COMPILER DESIGN LABORATORY
6th SEMESTER 2018

Submitted by:
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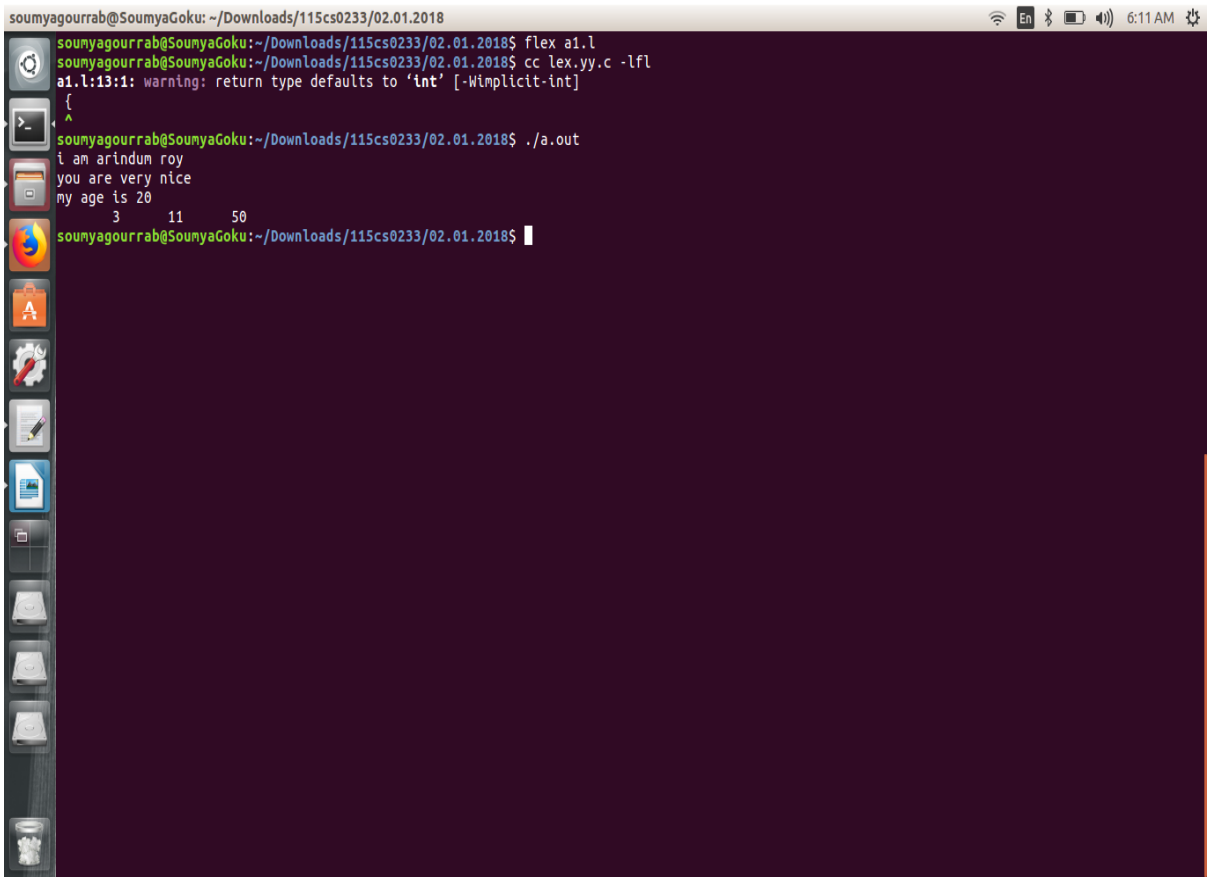
ASSIGNMENT-1

1. Write a flex program which reads through a file and reports the number of lines, words, and characters in the file.

Solution:

```
%{
int chars = 0;
int words = 0;
int lines = 0;
%}
%%
[a-zA-Z]+ { words++; chars += strlen(yytext); }
\n { chars++; lines++; }
. { chars++; }

%%
main(int argc, char **argv)
{
yylex();
printf("%8d%8d%8d\n", lines, words, chars);
}
```

Output:


soumyagourrab@SoumyaGoku: ~/Downloads/115cs0233/02.01.2018
6:11 AM
soumyagourrab@SoumyaGoku:~/Downloads/115cs0233/02.01.2018$ flex a1.l
soumyagourrab@SoumyaGoku:~/Downloads/115cs0233/02.01.2018$ cc lex.yy.c -lfl
a1.l:13:1: warning: return type defaults to 'int' [-Wimplicit-int]
{
^
soumyagourrab@SoumyaGoku:~/Downloads/115cs0233/02.01.2018$ ./a.out
i am arindum roy
you are very nice
my age is 20
3 11 50
soumyagourrab@SoumyaGoku:~/Downloads/115cs0233/02.01.2018$

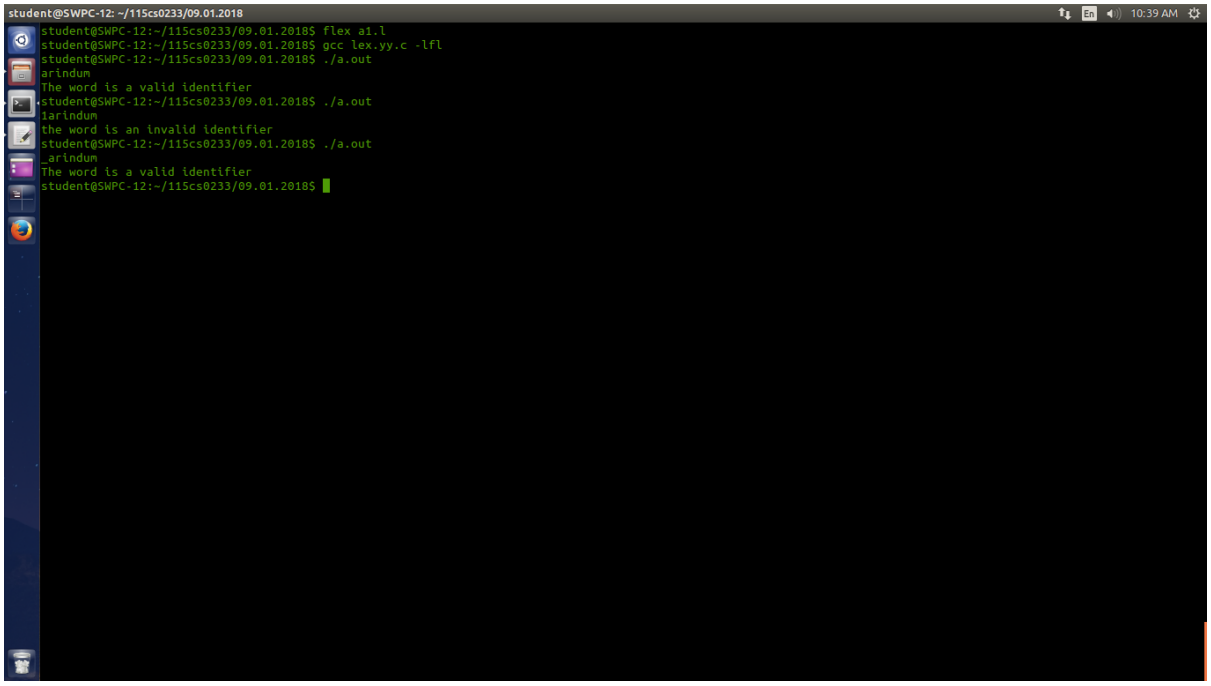
ASSIGNMENT-2

1. Write a flex program that will recognize a valid identifier having symbols a-z, A-Z, 0-9 and underscore. Each identifier should not start with a symbol like decimal or full stop, comma, semi colon, colon. (+, -, *, |, @, &, $, #) are considered as invalid symbols.

Solution:

```
%{
%}
%%
([a-zA-Z_][a-zA-Z0-9_]*) { printf("The word is a valid identifier\n");return 0;}
. {printf("the word is an invalid identifier\n");return 0;}
%%
main(int argc, char **argv)
{
yylex();
}
```

Output:

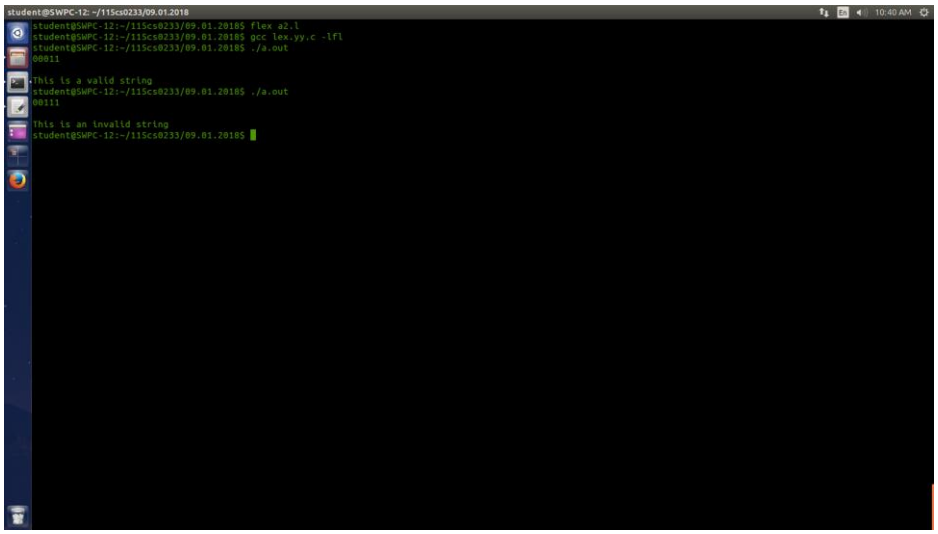


2. Write a flex application that will recognize strings of odd 0’s and even 1’s.

Solution:

```
%{
int noz=0;
int noo=0;
%}
%%
[0] {noz++;}
[1] {noo++;}
. {printf("invalid");}
%%
main(int argc, char **argv) /** *BEGINNING OF THE MAIN FUNCTION */
{
yylex();
if(noz%2 !=0 && noo%2==0)
printf("This is a valid string\n");
else
printf("This is an invalid string\n");
}
```

Output:

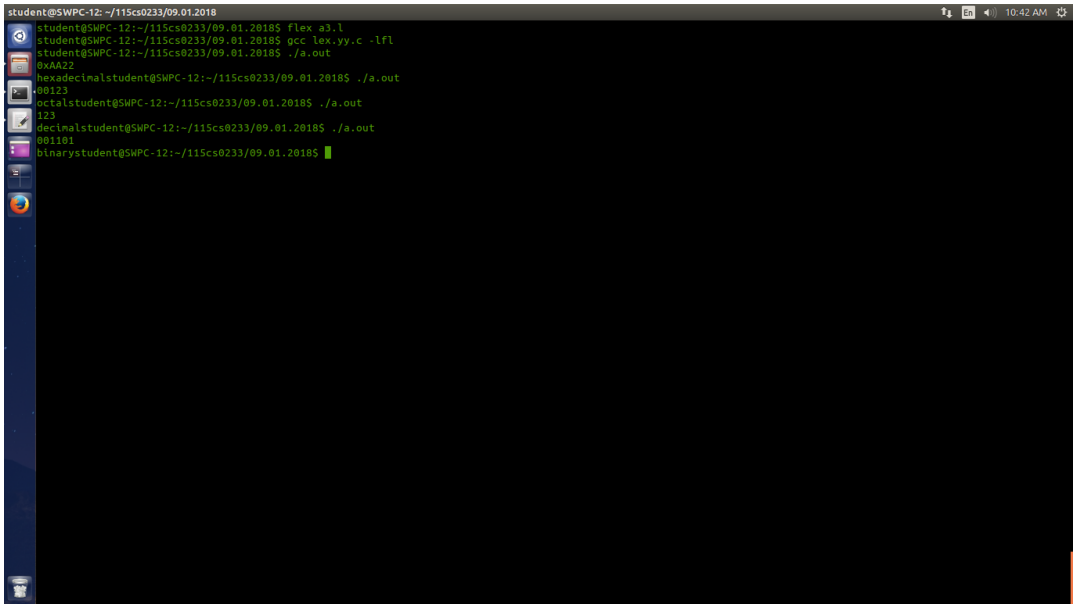


3. Write a flex application that will identify signed or unsigned integers and long integer constant in decimal, hexadecimal, binary and octal representation in C.

Solution:

```
%{
%}
%%
[+]                     { printf("unsigned");}
[-]                     {printf("signed");}
0[xX][0-9a-fA-F]+       { printf("hexadecimal");return 0; }
[0-1]+                  { printf("binary");return 0; }
0[0-7]+                 { printf("octal");return 0; }
[0-9]+                  { printf("decimal");return 0; }
.                       {printf("The word is invalid");return 0;}
%%
main(int argc, char **argv)
{
yylex();
}
```

Output:

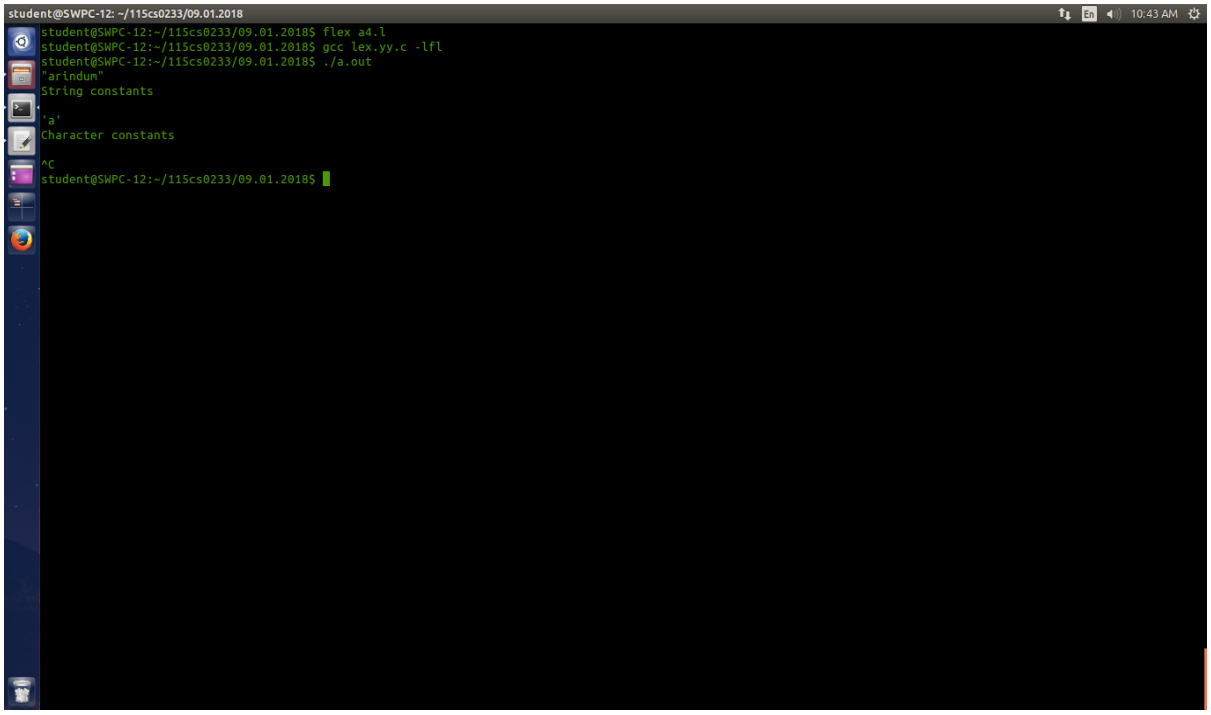


4. Write a flex program that will identify characters and string constants as identified in C language.

Solution:

```
%{
%}
%%
\"(\\.|[^"\\])*\" {printf("String constants\n");} /** *FOR STRING CONSTANTS */
\'(\\.|[^"\\])\' {printf("Character constants\n");} /** *FOR CHARACTER CONSTANTS */
%%
main(int argc, char **argv) /** *BEGINNING OF THE MAIN FUNCTION */
{
yylex();
}
```

Output:



ASSIGNMENT-3

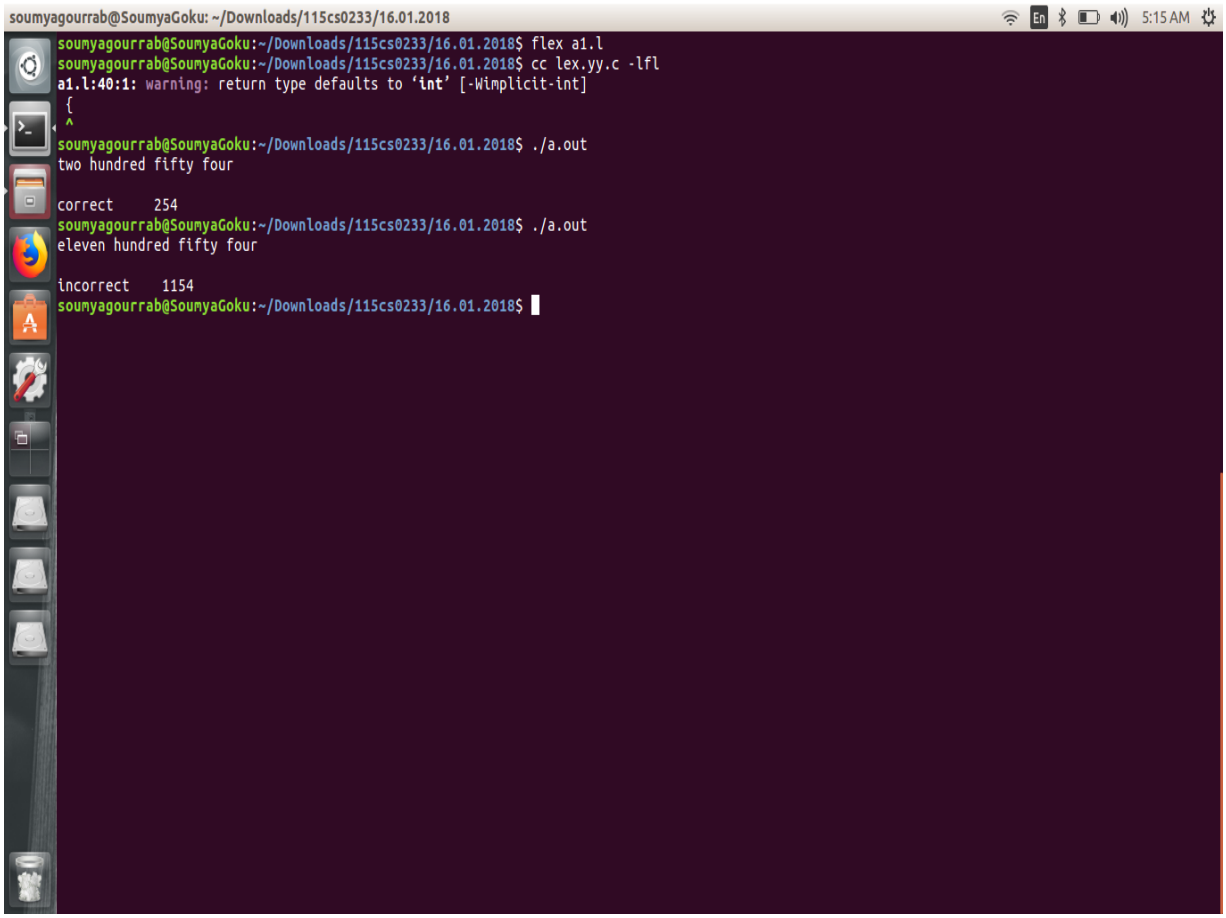
1. Design a machine that will recognize numbers between 0-999. For example: "Two hundred thirty-nine" is a correct form of 239 in words. It should also detect an incorrect input "Twelve hundred twenty-two."

Solution:

```
%{
        int sum = 0;
%}
%%
"zero"          {sum+=0;}
"one"           {sum+=1;}
"two"           {sum+=2;}
"three"                 {sum+=3;}
"four"          {sum+=4;}
"five"          {sum+=5;}
"six"           {sum+=6;}
"seven"                 {sum+=7;}
"eight"         {sum+=8;}
"nine"          {sum+=9;}
"hundred"       {sum*=100;}
"ten"           {sum+=10;}
"eleven"        {sum+=11;}
"twelve"        {sum+=12;}
"thirteen"      {sum+=13;}
"fourteen"      {sum+=14;}
"fifteen"       {sum+=15;}
"sixteen"       {sum+=16;}
"seventeen"     {sum+=17;}
"eighteen"      {sum+=18;}
```

```
"nineteen"              {sum+=19;}
"twenty"                {sum+=20;}
"thirty"                {sum+=30;}
"forty"                 {sum+=40;}
"fifty"                 {sum+=50;}
"sixty"                 {sum+=60;}
"seventy"               {sum+=70;}
"eighty"                {sum+=80;}
"ninety"                        {sum+=90;}
%%

main(int argc, char **argv)
{
        yylex();
        if((sum>=0) && (sum<=999))
                printf("correct%8d\n", sum);
        else
                printf("incorrect%8d\n", sum);
}
```

Output:


soumyagourrab@SoumyaGoku: ~/Downloads/115cs0233/16.01.2018
5:15 AM
soumyagourrab@SoumyaGoku:~/Downloads/115cs0233/16.01.2018$ flex a1.l
soumyagourrab@SoumyaGoku:~/Downloads/115cs0233/16.01.2018$ cc lex.yy.c -lfl
a1.l:40:1: warning: return type defaults to 'int' [-Wimplicit-int]
{
^
soumyagourrab@SoumyaGoku:~/Downloads/115cs0233/16.01.2018$ ./a.out
two hundred fifty four
correct 254
soumyagourrab@SoumyaGoku:~/Downloads/115cs0233/16.01.2018$ ./a.out
eleven hundred fifty four
incorrect 1154
soumyagourrab@SoumyaGoku:~/Downloads/115cs0233/16.01.2018$

ASSIGNMENT-4

1. Consider the following tokens:

	code	value
begin	1	-
end	2	-
if	3	-
else	4	-
then	5	-
identifier	6	(6,sym_tab_ptr)
constants	7	(7,sym_tab_ptr)
“==”	8	(8,1)
!=	8	(8,2)
>=	8	(8,3)
<=	8	(8,4)
<	8	(8,5)
>	8	(8,6)

Design a DFA that will identify and display the code and values for valid tokens, manage symbol table for identifiers and constants, and find errors.

Solution:

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

// Returns 'true' if the character is a DELIMITER.
bool isDelimiter(char ch)
{
   if (ch == ' ' || ch == '+' || ch == '-' || ch == '*' ||
      ch == '/' || ch == ',' || ch == ';' || ch == '>' ||
```

```
        ch == '<' || ch == '=' || ch == '(' || ch == ')' ||
        ch == '[' || ch == ']' || ch == '{' || ch == '}')
        return (true);
    return (false);
}

// Returns 'true' if the character is an OPERATOR.
bool isOperator(char ch)
{
    if (ch == '+' || ch == '-' || ch == '*' ||
        ch == '/' || ch == '>' || ch == '<' ||
        ch == '=')
        return (true);
    return (false);
}

// Returns 'true' if the string is a VALID IDENTIFIER.
bool validIdentifier(char* str)
{
    if (str[0] == '0' || str[0] == '1' || str[0] == '2' ||
        str[0] == '3' || str[0] == '4' || str[0] == '5' ||
        str[0] == '6' || str[0] == '7' || str[0] == '8' ||
        str[0] == '9' || isDelimiter(str[0]) == true)
        return (false);
    return (true);
}

// Returns 'true' if the string is a KEYWORD.
bool isKeyword(char* str)
```

```
{
    if (!strcmp(str, "if") || !strcmp(str, "else") ||
        !strcmp(str, "while") || !strcmp(str, "do") ||
        !strcmp(str, "break") ||
         !strcmp(str, "continue") || !strcmp(str, "int")
        || !strcmp(str, "double") || !strcmp(str, "float")
        || !strcmp(str, "return") || !strcmp(str, "char")
        || !strcmp(str, "case") || !strcmp(str, "char")
        || !strcmp(str, "sizeof") || !strcmp(str, "long")
        || !strcmp(str, "short") || !strcmp(str, "typedef")
        || !strcmp(str, "switch") || !strcmp(str, "unsigned")
        || !strcmp(str, "void") || !strcmp(str, "static")
        || !strcmp(str, "struct") || !strcmp(str, "goto"))
        return (true);
    return (false);
}

// Returns 'true' if the string is an INTEGER.
bool isInteger(char* str)
{
    int i, len = strlen(str);

    if (len == 0)
        return (false);
    for (i = 0; i < len; i++) {
        if (str[i] != '0' && str[i] != '1' && str[i] != '2'
            && str[i] != '3' && str[i] != '4' && str[i] != '5'
            && str[i] != '6' && str[i] != '7' && str[i] != '8'
            && str[i] != '9' || (str[i] == '-' && i > 0))
```

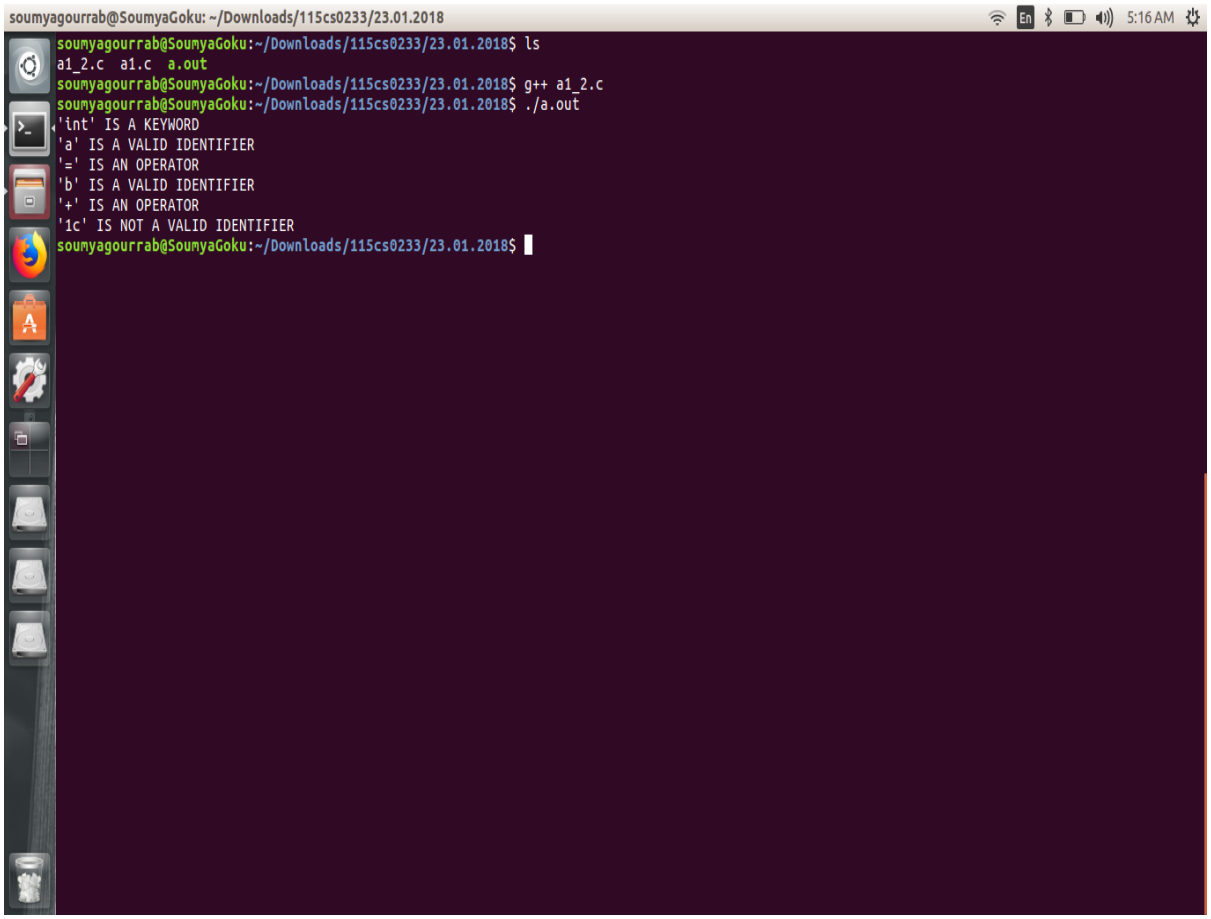
```
            return (false);
    }
    return (true);
}

// Returns 'true' if the string is a REAL NUMBER.
bool isRealNumber(char* str)
{
    int i, len = strlen(str);
    bool hasDecimal = false;

    if (len == 0)
        return (false);
    for (i = 0; i < len; i++) {
        if (str[i] != '0' && str[i] != '1' && str[i] != '2'
            && str[i] != '3' && str[i] != '4' && str[i] != '5'
            && str[i] != '6' && str[i] != '7' && str[i] != '8'
            && str[i] != '9' && str[i] != '.' ||
            (str[i] == '-' && i > 0))
            return (false);
        if (str[i] == '.')
            hasDecimal = true;
    }
    return (hasDecimal);
}

// Extracts the SUBSTRING.
char* subString(char* str, int left, int right)
{
```

```
    int i;
    char* subStr = (char*)malloc(
                sizeof(char) * (right - left + 2));

    for (i = left; i <= right; i++)
        subStr[i - left] = str[i];
    subStr[right - left + 1] = '\0';
    return (subStr);
}

// Parsing the input STRING.
void parse(char* str)
{
    int left = 0, right = 0;
    int len = strlen(str);

    while (right <= len && left <= right) {
        if (isDelimiter(str[right]) == false)
            right++;

        if (isDelimiter(str[right]) == true && left == right) {
            if (isOperator(str[right]) == true)
                printf("'%c' IS AN OPERATOR\n", str[right]);

            right++;
            left = right;
        } else if (isDelimiter(str[right]) == true && left != right
                || (right == len && left != right)) {
            char* subStr = subString(str, left, right - 1);
```

```
            if (isKeyword(subStr) == true)
                printf("'%s' IS A KEYWORD\n", subStr);

            else if (isInteger(subStr) == true)
                printf("'%s' IS AN INTEGER\n", subStr);

            else if (isRealNumber(subStr) == true)
                printf("'%s' IS A REAL NUMBER\n", subStr);

            else if (validIdentifier(subStr) == true
                    && isDelimiter(str[right - 1]) == false)
                printf("'%s' IS A VALID IDENTIFIER\n", subStr);

            else if (validIdentifier(subStr) == false
                    && isDelimiter(str[right - 1]) == false)
                printf("'%s' IS NOT A VALID IDENTIFIER\n", subStr);
            left = right;
        }
    }
    return;
}

// DRIVER FUNCTION
int main()
{
     // maximum legth of string is 100 here
    char str[100] = "int a = b + 1c; ";
```

```
    parse(str); // calling the parse function


    return (0);
}
```

Output:



ASSIGNMENT-5

1. Design a flex-bison application that will check the correctness of the declaration of variables and functions in C language.

Example:

type id1, id2;

type func1(type param1, type param2);

type= {void, int, char, float} (keywords)

id1, id2, func1, param1, param2 are identifiers.

Token separators or punctuations are , ; ( )

Solution:

Flex code:

```
%{
#include "a1.tab.h"
#include <string.h>
extern int yylex(void);

int yylval;
int count = 0;

char cc[100][100];
int n = 0;
int c = 0;
int i;
int l;
int flag=0;
%}
```

```
%%
("int")|("float")|("char")|("void") { return D;}
[ ][a-zA-Z_][a-zA-Z0-9]* {
        c=1;
        for(i=0;i<n;i++){
                if(strcmp(cc[i],yytext)==0){
                        printf("Identifier Already Declared\n");
                        c=0;
                        flag=1;
                }
        }
        if(c==1){
                strcpy(cc[n],yytext);
                n=n+1;
                count++;
        }
        return ID;
}
"(" {return X;}
")" {return Y;}
";" { return E;}
"," { return CO;}
[\n] { return EOL;}
[ \t] { }
. { printf("Invalid Identifier\n");
        return I;}
%%
```

Bison code:

```
%{
#include <stdio.h>
int yylex();

void yyerror(const char *s);

extern int flag;
%}



%token D ID E CO EOL I X Y
%%
S:
| D ID X Z Y E { printf(" The given function declaration is correct  \n"); return 0;}
| D F E EOL{ if(flag==0)printf(" The given variable declaration is correct  \n"); else printf("The given variable declaration is incorrect \n"); return 0;}
| D EOL{printf("Incorrect\n Incomplete Statement \n"); return 0;}
| D F EOL{printf("Incorrect\n Incomplete Statement \n" ); return 0;}
| D IN F IN E EOL
;
Z: D ID CO Z { }
| D ID { }
| { }
;
F: ID CO F {  }
| ID {  }
;
IN: I {  }
```

```
;
%%

main(int argc, char **argv) {
   yyparse();
}

void yyerror(const char *s) {
        printf("%s \n", s);
}
```

Output: