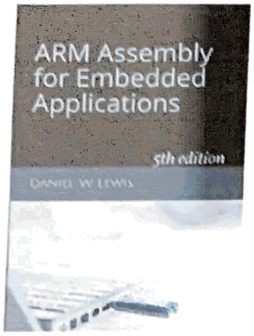

ARM Instructions Worksheet #3

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 00000128_{16}? 0xFACEFACE

What hex *address* did that value come from? 0000010C

What hex *data* is copied into R0 by the LDR instruction at address $0000012C_{16}$? 0xBEEFBEEF

What hex *address* did that value come from? 00000100

What hex *address* is left in R1 by the LDR instruction at address $0000012C_{16}$? 00000104

What hex *data* is copied into R0 by the LDR instruction at address 00000130_{16}? 0xF00DF00D

What hex *address* did that value come from? 00000108

What hex *address* is left in R1 by the LDR instruction at address 00000130_{16}? 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 00000110_{16}? 00000100

What hex *data* is copied from the address in R1 by the LDR at address 00000114_{16}? 0xBEEFBEEF

***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 00000118_{16}? 0xCODECODE

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 00000120_{16}? 0xF00DF00D

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 00000128_{16}? 0xFACEFACE

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 $0000012C_{16}$? 0xBEEFBEEF

What hex *address* did that value come from? 00000100

What hex *address* is left in R1 by the LDR instruction at address $0000012C_{16}$? 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 00000130_{16}? 0xF00DF00D

What hex *address* did that value come from? 00000108

What hex *address* is left in R1 by the LDR instruction at address 00000130_{16}? 00000108