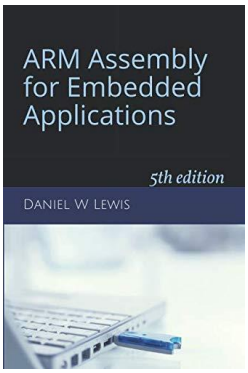

ARM Instructions Worksheet #2

Load, Store, Zero-Fill, Sign-Ext

Prerequisite Reading: Chapters 3 and 4
Revised: April 27, 2021

Objectives: *To use the web-based simulator ("CPULator") to better understand how the ...*

1. LDRB and LDRH instructions copy unsigned 8 and 16-bit variables into 32-bit registers by zero-filling
2. LDRSB and LDRSH instructions copy 2's complement 8 and 16-bit variables into 32-bit registers by sign-extending
3. STRB and STRH instructions write the least-significant 8 and 16-bits of a 32-bit register to memory

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

```
                    .syntax      unified
                    .global      _start

00000000  _start:   LDR    R1,=0x00000100      // *** EXECUTION STARTS HERE ***
00000004            LDR    R0,=0x00000000      // Initialize word at address 0x100 to 0.
00000008            STR    R0,[R1]

0000000C            LDR    R0,=0x1234BCDE      // R0 <-- 1234BCDE
00000010            STRH   R0,[R1]             // Demonstrate the STRH  instruction
00000014            LDRSH  R0,[R1]             // Demonstrate the LDRSH instruction
00000018            LDRH   R0,[R1]             // Demonstrate the LDRH  instruction

0000001C            LDR    R0,=0x123456AF      // R0 <-- 123456AF
00000020            STRB   R0,[R1]             // Demonstrate the STRB  instruction
00000024            LDRSB  R0,[R1]             // Demonstrate the LDRSB instruction
00000028            LDRB   R0,[R1]             // Demonstrate the LDRB  instruction

0000002C            LDR    R0,=0x12345678      // R0 <-- 12345678
00000030            STR    R0,[R1]             // Demonstrate the STR   instruction
00000034            LDRSB  R0,[R1]             // Demonstrate the LDRSB instruction

00000038  done:     B      done

                    .end
```

What hex value is in memory address 100_{16} after executing the 1st three instructions?

What hex value is left in R0 by the LDR instruction at address $0000000C_{16}$?

What hex value is left in address 100_{16} by the STRH at address 00000010_{16}?

What hex value is left in R0 by the LDRSH instruction at address 00000014_{16}?

What hex value is left in `R0` by the `LDRH` instruction at address 00000018_{16}?

What hex value is left in `R0` by the `LDR` instruction at address $0000001C_{16}$?

What hex value is left in address 100_{16} by the `STRB` at address 00000020_{16}?

What hex value is left in `R0` by the `LDRSB` instruction at address 00000024_{16}?

What hex value is left in `R0` by the `LDRB` instruction at address 00000028_{16}?

What hex value is left in address 100_{16} by the `STR` at address 00000030_{16}?

What hex value is left in `R0` by the `LDRSB` instruction at address 00000034_{16}?

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 **3** times to execute the first 3 instructions. (The 3rd `LDR` should be highlighted in yellow.)*

What hex value is in memory address 100_{16} after executing the 1st three instructions?

***Step 2:** Press F2 exactly **2** times to execute the `LDR`, `STRH` sequence.*

What hex value is left in `R0` by the `LDR` instruction at address $0000000C_{16}$?

What hex value is left in address 100_{16} by the `STRH` at address 00000010_{16}?

***Step 3:** Press F2 exactly **once** to execute the `LDRSH`.*

What hex value is left in `R0` by the `LDRSH` instruction at address 00000014_{16}?

***Step 4:** Press F2 exactly **once** to execute the `LDRH`.*

What hex value is left in `R0` by the `LDRH` instruction at address 00000018_{16}?

***Step 5:** Press F2 exactly **2** times to execute the `LDR`, `STRB` sequence.*

What hex value is left in `R0` by the `LDR` instruction at address $0000001C_{16}$?

What hex value is left in address 100_{16} by the `STRB` at address 00000020_{16}?

***Step 6:** Press F2 exactly **once** to execute the `LDRSB`.*

What hex value is left in `R0` by the `LDRSB` instruction at address 00000024_{16}?

***Step 7:** Press F2 exactly **once** to execute the `LDRB`.*

What hex value is left in `R0` by the `LDRB` instruction at address 00000028_{16}?

***Step 8:** Press F2 exactly **3** times to execute the `LDR`, `STR`, `LDRSB` sequence.*

What hex value is left in address 100_{16} by the `STR` at address 00000030_{16}?

What hex value is left in `R0` by the `LDRSB` instruction at address 00000034_{16}?