A
Project Report
on

Compiler for Mathematical operations using English like sentences

Developed by

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CERTIFICATE

This is to certify that the project entitled "**Mathematical operations using English like sentences"** is a bonafied report of the work carried out **by**

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of Department of Information Technology, semester VI, under the guidance and supervision for the award of the degree of Bachelor of Technology at Dharmsinh Desai University, Nadiad (Gujarat). They were involved in Project in subject of "**Language Translator**" during academic year 2020-2021.

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1. INTRODUCTION

1.1 Project Details

Grammar Name: Mathematical operations using English like sentences

Grammar Rules:

Write an appropriate language description for a layman language which can do mathematical operations using English like sentences.

Example of valid program in this language is –

Add 100,200,300,400.

Subtract 250 from result.

Multiply 400 to it.

Divide the answer by 2.

Show me the answer.

Regular Expression:

Regular definition for layman Language:

Regular Defination	Examples:
Keywords	From, from, Show, show, by, to, it, result, the, me, Answer, answer
Operation	Add, Sub(Subtract), Mul(Multiply), Div(Divide)
Digit(Number)	[0-9]
Que. Mark	“?”(EOF)
White Space	(Tab | Newline)$^+$
Letter	[A-Za-z]

Regular Expression Related to Regular Language:

Int	{Digit}$^+$- Atleast one or more Digit
Float	{Digit}+(\.{Digit}+)?(E[+\-]?{Digit}+)? – Means Digit followed by digit or exponent of 10(digit)
Space	{white space}$^+$

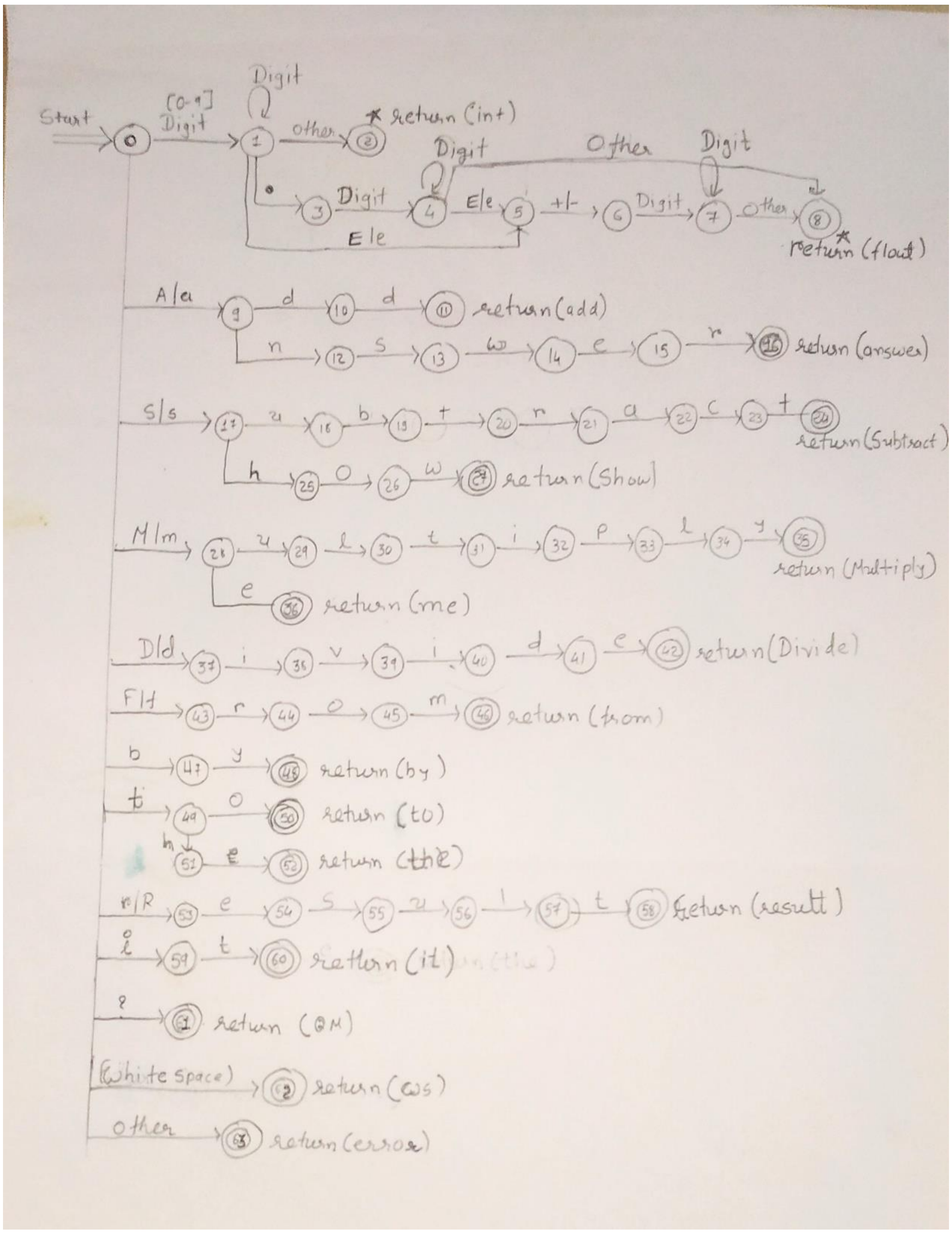
1.2 Project Planning

List of Students with their Roles/Responsibilities:

1. Karia Stuti (IT055)
    - DFA design
    - Regular Expressions
2. Kathiriya Darshakkumar (IT057)
    - Grammar Rules
    - Complete parser with Flex and Bison (Yacc) code
    - Testing with different test cases
    - Documentation
3. Limbani Nihal (IT064)
    - Algorithm Design
    - Regular Expressions
    - C++ implementation

2. LEXICAL PHASE DESIGN

2.1 Deterministic Finite Automaton design for lexer



2.2 Algorithm of lexer

```
while not eof do
state := 0;
input(ch);
case state of
        0:case ch of
                digit: state:= 1;
                'a'|'A': state:=9;
                's'|'S': state:=17;
                'm'|'M': state:=28;
                'd'|'D': state:=37;
                'f'|'F': state:=43;
                'b': state:=47;
                't': state:=49;
                'r'|'R': state:=53;
                'i': state:=59;
                '?': state:=61;
                ' '|'\t: state:=62;
                else: state:=63;
        end case
        1:case ch of
                digit: state:=1;
                '.': state:=3;
                'e'|'E': state:=5;
                else: state:2;
        end case;
        2:case ch of
                unput(ch);//return int
                exit while;
        end case;
        3:case ch of
                digit: state:=4;
                else: exit while;
        end case;
        4:case ch of
                digit: state:=4;
                'e'|'E': state:=5;
                else: state:=8;
        end case;
        5:case ch of
                '+'|'-': state:=6;
                else: exit while;
        end case;
        6:case ch of
                digit: state:=7;
                else: exit while;
        end case;
        7:case ch of
                digit: state:=7;
                else: state:=8;
        end case;
        8:case ch of
                unput(ch);//return float
                exit while;
        end case;
        9:case ch of
                'd': state:=10;
```

```
            'n': state:=12;
            else: exit while;
    end case;
    10:case ch of
            'd': state:=11;
            else: exit while;
    end case;
    11:case ch of
            unput(ch);//return add
            exit while;
    end case;
    12:case ch of
            's': state:=13;
            else: exit while;
    end case;
    13:case ch of
            'w': state:=14;
            else: exit while;
    end case;
    14:case ch of
            'e': state:=15;
            else: exit while;
    end case;
    15:case ch of
            'r': state:=16;
            else: exit while;
    end case;
    16:case ch of
            unput(ch);//return answer
            exit while;
    end case;
    17:case ch of
            'u': state:=18;
            'h': state:=25;
            else: exit while;
    end case;
    18:case ch of
            'b': state:=19;
            else: exit while;
    end case;
    19:case ch of
            't': state:=20;
            else: exit while;
    end case;
    20:case ch of
            'r': state:=21;
            else: exit while;
    end case;
    21:case ch of
            'a': state:=22;
            else: exit while;
    end case;
    22:case ch of
            'c': state:=23;
            else: exit while;
    end case;
    23:case ch of
            't': state:=24;
            else: exit while;
    end case;
```

```
24:case ch of
        unput(ch);//return subtract
        exit while;
end case;
25:case ch of
        'o': state:=26;
        else: exit while;
end case;
26:case ch of
        'w': state:=27;
        else: exit while;
end case;
27:case ch of
        unput(ch);//return show
        exit while;
end case;
28:case ch of
        'u': state:=29;
        'e': state:=36;
        else: exit while;
end case;
29:case ch of
        'l': state:=30;
        else: exit while;
end case;
30:case ch of
        't': state:=31;
        else: exit while;
end case;
31:case ch of
        'i': state:=32;
        else: exit while;
end case;
32:case ch of
        'p': state:=33;
        else: exit while;
end case;
33:case ch of
        'l': state:=34;
        else: exit while;
end case;
34:case ch of
        'y': state:=35;
        else: exit while;
end case;
35:case ch of
        unput(ch);//return multiply
        exit while;
end case;
36:case ch of
        unput(ch);//return me
        exit while;
end case;
37:case ch of
        'i': state:=38;
        else: exit while;
end case;
38:case ch of
        'v': state:=39;
        else: exit while;
```

```
end case;
39:case ch of
        'i': state:=40;
        else: exit while;
end case;
40:case ch of
        'd': state:=41;
        else: exit while;
end case;
41:case ch of
        'e': state:=42;
        else: exit while;
end case;
42:case ch of
        unput(ch);//return divide
        exit while;
end case;
43:case ch of
        'r': state:=44;
        else: exit while;
end case;
44:case ch of
        'o': state:=45;
        else: exit while;
end case;
45:case ch of
        'm': state:=46;
        else: exit while;
end case;
46:case ch of
        unput(ch);//return from
        exit while;
end case;
47:case ch of
        'y': state:=48;
        else: exit while;
end case;
48:case ch of
        unput(ch);//return by
        exit while;
end case;
49:case ch of
        'o': state:=50;
        'h': state:=51;
        else: exit while;
end case;
50:case ch of
        unput(ch);//return to
        exit while;
end case;
51:case ch of
        'e': state:=52;
        else: exit while;
end case;
52:case ch of
        unput(ch);//return the
        exit while;
end case;
53:case ch of
        'e': state:=54;
```

```
                else: exit while;
        end case;
        54:case ch of
                's': state:=55;
                else: exit while;
        end case;
        55:case ch of
                'u': state:=56;
                else: exit while;
        end case;
        56:case ch of
                'l': state:=57;
                else: exit while;
        end case;
        57:case ch of
                't': state:=58;
                else: exit while;
        end case;
        58:case ch of
                unput(ch);//return result
                exit while;
        end case;
        59:case ch of
                't': state:=60;
                else: exit while;
        end case;
        60:case ch of
                unput(ch);//return it
                exit while;
        end case;
        61:case ch of
                unput(ch);//return QM
                exit while;
        end case;
        62:case ch of
                unput(ch);//return WS
                exit while;
        end case;
        63:case ch of
                unput(ch);//return OTHER(error)
                exit while;
        end case;
exit while;
```

2.3 Implementation of lexer

C++ code:

```
#include <bits/stdc++.h>
using namespace std;
int operation(char buf[])
{
   char op[10][10]={"Add","add","Sub","sub","Mul","mul","Div","div"};
   for(int i=0;i<8;i++)
   {
      if(strcmp(op[i],buf)==0)
      return 1;
   }
   return 0;
}
int keyword(char buf[])
{
   char key[20][20]={"From", "from", "Show", "show", "by", "to", "it", "number",
"and", "result","Result", "the", "me", "Answer", "answer" };
   for(int i=0;i<15;i++)
   {
      if(strcmp(key[i],buf)==0)
      return 1;
   }
   return 0;
}
int number(char buf[])
{
   int n=strlen(buf);
   for(int i=0;i<n;i++)
   {
      if(buf[i]>='0' && buf[i]<='9')
      {
         return 1;
      }
      else
      {
         return 0;
      }
   }
   return 1;
}
int main()
{

   FILE *f;
   f=freopen("D:/00 Study/SEM 6/0LAB/LT/LAB 3/inputExpfile2.txt", "r", stdin);
```

```
  freopen("D:/00 Study/SEM 6/0LAB/LT/LAB 3/output2.txt", "w", stdout);
  char ch,buffer[15];
  int d=0;
  while((ch = fgetc(f)) != EOF){
     if(ch=='\n')
     {
        printf("Started New Line. \n");
        continue;
     }
     if(ch=='?')
     {
        printf("It shown end of line: %c\n",ch);
        continue;
     }
     if(isalnum(ch))
     {
        buffer[d++]=ch;
     }
     else if((ch==' ' || ch=='\n') && (d!=0)){
        buffer[d]='\0';
        d=0;
        if(ch!=',')
        {
           if(number(buffer)==1){
              printf("Number identify: %s\n", buffer);
           }
        }
        else{
           printf("\n");
           continue;
        }
        if(operation(buffer)==1)
        {
           printf("operator identify: %s\n",buffer);
        }
        else if(keyword(buffer)==1)
        {
           printf("Keyword identify: %s\n",buffer);
        }
     }
     else if(ch==','||ch==' ')
     {
           continue;
     }
     else
     {
        printf("Not identify token %c\n",ch);
     }
 }
}
```

Flex-code:

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

Keywords
	"From"|"from"|"show"|"Show"|"by"|"to"|"it"|"the"|"me"|"number"|"and"|"Resu
lt"|"result"|"answer"|"Answer"
Operator		"Add"|"add"|"Sub"|"sub"|"Mul"|"mul"|"Div"|"div"
Digit		[0-9]
QM		"?"
WS		[\t\n]
Int		{Digit}+
Float		{Digit}+(\.{Digit}+)?(E[+\-]?{Digit}+)?
Space		{WS}+

%%
{Keywords}	{printf("Keyword : %s\n",yytext);totaltk++;}
{Operator}  {printf("operator is: %s\n",yytext);totaltk++;}
{Int}  {printf("Integer : %s\n",yytext);totaltk++;}
{Float}  {printf("Float No : %s\n",yytext);totaltk++;}
{QM}  {printf("\n");totaltk++;}
{Space} {}
.	{}
%%
int yywrap()
{
	return 1;
}
int main()
{
	yylex();
	printf("Total Number of Tokens In our Example: %d\n",totaltk);
	return 0;
}
```

2.4 Execution environment setup

Step by Step Guide to Install FLEX and Run FLEX Program using Command Prompt(cmd)

Step 1 /*For downloading CODEBLOCKS */

- Open your Browser and type in "codeblocks"
- Goto to Code Blocks and go to the downloads section.
- Click on "Download the binary release".
- Download codeblocks-20.03mingw-setup.exe
- Install the software and keep clicking on next.

/*For downloading FLEX GnuWin32 */

- Open your Browser and type in "download flex gnuwin32" - Go to "Download GnuWin from SourceForge.net"
- Downloading will start automatically.
- Install the software keep clicking on next

/*SAVE IT INSIDE C FOLDER*/

Step 2 /*PATH SETUP FOR CODEBLOCKS*/

- After successful installation

Goto program files → CodeBlocks → MinGW → Bin

- Copy the address of bin, it should somewhat look like

this:-C:\Program Files (x86)\CodeBlocks\MinGW\bin

- Open Control Panel → Goto System → Advanced System Settings → Environment Variables
- Environment Variables → Click on path which is inside System variables →Click on edit
- Click on New and paste the copied path to it:-

C:\Program Files (x86)\CodeBlocks\MinGW\bin
Press Ok!

Step 3 /*PATH SETUP FOR GnuWin32*/

- After successful installation Goto C folder
- Goto GnuWin32 → Bin
- Copy the address of bin it should somewhat look lik e this:-C:\GnuWin32\bin
- Open Control Panel → Goto System → Advanced System Settings → Environment Variables
- Environment Variables → Click on Path which is inside System variables →Click on edit
- Click on New and paste the copied path to it:- C:\GnuWin32\bin
- Press Ok!

/*WARNING!!! PLEASE MAKE SURE THAT PATH OF CODEBLOCKS IS BEFORE GNUWIN32---THE ORDER MATTERS*/

Step 4

- Create a folder on Desktop flex_programs or whichever name you like.
- Open notepad type in a flex program.
- Save it inside the folder like filename.l
- Note :- also include “”” void yywrap(){} “””””” in the .l file

/*Make sure while saving save it as all files rather than as a text document*/

Step 5 /*To RUN FLEX PROGRAM*/

- Goto to Command Prompt(cmd)
- Goto the directory where you have saved the program.
- Type in command :- **flex filename.l**
- Type in command :- **gcc lex.yy.c**
- Execute/Run for windows command prompt :-

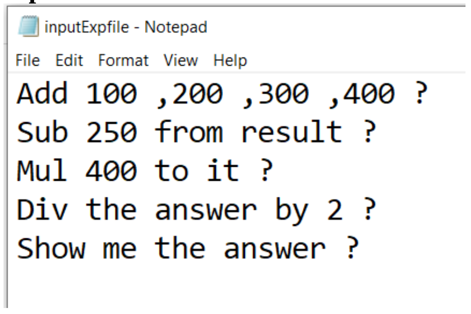
a.exe

Finished.

2.5 Output screenshots of lexer

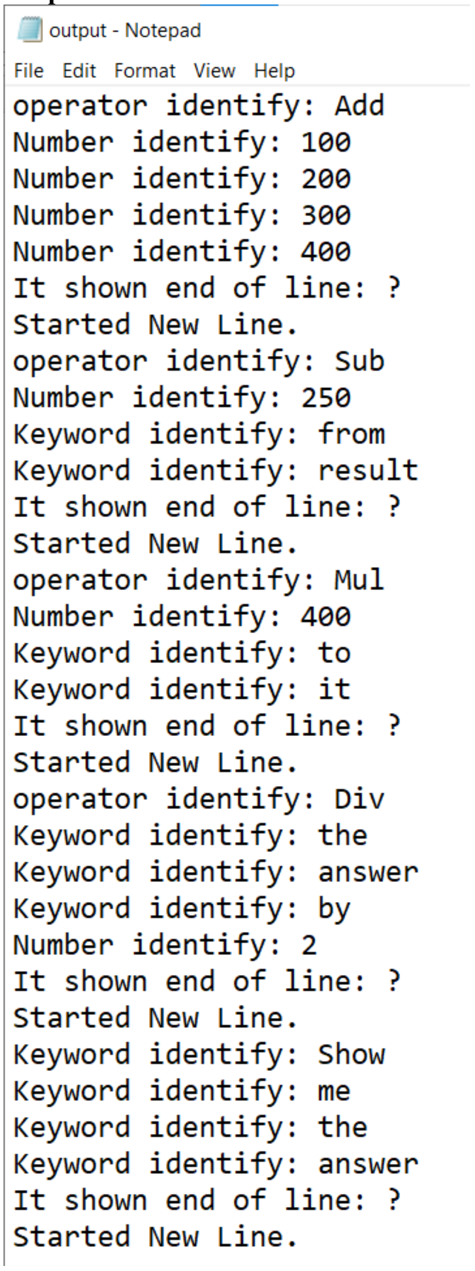
C++ code Output:

Input File:



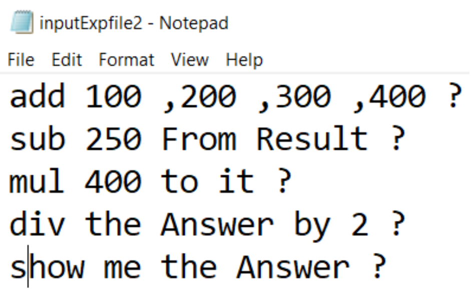
```
Add 100 ,200 ,300 ,400 ?
Sub 250 from result ?
Mul 400 to it ?
Div the answer by 2 ?
Show me the answer ?
```

Output File:



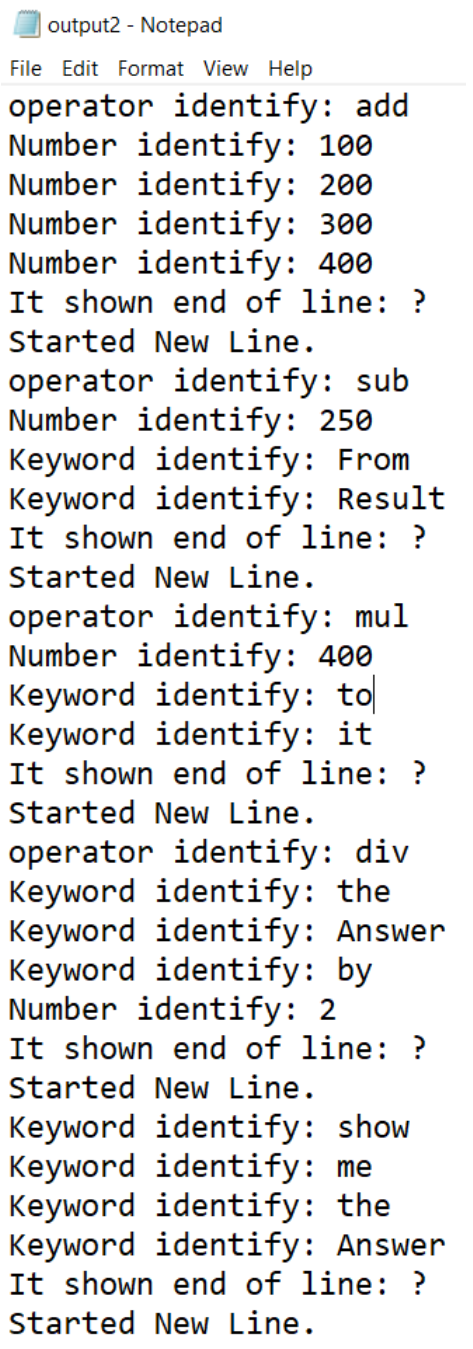
```
operator identify: Add
Number identify: 100
Number identify: 200
Number identify: 300
Number identify: 400
It shown end of line: ?
Started New Line.
operator identify: Sub
Number identify: 250
Keyword identify: from
Keyword identify: result
It shown end of line: ?
Started New Line.
operator identify: Mul
Number identify: 400
Keyword identify: to
Keyword identify: it
It shown end of line: ?
Started New Line.
operator identify: Div
Keyword identify: the
Keyword identify: answer
Keyword identify: by
Number identify: 2
It shown end of line: ?
Started New Line.
Keyword identify: Show
Keyword identify: me
Keyword identify: the
Keyword identify: answer
It shown end of line: ?
Started New Line.
```

Input File2: Show case sensitive



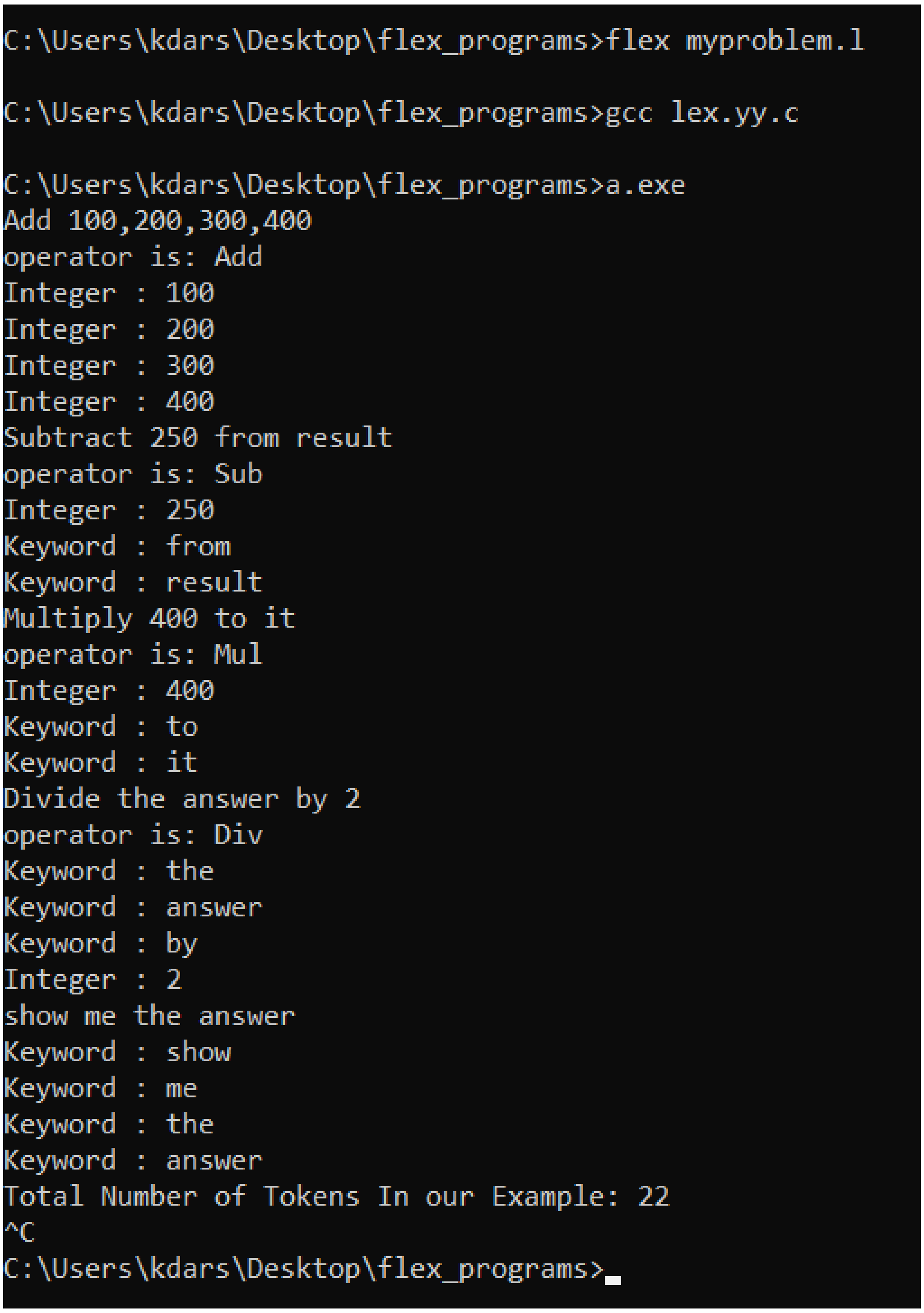
```
add 100 ,200 ,300 ,400 ?
sub 250 From Result ?
mul 400 to it ?
div the Answer by 2 ?
show me the Answer ?
```

Output File2:

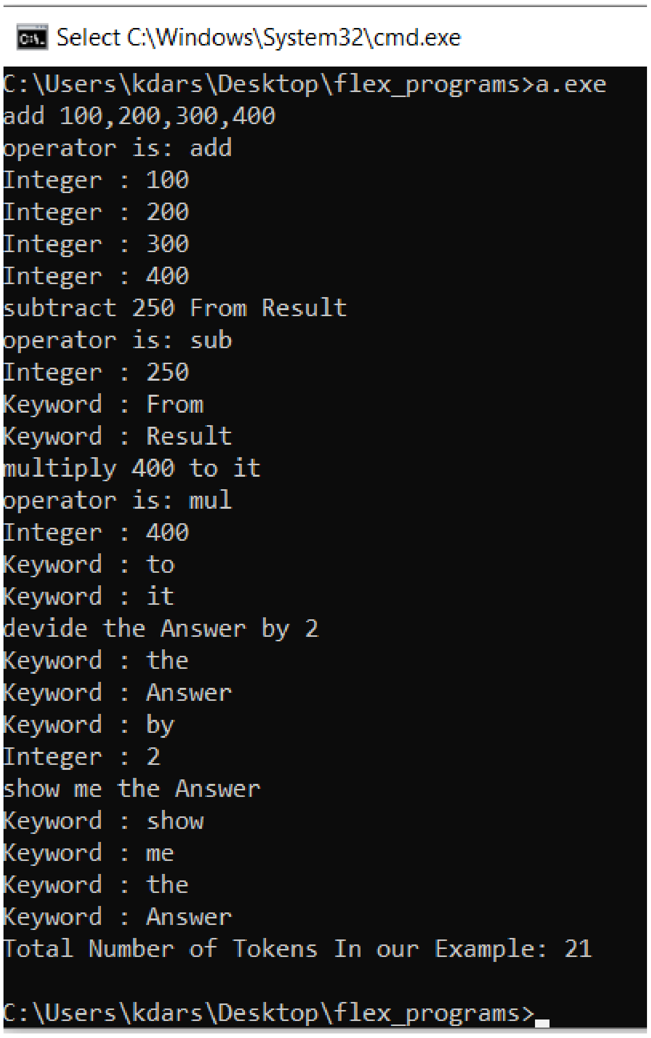


```
operator identify: add
Number identify: 100
Number identify: 200
Number identify: 300
Number identify: 400
It shown end of line: ?
Started New Line.
operator identify: sub
Number identify: 250
Keyword identify: From
Keyword identify: Result
It shown end of line: ?
Started New Line.
operator identify: mul
Number identify: 400
Keyword identify: to
Keyword identify: it
It shown end of line: ?
Started New Line.
operator identify: div
Keyword identify: the
Keyword identify: Answer
Keyword identify: by
Number identify: 2
It shown end of line: ?
Started New Line.
Keyword identify: show
Keyword identify: me
Keyword identify: the
Keyword identify: Answer
It shown end of line: ?
Started New Line.
```

Flex Code Output:



```
C:\Users\kdars\Desktop\flex_programs>flex myproblem.l

C:\Users\kdars\Desktop\flex_programs>gcc lex.yy.c

C:\Users\kdars\Desktop\flex_programs>a.exe
Add 100,200,300,400
operator is: Add
Integer : 100
Integer : 200
Integer : 300
Integer : 400
Subtract 250 from result
operator is: Sub
Integer : 250
Keyword : from
Keyword : result
Multiply 400 to it
operator is: Mul
Integer : 400
Keyword : to
Keyword : it
Divide the answer by 2
operator is: Div
Keyword : the
Keyword : answer
Keyword : by
Integer : 2
show me the answer
Keyword : show
Keyword : me
Keyword : the
Keyword : answer
Total Number of Tokens In our Example: 22
^C
C:\Users\kdars\Desktop\flex_programs>
```



```
C:\Users\kdars\Desktop\flex_programs>a.exe
add 100,200,300,400
operator is: add
Integer : 100
Integer : 200
Integer : 300
Integer : 400
subtract 250 From Result
operator is: sub
Integer : 250
Keyword : From
Keyword : Result
multiply 400 to it
operator is: mul
Integer : 400
Keyword : to
Keyword : it
devide the Answer by 2
Keyword : the
Keyword : Answer
Keyword : by
Integer : 2
show me the Answer
Keyword : show
Keyword : me
Keyword : the
Keyword : Answer
Total Number of Tokens In our Example: 21

C:\Users\kdars\Desktop\flex_programs>
```

In second ss there is devide instead of divide. =>Show that one less token identify.
All see that case sensitive validation in this ss.

3. SYNTAX ANALYZER DESIGN

3.1 Grammar rules

E->S
S-> OPERATION |SHOW
OPERATION -> NUMBER SEMI | NUMBER | KEYWORD
NUMBER-> SEMI NUMBER | KEYWORD | QUE
SHOW-> SHOW KEYWORD
KEYWORD-> KEYWORD | QUE

3.2 Yacc based implementation of syntax analyzer

- **lab9.l**

```
%{
#include<stdio.h>
#include "y.tab.h"
%}
%%
"Add"|"add"|"Sub"|"sub"|"Mul"|"mul"|"Div"|"div" {printf("<%s,
OPERATION>\n", yytext); return OPERATION;}

"From"|"from"|"by"|"to"|"it"|"number"|"and"|"result"|"Result"|"the"|"me"|"Answer"|
"answer" {printf("<%s, KEYWORD>\n", yytext); return KEYWORD;}

"Show"|"show" {printf("<%s, KEYWORD>\n", yytext); return SHOW;}

"," {return SEMICOLON;}

[0-9]+ {printf("<%s, NUMBER>\n",yytext); return NUMBER;}

"?" {printf("<%s, QUESTION MARK>\n",yytext); return QM;}

\n {return NL;}

. {}
%%

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

- **lab9.y**

```
%{

#include<stdio.h>
#include "y.tab.h"
int yyerror(char *s);
int yyparse(void);

%}

%token OPERATION KEYWORD SHOW SEMICOLON QM NUMBER NL

%%

E : S NL { return 0;}

S : T {printf("\nYour Given String is Valid\n\n");}

T : OPERATION NUMBER SEMICOLON NUMBER SEMICOLON NUMBER
SEMICOLON NUMBER QM |
        OPERATION NUMBER KEYWORD KEYWORD QM |
        OPERATION KEYWORD KEYWORD KEYWORD NUMBER QM|
        SHOW KEYWORD KEYWORD KEYWORD QM

%%

int main()
{
   while(1)
   {
      printf("Enter your language input:");
      yyparse();
   }
}
int yyerror(char *s)
{
   fprintf(stderr,"%s\n",s);
   exit(0);
}
```

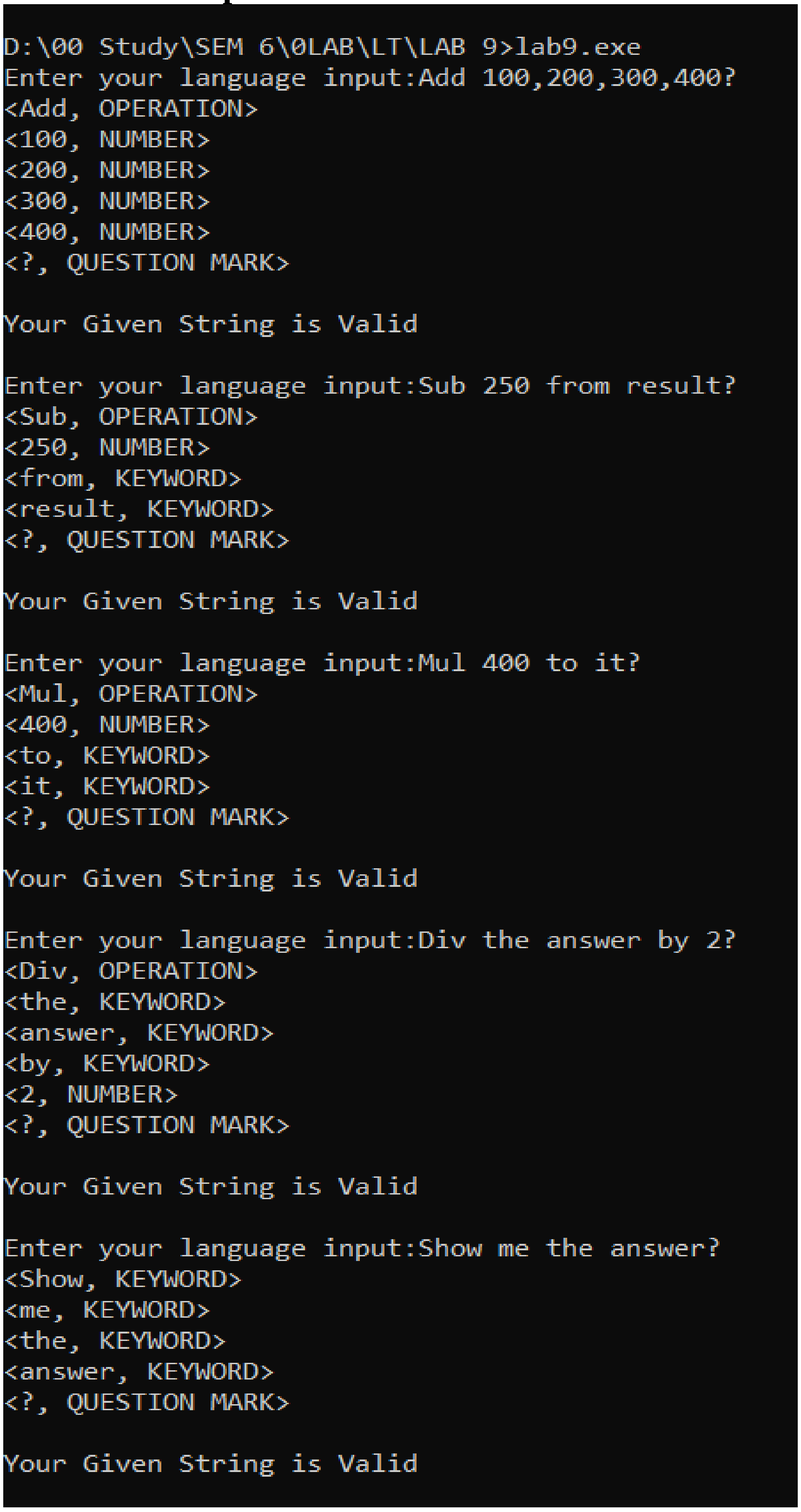
3.3 Execution environment setup

- http://gnuwin32.sourceforge.net/packages/flex.html
- http://gnuwin32.sourceforge.net/packages/bison.html
- When installing on windows you store this in c:/gnuwin32 folder and not inc:/program files(X86)/gnuwin32
- https://sourceforge.net/projects/orwelldevcpp/
- Set environment variable and then run program
- Open a prompt, cd to the directory where your ".l" and ".y" are, and compilethem with:

```
flex lab9.l
bison -dy lab9.y
gcc lex.yy.c y.tab.c lab9.exe
lab9.exe
```

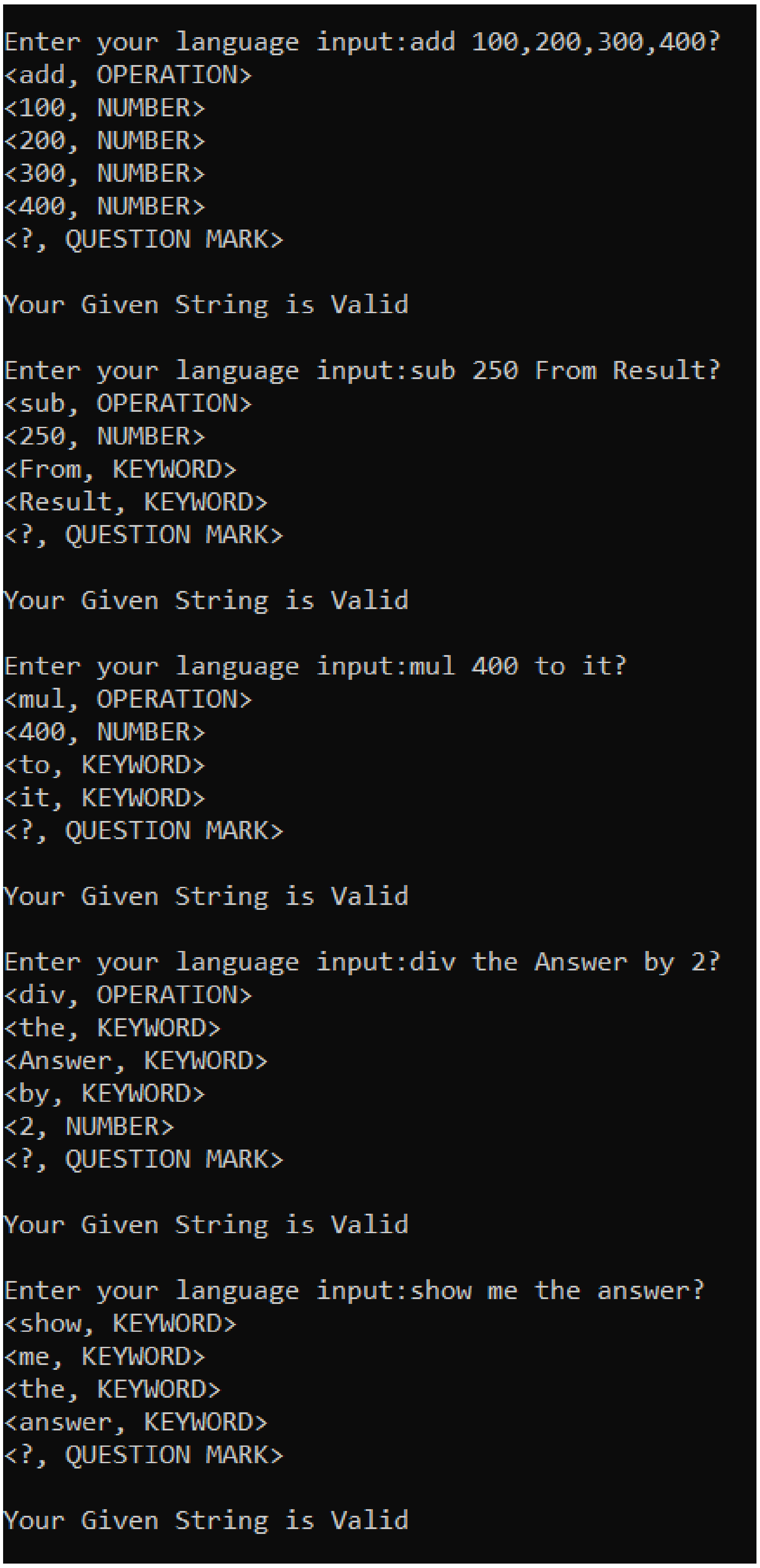
3.4 Output screenshots of implementation

Case: Valid Input



```
D:\00 Study\SEM 6\0LAB\LT\LAB 9>lab9.exe
Enter your language input:Add 100,200,300,400?
<Add, OPERATION>
<100, NUMBER>
<200, NUMBER>
<300, NUMBER>
<400, NUMBER>
<?, QUESTION MARK>

Your Given String is Valid

Enter your language input:Sub 250 from result?
<Sub, OPERATION>
<250, NUMBER>
<from, KEYWORD>
<result, KEYWORD>
<?, QUESTION MARK>

Your Given String is Valid

Enter your language input:Mul 400 to it?
<Mul, OPERATION>
<400, NUMBER>
<to, KEYWORD>
<it, KEYWORD>
<?, QUESTION MARK>

Your Given String is Valid

Enter your language input:Div the answer by 2?
<Div, OPERATION>
<the, KEYWORD>
<answer, KEYWORD>
<by, KEYWORD>
<2, NUMBER>
<?, QUESTION MARK>

Your Given String is Valid

Enter your language input:Show me the answer?
<Show, KEYWORD>
<me, KEYWORD>
<the, KEYWORD>
<answer, KEYWORD>
<?, QUESTION MARK>

Your Given String is Valid
```

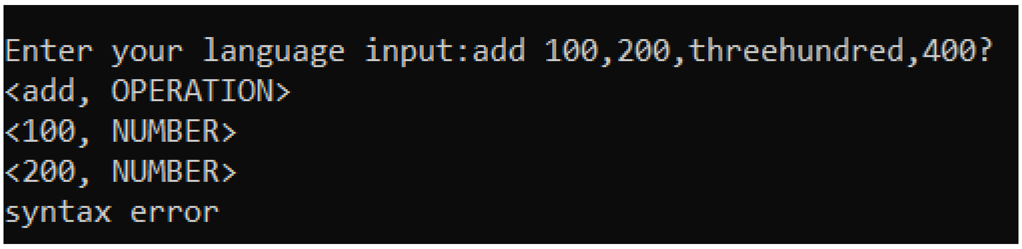
Case: Language seen Some Case sensitive Input.



```
Enter your language input:add 100,200,300,400?
<add, OPERATION>
<100, NUMBER>
<200, NUMBER>
<300, NUMBER>
<400, NUMBER>
<?, QUESTION MARK>

Your Given String is Valid

Enter your language input:sub 250 From Result?
<sub, OPERATION>
<250, NUMBER>
<From, KEYWORD>
<Result, KEYWORD>
<?, QUESTION MARK>

Your Given String is Valid

Enter your language input:mul 400 to it?
<mul, OPERATION>
<400, NUMBER>
<to, KEYWORD>
<it, KEYWORD>
<?, QUESTION MARK>

Your Given String is Valid

Enter your language input:div the Answer by 2?
<div, OPERATION>
<the, KEYWORD>
<Answer, KEYWORD>
<by, KEYWORD>
<2, NUMBER>
<?, QUESTION MARK>

Your Given String is Valid

Enter your language input:show me the answer?
<show, KEYWORD>
<me, KEYWORD>
<the, KEYWORD>
<answer, KEYWORD>
<?, QUESTION MARK>

Your Given String is Valid
```

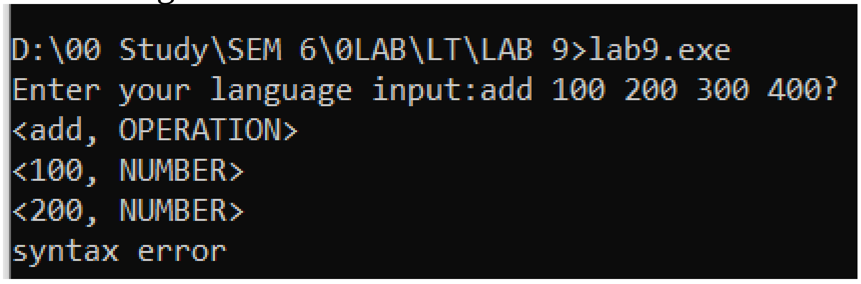
Invalid Input Error:

If user enter number in word form then:



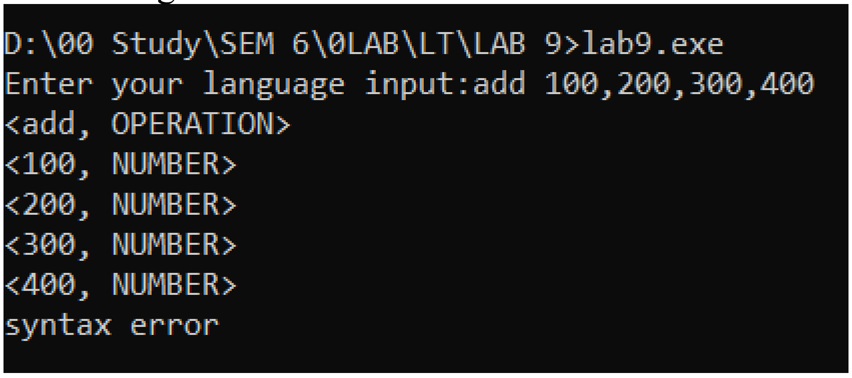
```
Enter your language input:add 100,200,threehundred,400?
<add, OPERATION>
<100, NUMBER>
<200, NUMBER>
syntax error
```

If user forget to enter semicolon in between two number then:



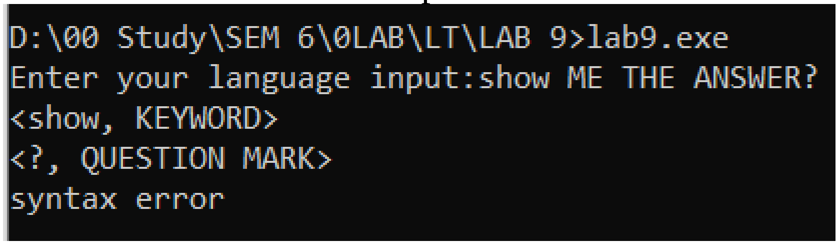
```
D:\00 Study\SEM 6\0LAB\LT\LAB 9>lab9.exe
Enter your language input:add 100 200 300 400?
<add, OPERATION>
<100, NUMBER>
<200, NUMBER>
syntax error
```

If user forget to enter “?” at the end then:



```
D:\00 Study\SEM 6\0LAB\LT\LAB 9>lab9.exe
Enter your language input:add 100,200,300,400
<add, OPERATION>
<100, NUMBER>
<200, NUMBER>
<300, NUMBER>
<400, NUMBER>
syntax error
```

If user enter invalid case Input then:



```
D:\00 Study\SEM 6\0LAB\LT\LAB 9>lab9.exe
Enter your language input:show ME THE ANSWER?
<show, KEYWORD>
<?, QUESTION MARK>
syntax error
```

4.CONCLUSION

This project has been implemented from what we have learnt in our college curriculum and many resources from the web.

After doing this project we were able to better understand different concepts of Language Translators. We conclude that we have got more knowledge about how different compilers are working and handling theerrors.

We would like to thank Prof. Nikita P. Desai for teaching this interesting subject,for the guidance in the project.