**ARM Instructions Worksheet #11**

**Constant Multiples**

Prerequisite Reading: Chapter 7  
Revised: May 11, 2020

**Objectives:** *To use the web-based simulator (“CPUlator”) to better understand …*

1. That multiplying by a constant requires two instructions – one to load a register with the constant followed by a MUL.
2. The use of a single addition or subtraction with shifting to compute N times a variable without multiplying.
3. The use of a two-instruction sequence to compute N times a variable in the same time as using a MUL.

**To do offline: Answer the questions that follow the listing below. (Numbers at far left are memory addresses.)**

```assembly
.global _start
.syntax unified

00000000 _start: LDR R1,=1 // *** EXECUTION STARTS HERE ***

// Creating multiples using 1 instruction (faster than MUL)
00000004 LSL R0,R1,3
00000008 ADD R0,R1,R1,LSL 3
0000000C RSB R0,R1,R1,LSL 3
00000010 SUB R0,R1,R1,LSL 3
00000014 MVN R0,R1,LSL 3

// Creating multiples using 2 instructions (same time as MUL)
00000018 ADD R0,R1,R1,LSL 2
0000001C LSL R0,R0,1
00000020 ADD R0,R1,R1,LSL 2
00000024 ADD R0,R1,R0,LSL 2
00000028 ADD R0,R1,R1,LSL 4
0000002C SUB R0,R0,R1,LSL 2
00000030 RSB R0,R1,R1,LSL 3
00000034 LSL R0,R0,1
00000038 ADD R0,R1,R1,LSL 2
0000003C RSB R0,R1,R0,LSL 2
00000040 done: B done // Infinite loop

.end
```
What is in register R0 after executing the LSL instruction at address 00000004₁₆?

What is in register R0 after executing the ADD instruction at address 00000008₁₆?

What is in register R0 after executing the RSB instruction at address 0000000C₁₆?

What is in register R0 after executing the SUB instruction at address 00000010₁₆?

What is in register R0 after executing the MVN instruction at address 00000014₁₆?

What is in register R0 after executing the LSL instruction at address 0000001C₁₆?

What is in register R0 after executing the ADD instruction at address 00000024₁₆?

What is in register R0 after executing the SUB instruction at address 0000002C₁₆?

What is in register R0 after executing the LSL instruction at address 00000034₁₆?

What is in register R0 after executing the RSB instruction at address 0000003C₁₆?

Getting ready: Now use the simulator to collect the following information and compare to your earlier answers.

1. Click [here](#) to open a browser for the ARM instruction simulator with pre-loaded code.
2. Change the number format in the “Settings” window to signed decimal.

Step 1: Press F2 once per ARM instruction as needed to see what the simulator says for the following:

What is in register R0 after executing the LSL instruction at address 00000004₁₆?

What is in register R0 after executing the ADD instruction at address 00000008₁₆?

What is in register R0 after executing the RSB instruction at address 0000000C₁₆?

What is in register R0 after executing the SUB instruction at address 00000010₁₆?

What is in register R0 after executing the MVN instruction at address 00000014₁₆?

What is in register R0 after executing the LSL instruction at address 0000001C₁₆?

What is in register R0 after executing the ADD instruction at address 00000024₁₆?

What is in register R0 after executing the SUB instruction at address 0000002C₁₆?

What is in register R0 after executing the LSL instruction at address 00000034₁₆?

What is in register R0 after executing the RSB instruction at address 0000003C₁₆?