



`sw`, `beq`, and `j`. For this question, you are required to modify the datapath to include the multicycle implementation of the `bne` instruction. Specifically, you must:

- a. [5 points] Write a multicycle RTL description of an implementation of the `bne` instruction that uses as few cycles as possible without extending the clock cycle of your design.
- b. [5 points] List all new and modified components required for the implementation of the `bne` instruction. Also, list the input, output, and control signals for each of those components. Indicate the number of bits in each signal.
- c. [5 points] Add any necessary datapath components and control signals to the multicycle datapath. A pdf version of Figure 5.28 is available on the class website(Homework).

6. [15 points] Repeat Steps ~~1a, 1b and 1c~~ for the `mfcc0` and `mtcc0` MIPS instructions (combine the component lists and the datapath modifications). *Hint*: Page A71 (on the CD) of Hennessey and Patterson, has a description for these two instructions.

7.[10 points] Repeat Steps ~~1a and 1b~~ for an “undefined” instruction in MIPS. Figure 5.39 in your textbook, shows the modifications required for the datapath. *Hint*: Save PC-4 in EPC, modify the PC, and update the Status Register. Read through pages 340-343 and pages A33-A35 (on the CD) of Patterson and Hennessey for more information.

8. Figure 5.24 of Patterson & Hennessey, shows a complete datapath for a single-cycle 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 single cycle implementation of the `bne` instruction.

- a. [5 points] Write a single-cycle RTL description of an implementation of the `bne` instruction.
- b. [5 points] List all new and modified components required for the implementation of the `bne` instruction. Also, list the input, output, and control signals for each of those components. Indicate the number of bits in each signal.
- c. [5 points] Add any necessary datapath components and control signals to the single-cycle datapath. A pdf version of Figure 5.24 is available on the class website(Homework).