先乘除後加減

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作法：

照著講義內架構來製造優先順序，如下圖。

- <expression> → <factor> {<add op><factor>}
- <factor>→ <primary> {<mult op><primary>}
- <primary> → (< expression >)
- <primary> → ID
- <primary> → INTLITERAL

用左結合的方式先處理為加號或負號，再分支出乘號或除號，最後再處理複數和括號。

程式碼：

Flex：

```
%{
    #include "y.tab.h" // Ensure this includes the yylval declaration
%}

%%

[0-9]+  {
            yylval.intValue = atoi(yytext); // Convert string to
integer     return Realnumber;
        }
"+"     { return Plus; }
"-"     { return Minus; }
"*"     { return Mult; }
"/"     { return Div; }
"("     { return Left; }
")"     { return Right; }
[ \t]   { /* Ignore whitespace */ }
\n      { return '\n'; }
<<EOF>> { return '\n'; }
.       { printf("Unknown character: %s\n", yytext); }

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

Yacc :

```
%{
    #include<stdio.h>
    #include<stdlib.h> // Required for atof
    void yyerror(char *msg);
    extern int yylex();
%}

%union {
    int intValue; // Integer type for numbers
}

%token <intValue> Realnumber
%token Plus Minus Mult Div Left Right
%type <intValue> expression factor primary

%left Plus Minus
%left Mult Div
%right UMINUS
%%

statement :
    /* empty */
    | expression '\n' statement
    | expression statement
    ;

expression :
    expression Plus factor
        { $$ = $1 + $3; printf("%d add %d is %d\n", $1, $3, $$); }
    | expression Minus factor
        { $$ = $1 - $3; printf("%d cut %d is %d\n", $1, $3, $$); }
    | factor
        { $$ = $1; }
    ;

factor :
    factor Mult primary
        { $$ = $1 * $3; printf("%d mult %d is %d\n", $1, $3, $$);
}   | factor Div primary
        { $$ = $1 / $3; printf("%d div %d is %d\n", $1, $3, $$); }
    | primary
        { $$ = $1; }
    ;

primary :
    Realnumber
        { $$ = $1; }
    | Minus primary %prec UMINUS
        { $$ = -$2; printf("neg %d is %d\n", $2, $$); }
    | Left expression Right
        { $$ = $2; }
    ;

%%

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

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

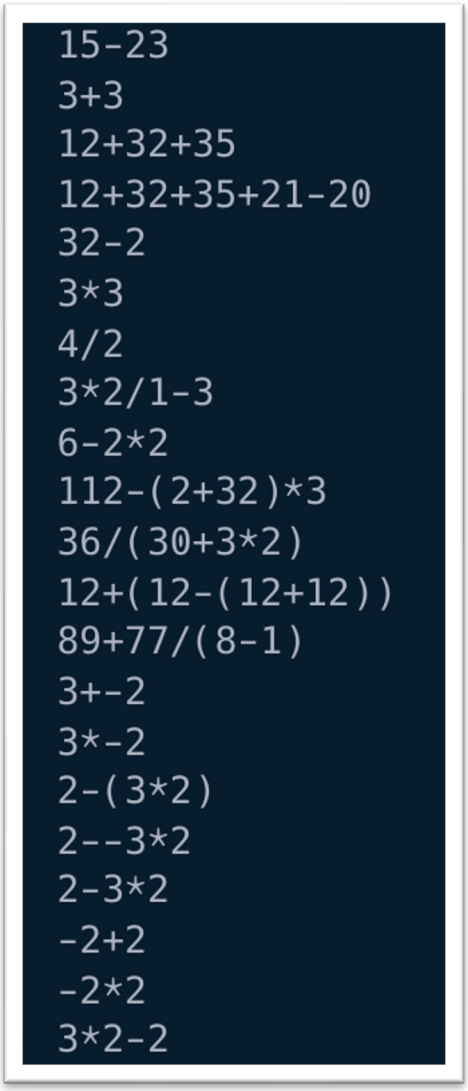
C++ :

```cpp
#include <iostream>
#include <fstream>
#include <string>
using namespace std;

int numC=0,symC=0;
int nextMinus=0;
int numArray[100];
char symArray[100];

int prec(char symbol)
{
    if(symbol=='+'||symbol=='-') return 1;
    if(symbol=='*'||symbol=='/') return 2;
    return 0;
}

void readNeg(string num)
{
    if(num[symC+numC]=='-')
    {
        nextMinus=1;
    }
}

void dostringToInt(string num)
{
    int number=0;
    for(char i : num)
    {
        if(i!=13) number=(i-'0')+number*10;
    }
    if(nextMinus==1) {number*=-1;nextMinus=0;}
    numArray[numC++] = number;
}

void doCalculate()
{
    int a = numArray[numC-2];
    int b = numArray[numC-1];
    int c = symArray[symC-1];
    if(c=='+') {cout << a << "+" << b << "=" << a+b << endl;numArray[numC-
2]=a+b;} if(c=='-') {cout << a << "-" << b << "=" << a-b << endl;numArray[numC-2]=a-
b;} if(c=='*') {cout << a << "*" << b << "=" << a*b << endl;numArray[numC-
2]=a*b;} if(c=='/') {cout << a << "/" << b << "=" << a/b << endl;numArray[numC-
2]=a/b;}
    symC--;
    numC--;
}

void dealBracket()
{
    while(symArray[symC-1]!='(')
    {
        doCalculate();
    }
    symC--;
}


void throwIntoArray(string input)
{
    int last;
    string numTemp;
    if(input[0]=='('||input[0]=='-') last=0;
    else last=1;

    for(char c : input)
    {
        if(c=='(')
        {
            readNeg(input);
            if(numTemp!="") {dostringToInt(numTemp);numTemp="";}
            symArray[symC++]=c;
            last=0;
        }
        else if(c==')')
        {
            if(numTemp!="") {dostringToInt(numTemp);numTemp="";}
            dealBracket();
            last=0;
        }
```

```
        else if(c== '*' ||c== '/' ||c== '+' ||c== '-')
        {
            readNeg(input);
            if(numTemp!="") {dostringToInt(numTemp);numTemp="";}
            if(nextMinus==1&&c=='-') continue;
            if(symC==0) symArray[symC++]=c;
            else
            {
                while(prec(c)<=prec(symArray[symC-1]))
                {
                    doCalculate();
                }
                if(prec(c)>prec(symArray[symC-1])) symArray[symC++]=c;
            }
            last=0;
        }
        else if(c!='\r')
        {
            numTemp+=c;
            last=1;
        }
    }
    if(numTemp!="") {dostringToInt(numTemp);numTemp="";}
    while(symC>0){doCalculate();}
    cout << endl << "ans:" << numArray[0] << endl << "------" << endl;
}
void init()
{
    for(int i=0;i<100;i++)
    {
        numArray[i]=0;
        symArray[i]=' ';
    }
    numC=0;
    symC=0;
}

int main()
{
    string input;
    ifstream in;
    in.open("test.txt");
    while(getline(in,input,'\n'))
    {
        throwIntoArray(input);
        init();
    }
}
```

執行結果：

Input：

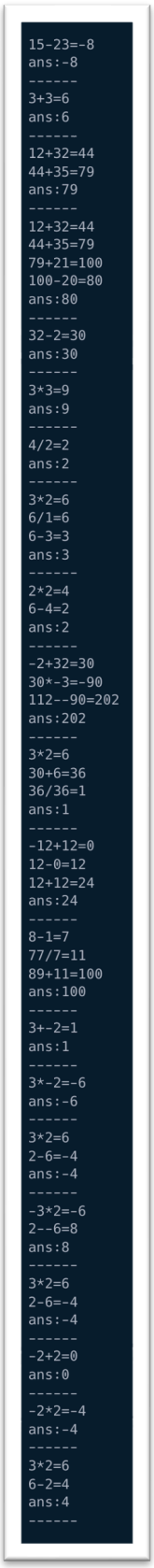

15-23
3+3
12+32+35
12+32+35+21-20
32-2
3*3
4/2
3*2/1-3
6-2*2
112-(2+32)*3
36/(30+3*2)
12+(12-(12+12))
89+77/(8-1)
3+-2
3*-2
2-(3*2)
2--3*2
2-3*2
-2+2
-2*2
3*2-2

Output：

Yacc:

```
15 cut 23 is -8
3 add 3 is 6
12 add 32 is 44
44 add 35 is 79
12 add 32 is 44
44 add 35 is 79
79 add 21 is 100
100 cut 20 is 80
32 cut 2 is 30
3 mult 3 is 9
4 div 2 is 2
3 mult 2 is 6
6 div 1 is 6
6 cut 3 is 3
2 mult 2 is 4
6 cut 4 is 2
2 add 32 is 34
34 mult 3 is 102
112 cut 102 is 10
3 mult 2 is 6
30 add 6 is 36
36 div 36 is 1
12 add 12 is 24
12 cut 24 is -12
12 add -12 is 0
8 cut 1 is 7
77 div 7 is 11
89 add 11 is 100
neg 2 is -2
3 add -2 is 1
neg 2 is -2
3 mult -2 is -6
3 mult 2 is 6
2 cut 6 is -4
neg 3 is -3
-3 mult 2 is -6
2 cut -6 is 8
3 mult 2 is 6
2 cut 6 is -4
neg 2 is -2
-2 add 2 is 0
neg 2 is -2
-2 mult 2 is -4
3 mult 2 is 6
6 cut 2 is 4
```

C++:


15-23=-8
ans:-8

3+3=6
ans:6

12+32=44
44+35=79
ans:79

12+32=44
44+35=79
79+21=100
100-20=80
ans:80

32-2=30
ans:30

3*3=9
ans:9

4/2=2
ans:2

3*2=6
6/1=6
6-3=3
ans:3

2*2=4
6-4=2
ans:2

-2+32=30
30*-3=-90
112--90=202
ans:202

3*2=6
30+6=36
36/36=1
ans:1

-12+12=0
12-0=12
12+12=24
ans:24

8-1=7
77/7=11
89+11=100
ans:100

3+-2=1
ans:1

3*-2=-6
ans:-6

3*2=6
2-6=-4
ans:-4

-3*2=-6
2--6=8
ans:8

3*2=6
2-6=-4
ans:-4

-2+2=0
ans:0

-2*2=-4
ans:-4

3*2=6
6-2=4
ans:4

討論：

輸入結尾如果沒有換行的話會 syntax error，在 statement 加入沒有換行的規則就可以解決。

心得：

這個作業有點麻煩但不會很困難。

（註：有多做 c++版本）