Rose-Hulman Institute of Technology
Computer Science and Software Engineering
Prof. Archana Chidanandan

Homework 4
RTL, Datapath and Control Design
Total points: 25 points + 10 points (extra credit)

This assignment is due Wednesday, 28th January 2003 for Sections 1 and 2 at the beginning of class.

Learning Objectives

In the process of completing this homework assignment, students will develop their abilities to

- Design datapaths to support machine language instruction sets by specifying the interconnections between components and the behavior of the associated control units.
- Design control units to support machine language instruction sets by applying combinational and sequential digital logic design principles.
- Describe the implementation of machine language instructions using Register Transfer Language.

General Instructions

- The pdf files for Figures 5.33, 5.29 and 5.42 are available on the class web-site(Homework).
- Submit your solutions on a separate sheet of paper.

Problems

1. [5 points each] For each of the problems below, modify the textbook's multi-cycle control (Figure 5.42 on page 396, respectively) to implement the indicated MIPS instruction.

    a. Modify the control to implement the MIPS `addi` instruction.

    b. Modify the control to implement the MIPS `mfc0` instruction.

    c. Modify the control to implement the MIPS `mtc0` instruction.

2. Figure 5.33 of Patterson & Hennessy, shows a complete datapath for a multicycle implementation of most R-Type MIPS assembly language instructions, as well as `lw`, `sw`, `beq`, and `j`. For this question, you are required to modify the datapath to include the multicycle implementation of the `jr` instruction. Specifically, you must:

    a. [4 points] Write a multicycle RTL description of an implementation of the `jr` instruction that uses as few cycles as possible without extending the clock cycle of your design.

    b. [6 points] Add any necessary datapaths and control signals to the multicycle datapath to implement the `jr` instruction.

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3. [Extra credit: 10 points]
    a. [2.5 x 2 = 5 points]Write the single-cycle RTL descriptions for the for the MIPS instructions `jal` and `lui`

    b. [2.5 x 2 = 5 points] Modify the datapath in Figure 5.29 on page 372 of Hennessy and Patterson, to implement the `jal` and `lui` instructions. Use two different copies of the datapath to make the changes for each of the two instructions. *Hint:* In class, you have modified the multi-cycle datapath to implement the `jal` and `lui` instructions. The class web-site also has a link to the multi-cycle implementation RTL descriptions and datapath for these two instructions(Resources).