**ARM Instructions Worksheet #2**

**Load, Store, Zero-Fill, Sign-Ext**

**Prerequisite Reading:** Chapters 3 and 4  
Revised: March 26, 2020

**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.)

```assembly
.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 LDRS 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\textsubscript{16} after executing the 1\textsuperscript{st} three instructions?  

What hex value is left in R0 by the LDR instruction at address 0000000C\textsubscript{16}?  

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

What hex value is left in R0 by the LDRSH instruction at address 00000014\textsubscript{16}?
What hex value is left in R0 by the LDRH instruction at address 000001816?

What hex value is left in R0 by the LDR instruction at address 000001C16?

What hex value is left in address 10016 by the STRB at address 000002016?

What hex value is left in R0 by the LDRSB instruction at address 000002416?

What hex value is left in R0 by the LDRB instruction at address 000002816?

What hex value is left in address 10016 by the STR at address 000003016?

What hex value is left in R0 by the LDRSB instruction at address 000003416?

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 10016 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 000000C16?

What hex value is left in address 10016 by the STRH at address 000001016?

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

What hex value is left in R0 by the LDRSH instruction at address 000001416?

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

What hex value is left in R0 by the LDRH instruction at address 000001816?

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 000001C16?

What hex value is left in address 10016 by the STRB at address 000002016?

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

What hex value is left in R0 by the LDRSB instruction at address 000002416?

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

What hex value is left in R0 by the LDRB instruction at address 000002816?

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

What hex value is left in address 10016 by the STR at address 000003016?

What hex value is left in R0 by the LDRSB instruction at address 000003416?