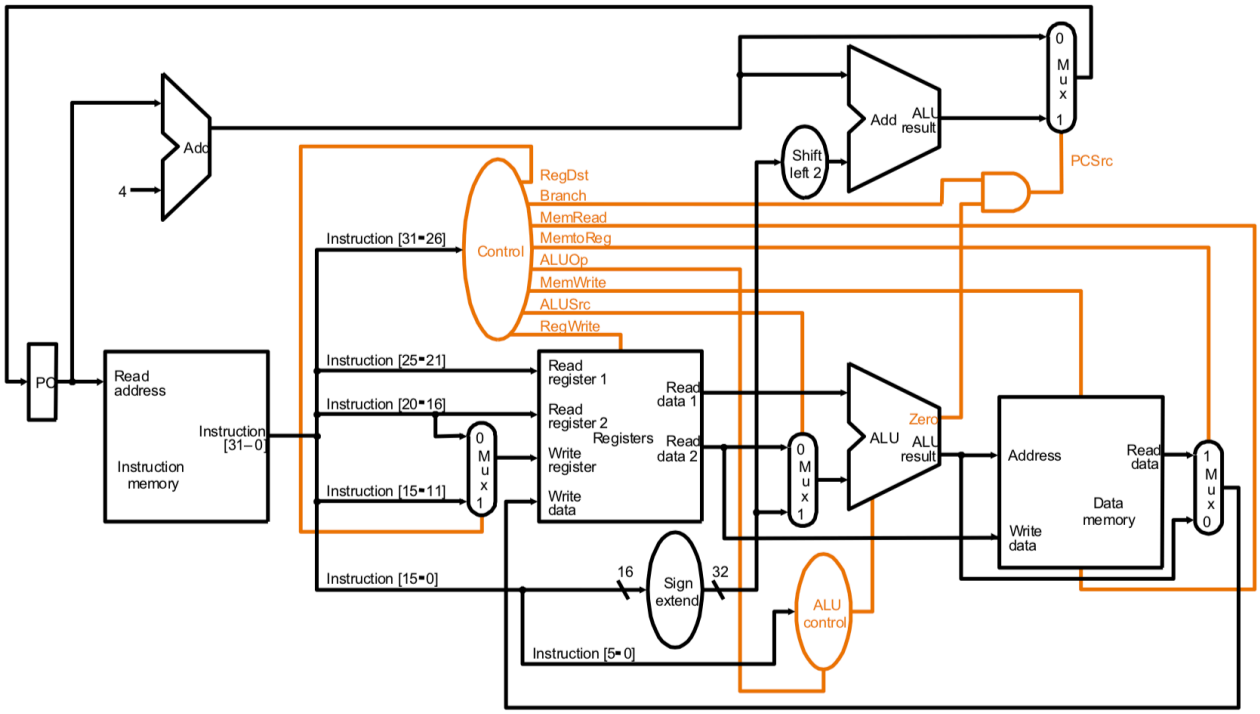
EC413 Computer Organization
Lab 7 – Single-Cycle CPU

Overview:

The purpose of Lab 7 is to learn in-depth how a CPU works. Given the basic single-cycle MIPS CPU, you will add, debug, and test several new features.



Tasks:

1. Synthesize the project and generate outputs for the given instruction sequence. [Pre-lab]
2. In lab 5, you implemented I-format only for ADD. Implement all I-format ALU instructions - ANDI, SUBI, ORI, SLTI (Hint: you can do this without adding any new hardware, i.e., just by modifying the control.)
3. Add instruction J. You may start with the general implementation using the text provided in pre-lab. If you implement your own block, explain with comments.
    a. J target → This jumps to the address "target"
4. Add instruction JR.
    a. JR $s → This jumps to the address contained in register $s
5. Add instruction BNE.
6. Add instruction LUI.
    a. The immediate value is shifted left 16 bits and stored in the register. The lower 16 bits are zeroes.
    b. lui $t, imm → $t = (imm << 16); advance_pc (4);
7. Create a new testbench which tests all the following instructions
    a. **ALU:** ADD, ADDI, SUB, SUBI, OR, ORI, AND, ANDI, MOV, NOT, SLT, SLTI
    b. **Memory:** SW, LW, LUI
    c. **Branch:** BEQ, BNE
    d. **Jump:** J, JR

Deliverables:

- All of your .v files.
- A new testbench which includes all the instructions. During the demo, you will be asked to use this testbench and show all the operations. You may be asked to make minor modifications in the testbench.
- A lab report, including:
    - For each task, describe what you did. If you added hardware (BNE, LUI, JR), submit a modified diagram.
    - Waveforms of how you tested your design, along with a brief explanation. You do not need to submit a waveform for all the instructions. Please make sure to submit at least 1 waveform for ALU, memory, branch and jump instructions.

Note:
The ALUOp for the ALU operations are slightly different from lab6. It is highly advisable to use the provided codes. In case you are using your previous lab codes, make sure to change the ALUOp.