ARM Instructions Worksheet #3
Addressing Modes

Prerequisite Reading: Chapter 4
Revised: March 26, 2020

Objectives: *To use the web-based simulator ("CPULator") to better understand the four addressing modes:*

1. Immediate Offset Addressing: `[R1]` and `[R1,4]`
2. Register Offset Addressing: `[R1,R2]` and `[R1,R2,LSL 2]`
3. Post-Indexed Addressing: `[R1],4`
4. Pre-Indexed Addressing: `[R1,4]!`

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

```
                    .syntax    unified
                    .global    _start
                    .skip      0x100

00000100  Array32:  .word  0xBEEFBEEF       // uint32_t Array[4] ;
00000104            .word  0xC0DEC0DE
00000108            .word  0xF00DF00D
0000010C            .word  0xFACEFACE

00000110  _start:   LDR    R1,=Array32      // *** EXECUTION STARTS HERE ***
00000114            LDR    R0,[R1]          // Address provided by R1
00000118            LDR    R0,[R1,4]        // Address = R1 + 4

0000011C            LDR    R2,=8            // R2 = Offset = 8
00000120            LDR    R0,[R1,R2]       // Address = R1 + R2

00000124            LDR    R2,=3            // R2 = Subscript = 3
00000128            LDR    R0,[R1,R2,LSL 2] // Address = R1 + 4*R2

0000012C            LDR    R0,[R1],4        // Address = R1; Post-Increment
00000130            LDR    R0,[R1,4]!       // Address = R1 + 4; Pre-Increment

00000134  done:     B      done            // infinite loop

                    .end
```

What hex *address* is copied into R1 by the LDR instruction at address 00000110_{16}?

> 00000100

What hex *data* is copied from the address in R1 by the LDR at address 00000114_{16}?

> 0xBEEFBEEF

What hex *data* is copied into R0 by the LDR instruction at address 00000118_{16}?

> 0xC0DEC0DE

What hex *address* did that value come from?

> 00000104

What hex *data* is copied into R0 by the LDR instruction at address 00000120_{16}?

> 0xF00DF00D

What hex *address* did that value come from?

> 00000108

What hex _data_ is copied into R0 by the LDR instruction at address 00000128₁₆?	0xFACE FACE
What hex _address_ did that value come from?	0000010C
What hex _data_ is copied into R0 by the LDR instruction at address 0000012C₁₆?	0xBEEF BEEF
What hex _address_ did that value come from?	00000100
What hex _address_ is left in R1 by the LDR instruction at address 0000012C₁₆?	00000104
What hex _data_ is copied into R0 by the LDR instruction at address 00000130₁₆?	0xFOODFOOD
What hex _address_ did that value come from?	00000108
What hex _address_ is left in R1 by the LDR instruction at address 00000130₁₆?	00000108

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. Press Ctrl-M to open the memory display window and drag-n-drop it about halfway to the right.
3. In the "Memory" window, enter 0x100 into the search box and press Enter to highlight that address for easy reference.

Step 1: Press F2 exactly 2 times to execute the first two LDR instructions. (The 3ʳᵈ LDR should be highlighted in yellow.)

What hex _address_ is copied into R1 by the LDR instruction at address 00000110₁₆?	00000100
What hex _data_ is copied from the address in R1 by the LDR at address 00000114₁₆?	0x BEEFBEEF

Step 2: Press F2 exactly once to execute the LDR R0, [R1, #4]

What hex _data_ is copied into R0 by the LDR instruction at address 00000118₁₆?	0x CODECODE
What hex _address_ did that value come from?	00000104

Step 3: Press F2 exactly 2 times to execute the LDR R2,=8 (MOV R2,#8) and the LDR R0,[R1,R2]

What hex _data_ is copied into R0 by the LDR instruction at address 00000120₁₆?	0x FOOD FOOD
What hex _address_ did that value come from?	00000108

Step 4: Press F2 exactly 2 times to execute the LDR R2,=3 (MOV R2,#3) and the LDR R0,[R1,R2,LSL #2]

What hex _data_ is copied into R0 by the LDR instruction at address 00000128₁₆?	0x FACE FACE
What hex _address_ did that value come from?	0000010C

Step 5: Press F2 exactly once to execute the LDR R0,[R1], #4

What hex _data_ is copied into R0 by the LDR instruction at address 0000012C₁₆?	0xBEEFBEEF
What hex _address_ did that value come from?	00000100
What hex _address_ is left in R1 by the LDR instruction at address 0000012C₁₆?	00000104

Step 6: Press F2 exactly once to execute the LDR R0, [R1, #4]!

What hex _data_ is copied into R0 by the LDR instruction at address 00000130₁₆?	0xFOODFOOD
What hex _address_ did that value come from?	00000108
What hex _address_ is left in R1 by the LDR instruction at address 00000130₁₆?	00000108