10) {
    printf("Greater\n");[Token] Keyword            → int
[Token] Identifier         → x
[Token] Operator           → =
[Token] Number             → 5
[Token] Special Symbol     → ;
[Token] Keyword            → if
[Token] Special Symbol     → (
[Token] Identifier         → x
[Token] Operator           → >=
[Token] Number             → 10
[Token] Special Symbol     → )
[Token] Special Symbol     → {

}
[Token] Identifier         → printf
[Token] Special Symbol     → (
[Token] String Literal     → "Greater\n"
[Token] Special Symbol     → )
[Token] Special Symbol     → ;
[Token] Special Symbol     → }
```

6 Program to implement Recursive Descent Parsing in C.

Code:

```
#include <stdio.h>

#include <stdlib.h>

#include <string.h>


const char *input;

int pos = 0;


int match(char exp) {

    if (input[pos] == exp) {

        pos++;

        return 1;

    } else {

        printf("Syntax Error: Expected '%c' at position %d\n", exp, pos);
        exit(1);
    }
}

// Forward declarations
int E();
int E_p();
int T();
int T_p();
int F();

int E() {
    T();
    return E_p();
}

int E_p() {
    if (input[pos] == '+') {
        match('+');
        T();
        return E_p();
    } else if (input[pos] == '-') {
        match('-');
        T();
        return E_p();
    }
    return 1; // epsilon
}
int T() {
    F();
    return T_p();
}
int T_p() {
    if (input[pos] == '*') {
        match('*');
        F();
        return T_p();
    } else if (input[pos] == '/') {
        match('/');
        F();
        return T_p();
    }
    return 1; // epsilon
}

int F() {
    if (input[pos] == 'i') {
        match('i');
        return 1;
    } else {
        printf("Syntax Error: Expected 'i' at position %d\n", pos);
        exit(1);
    }
}
int parse() {
    E();
    if (input[pos] == '\0') {
        printf("Parsed successfully.\n");
        return 1;
    } else {
        printf("Syntax Error: Unexpected characters at position %d\n", pos);
        exit(1);
    }
}
int main() {
    input = "i+i*i-i/i";
    parse();
    return 0;
}
```

Output:



```
Parsed successfully.
```

7.

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

YACC stands for **Yet Another Compiler-Compiler**.
It is a **tool used to generate parsers**, especially **LALR(1)** parsers, for interpreting structured input (like programming languages).

It works alongside **Lex**, which handles **lexical analysis** (tokenizing), while YACC does **syntax analysis** (parsing based on grammar).

YACC helps:

- Convert high-level grammar into a parser automatically.
- Enforce the **syntax rules** of a programming language.
- Act as the middle step in building **interpreters or compilers**.

YACC takes:

- **Tokens** from a lexical analyzer (like Flex/Lex).

- **Grammar rules** written in a BNF-like format.
- **Action code** (usually in C) to execute when rules match.

It outputs:

- A `y.tab.c` file (C code of the parser).
- This parser calls `yylex()` (defined by Lex) to get tokens and applies grammar rules to parse them.

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

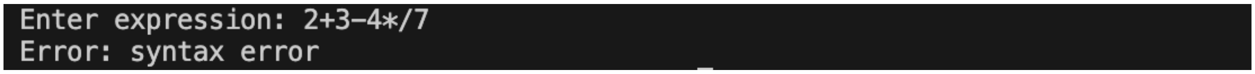
Lex file :

```
%{
#include "sample.tab.h"   // This header is auto-generated by Bison and includes token definitions like NUM
%}

%%
[0-9]+      { yylval = atoi(yytext); return NUM; }
[ \t]       ;
[-+*/()\n]  return yytext[0];
.           { printf("Invalid character: %s\n", yytext); }
%%

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

Yacc file:

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

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

%token NUM

%%

S:
    E '\n'  { printf("Valid expression\n"); return 0; }
;

E: E '+' T
  | E '-' T
  | T
;

T:
    T '*' F
  | T '/' F
  | F
;

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

%%

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

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

output:



```
Enter expression: 2+3-4*/7
Error: syntax error
```

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

Code:

Flex file

```
%{

#include "calc.tab.h"

%}


%%


[0-9]+      { yylval = atoi(yytext); return NUM; }

[ \t]       ; // Ignore spaces and tabs

[-+*/()\n]  return yytext[0];

.           { printf("Invalid character: %s\n", yytext); }


%%
```

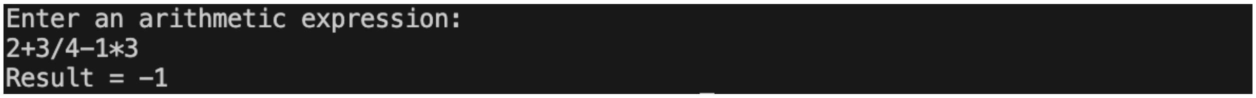
```
int yywrap() {
    return 1;
}
```

Bison file

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

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

%token NUM

%%
S : E '\n'        { printf("Result = %d\n", $1); return 0; }
  ;

E : E '+' T       { $$ = $1 + $3; }
  | E '-' T       { $$ = $1 - $3; }
  | T             { $$ = $1; }
  ;

T : T '*' F       { $$ = $1 * $3; }
  | T '/' F       {
             if ($3 == 0) {
               yyerror("Division by zero");
               exit(1);
             }
```

```
                $$ = $1 / $3;
              }
  | F          { $$ = $1; }
  ;

F : NUM          { $$ = $1; }
  | '(' E ')'     { $$ = $2; }
  ;
%%

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

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

Output:



```
Enter an arithmetic expression:
2+3/4-1*3
Result = -1
```

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

Code:

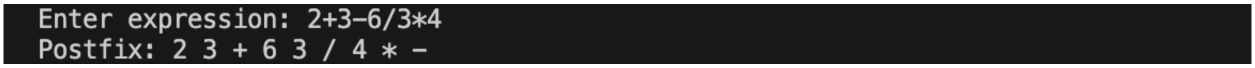
Flex file

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


%%
[0-9]+      { yylval.intval = atoi(yytext); return NUMBER; }
[ \t]       ; /* skip whitespace */
\n          return '\n';
[-+*/%()]   return yytext[0];
.           { printf("Invalid character"); return 0; }
%%


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

Bison file

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

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

char postfix[1024];
%}

%union {
    int intval;
}

%token <intval> NUMBER

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

%type <intval> expr term factor

%%
input:
    | input expr '\n' { printf("Postfix: %s\n", postfix); postfix[0] = '\0'; }
    ;

expr:
    term           { $$ = $1; }
    | expr '+' term   { strcat(postfix, "+ "); }
    | expr '-' term   { strcat(postfix, "- "); }
    ;

term:
    factor         { $$ = $1; }
    | term '*' factor { strcat(postfix, "* "); }
    | term '/' factor { strcat(postfix, "/ "); }
    | term '%' factor { strcat(postfix, "% "); }
    ;

factor:
    NUMBER         { char num[20]; sprintf(num, "%d ", $1); strcat(postfix, num); $$ = $1; }
    | '(' expr ')'    { $$ = $2; }
    ;

%%

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

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

Output:



```
Enter expression: 2+3-6/3*4
Postfix: 2 3 + 6 3 / 4 * -
```