

Quarter Square Multiplication:

Two quantities can be multiplied using quarter squares by employing the following identity some attribute to Babylonian mathematics:

$$\left\lfloor \frac{(x+y)^2}{4} \right\rfloor - \left\lfloor \frac{(x-y)^2}{4} \right\rfloor = \frac{1}{4} \left((x^2 + 2xy + y^2) - (x^2 - 2xy + y^2) \right) = \frac{1}{4} (4xy) = xy.$$

If $x + y$ is odd then $x - y$ will also be odd, this means any fraction will cancel out, so no accuracy is lost by discarding the remainder.

Formula: $\frac{1}{4}(x^2 + y^2)^2 - \frac{1}{4}(x^2 - y^2)^2$

Algorithm:

```
int res=0
// Quarter square for the sum of x and y
int q1 =(1/4)* ((x + y)^ 2);

// Quarter square for the difference of x and y
int q2 =(1/4)* ((x - y) ^ 2);

// Formula for Quarter Square Multiplication
int result = (q1) - (q2);
```

RISC-V Code:

Quarter Square Multiplication for Multiplying 2 Numbers in RISC-V
Assembly Language

.data

Initialize the data section with the two numbers to be
multiplied

num1: .word 7

num2: .word 5

result: .word 0

.text

Program starts at the .text section

la x1, result

Load the first number into register t0

lw t0, num1

Load the second number into register t1

lw t1, num2

Calculate $(a+b)^2$

add t2, t0, t1

mul t2, t2, t2

srli t2, t2, 2 # $t2 = 1/4 * (a+b)^2$

Calculate $(a-b)^2$

sub t3, t0, t1

mul t3, t3, t3

srli t3, t3, 2 # $t3 = 1/4 * (a-b)^2$

Calculate the final result: $1/4 * (a+b)^2 - 1/4 * (a-b)^2$

sub t4, t2, t3

Store the final result in the result variable

sw t4, 0(x1)

```
# Halt the program
nop
```

Output:

Expected results:

$135 \times 243 = 32805$

$135 \times (-897) = -121095$

Obtained results:

Memory viewer						
Address	Word	Byte 0	Byte 1	Byte 2	Byte 3	
0x10000008	32805	37	128	0	0	
0x10000004	243	243	0	0	0	
0x10000000	135	135	0	0	0	

Execution info

Cycles: 15

Instrs. retired: 15

CPI: 1

IPC: 1

Clock rate: 10.20 Hz

Memory viewer						
Address	Word	Byte 0	Byte 1	Byte 2	Byte 3	
0x10000008	-121095	249	38	254	255	
0x10000004	-897	127	252	255	255	
0x10000000	135	135	0	0	0	

Execution info

Cycles: 15

Instrs. retired: 15

CPI: 1

IPC: 1

Clock rate: 10.42 Hz