22C:060: Computer Organization
Homework 6
Total points = 50
Due Thursday December 5, 2013, **5:00 AM (not PM)**

1. **Do not consult others. You must solve the problems on your own.**

2. To submit your work, *zip* (or *tar*) them into a single file that has your last name as the prefix. Use ICON drop box to submit your assignment.

Question 1. (15+15=30 points)

Fig. 4.17 in your textbook shows the datapath as well as the control signals of a single-cycle version of MIPS that supports the instructions **lw, sw**, a few R-type instructions, and **beq**. (If you have any doubt about which figure is this, then please double check with me, or one of the TAs).

Part 1. Simplify the datapath of Fig. 4.17 by removing all the unnecessary units and redundant signals so that it supports only **add** and **subtract** instructions (and not the remaining instructions). Show *only* those control signals that are required in this design. Assume that ALUop is a 1-bit signal in the residual datapath (ALUop = 0 means *add* and ALU = 1 means *subtract*).

Part 2. Derive logical expressions for each of these control signals as a function of the opcode bits [bits 31-26] and the function field bits [bits 15-0] of the instruction word. Explain your derivation. (Hint: Tables 4.12, 4.13, 4.22 may be useful)

Question 2. (20 points)

Let us try to add the instruction **swap (rs, rt)** to the MIPS instruction set, and use the I-type format and invent a new opcode to represent that instruction (with the immediate field = 0). The objective this instruction is to exchange the contents of the registers **rs** and **rt**. Here is the question:

Alice and Bob argue about the implementation of the swap instruction using the datapath of Fig. 4.17. Alice believes, it can be implemented using Fig. 4.17, but Bob believes this is impossible. Whom do you support? If you support Alice, then explain how **swap (rs, rt)** can be implemented using the datapath of Fig. 4.17. If you agree with Bob, then explain why swap cannot be implemented using the datapath of Fig 4.17.