# Laboratory 4

# Arithmetic Operations

**Concepts:**

* Using the S12 arithmetic operations

**Objectives:**

* Use the S12 arithmetic operations (adds, subtracts, multiplies, and divides) to implement mathematical functions using integers.

**Files Needed:**

* Lab04.zip from Blackboard

**Assignment:**

In this lab, you will write a program in assembly that solves for the real roots of a second order polynomial using the quadratic formula.

Your program must meet the following requirements.

1. Inputs a, b, and c shown in the equation above are all 8-bit signed numbers supplied by the user in addresses $3000, $3001, and $3002 respectively.
2. If the equation has two real solutions, your program must return them as 16-bit signed numbers in addresses $3010 and $3012 (in any order), and address $3014 must be set to $00 to indicate success. Note that if the equation has a repeated root, it must be stored in both locations.
3. If the equation does not have two real roots (i.e. the expression under the radical is negative) or if input a is 0 (which would result in a divide-by-0 error), your program must write $FF to address $3014. There is no requirement for the values in locations $3010 to $3013 in this case.
4. To help keep things simple, you may assume the inputs will be restricted such that if the equation has two real roots, they will be integers.

Write your program in assembly using CodeWarrior. Be sure to test the program with several sets of data.

You should use the Lab04 template available on Blackboard. Your program requires the square root operation, and there is no square root assembly instruction. Lab04 contains a subroutine that does this. To use it, load register D with a positive 16-bit signed number and enter “JSR sqrt” as the next assembly instruction. The square root is available as a 16-bit signed number in D (and the input is destroyed by the subroutine).

The template has a small main program that shows the proper use of this subroutine by calling it several times with different values. A NOP instruction has been added after each “JSR sqrt” as convenient spots to place breakpoints to verify the result in D. These should be removed after experimenting with the subroutine.

**Deliverables/Scoring:**

Successful video demonstration of the program is required for acceptance of the lab report, then,

* 10 points - Compliance with posted lab report guidelines.
* 90 points – Assembly code for the program.

Submit the deliverables according to the lab report guidelines posted on Blackboard. Note that a PDF report with the code and an assembly file must be submitted in a ZIP file.