

Computer Engineering ECE 449

Final Exam

1. Define the following three kinds of pipeline hazards: *structural*, *data*, and *control* (or branch) hazards. Explain what can be done to eliminate the effects of each kind of hazard. (15 points)
2. Explain the distinction between exceptions and interrupts. Give examples of two different classes of exceptions. Explain how interrupt processing is incorporated into a processor. (10 points)
3. Explain the concept of *precise* interrupts and how they may be implemented. (10 points)
4. Explain the operations of a memory management unit (MMU) and a translation lookaside buffer (TLB). What are the benefits of introducing such devices into a computer system? (10 points)
5. Design an odometer module for a mobile robot application. (30 points)

Assume that you will have wheel encoder pulses (64 pulse per revolution) and a signal that indicates forward or reverse motion. Maximum wheel rotation is 20 revolutions per second.

Your module is intended to be incorporated as a peripheral unit in an embedded processor (think NiosII). The module needs to keep track of the (signed) total of pulses, and the number of pulses per second. Velocity information (pulses/second) should be maintained in a 16 element FIFO. If the FIFO is filled, the oldest value is discarded. The total count is cleared when a control bit (CLEAR) is set high. The module should have the additional capability of signaling when the total count reaches a designated value. The module should also have the capability of returning the difference between actual velocity and a designated target velocity. The module should have the provision for setting the rate at which velocity is measured (in 1/4 second increments). The default rate should be 1 velocity measurement per second.

Define the control registers and data registers needed for the interface between your module and the host computer. Define functional units and datapath modules that will be required.

6. Describe the operation of the controller-area network (CAN) used in automotive applications. Review the basic technology, the data transmission rate, and data frame organization. Investigate and report on the availability of low-cost CAN development systems suitable for use in ECE 449 (maybe next year!) (25 points)