Digital Design and Computer Architecture (E85)

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Problem Set 8

1) How would you implement an R_{rshift}-Type data processing instruction as a pseudo instruction? Which instructions would be executed for the following instruction?

```
ADD R0, R1, [R2 LSL R3]
```

2) Your friend is an incredibly skilled circuit designer. She has offered to redesign one of the units in the single-cycle ARM processor to have half the delay. Using the delays from Table 0.5 from chapter 7, which unit should she work on to obtain the greatest speedup of the overall processor? What would the cycle time of the improved machine be?

3) Show how the following ARM program would be loaded into memory and executed by executing each of the steps below:

   a. First show the address next to each assembly instruction. Assume the instructions are placed at the bottom of the text section of a standard ARM memory where the exception handlers end at 0x00008000.

   b. Draw the symbol table showing the labels and their addresses. X and Y are global variables which are offset from the static base (SB) by one and two words respectively. The static base is at 0x00E00000 .

   c. Convert all instructions into machine code.

   d. How big (how many bytes) are the data and text segments?

   e. Sketch a memory map showing where data and instructions are stored

```
# ARM assembly
function:
    ADD  SP, SP, #-4
    STR  LR, [SP, #0]
    LDR  R0, .X
    LDR  R0, R0
    LDR  R1, .Y          ;X and Y are global variables
    LDR  R1, R1
    BL   diff
    LDR  LR, [SP, #0]
    ADD  SP, SP, #4
    MOV  PC, LR
diff:
    SUB  R3, R0, R1
    MOV  PC, LR
.X:
    .word X
.Y:
    .word Y
```

4) Suppose one of the following control signals in the single-cycle ARM processor has a stuck-at-0 fault, meaning that the signal is always 0, regardless of the intended value. What instructions would malfunction? Why?

```
a. MemtoReg

b. PCSrc

c. ALUControl
```

4) Time

Please indicate how many hours you spent on this problem set. This will not affect your grade (unless completely omitted), but will be helpful for calibrating the workload for next semester's class.