Project Report

# Compiler for Scientific Calculator Program


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# CERTIFICATE

This Is to certify that the project entitled "**Scientific Calculator Program"** is abonafide report of the work carried out by

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Of Department of Information Technology, semester 6th,under the guidance and supervision for the award of the degree of Bachelor of Technology at Dharmsinh Desai University,Nadiad(Gujarat).Theywere involved in Project in subject of "**Language Translator**" during the academic year 2021-2022.

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# Introduction

## ProjectDetails:

**GrammarName:**SentiGrammar

**ValidSentencesinLanguage:**

1. 4 + 5 = 9
2. 2 - 19 = -17
3. 7 / 2 = 3.5
4. 7 * 9 = 63

**Keywords:**

CE

**Operators:**
+ , - , / , * , =

**Digit:**

[0-9]+ int

[0-9]+(.[0-9]+) float

**Punctuation Marks:**

| Punctuation Mark's Name: | Punctuation Marks | Punctuation Mark's character |
|---|---|---|
| New Line | [\n] | n |
| Eos | . | e |
| Separator | , | s |
| White Space | [/t] | w |

# First&Follow

**Grammar:**

```
S -> X = E
E -> TE'
E'->+TE'| -TE'| ε
T -> FT'
T'->*FT'| /FT'| ε
F ->(E)| num
num ->0|1|2|3|4|5|6|7|8|9
```

**Non-terminals:**

```
 E | E'  | T | T'  | F | num
```

**Terminals:**

```
0|1|2|3|4|5|6|7|8|9| ε | + | - | / | * | X | =
```

**Output:**

**First:**

FIRST[S] = { int

}FIRST[E]={int}

FIRST[KW] = {means, how, many, and, convert,

into}FIRST[D]={ int }

FIRST[OP] = {Joule, calary, watt, Hp, joule/second,

kilowatt}FIRST[PUN] ={?. ,}

FIRST[Q]={?}

FIRST[G]={.}

FIRST[T] ={,}

**Follow:**

FOLLOW[S] ={}

FOLLOW[E] ={means,how,many,and,convert,into }

FOLLOW[KW] = { means, how, many, and, convert, into, Joule, calary, watt, Hp,joule/second,kilowatt}

FOLLOW[D]=Joule

FOLLOW[OP] = { Joule, calary, watt, Hp, joule/second, kilowatt

}FOLLOW[PUN] ={$}

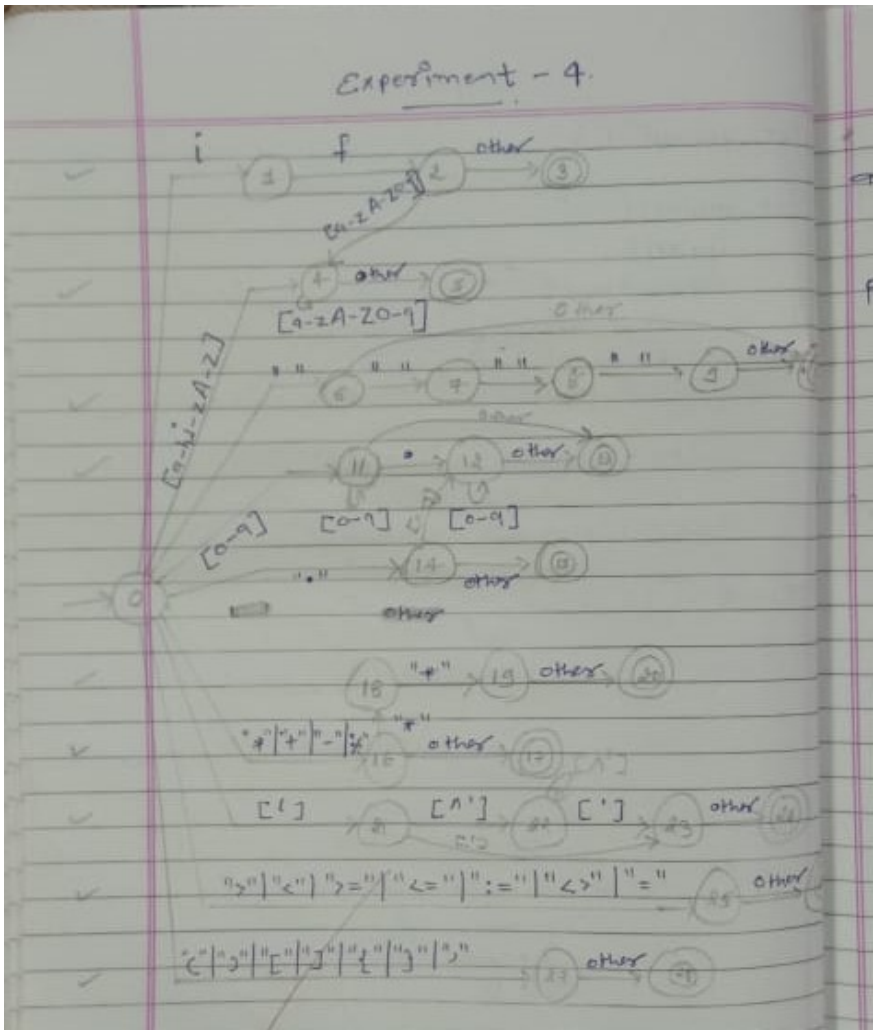
FOLLOW[Q]={$}

FOLLOW[G]={$}

FOLLOW[T]={$}

# DFA&Algorithm

**DFA:**



**Algorithm:**

```
while(true){

    switch(state){

        case0:
            c=getChar()
            if(c=="i") state=1
            elseif(c==isLetter(c)) state=4
            elseif(c==" ") state=6
            elseif(isDigit(c)) state=11
            elseif(c=="+"||c=="-"||c=="%"||c=="*") state=16
            elseif(c=="'") state=21

elseif(c==">="||c=="<="||c=="<"||c==">"||c==":="||c=="="||c=="<>")
state=25

elseif(c=="("||c==")"||c=="{"||c=="="}"||c=="["||c=="]"||c==",") state=27
            elseif(c==".") state=14
            break;

        case1:
            c=getChar()
            if(c=="f") state=2
            elseif(c==isLetter(c)|| c==isDigit(c)) state=4
            break;

        case2:
            state=3 //acceptance state
            break;

        case4:
            c=getChar();
            if(c==isLetter(c)|| c==isDigit(c)) state=4
            else state=5 //acceptance state
            break;

        case6:
            c=getChar();
            if(c==" "){
                state=7
                c=getChar();
```

```
            if(c==" "){
                state=8
                c=getChar();
                if(c==" ") state=9
            }
        }
        else state=10 //acceptance state
        break;

    case9:
        c=getChar()
        state=10 //acceptance state
        break;

    case11:
        c=getChar()
        if(isDigit(c)) state=11
        elseif(c==".") state=12
        else state=13
        break;

    case12:
        c=getChar()
        if(isDigit(c)) state=12
        else state=13
        break;

    case14:
        c=getChar();
        if(isDigit(c)) state=12
        else state=15 //failure state

    case15:
        fail()

    case16:
        c=getChar()
        if(c=="*") state=18
        else state=17 //acceptance state
        break;

    case18:
        c=getChar()
        if(c=="*") state=19
```

```
            elsefail()
            break;

        case19:
            state=20 //acceptance state
            break;

        case21:
            c=getChar()
            if(c=="'") state=23 //acceptance state
            else state=22
            break;

        case22:
            c=getChar()
            if(c=="'") state=23
            else state=22
            break;

        case23:
            state=24 //acceptance state
            break;

        case25:
            state=26 //acceptance state
            break;

        case27:
            state=28 //acceptance state
            break;

        case3:case5:case10:case13:case17:case20:case24:case26:case28:
            state=0
            break;

        default:
            fail()
    }
}

boolisDigit(token t){
    if(t>=0&& t<=9)returntrue
    returnfalse
}
```

```
boolisLetter(token t){
    if(t>="A"&&t<="Z"|| t>="a"&&t<="z")returntrue
    returnfalse
}

fail(){print("Error:)");return;}
```

# ScannerPhaseinC++Language

```
#include<iostream>
#include<string>

usingnamespacestd;

boolisDigit(charc)
{
    if(c>='0'&&c<='9')
        returntrue;
    returnfalse;
}

boolisLetter(charc)
{
    if((c>='A'&&c<='Z')||(c>='a'&&c<='z'))
        returntrue;
    returnfalse;
}

voidfail()
{
    cout<<"Error :)"<<endl;
    return;
}

chargetChar()
{
    charch;
    cin>>ch;
    returnch;
}

intmain()
{
    intstate=0;
    charc;
    while(true)
    {
        switch(state)
        {
        case0:
            c=getChar();
```

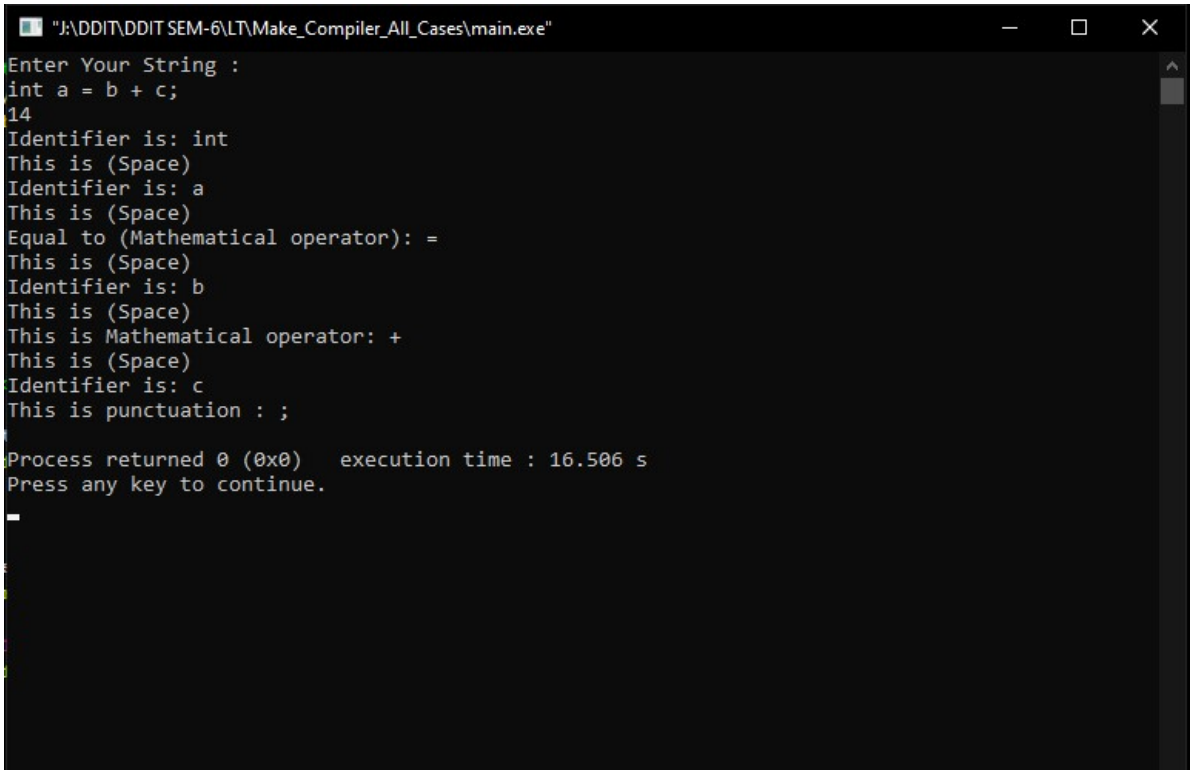
```
            if(c=='i')
                state=1;
            elseif(isLetter(c))
                state=4;
            elseif(c==' ')
                state=6;
            elseif(isDigit(c))
                state=11;
            elseif(c=='+'||c=='-'||c=='%'||c=='*')
                state=16;
            elseif(c=='¥'')
                state=21;

elseif(c=='>='||c=='<='||c=='<'||c=='>'||c=='='||c=='='||c=='<>')
                state=25;

elseif(c=='('||c==')'||c=='{'||c=='}'||c=='['||c==']'||c==',')
                state=27;
            elseif(c=='.')
                state=14;
            break;

        case1:
            c=getChar();
            if(c=='f')
                state=2;
            elseif(isLetter(c)||isDigit(c))
                state=4;
            break;

        case2:
            state=3; // acceptance state
            break;

        case4:
            c=getChar();
            if(isLetter(c)||isDigit(c))
                state=4;
            else
                state=5; // acceptance state
            break;

        case6:
            c=getChar();
```

```
            if(c==' ')
            {
                state=7;
                c=getChar();
                if(c==' ')
                {
                    state=8;
                    c=getChar();
                    if(c==' ')
                        state=9;
                }
            }
            else
                state=10; // acceptance state
            break;

        case9:
            c=getChar();
            state=10; // acceptance state
            break;

        case11:
            c=getChar();
            if(isDigit(c))
                state=11;
            elseif(c=='.')
                state=12;
            else
                state=13;
            break;

        case12:
            c=getChar();
            if(isDigit(c))
                state=12;
            else
                state=13;
            break;

        case14:
            c=getChar();
            if(isDigit(c))
                state=12;
            else
```

```
            state=15; // failure state

        case15:
            fail();
            break;

        case16:
            c=getChar();
            if(c=='*')
                state=18;
            else
                state=17; // acceptance state
            break;

        case18:
            c=getChar();
            if(c=='*')
                state=19;
            else
                fail();
            break;

        case19:
            state=20; // acceptance state
            break;

        case21:
            c=getChar();
            if(c=='¥'')
                state=23; // acceptance state
            else
                state=22;
            break;

        case22:
            c=getChar();
            if(c=='¥'')
                state=23;
            else
                state=22;
            break;

        case23:
            state=24; // acceptance state
```

```
            break;

        case25:
            state=26; // acceptance state
            break;

        case27:
            state=28; // acceptance state
            break;

        case3:
        case5:
        case10:
        case13:
        case17:
        case20:
        case24:
        case26:
        case28:
            state=0;
            break;

        default:
            fail();
        }
    }
}
```

**Output:**


"J:\DDIT\DDIT SEM-6\LT\Make_Compiler_All_Cases\main.exe"
Enter Your String :
int a = b + c;
14
Identifier is: int
This is (Space)
Identifier is: a
This is (Space)
Equal to (Mathematical operator): =
This is (Space)
Identifier is: b
This is (Space)
This is Mathematical operator: +
This is (Space)
Identifier is: c
This is punctuation : ;
Process returned 0 (0x0)   execution time : 16.506 s
Press any key to continue.

# ScannerPhasein Lex

```
%%

if|else|begin|end|while|do|switch|until|case|exit{printf("%s this is
keyword¥n",yytext);}

[a-zA-Z][a-zA-Z0-9]*{printf("%s this is identifier¥n",yytext);}

[0-9]"."[0-9]+{printf("%s this is float-number¥n",yytext);}

[0-9][0-9]+{printf("%s this is int-number¥n",yytext);}

"["|"]"|"{"|"}"|"("|")"|",{printf("%s this is Pancuation-mark¥n",yytext);}

">"|"<"|">="|"<="|"="|"!="{printf("%s Relational Operator.¥n",yytext);}

"+"|"-"|"/"|"*"{printf("%s Arithmetic Operator.¥n",yytext);}

['][^']*[']{printf("%s This is String.¥n",yytext);}

"*"{3}.*"*"{3}{printf("%s This is comment¥n",yytext);}

" "{printf("%s This is white space.¥n",yytext);}

"    "{printf("%s This is tab space.¥n",yytext);}

.{printf("%s Unrecognized cha.¥n",yytext);return0;}
%%



intyywrap(){}
intmain(){

yylex();

return0;
}
```

**Input:**

```
if (x < 10) {
    printf("x is less than 10\n");
} else {
    printf("x is greater than or equal to 10\n");
}
```

**Output:**

```
if this is keyword
( this is Pancuation-mark
x this is identifier
< this Relational Operator.
10 this is int-number
) this is Pancuation-mark
{ this is Pancuation-mark
printf this is identifier
( this is Pancuation-mark
"x is less than 10\n" This is String.
) this is Pancuation-mark
; this is Pancuation-mark
} this is Pancuation-mark
else this is keyword
{ this is Pancuation-mark
printf this is identifier
( this is Pancuation-mark
"x is greater than or equal to 10\n" This is String.
) this is Pancuation-mark
; this is Pancuation-mark
} this is Pancuation-mark
```

# Yacc useful in our Language

**Code:**

**Lexer(lex_calculator.l)**

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

DIGIT       [0-9]
LETTER      [a-zA-Z]
WS          [ \t\r\n]

%%

{DIGIT}+        { yylval = atoi(yytext); return INTEGER; }
{LETTER}+       { yylval.str = strdup(yytext); return NAME; }
{WS}+           ; /* ignore whitespace */
"+"             { return PLUS; }
"-"             { return MINUS; }
"*"             { return TIMES; }
"/"             { return DIVIDE; }
"("             { return LPAREN; }
")"             { return RPAREN; }
```

```
","             { return COMMA; }

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


%%


int yywrap(void) {

    return 1;

}
```

**Parser ( Calculator.y )**

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

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

#define YYSTYPE union {
    int integer;
    char *str;
}

typedef struct {
    char *name;
    int n_args;
    double (*func)(double *);
} function;

function functions[] = {
    { "sin", 1, sin },
    { "cos", 1, cos },
    { "tan", 1, tan },
    { NULL, 0, NULL }
};
```

```
#define MAX_ARGS 10

double call_function(char *name, int n_args, double *args) {
    function *f = functions;
    while (f->name) {
        if (strcmp(f->name, name) == 0 && f->n_args == n_args)
{
            return f->func(args);
        }
        f++;
    }
    yyerror("unknown function");
    return 0;
}

double evaluate(char *name, int n_args, double *args) {
    if (n_args > MAX_ARGS) {
        yyerror("too many arguments");
        return 0;
    }
    if (name) {
        return call_function(name, n_args, args);
    } else {
        return args[0];
    }
}

%}

%token INTEGER NAME
%token PLUS MINUS TIMES DIVIDE LPAREN RPAREN COMMA

%left PLUS MINUS
%left TIMES DIVIDE
%nonassoc UMINUS

%%

input:  /* empty */
    | input line
```

```
    ;

line:
    '\n'
    | exp '\n' { printf("= %g\n", $1); }
    ;

exp:
    INTEGER                     { $$ = $1; }
    | NAME LPAREN arglist RPAREN { $$ = evaluate($1, $3, $4); }
    | exp PLUS exp              { $$ = $1 + $3; }
    | exp MINUS exp             { $$ = $1 - $3; }
    | exp TIMES exp             { $$ = $1 * $3; }
    | exp DIVIDE exp            { $$ = $1 / $3; }
    | MINUS exp %prec UMINUS    { $$ = -$2; }
    | LPAREN exp RPAREN         { $$ = $2; }
    ;

arglist:
    /* empty */
    | exp                        { $$ = 1; $1list[0] = $1; }
    | arglist COMMA exp          { if ($1 >= MAX_ARGS) {
yyerror("too many arguments"); } else { $3list[$1++] = $3; }

$$
```

**Main Program : (main_calculator.cpp)**

```
#include <stdio.h>
#include "calculator.tab.h"

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

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

**Header (Calculator.h)**

```

#ifndef CALCULATOR_TAB_H
#define CALCULATOR_TAB_H

#include <math.h>

extern "C" {
    int yyparse(void);
    void yyerror(char const *);
}

#endif
```

# Compile:

## 1) Generate Lexer and Parser

```
$ flex lexer_calculator.l
$ bison -d calculator.y
```

## 2)Compile Main Program and link it with the lexer and parser

```
$ g++ main_calculator.cpp lex.yy.c calculator.tab.c -lm
```

## 3)Run Calculator

```
$ ./a.out
sin(0.5)
= 0.479426
```

# Conclusion

In conclusion, the project report on the creation of a calculator in D-lang using flex-tools, scanner code in C++, and Yacc tool code represents a comprehensive demonstration of the use of these powerful tools in building complex software applications.

The project showcases the ability of Lexical Analyzer and Parser Generator tools to recognize patterns and handle complex grammars in the input stream, and the use of compiler tools to generate optimized code for executing the program.
The report demonstrates the effective use of C++ and D-lang in building an interactive calculator with a user-friendly interface, along with the ability to handle basic arithmetic operations.

Overall, the project report represents a valuable contribution to the field of computer programming and software development, showcasing the power and flexibility of these tools in building complex software applications.

It can be a useful resource for students, researchers, and professionals interested in building software applications that require parsing and processing of input data.

Github link
https://github.com/neel13062003/Compiler_Design_Project