SSN COLLEGE OF ENGINEERING

ASSIGNMENT 1 : LEXICAL ANALYSER USING C

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Aim:

To write a program in C that simulates a Lexical Analyser.

Code:

```
#include<stdio.h>
#include<string.h>
#include<sys/types.h>
#include<sys/stat.h>
#include<fcntl.h>
#include<unistd.h>
#include<stdlib.h>
#include<ctype.h> int main()
{
    FILE* fp;     int count  =
0;     char* line = NULL;
size_t len = 0;     ssize_t
linelen;     char
store1[10][100];     char
store2[10][100];     fp =
fopen("./in.c", "r");     int
dtype[10], cnt = 0;
    while((linelen = getline(&line, &len, fp)) != -1)
    {
        if(line[0] == '#')
        {
            for(int i = 0; i < strlen(line); i++)
            {
                if(line[i] != '\n') printf("%c", line[i]);
            }
            printf(" - preprocessor directive\n");
        }
        char* int1 = strstr(line,"int ");
        char* float1 = strstr(line,"float ");
        char* for1 = strstr(line,"for(");
        char* if1 = strstr(line,"if("); char*
        else1 = strstr(line,"else"); int
        declare = 0; int conditional = 0;
        if(int1 != NULL)   {     declare =
        1;     printf("int - keyword\n");
```

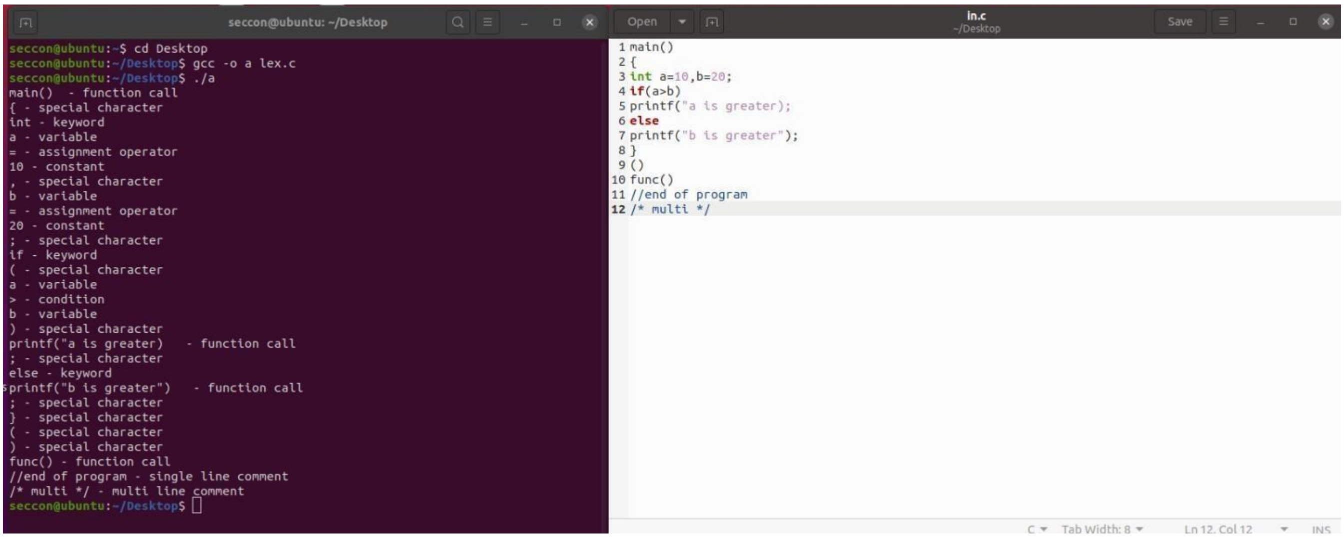
```
char* p = int1; char
str[10]; int slen = 0;
char* t = p; int jumplen =
strlen("int "); t = t + 4;
while(*t != '\0') {
char c = *t; str[slen++]
= c; t = t +
1; if(*t
== '=')
{ dtype[cnt++] =
0; t = t + 1;
str[slen] = '\0';
strcpy(store1[count], str);
slen = 0; str[0] = '\0';
while(isdigit(*t) || *t == '.')
{
char c = *t;
str[slen++] = c; t
= t + 1; }
str[slen] = '\0';
slen = 0;
strcpy(store2[count], str);
} if(*t
==',' | *t == ';') {
count = count + 1;
t = t + 1; }
}
}
if(float1 != NULL) {
declare = 1;
printf("float -
keyword\n"); char* p
=
float1; char str[10]; int slen
= 0; char* t = p; int
jumplen = strlen("float "); t
= t + 6; while(*t != '\0') {
char c = *t;
str[slen++]=c;
t = t + 1; if(*t
== '=')
{ dtype[cnt++]
= 1; t = t +
1; str[slen] = '\0';
strcpy(store1[count], str); slen
= 0; str[0] = '\0';
while(isdigit(*t) || *t == '.')
{ char c =
```

```
*t;                    str[slen++] = c;                    t
= t + 1;                 }
str[slen] = '\0';                slen = 0;
strcpy(store2[count], str);
            }              if(*t ==
',' | *t == ';')              {
count = count + 1;
t = t + 1;
            }
         }
}
      if(for1 != NULL)
printf("for - keyword\n");
if(if1 != NULL)
      {          printf("if - keyword\n");
conditional = 1;
      }
      if(else1 != NULL)          printf("else
- keyword\n"); char* templine; templine =
line; int first
= 1; if(declare == 1)
      {
         while(templine != NULL)
         { if(first == 1)
            {    templine = strstr(templine,"
         ");       first = 0;
            }    else
            {                printf(", - special character\n");
            }
int equindex;
            for(int z = 0; z < strlen(templine); z++)              {
if(*(templine + z) == '=')                  {
equindex
= z;
break;
               }
            }
            for(int j = 1; j < equindex; j++)
            {
               printf("%c", *(templine + j));
            }
            printf(" - variable\n");             printf("=
- assignment operator\n");              templine
= strstr(templine, "=");              int
commaindex;
            for(int z = 0; z < strlen(templine); z++)
            {
               if(*(templine + z) == ',')
```

```
                    {
commaindex = z;
break;
                    }
                }
                for(int j = 1; j < commaindex; j++)
                {
                    printf("%c", *(templine + j));
                }
                printf(" - constant\n");
                templine = strstr(templine, ",");
            }
        }
        char* main1 = strstr(line, "main("); char*
        printf1 = strstr(line, "printf(");
        if(main1 != NULL || printf1 !=
        NULL)   {     for(int i = 0; i <
        strlen(line);  i++)
            {     if(line[i]=='\t' || line[i]==';' || line[i] ==
            '\n')
                {     printf("
                ");
             }
                else
                {         printf("%c", line[i]);
                }
            }             printf(" - function call\n");
        }
        char* popen = strstr(line, "{");          if(popen !=
NULL) printf("{ - special character\n");          char*
semicolon = strstr(line, ";");
        if(semicolon != NULL) printf("; - special character\n");          char*
pclose = strstr(line, "}");
        if(pclose != NULL) printf("} - special character\n");
char* bracket_open = strstr(line, "(");
        if(bracket_open != NULL && main1 == NULL && printf1 == NULL) printf("( -
special character\n");         char* tempvar;           if(conditional == 1)
        {             tempvar =
strstr(line, "(");
int i;             int condition;
            for(int z = 0; z < strlen(tempvar); z++)
            {
                if(*(tempvar + z) == '<' || *(tempvar + z) == '>')
                {
condition = z;
break;
                }
            }
```

```
            for(int j = 1; j < condition; j++)
            {
                printf("%c", *(tempvar + j));
            }
            printf(" - variable\n");              char* tempvar1 =
strstr(tempvar, "<");              char* tempvar2 =
strstr(tempvar, ">");             if(tempvar1
!= NULL) tempvar = tempvar1;             if(tempvar2 != NULL)
tempvar = tempvar2;              printf("%c - condition\n",
*(tempvar));
            for(int z = 1; z < strlen(tempvar); z++)
            {
                if(*(tempvar + z) == ')')
                {
        condition = z;
                    break;
                }    else
                {
                    printf("%c", *(tempvar + z));
                }
            }
            printf(" - variable\n");
        }        char* bracket_close = strstr(line,
")");
        if(bracket_close != NULL && main1 == NULL && printf1 == NULL) printf(") -  special
character\n");
    }
fclose(fp);
    return 0;
}
```

Output:



Learning Outcome:

- The role and operation of Lexical Analyser was understood.
- Implementation of Regular Expression has been learnt.
- Learnt to parse the program and token identification.
- Understood the role of a Lexical Analyser in compilation.
- Understood the significance of keywords and general structure of a C program.

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ASSIGNMENT 2: LEXICAL ANALYSER USING LEX TOOL

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Aim:

To write a program using Lex to perform the basic functionalities of a Lexical Analyser, and to form a symbol table on the parsed program.

Code:

```
 %{
#include<stdio.h>
#include<stdlib.h>
#include<string.h>   struct
symbol{     char  type[10];
char name[20];     char
value[100]; };  //For
Symbol Table

typedef    struct    symbol    sym;           sym
sym_table[1000];    int   cur_size  =  -1;  char
current_type[10];   %}  number_const [-+]?[0-
9]+(\.[0-9]+)?      char_const  \'.\'  string_const
\".*\"  identifier [azA-Z_][a-zA-Z0-9_]* function
[a-zAZ_][a-zAZ0-9]*[(].*[)] keyword
(int|float|char|unsigned|typedef|struct|return|continue|break|if|else|for|while|do|e
xtern|auto|case|switch|enum|goto|long|double|sizeof|void|default|register) pp_dir ^[#].*[>]$
rel_ops ("<"|">"|"<="|">="|"=="|"!=") assign_ops
("="|"+="|"-="|"%="|"/="|"*=") arith_ops ("+"|"-
"|"%"|"/"|"*") single_cmt [/][/].*  multi_cmt
([/][/].*)|([/][*](.|[\n\r])*[*][/]) spl_chars [{}(),;\[\]]
/*Rules*/

%%

{pp_dir} {     printf("PPDIR
");
    strcpy(current_type, "INVALID");
}

{keyword} {     printf("KW
");
     if(strcmp(yytext, "int") == 0){         strcpy(current_type, "int");
    }
    else if(strcmp(yytext, "float") == 0){         strcpy(current_type, "float");
    }
    else if(strcmp(yytext, "double") == 0){
```

```
strcpy(current_type, "double");
    }
    else if(strcmp(yytext, "char") == 0){         strcpy(current_type, "char");
    }     else{
        strcpy(current_type, "INVALID");
    }
}
 {function} {     printf("FUNCT
");
}

{identifier} {     printf("ID ");

    if(strcmp(current_type, "INVALID") != 0){         cur_size++;
strcpy(sym_table[cur_size].name, yytext);         strcpy(sym_table[cur_size].type,
current_type);                                         if(strcmp(current_type,    "char")    ==    0){
strcpy(sym_table[cur_size].value, "NULL");
        }
        else if(strcmp(current_type, "int") == 0){
strcpy(sym_table[cur_size].value, "0");
        }         else{
            strcpy(sym_table[cur_size].value, "0.0");
        }
    }
}

{single_cmt} {     printf("SCMT
");
}
 {multi_cmt} {     printf("MCMT
");
}

{number_const} {     printf("NUM_CONST
");
 if(strcmp(current_type,        "INVALID")  !=        0){         strcpy(sym_table[cur_size].value,
       yytext);
    }
}
 {char_const} {     printf("CHAR_CONST
");
     if(strcmp(current_type, "char") == 0){
strcpy(sym_table[cur_size].value, yytext);
    }
}

{string_const} {     printf("STR_CONST
```

```
");
}
 {rel_ops} {     printf("REL_OP
");
}
 {arith_ops} {     printf("ARITH_OP
");
}
 {assign_ops} {     printf("ASSIGN_OP
");
}
 {spl_chars} {     if(strcmp(yytext, ";") == 0){
strcpy(current_type, "INVALID");
    }

 }
 \n {     printf("\n");
}

[ \t] { }


%%              int
yywrap(void)
{     return 1;
}

int main(int argc, char *argv[]){ int i = 0;


    yyin = fopen(argv[1], "r");     yylex();
      printf("\n\t-----------------------------------------
\n");              printf("\n\t\t\t\tSYMBOL  TABLE");
printf("\n\t\tNAME\tTYPE\tVALUE\n");     for(i
= 0; i <= cur_size; i++){          printf("\t\t%s\t%s\t%s\n", sym_table[i].name,
sym_table[i].type, sym_table[i].value);     }      printf("\t-----------------------------------------\n");

    return 0;
}
```

OUTPUT:

```
KW FUNCT
KW ID ASSIGN_OP NUM_CONST ID
KW ID ASSIGN_OP NUM_CONST
KW ID ID ASSIGN_OP CHAR_CONST
KW ID ASSIGN_OP NUM_CONST

FUNCT

ID ASSIGN_OP ID ARITH_OP NUM_CONST

KW ID REL_OP NUM_CONST
FUNCT


KW ID REL_OP NUM_CONST
FUNCT
ID ASSIGN_OP NUM_CONST



SCMT
MCMT

KW NUM_CONST


        -------------------------------------------


                        SYMBOL TABLE
                NAME    TYPE    VALUE
                a       int     1
                b       int     0
                c       int     2
                d       char    NULL
                e       char    'Z'
                f       float   1.23
        -------------------------------------------
```

Learning Outcome:

- Learnt the basics of Lex tool.
- Implement recognition for regular expressions using Lex terminology.
- Learnt to implement a basic symbol table using Lex on the parsed C program.
- Realized that Lex tool is more powerful and easy-to-use for Lexical Analysis.

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ASSIGNMENT 3: ELIMINATION OF LEFT RECURSION USING C

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Aim:

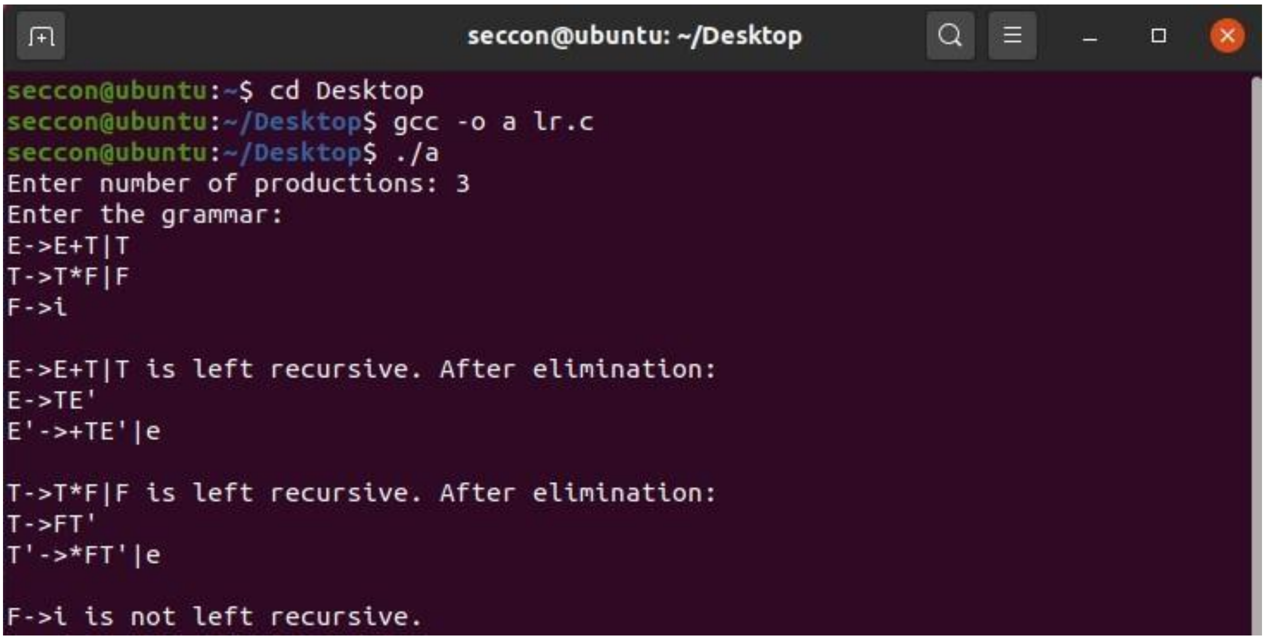
Write a program in C to find whether the given grammar is Left Recursive or not. If it is found to be left recursive, convert the grammar in such a way that the left recursion is removed.

Code:

```
#include<stdio.h> #include<string.h>  int
main()
{
    char non_terminal, productions[10][100], splits[10][10];
int num;      printf("Enter number of productions: ");
scanf("%d", &num);     printf("Enter the grammar:\n");
    for(int i = 0; i < num; i++)
    {
        scanf("%s", productions[i]);
    }
    for(int i = 0; i < num; i++)
    {
        printf("\n%s", productions[i]);         non_terminal
= productions[i][0];
        char production[100], *token;         int j, flag
= 0;         for(j = 0; productions[i][j + 3]
!= '\0'; j++)             production[j] =
productions[i][j + 3];         production[j] = '\0';
j = 0;
        token = strtok(production, "|");
while(token != NULL)
        {
            strcpy(splits[j], token);             if(token[0] ==
non_terminal && flag == 0) flag = 1;             else
if(token[0] != non_terminal && flag == 1) flag = 2;
j++;
            token = strtok(NULL, "|");
        }
        if(flag == 0) printf(" is not left recursive.\n");
        else if(flag == 1) printf(" is left recursive, cannot reduce.\n");         else
        {
            printf(" is left recursive. After elimination:\n");             flag
= 0;
            for(int k = 0; k < j; k++)
            {
                if(splits[k][0] != non_terminal) {
                    if(flag != 0)
```

```
                    {
                        printf("|%s%c\'", splits[k], non_terminal);
                    }                   else
{                         flag = 1;
                        printf("%c->%s%c\'", non_terminal, splits[k], non_terminal);
                    }
                }
}              printf("\n");
flag = 0;
            for(int k = 0; k < j; k++)
            {
                if(splits[k][0] == non_terminal) {
                    if(flag != 0)
                    {
                        printf("|%s%c\'", splits[k] + 1, non_terminal);
                    }                   else
{                         flag = 1;
                        printf("%c\'->%s%c\'", non_terminal, splits[k] + 1, non_terminal);
                    }
                }
}
            printf("|e\n");
        }
    }
}
```

OUTPUT:




```
seccon@ubuntu:~$ cd Desktop
seccon@ubuntu:~/Desktop$ gcc -o a lr.c
seccon@ubuntu:~/Desktop$ ./a
Enter number of productions: 3
Enter the grammar:
E->E+T|T
T->T*F|F
F->i

E->E+T|T is left recursive. After elimination:
E->TE'
E'->+TE'|e

T->T*F|F is left recursive. After elimination:
T->FT'
T'->*FT'|e

F->i is not left recursive.
```

Learning Outcome:

- Learnt about left recursive grammars.
- Learnt to check if a grammar is left recursive using C.
- Successfully implemented a conversion in C which converts left recursive grammar to non left recursive grammar.

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ASSIGNMENT 4: Recursive Descent Parser using C

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Aim:

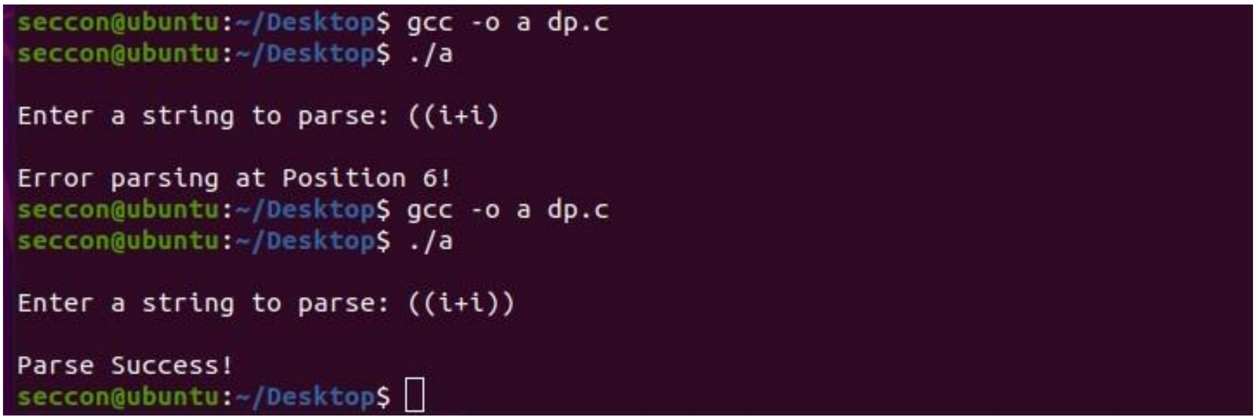
To implement a recursive descent parser using C

Code:

```
#include<stdio.h>
#include<stdlib.h
> void E(); void
Eprime(); void
T(); void
Tprime(); void
F(); char s; int
pos = 0;
void parse(char c)
{    if(s ==
c) {
        s = getchar();
    }
else {
        printf("Error at position %d!\n", pos);
exit(0);
    }
}
void E()
{
    T();
    Eprime();
}
void Eprime()
{    if(s == '+')
{        pos++;
parse('+');
T();
        Eprime();
    }
}
void T()
{
    F();
    Tprime();
}
```

```
void Tprime()
{     if(s == '*')
{         pos++;
parse('*');
F();
        Tprime();
    }
}
void F()
{     if(s == '(') {
pos++;
parse('(');
E();         pos++;
parse(')');     }
else if(s == 'i') {
pos++;
parse('i');
parse('d');     }
else {
        printf("Error at position %d!\n", pos);
        exit(0);
    }
}
int main()
{
    printf("Enter string to parse:
");     s = getchar();     E();
printf("Parse Success!\n");
    return 0;
}
```

OUTPUT:



Learning Outcome:

- Learnt the working of Recursive Descent Parser
- Understood why it doesn’t support Left Recursive Grammars
- Successfully implemented a Recursive Descent Parser using c using return handling and recursion.

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ASSIGNMENT 5: Implementation of Desk Calculator using Yacc Tool

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Aim:

To implement a Desk Calculator using Yacc Tool

Code:

Calculator.l

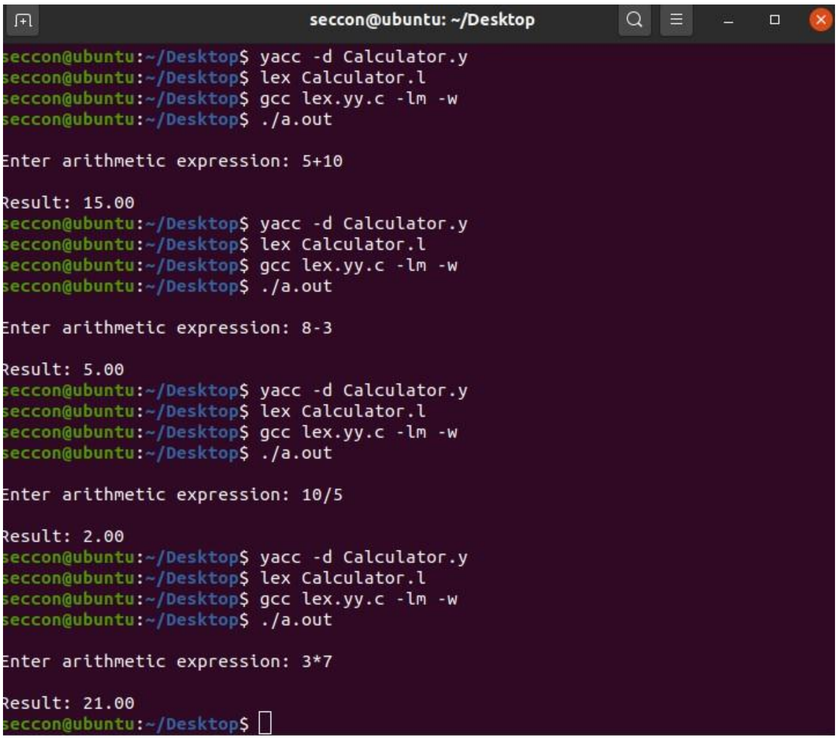
```
%{
#include<stdio.h>
#include<stdlib.h>
#include<string.h>
#include "y.tab.h" extern
int yylval;
%}
%% [0-9]+
{
  yylval = atoi(yytext);
return INTEGER;
}
(" "|"\t") { }
("+"|"-"|"*"|"/"|"^"|"("|")"|"\n") { return *yytext; }
. {   char
err[25];
  sprintf(err, "Invalid character: %s\n", yytext);
yyerror(err);
}
```

Calculator.y

```
%{
#include<stdio.h>
#include<stdlib.h>
#include<math.h> int
yylex(void);
#include "y.tab.h"
%}
%token INTEGER
%%
program: line program
| line
line: expr '\n' { printf("%d\n", $1); }
expr: expr '+' mulex { $$ = $1 + $3; }
| expr '-' mulex { $$ = $1 - $3; }
```

```
     | mulex { $$ = $1; }
mulex: mulex '*' powex { $$ = $1 * $3; }
      | mulex '/' powex { $$ = $1 / $3; }
      | powex { $$ = $1; }
powex: powex '^' term { $$ = pow($1, $3); }
      | term { $$ = $1; } term:
'(' expr ')' { $$ = $2; }
     | INTEGER { $$ = $1; }
%%
int yyerror(char* s)
{
  fprintf(stderr, "%s\n", s);
return 0; } int yywrap() {
return 1; } int main() {
yyparse();   return 0; }
```

OUTPUT:



Learning Outcome:

- Learnt about Yacc Parser Generator and that it is LALR(1) parser.
- Learnt to visualize parser’s working using scanner.
- Learnt to integrate Yacc and Lex in one file.
- Successfully implemented a basic calculator using Yacc tool, understanding it’s syntax.

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ASSIGNMENT 6: IMPLEMENTATION OF SYNTAX CHECKER USING YACC TOOL

Aim:

Develop a Syntax checker to recognize the tokens necessary for the following statements by writing suitable grammars

Assignment statement

Conditional statement

Looping statement

Code:

SyntaxCheck.y

```
%{
   #include <stdio.h>
   #define YYSTYPE double
   int flag = 0;
%}

%token  NUM ASSIGN ID
%token  RELOP LOGIC ARITH INCDEC
%token  IF ELIF ELSE
%token  FOR WHILE

%%
Lines   :   Block Lines
        |   Block
        ;

Block   :   Loop '{' Block
        |   ConStmt '{' Block
        |   Expr ';'
        |   '}'
        ;

Loop    :   FOR '(' Expr ';' Condns ';' Expr ')'
        |   FOR '(' ';' Condns ';' ')'
        |   WHILE '(' Condns ')'
        ;

ConStmt :   IF '(' Condns ')'
```

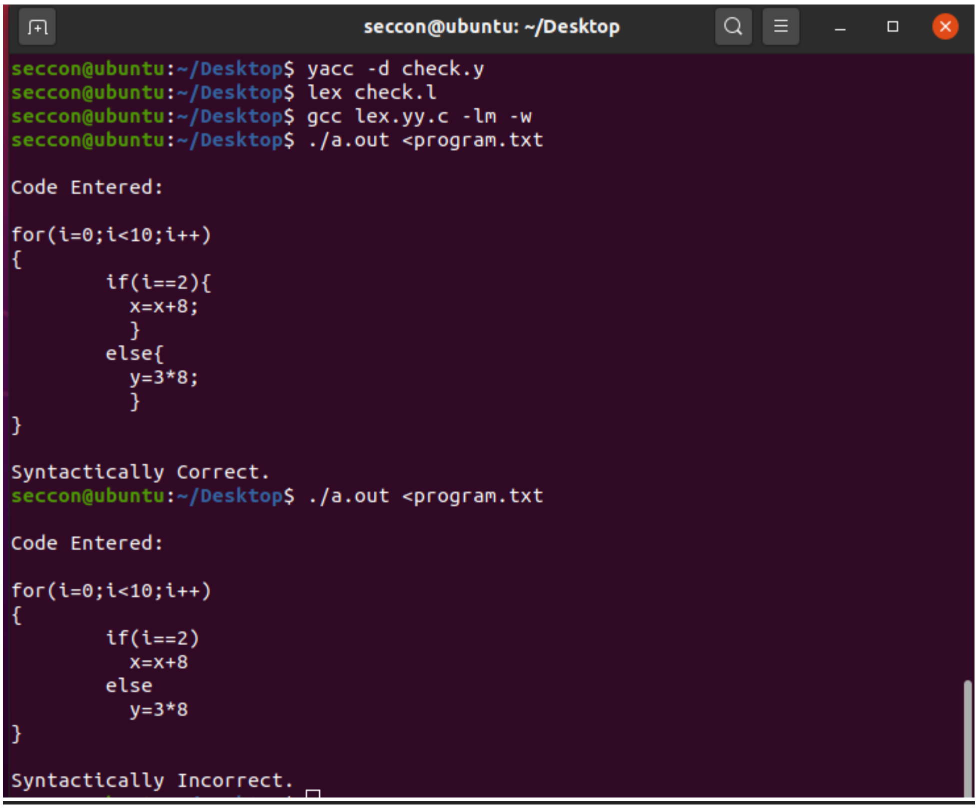
```
        | ELIF '(' Condns ')'
        | ELSE
        ;

Condns  :   Condn LOGIC Condns
        | Condn
        ;

Condn   :   ID RELOP ID
        | ID RELOP NUM
        | ID
        ;

Expr    :   Init
        | ID ASSIGN ID ARITH ID
        | ID ASSIGN ID ARITH NUM
        | ID ASSIGN NUM ARITH NUM
        | ID INCDEC
        | INCDEC ID
        ;

Init    :   ID ASSIGN Init
        | ID ASSIGN ID
        | ID ASSIGN NUM
        ;
%%

int yyerror(char *s){
    flag = 1;
    //fprintf(stderr, "%s\n", s);
    return 1;
}

int main(void){

    printf("\nCode Entered:\n\n");
    system("cat program.txt");
    yyparse();

    if(flag){
        printf("\nSyntactically Incorrect.\n");
    }

    else{
        printf("\nSyntactically Correct.\n");
    }
```

```
    return 0;
}
```

SyntaxCheck.l

```
%{
    #include <stdio.h>
    #include "y.tab.c"
    extern YYSTYPE yylval;
%}

assign      ("=")
relop       ("=="|"!="|">="|"<="|"<"|">")
arithop     ("+"|"-"|"/"|"%"|"*")
incdec      ("++"|"--")
logical     ("||"|"&&")
identifier  [a-zA-Z_][a-zA-Z0-9_]*


%%

[0-9]+          {return NUM;}
{assign}        {return ASSIGN;}
{relop}         {return RELOP;}
{logical}       {return LOGIC;}
{arithop}       {return ARITH;}
{incdec}        {return INCDEC;}
"if"            {return IF;}
"else if"       {return ELIF;}
"else"          {return ELSE;}
"for"           {return FOR;}
"while"         {return WHILE;}
{identifier}    {return ID;}


[ \t]           {;}
[\n]            {;}
.               {return *yytext;}

%%

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

Output:



```
seccon@ubuntu: ~/Desktop
seccon@ubuntu:~/Desktop$ yacc -d check.y
seccon@ubuntu:~/Desktop$ lex check.l
seccon@ubuntu:~/Desktop$ gcc lex.yy.c -lm -w
seccon@ubuntu:~/Desktop$ ./a.out <program.txt

Code Entered:

for(i=0;i<10;i++)
{
        if(i==2){
          x=x+8;
          }
        else{
          y=3*8;
          }
}

Syntactically Correct.
seccon@ubuntu:~/Desktop$ ./a.out <program.txt

Code Entered:

for(i=0;i<10;i++)
{
        if(i==2)
          x=x+8
        else
          y=3*8
}

Syntactically Incorrect.
```

Learning Outcome:

- Understood how to construct grammar for a program syntax checker.
- Realised that Yacc is LALR(1) parser
- Successfully implemented a syntax checker using Yacc parser