Practical 1

- **Write a C program to remove all the comments from the program.**

```
#include <stdio.h>

int main() {
    FILE *inputFile, *outputFile;
    char inputFile_name[100], outputFile_name[100];
    char c, next;

    printf("Enter the name of the input file: ");
    scanf("%s", inputFile_name);

    printf("Enter the name of the output file: ");
    scanf("%s", outputFile_name);

    inputFile = fopen(inputFile_name, "r");
    if (inputFile == NULL) {
        printf("Unable to open input file.\n");
        return 1;
    }

    outputFile = fopen(outputFile_name, "w");
    if (outputFile == NULL) {
        printf("Unable to open output file.\n");
        fclose(inputFile);
        return 1;
    }

    int insideComment = 0;

    while ((c = fgetc(inputFile)) != EOF) {
        if (insideComment) {
            if (c == '*' && (next = fgetc(inputFile)) == '/') {
                insideComment = 0;
            }
        } else {
            if (c == '/') {
                next = fgetc(inputFile);
                if (next == '/') {
                    // Single-line comment, skip until the end of the line
```

```
                while ((c = fgetc(inputFile)) != '\n' && c != EOF) {
                    continue;
                }
            } else if (next == '*') {
                // Multi-line comment, set insideComment flag
                insideComment = 1;
            } else {
                // Not a comment, write '/' and the next character
                fputc(c, outputFile);
                fputc(next, outputFile);
            }
        } else {
            // Not a comment, write the character
            fputc(c, outputFile);
        }
    }
}

fclose(inputFile);
fclose(outputFile);

printf("Comments removed successfully.\n");

return 0;
}
```

Output:

```
PS E:\Codes\CD\Practical 1> gcc -o prac_1 prac_1.c
PS E:\Codes\CD\Practical 1> ./prac_1
Enter the name of the input file: example.txt
Enter the name of the output file: example_1.txt
Comments removed successfully.
```

example.txt

```
1  Hi
2  I am Anant
3  /* Comment 1 */
4  // Comment 2
```

example_1.txt

```
1  Hi
2  I am Anant
3
4
```

- **Write a C program to recognize identifiers and numbers.**

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

bool isIdentifierChar(char ch) {
    return isalnum(ch) || ch == '_';
}

bool isIdentifier(const char *str) {
    if (!isalpha(str[0]) && str[0] != '_')
        return false;

    for (int i = 1; i < strlen(str); i++) {
        if (!isIdentifierChar(str[i]))
            return false;
    }

    return true;
}

bool isNumber(const char *str) {
    int len = strlen(str);
    bool hasDecimal = false;

    for (int i = 0; i < len; i++) {
        if (i == 0 && (str[i] == '-' || str[i] == '+')) {
            continue;
        } else if (isdigit(str[i])) {
            continue;
        } else if (str[i] == '.') {
            if (hasDecimal)
                return false;
            hasDecimal = true;
        } else {
            return false;
        }
    }

    return hasDecimal || len > 1;
}
```

```
int main() {
    char input[100];

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

    if (isIdentifier(input)) {
        printf("%s is a valid identifier.\n", input);
    } else if (isNumber(input)) {
        printf("%s is a valid number.\n", input);
    } else {
        printf("%s is neither a valid identifier nor a valid number.\n", input);
    }

    return 0;
}
```

Output:

```
PS E:\Codes\CD\Practical 1> gcc -o prac1_2 prac1_2.c
PS E:\Codes\CD\Practical 1> ./prac1_2
Enter an identifier or a number: myVar
myVar is a valid identifier.
PS E:\Codes\CD\Practical 1> ./prac1_2
Enter an identifier or a number: 42
42 is a valid number.
PS E:\Codes\CD\Practical 1> ./prac1_2
Enter an identifier or a number: 123abc
123abc is neither a valid identifier nor a valid number.
PS E:\Codes\CD\Practical 1>
```

Practical 2

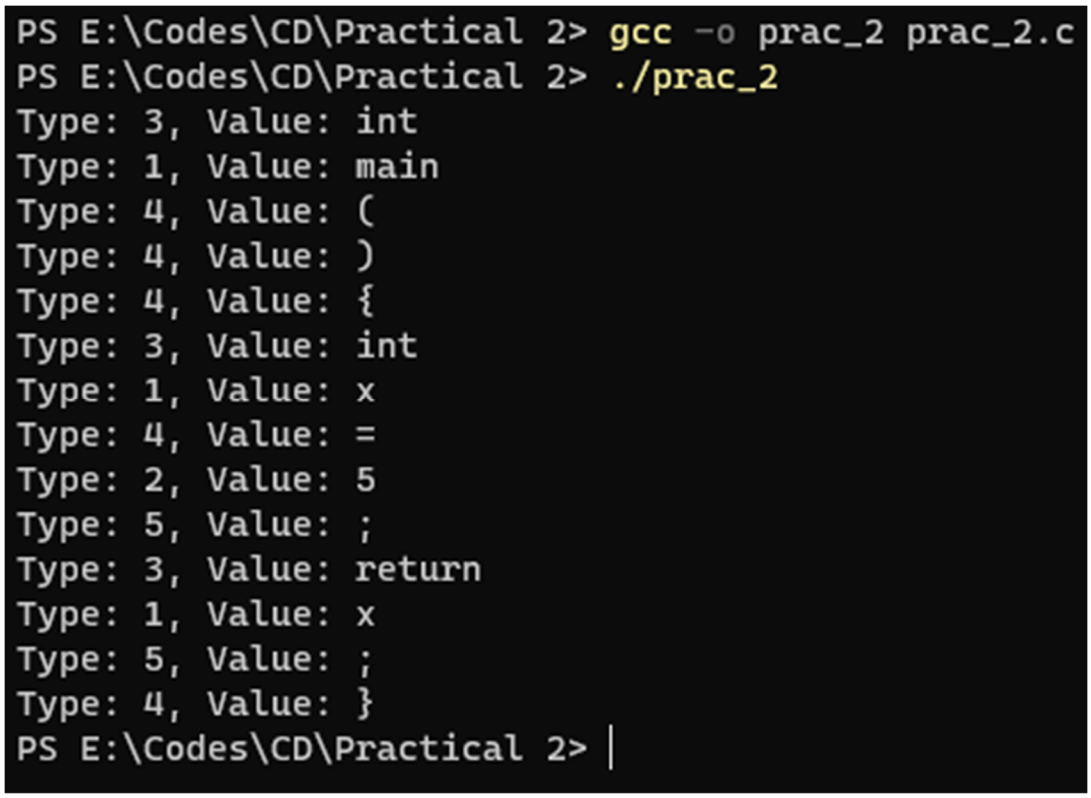
- **Write a C program to generate tokens for a C program.**

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

typedef enum {
    TOKEN_UNKNOWN,
    TOKEN_IDENTIFIER,
    TOKEN_NUMBER,
    TOKEN_KEYWORD,
    TOKEN_OPERATOR,
    TOKEN_SEPARATOR,
} TokenType;

typedef struct {
    TokenType type;
    char value[100]; // Assuming a maximum token length of 100 characters
} Token;

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

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

    return 0;
}

void tokenizeCProgram(const char *program) {
    int programLength = strlen(program);
    int currentIndex = 0;

    while (currentIndex < programLength) {
        Token token;
```

```
    token.type = TOKEN_UNKNOWN;
    memset(token.value, 0, sizeof(token.value));

    while (isspace(program[currentIndex])) {
        currentIndex++;
    }

    if (isalpha(program[currentIndex]) || program[currentIndex] == '_') {
        int tokenLength = 0;
        while (isalnum(program[currentIndex]) || program[currentIndex] == '_') {
            token.value[tokenLength++] = program[currentIndex++];
        }

        token.value[tokenLength] = '\0';

        if (isKeyword(token.value)) {
            token.type = TOKEN_KEYWORD;
        } else {
            token.type = TOKEN_IDENTIFIER;
        }
    }

    else if (isdigit(program[currentIndex]) || program[currentIndex] == '-' ||
program[currentIndex] == '+') {
        int tokenLength = 0;
        while (isdigit(program[currentIndex]) || program[currentIndex] == '.' ||
program[currentIndex] == 'e' || program[currentIndex] == 'E' ||
program[currentIndex] == '-' || program[currentIndex] == '+') {
            token.value[tokenLength++] = program[currentIndex++];
        }

        token.value[tokenLength] = '\0';
        token.type = TOKEN_NUMBER;
    }

    else {
        token.value[0] = program[currentIndex++];
        token.value[1] = '\0';

        if (strchr("+-*/%=&|<>!(){}", token.value[0]) != NULL) {
            token.type = TOKEN_OPERATOR;
        } else {
            token.type = TOKEN_SEPARATOR;
        }
```

```
        }

        printf("Type: %d, Value: %s\n", token.type, token.value);
    }
}

int main() {
    const char *cProgram = "int main() { int x = 5; return x; }";

    tokenizeCProgram(cProgram);

    return 0;
}
```

Output:



Practical 3

- **To Study about Lexical Analyzer Generator (LEX).**

  Lexical Analyzer Generator, often referred to as Lex, is a tool for generating lexical analyzers, which are an essential component of a compiler or interpreter. Lex helps convert a source code text into a stream of tokens for further processing by a parser. Lex is typically used in combination with another tool called Yacc (Yet Another Compiler Compiler) for creating the complete front end of a compiler.
  Here are the key concepts and steps to understand Lex and its role in compiler construction:

  1. **Lexical Analysis (Scanning):** Lexical analysis is the first phase of the compiler, where the source code is read character by character and converted into a stream of tokens. Tokens are the smallest units of meaning in a programming language, such as keywords, identifiers, constants, and operators. Lex helps automate the process of recognizing and categorizing tokens.
  2. **Regular Expressions:** Lex uses regular expressions to describe the patterns of tokens in the source code. Regular expressions are a powerful way to define matching patterns for strings. Lex allows you to define regular expressions that correspond to the tokens you want to recognize.
  3. **Lexical Rules:** In Lex, you write a set of rules that consist of regular expressions and associated actions. These rules specify how to recognize tokens and what to do when a match is found. When Lex reads the input source code, it applies these rules to find the longest possible match for each token.
  4. **Token Actions:** For each rule, you can specify an action to be performed when a token is recognized. These actions can include updating symbol tables, generating code, or simply recording information about the token.
  5. **Lexical Analyzer Generation:** Once you have defined your lexical rules in a Lex program, you run Lex to generate a C source code file for the lexical analyzer. Lex produces a C program that can scan the input source code and produce tokens based on your rules.
  6. **Integration with Yacc:** Lexical analyzers generated by Lex are often used in conjunction with parsers generated by Yacc (or Bison). Yacc is responsible for parsing the syntax and structure of the source code, while Lex handles the recognition of individual tokens.
  7. **Compilation:** After generating the lexical analyzer using Lex, you compile the resulting C code along with the parser generated by Yacc to create the complete compiler or interpreter.

- **Create 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 charCount = 0;
int lineCount = 0;
int wordCount = 0;
%}

%%
[a-zA-Z]+   { wordCount++; }
\n          { lineCount++; charCount++; }
.           { charCount++; }
%%

int main() {
    yylex();
    printf("Character count: %d\n", charCount);
    printf("Line count: %d\n", lineCount);
    printf("Word count: %d\n", wordCount);
    return 0;
}
```

  Output:

```
E:\Codes\CD\Practical 3>flex prac_3.l

E:\Codes\CD\Practical 3>gcc -o prac_3 lex.yy.c

E:\Codes\CD\Practical 3>prac_3.exe < example.txt
Character count: 13
Line count: 2
Word count: 14
```

Practical 4

- **WAP to implement yytext method in a LEX program.**

Lex Code:

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

%%
[a-zA-Z]+   { printf("Word: %s\n", yytext); }
[0-9]+      { printf("Number: %s\n", yytext); }
.           { /* Ignore other characters */ }
%%

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

Output:

```
E:\Codes\CD\Practical 4>prac_4.exe < example.txt
Word: Hi
Word: I
Word: am
Word: Anant
Word: Patel

Word: I
Word: study
Word: in
Word: ADIT

Word: I
Word: am
Word: currently
Word: in
Word: last
Word: year
```

- **WAP to implement ECHO, REJECT functions provided in Lex.**

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

%%
[a-zA-Z]+   {
              printf("Word: %s\n", yytext);
              ECHO;
            }

[0-9]+      {
              printf("Number: %s\n", yytext);
              REJECT;
            }

.           { ECHO; }
%%

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

Output:

```
E:\Codes\CD\Practical 4>flex prac_4b.l

E:\Codes\CD\Practical 4>gcc -o prac_4b lex.yy.c

E:\Codes\CD\Practical 4>prac_4b.exe < example.txt
Word: Hi
Hi Word: I
I Word: am
am Word: Anant
Anant Word: Patel
Patel
Word: I
I Word: study
study Word: in
in Word: ADIT
ADIT
Word: I
I Word: am
am Word: currently
currently Word: in
in Word: last
last Word: year
year
```

- **WAP to implement BEGIN directive in a LEX program.**

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

%option noyywrap

%x STATE1
%x STATE2

%%
"BEGIN1"    { BEGIN STATE1; }
"BEGIN2"    { BEGIN STATE2; }
<STATE1>.   { printf("In State 1: %s\n", yytext); }
<STATE2>.   { printf("In State 2: %s\n", yytext); }
.           { printf("Default State: %s\n", yytext); }
\n          { /* ignore newlines */ }

%%

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

Output:

```
E:\Codes\CD\Practical 4>flex prac_4c.l

E:\Codes\CD\Practical 4>gcc -o prac_4c lex.yy.c

E:\Codes\CD\Practical 4>prac_4c < example.txt
Default State: H
Default State: i
Default State:
Default State: I
Default State:
Default State: a
Default State: m
Default State:
Default State: A
Default State: n
Default State: a
Default State: n
Default State: t
Default State:
Default State: P
Default State: a
Default State: t
Default State: e
Default State: l
```

Practical 5

- **Write a Lex program to count number of vowels and consonants in a given input string.**

```
%{
#include <stdio.h>
int vowelCount = 0;
int consonantCount = 0;
%}

%%
[aAeEiIoOuU]   { vowelCount++; }
[a-zA-Z]       { consonantCount++; }
.           { /* Ignore other characters */ }
%%

int main() {
    yylex();
    printf("Vowel count: %d\n", vowelCount);
    printf("Consonant count: %d\n", consonantCount);
    return 0;
}
```

Output:

```
E:\Codes\CD\Practical 5>flex prac_5.l

E:\Codes\CD\Practical 5>gcc -o prac_5 lex.yy.c

E:\Codes\CD\Practical 5>prac_5.exe < example.txt


Vowel count: 20
Consonant count: 29
```

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

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

%%
[0-9]+       { printf("Number: %s\n", yytext); }
.            { /* Ignore other characters */ }
%%

int main(int argc, char* argv[]) {
    if (argc != 2) {
        printf("Usage: %s <input_file>\n", argv[0]);
        return 1;
    }

    FILE* inputFile = fopen(argv[1], "r");
    if (!inputFile) {
        printf("Unable to open input file.\n");
        return 1;
    }

    yyin = inputFile; // Set Lex input to the provided file
    yylex(); // Start Lexical Analysis
    fclose(inputFile);
    return 0;
}
```

Output:

```
E:\Codes\CD\Practical 5>flex prac_5b.l

E:\Codes\CD\Practical 5>gcc -o prac_5b lex.yy.c

E:\Codes\CD\Practical 5>prac_5b number.txt
Number: 1

Number: 2

Number: 3

Number: 4

Number: 5
```

- **Write a Lex program to count the number of comment lines in a given C program.**

```
%{
#include<stdio.h>
#include<stdlib.h>
int a=0,b=0,c=0,d;
%}
%option noyywrap
%x COMMENT
%%
"//".*   {a++;}
"/*"     { BEGIN COMMENT; }
<COMMENT>"*/" {c++; BEGIN INITIAL; }
<COMMENT>.    ;
%%
void main(int argc,char *argv[]){
   yyin=fopen(argv[1],"r");
   yylex();
   printf("single line %d \nmultiline %d \n",a,c);
   d=a+c;
   printf("total %d \n",d);
}
```

Output:

```
E:\Codes\CD\Practical 5>flex prac_5c.l

E:\Codes\CD\Practical 5>gcc -o prac_5c lex.yy.c

E:\Codes\CD\Practical 5>prac_5c < example.c
#include<stdio.h>
int main(){

    int a = 0;
    printf(&a);



    return 0;
}single line 1
multiline 1
total 2
```

Practical 6

- **WAP to implement unput and input.**

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

%%
[a-zA-Z]+   {
            printf("Word: %s\n", yytext);
            unput(' '); // Push a space back into the input stream
          }

.         {
            char c = input(); // Get the next character from the input stream
            if (c != EOF) {
                printf("Character: %c\n", c);
            }
          }
%%

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

Output:

```
E:\Codes\CD\Practical 6>flex prac_6.l

E:\Codes\CD\Practical 6>gcc -o prac_6 lex.yy.c

E:\Codes\CD\Practical 6>prac_6.exe < example.txt
Word: Hi
Character:
Word: I
Character:
Word: am
Character:
Word: Anant
Character:
Word: Patel
Character:
```

- **WAP to implement yyterminate, yy_flush_bufferin LEX program.**

```
%{
#include <stdio.h>
%}
%option noyywrap
%%
"exit"      { printf("Terminating lexer\n"); yyterminate(); }
.           { printf("Unhandled character: %c\n", yytext[0]); }
%%

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

Output:

```
E:\Codes\CD\Practical 6>flex prac_6b.l

E:\Codes\CD\Practical 6>gcc -o prac_6b lex.yy.c

E:\Codes\CD\Practical 6>prac_6b
Hello
Unhandled character: H
Unhandled character: e
Unhandled character: l
Unhandled character: l
Unhandled character: o

exit
Terminating lexer
```

- **WAP to implement yywrap in LEX program.**

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

%%
[a-zA-Z]+   { printf("Word: %s\n", yytext); }
.           { /* Ignore other characters */ }
%%

int yywrap() {
    // Custom logic to switch to a new input source or terminate the lexer
    return 1; // Returning 1 indicates that there are no more input sources
}

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

Output:

```
E:\Codes\CD\Practical 6>flex prac_6c.l

E:\Codes\CD\Practical 6>gcc -o prac_6c lex.yy.c

E:\Codes\CD\Practical 6>prac_6c < example.txt
Word: Hi
Word: I
Word: am
Word: Anant

Word: Know
Word: more
Word: about
Word: me
```

- **WAP to implement yymore and yyless in LEX program.**

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

%%
[a-zA-Z]+   {
              printf("Original Token: %s\n", yytext);
              yymore();  // Append text to the current token
              printf("Appended Token: %s\n", yytext);
            }
[0-9]+      {
              printf("Original Token: %s\n", yytext);
              yyless(2); // Shorten the current token by 2 characters
              printf("Shortened Token: %s\n", yytext);
            }
.           { /* Ignore other characters */ }
%%

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

Output:

```
E:\Codes\CD\Practical 6>flex prac_6d.l

E:\Codes\CD\Practical 6>gcc -o prac_6d lex.yy.c

E:\Codes\CD\Practical 6>prac_6d.exe < example.txt
Original Token: Hi
Appended Token: Hi
Original Token: I
Appended Token: I
Original Token: am
Appended Token: am
Original Token: Anant
Appended Token: Anant
Anant
Original Token: Know
Appended Token: Know
Original Token: more
Appended Token: more
Original Token: about
Appended Token: about
Original Token: me
Appended Token: me
```

Practical 7

- **WAP to find the “First” set**
  Input: The string consists of grammar symbols.
  Output: The First set for a given string.
  Explanation: The student has to assume a typical grammar. The program when run will ask for the string to be entered. The program will find the First set of the given string.

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

typedef struct {
  char symbol;
  char* first_set;
} FirstSet;

FirstSet* find_first_set(char* string) {
  FirstSet* first_sets = malloc(sizeof(FirstSet) * strlen(string));
  for (int i = 0; i < strlen(string); i++) {
    first_sets[i].symbol = string[i];
    first_sets[i].first_set = NULL;
  }

  // Recursively calculate the First set for each symbol.
  for (int i = 0; i < strlen(string); i++) {
    if (string[i] == 'S' || string[i] == 'A' || string[i] == 'B') {
      first_sets[i].first_set = malloc(sizeof(char) * 2);
      first_sets[i].first_set[0] = string[i];
      first_sets[i].first_set[1] = '\0'; // Null-terminate the string.
    } else if (string[i] == 'C') {
      first_sets[i].first_set = malloc(sizeof(char) * 3);
      strcpy(first_sets[i].first_set, "ab");
    }
  }

  return first_sets;
}

int main() {
  char string[] = "SABC";
```

```
  // Find the First set of the string.
  FirstSet* first_sets = find_first_set(string);

  // Print the First set.
  for (int i = 0; i < strlen(string); i++) {
    printf("%c: %s\n", first_sets[i].symbol, first_sets[i].first_set);
  }

  // Free the memory allocated for the First set.
  for (int i = 0; i < strlen(string); i++) {
    free(first_sets[i].first_set);
  }
  free(first_sets);

  return 0;
}
```

Output:

```
E:\Codes\CD\Practical 7>gcc -o prac_7 prac_7.c

E:\Codes\CD\Practical 7>prac_7.exe
S: S
A: A
B: B
C: ab
```

Practical 8

- **WAP to find the "Follow" set.**
  Input: The string consists of grammar symbols.
  Output: The Follow set for a given string.
  Explanation: The student has to assume a typical grammar. The program when run will ask for the string to be entered. The program will find the Follow set of the given string.

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

#define MAX_RULES 100
#define MAX_SYMBOLS 10

typedef struct {
    char symbols[MAX_SYMBOLS];
    int count;
} SymbolSet;

typedef struct {
    char nonTerminal;
    char production[MAX_SYMBOLS];
} ProductionRule;

bool isTerminal(char symbol) {
    return !(symbol >= 'A' && symbol <= 'Z');
}

bool isNonTerminal(char symbol) {
    return (symbol >= 'A' && symbol <= 'Z');
}

void addToSet(SymbolSet *set, char symbol) {
    if (set->count < MAX_SYMBOLS) {
        set->symbols[set->count++] = symbol;
    }
}

bool addToSetUnique(SymbolSet *set, char symbol) {
    for (int i = 0; i < set->count; i++) {
```

```
        if (set->symbols[i] == symbol) {
            return false; // Symbol is already in the set
        }
    }
    addToSet(set, symbol);
    return true;
}

bool containsEpsilon(char production[MAX_SYMBOLS], int len) {
    for (int i = 0; i < len; i++) {
        if (production[i] != 'e') {
            return false;
        }
    }
    return true;
}

void calculateFollow(ProductionRule rules[MAX_RULES], int numRules, char
startSymbol, char symbol, SymbolSet *followSet) {
    for (int i = 0; i < numRules; i++) {
        ProductionRule rule = rules[i];
        int len = strlen(rule.production);
        for (int j = 0; j < len; j++) {
            if (rule.production[j] == symbol) {
                if (j < len - 1) {
                    // Case 1: The symbol has non-epsilon symbols following it
                    for (int k = j + 1; k < len; k++) {
                        if (isTerminal(rule.production[k])) {
                            addToSet(followSet, rule.production[k]);
                            break;
                        } else {
                            // For non-terminals, add First set of the non-terminal's
production
                            bool hasEpsilon = false;
                            for (int l = k; l < len; l++) {
                                if (isTerminal(rule.production[l])) {
                                    addToSet(followSet, rule.production[l]);
                                    break;
                                } else {
                                    if (addToSetUnique(followSet, rule.production[l])) {
                                        if (!containsEpsilon(rules[l].production,
strlen(rules[l].production))) {
                                            break;
                                        }
```

```
                        hasEpsilon = true;
                    }
                }
            }
            if (!hasEpsilon) {
                break;
            }
        }
    }
    if (j == len - 1 || containsEpsilon(rule.production + j + 1, len - j - 1)) {
        // Case 2: The symbol is at the end or followed by epsilon
        if (rule.nonTerminal != symbol) {
            calculateFollow(rules, numRules, startSymbol, rule.nonTerminal,
followSet);
        }
    }
  }
 }
}

int main() {
    int numRules;
    printf("Enter the number of production rules: ");
    scanf("%d", &numRules);

    ProductionRule rules[MAX_RULES];
    printf("Enter the production rules in the format 'NonTerminal ->
Production':\n");
    for (int i = 0; i < numRules; i++) {
        scanf(" %c -> %[^\n]s", &rules[i].nonTerminal, rules[i].production);
        getchar(); // Consume the newline character
    }

    char startSymbol;
    printf("Enter the start symbol: ");
    scanf(" %c", &startSymbol);

    char symbol;
    printf("Enter a symbol to find its Follow set: ");
    scanf(" %c", &symbol);

    SymbolSet followSet;
```

```
    followSet.count = 0;

    // Initialize Follow set with '$' if the start symbol is being followed
    if (symbol == startSymbol) {
        addToSet(&followSet, '$');
    }

    calculateFollow(rules, numRules, startSymbol, symbol, &followSet);

    printf("Follow(%c) = {", symbol);
    for (int i = 0; i < followSet.count; i++) {
        printf(" %c", followSet.symbols[i]);
    }
    printf(" }\n");

    return 0;
}
```

Output:

```
E:\Codes\CD\Practical 8>prac_8.exe
Enter the number of production rules: 4
Enter the production rules in the format 'NonTerminal -> Production':
S -> AB
A -> aA | b
B -> bB | c
C -> aC | d
Enter the start symbol: S
Enter a symbol to find its Follow set: S
Follow(S) = { $ }
```

Practical 9

- **Construct a recursive descent parser for a given grammar.**

  Grammar:
  E -> T + E | T - E | T
  T -> F * T | F / T | F
  F -> (E) | num

  Code:

```
#include <stdio.h>
#include <stdbool.h>
#include <ctype.h>
#define MAX_EXPRESSION_SIZE 100
// Function prototypes
bool parseE(char input[], int* index);
bool parseT(char input[], int* index);
bool parseF(char input[], int* index);

bool parseE(char input[], int* index) {
    if (parseT(input, index)) {
        while (input[*index] == '+' || input[*index] == '-') {
            (*index)++;
            if (!parseT(input, index)) {
                return false;
            }
        }
        return true;
    }
    return false;
}
bool parseT(char input[], int* index) {
    if (parseF(input, index)) {
        while (input[*index] == '*' || input[*index] == '/') {
            (*index)++;
            if (!parseF(input, index)) {
                return false;
            }
        }
        return true;
    }
    return false;
}
```

```
bool parseF(char input[], int* index) {
    if (input[*index] == '(') {
        (*index)++;
        if (parseE(input, index) && input[*index] == ')') {
            (*index)++;
            return true;
        }
        return false;
    } else if (isdigit(input[*index])) {
        while (isdigit(input[*index])) {
            (*index)++;
        }
        return true;
    }
    return false;
}

int main() {
    char input[MAX_EXPRESSION_SIZE];
    int index = 0;

    printf("Enter an arithmetic expression: ");
    scanf("%s", input);

    if (parseE(input, &index) && input[index] == '\0') {
        printf("Valid expression\n");
    } else {
        printf("Invalid expression\n");
    }

    return 0;
}
```

Output:

```
E:\Codes\CD\Practical 9>gcc -o prac_9 prac_9.c

E:\Codes\CD\Practical 9>prac_9.exe
Enter an arithmetic expression: 2+10
Valid expression

E:\Codes\CD\Practical 9>prac_9.exe
Enter an arithmetic expression: 3*(4+1)/(5-2)
Valid expression
```

Practical 10

- **Write a C program for constructing of LL (1) parsing.**

Grammar:
E -> E + T | E - T | T
T -> T * F | T / F | F
F -> (E) | num
Code:

```
#include <stdio.h>
#include <stdbool.h>
#include <ctype.h>
#define MAX_EXPRESSION_SIZE 100
// Function prototypes
bool parseE(char input[], int* index);
bool parseT(char input[], int* index);
bool parseF(char input[], int* index);
bool match(char expected, char input[], int* index) {
    if (input[*index] == expected) {
        (*index)++;
        return true;
    }
    return false;
}
bool parseF(char input[], int* index) {
    if (input[*index] == '(') {
        (*index)++;
        if (parseE(input, index) && match(')', input, index)) {
            return true;
        }
        return false;
    } else if (isdigit(input[*index])) {
        (*index)++;
        return true;
    }
    return false;
}

bool parseT(char input[], int* index) {
    if (parseF(input, index)) {
        while (input[*index] == '*' || input[*index] == '/') {
            char op = input[*index];
            (*index)++;
            if (!parseF(input, index)) {
```

```
            return false;
        }
    }
    return true;
  }
  return false;
}

bool parseE(char input[], int* index) {
  if (parseT(input, index)) {
    while (input[*index] == '+' || input[*index] == '-') {
      char op = input[*index];
      (*index)++;
      if (!parseT(input, index)) {
        return false;
      }
    }
    return true;
  }
  return false;
}
int main() {
  char input[MAX_EXPRESSION_SIZE];
  int index = 0;
  printf("Enter an arithmetic expression: ");
  scanf("%s", input);
  if (parseE(input, &index) && input[index] == '\0') {
    printf("Valid expression\n");
  } else {
    printf("Invalid expression\n");
  }

  return 0;
}
```

Output:

```
E:\Codes\CD\Practical 10>prac_10.exe
Enter an arithmetic expression: 2+3
Valid expression

E:\Codes\CD\Practical 10>prac_10.exe
Enter an arithmetic expression: 7/2+6*3-(4+2)-
Invalid expression
```

Practical 11

- **Implement a C program to implement operator precedence parsing.**

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

#define MAX_EXPRESSION_SIZE 100

// Define operator precedence levels
int getPrecedence(char op) {
    switch (op) {
        case '+':
        case '-':
            return 1;
        case '*':
        case '/':
            return 2;
        default:
            return 0;
    }
}

// Function to perform binary operations
int applyOperator(int operand1, char operator, int operand2) {
    switch (operator) {
        case '+':
            return operand1 + operand2;
        case '-':
            return operand1 - operand2;
        case '*':
            return operand1 * operand2;
        case '/':
            if (operand2 != 0) {
                return operand1 / operand2;
            } else {
                printf("Error: Division by zero\n");
                exit(1);
            }
        default:
            printf("Error: Invalid operator\n");
            exit(1);
```

```
    }
}

// Operator precedence parsing function
int precedenceParse(char input[]) {
    int operandStack[MAX_EXPRESSION_SIZE];
    char operatorStack[MAX_EXPRESSION_SIZE];
    int operandTop = -1;
    int operatorTop = -1;
    int index = 0;

    while (input[index] != '\0') {
        if (isdigit(input[index])) {
            int operand = 0;
            while (isdigit(input[index])) {
                operand = operand * 10 + (input[index] - '0');
                index++;
            }
            operandStack[++operandTop] = operand;
        } else if (input[index] == '+' || input[index] == '-' || input[index] == '*' ||
input[index] == '/') {
            while (operatorTop >= 0 && getPrecedence(operatorStack[operatorTop])
>= getPrecedence(input[index])) {
                int operand2 = operandStack[operandTop--];
                int operand1 = operandStack[operandTop--];
                char op = operatorStack[operatorTop--];
                int result = applyOperator(operand1, op, operand2);
                operandStack[++operandTop] = result;
            }
            operatorStack[++operatorTop] = input[index];
            index++;
        } else {
            printf("Error: Invalid character in expression\n");
            exit(1);
        }
    }

    while (operatorTop >= 0) {
        int operand2 = operandStack[operandTop--];
        int operand1 = operandStack[operandTop--];
        char op = operatorStack[operatorTop--];
        int result = applyOperator(operand1, op, operand2);
        operandStack[++operandTop] = result;
    }
```

```
    return operandStack[0];
}

int main() {
    char input[MAX_EXPRESSION_SIZE];

    printf("Enter an arithmetic expression: ");
    scanf("%s", input);

    int result = precedenceParse(input);
    printf("Result: %d\n", result);

    return 0;
}
```

Output:

```
E:\Codes\CD\Practical 11>gcc -o prac_11 prac_11.c

E:\Codes\CD\Practical 11>prac_11.exe
Enter an arithmetic expression: 2+9
Result: 11
```

Practical 12

- **Given a parsing table, Parse the given input using Shift Reduce Parserfor any unambiguous grammar.**

Code:

Grammar:

1. S -> aSb
2. S -> ε

	‘+’	‘*’	‘(’	‘)’	‘id’	‘$’
0	S2		S4		S5	
1	S6	S7				
2	R2	S8		R2		R2
3	R4	R4		R4		R4
4	S6	S7				
5	R6	R6		R6		R6
6	S2		S4		S5	
7	R1	R1		R1		R1
8	R3	R3		R3		R3

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

#define MAX_STACK_SIZE 100
#define MAX_INPUT_SIZE 100

// Define the parsing table
int parsingTable[9][7] = {
    {2, -1, 4, -1, 5, -1, -1},
    {6, 7, -1, -1, -1, -1, -1},
    {-1, 8, -1, -1, -1, -1, -1},
    {-1, -1, -1, -1, -1, -1, -1},
    {6, 7, -1, -1, -1, -1, -1},
    {-1, -1, -1, -1, -1, -1, -1},
    {2, -1, 4, -1, 5, -1, -1},
```

```
    {-1, -1, -1, -1, -1, -1, -1},
    {-1, -1, -1, -1, -1, -1, -1}
};

// Define a stack for the parser
int stack[MAX_STACK_SIZE];
int top = -1;

// Function to perform a shift
operationvoid shift(int state) {
    top++;
    stack[top] = state;
}

// Function to perform a reduce operation
void reduce(int production) {
    int reduceLength;
    switch (production) {
        case 1:
            reduceLength = 3;
            break;
        case 2:
            reduceLength = 1;
            break;
        case 3:
            reduceLength = 3;
            break;
        case 4:
            reduceLength = 1;
            break;
        case 5:
            reduceLength = 3;
            break;
        case 6:
            reduceLength = 1;
            break;
        default:
            printf("Error: Invalid
            production\n");return;
    }

    // Pop elements from the stack based on the reduce
    lengthfor (int i = 0; i < reduceLength; i++) {
        top--;
    }
    // Determine the non-terminal to push onto the
```

```
    stackint nonTerminal;
    switch (production) {
        case 1:
            nonTerminal = 0; // E
            break;
        case 2:
            nonTerminal = 0; // E
            break;
        case 3:
            nonTerminal = 1; // T
            break;
        case 4:
            nonTerminal = 1; // T
            break;
        case 5:
            nonTerminal = 2; // F
            break;
        case 6:
            nonTerminal = 2; // F
            break;
        default:
            printf("Error: Invalid
            production\n");return;
    }

    // Push the non-terminal onto the stack based on the goto entry in the
parsing table
    int newState = parsingTable[stack[top]][nonTerminal];
    stack[++top] = newState;
}

// Function to perform the parsing
bool parse(char input[]) {
    int index = 0;
    stack[++top] = 0; // Push the initial state onto the
    stackint state, action;

    while (true) {
        state = stack[top];
        action = parsingTable[state][getInputIndex(input[index])];

        if (action == -1) {
            printf("Error: Invalid
            input\n");return false;
        } else if (action == 0) {
            printf("Error: Parsing completed with an
```

```
            error\n");return false;
        } else if (action < 0) { //
            Reducereduce(-action);
        } else { // Shift
            shift(action);
            index++;
        }

        if (input[index] == '\0' && state == 1)
            {printf("Parsing successful\n");
            return true;
        }
    }
}

// Function to get the index for the parsing table based on the
inputint getInputIndex(char input) {
    switch (input) {
        case '+':
            return 0;
        case '*':
            return 1;
        case '(':
            return 2;
        case ')':
            return 3;
        case 'id':
            return 4;
        case '$':
            return 5;
        default:
            printf("Error: Invalid input
            symbol\n");exit(1);
    }
}

int main() {
    char input[MAX_INPUT_SIZE];

    printf("Enter an input string (e.g., 'id + id $'):
    ");scanf("%s", input);

    // Append '$' to the end of the input
    stringstrcat(input, "$");
    if (parse(input)) {
        printf("Parsing succeeded!\n");
```

```
    } else {
        printf("Parsing failed.\n");
    }

    return 0;
}
```

	Action					Goto		
	+	*	(	)	id	E	T	F
0	s2		s4		s5	1	3	6
1		s7						
2	r2	r2		r2	r2			
3								
4	s2		s4		s5		8	6
5								
6								
7	s2		s4		s5			9
8	r4	r4		r4	r4			
9	r6	r6		r6	r6			

Stack	Input	Action
0	id+id*id$	Shift (State 5)
0id	+id*id$	Reduce using production 6 (F->id)
0F	+id*id$	Shift (State 2)
0F+	id*id$	Shift (State 4)
0F+id	*id$	Reduce using production 6 (F->id)
0F+F	*id$	Reduce using production 4 (T->F)
0F	*id$	Reduce using production 1 (E->T)
0T	*id$	Shift (State 8)
0T*	id$	Shift (State 4)
0T*id	$	Reduce using production 6 (F->id)
0T*F	$	Reduce using production 4 (T->F)
0T	$	Reduce using production 3 (T->T*F)
0T*	$	Reduce using production 2 (E->T)
0E	$	Accept (Parsing successful)

Practical 13

- **Introduction to YACC and generate calculator**

program.Code:

Yacc:

```
%{
/* Definition section */
#include<stdio.h>
int flag=0;
%}
%token NUMBER
%left '+' '-'
%left '*' '/' '%'
%left '(' ')'
/* Rule Section */
%%
Arithmetic Expression: E{
                    printf("\nResult=%d\n", $$);
                    return 0;
                    };
E:E'+'E {$$=$1+$3;}
|E'-'E {$$=$1-$3;}
|E'*'E {$$=$1*$3;}
|E'/'E {$$=$1/$3;}
|E'%'E {$$=$1%$3;}
|'('E')' {$$=$2;}
| NUMBER {$$=$1;}
;
%%
//driver code
void main()
{
printf("\nEnter Any Arithmetic Expression which can have operations Addition,
Subtraction, Multiplication, Division, Modulus and Round brackets:\n");

yyparse();
if(flag==0)
printf("\nEntered arithmetic expression is Valid\n\n");
}

int yyerror()
{
printf("\nEntered arithmetic expression is Invalid\n\n");
flag=1;
return 0;
```

```
}
```

Lex:

```
%{
/* Definition section */
#include<stdio.h>
#include "y.tab.h"
extern int yylval;
%}

/* Rule Section */
%%
[0-9]+ {
                yylval=atoi(yytext);
                return NUMBER;

        }
[\t] ;

[\n] return 0;

. return yytext[0];

%%

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

Output:

```
E:\Codes\CD\Practical 13>bison -dy prac13.y

E:\Codes\CD\Practical 13>flex prac13.l

E:\Codes\CD\Practical 13>gcc lex.yy.c y.tab.c
E:\Codes\CD\Practical 13>a.exe

Enter Any Arithmetic Expression which can have operations
Addition, Subtraction, Multiplication, Division, Modulus a
nd Round brackets:
5+6

Result=11
```

Practical 14

- **Generate 3-tuple intermediate code for given infix expression.Code:**

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

// Structure to represent an intermediate code
tuplestruct Tuple {
   char opcode;       // Operator (+, -, *, /,
   etc.)char operand1[5]; // Operand 1
   char operand2[5]; //
   Operand 2char result[5];  //
   Result
};

// Function to generate and print intermediate
code    void    generateIntermediateCode(char
*expression) {
   struct          Tuple
   code[100];        int
   codeIndex = 0;
   char
   stack[100][5];
   int  stackIndex
   =     0;     int
   tempCount   =
   0;

   for (int i = 0; i < strlen(expression);
      i++) {char token = expression[i];

      if (token >= 'a' && token <= 'z') {
         // Operand
         sprintf(stack[stackIndex], "t%d", tempCount);
         tempCount++;
         stackIndex++;
      } else if (token == '+' || token == '-' || token == '*' || token == '/') {
         // Operator
         strcpy(code[codeIndex].operand2, stack[--
         stackIndex]);strcpy(code[codeIndex].operand1,
         stack[--stackIndex]);code[codeIndex].opcode =
         token; sprintf(code[codeIndex].result, "t%d",
```

```
            tempCount); strcpy(stack[stackIndex],
            code[codeIndex].result); stackIndex++;
            codeIndex++;
            tempCount++;
        }
    }
    // Print intermediate code
    printf("Intermediate
    Code:\n"); for (int i = 0; i <
    codeIndex; i++) {
        printf("(%c, %s, %s, %s)\n", code[i].opcode, code[i].operand1,
code[i].operand2, code[i].result);
    }
}

int main() {
    char infixExpression[100];
    printf("Enter infix expression: ");
    scanf("%s", infixExpression);
    generateIntermediateCode(infixExpressio
    n); return 0;
}
```

Output:

```
E:\Codes\CD\Practical 14>gcc -o prac14 prac14.c

E:\Codes\CD\Practical 14>prac14.exe
Enter infix expression: A+B*C
Intermediate   Code:
(+, , V, t0)
(*, Q, t0, t1)
```

Practical 15

- **Extract predecessor and successor from given control flow graph.**

Code:

```
#include <iostream>
using namespace std;

struct Node
{
	int key;
	struct Node *left, *right;
};

void findPreSuc(Node* root, Node*& pre, Node*& suc, int key)
{
	if (root == NULL) return ;

	if (root->key == key)
	{
		if (root->left != NULL)
		{
			Node* tmp = root->left;
			while (tmp->right)
				tmp = tmp->right;
			pre = tmp ;
		}

		if (root->right != NULL)
		{
			Node* tmp = root->right ;
			while (tmp->left)
				tmp = tmp->left ;
			suc = tmp ;
		}
		return ;
	}

	if (root->key > key)
	{
		suc = root ;
		findPreSuc(root->left, pre, suc, key) ;
	}
	else
	{
		pre = root ;
```

```
                findPreSuc(root->right, pre, suc, key) ;
        }
}

Node *newNode(int item)
{
        Node *temp = new Node;
        temp->key = item;
        temp->left = temp->right = NULL;
        return temp;
}

Node* insert(Node* node, int key)
{
        if (node == NULL) return newNode(key);
        if (key < node->key)
                node->left = insert(node->left, key);
        else
                node->right = insert(node->right, key);
        return node;
}

int main()
{
        int key = 65; //Key to be searched in BST

        Node *root = NULL;
        root = insert(root, 50);
        insert(root, 30);
        insert(root, 20);
        insert(root, 40);
        insert(root, 70);
        insert(root, 60);
        insert(root, 80);


        Node* pre = NULL, *suc = NULL;

        findPreSuc(root, pre, suc, key);
        if (pre != NULL)
        cout << "Predecessor is " << pre->key << endl;
        else
        cout << "No Predecessor";

        if (suc != NULL)
        cout << "Successor is " << suc->key;
```

```
        else
        cout << "No Successor";
        return 0;
}
```

Output: