Name (Last, First) _____ Student ID number _____

UNIVERSITY OF CALIFORNIA

College of Engineering
Electrical Engineering and Computer Sciences Department

**EECS 145M: Microcomputer Interfacing Laboratory**

Spring Midterm #1 (Closed book- equation sheet provided- calculators OK)
Full credit can only be given if you show your work.
Wednesday, February 25, 2009

**PROBLEM 1** (30 points) Briefly describe ***all*** the inputs and outputs of the following circuit components and how their outputs depend on their inputs.

**1.1** (6 points) Edge-triggered flip-flop.

**1.2** (6 points) Transparent latch

**1.3** (6 points) Sample and hold amplifier

**1.4** (6 points) Tri-state buffer

**1.5** (6 points) A/D converter (12 bit)

**PROBLEM 2** (20 points)
A colleague (who has never taken 145M) has just designed a digital data acquisition system using a microcomputer, a digital input port with Edge-triggered flip-flop registers, and the following handshaking protocol:

**1** When the program is ready for data, it sets "ready for input data" TRUE.

**2** When the external circuit detects "ready for input data" TRUE, it pulses the clock input of the Edge-triggered flip-flops

**3** The external circuit asserts data on the input of the Edge-triggered flip-flops and makes "input data available" TRUE

**4** The program detects "input data available" TRUE and reads the output of the Edge-triggered flip-flops

**5** The program sets "ready for input data" FALSE, processes the data, and then returns to step 1

Your colleague complains that his design does not work, and that the values read during step 4 have nothing to do with the digital input data asserted in step 3. After carefully examining his steps, you find that two serious errors were made. What are these errors, and how would you fix them?

**PROBLEM 3** (50 points) Design an ultrasonic ranging system to be mounted on the front of a vehicle that continuously determines (1) the distance to any obstacle in front of the vehicle and (2) the relative speed between the vehicle and the obstacle.

You have the following components:

- An system that emits a short (1 ms), narrow-beam ultrasonic pulse and detects the reflected echo. The system is triggered by a digital low-to-high edge. It produces a digital output pulse that goes high when the ultrasonic pulse is emitted and goes low when the echo is detected.
- A computer with display screen, audible warning alarm, digital input/output port, and the ability to read time to the microsecond.

**3.1** (10 points) Sketch a diagram of your system, representing each major component as a labeled rectangle.

**3.2** (15 points) List the steps that your computer program must do to (1) trigger the ultrasonic pulses at 5 Hz, (2) determine both distance and velocity, (3) display the numbers on the display screen, and (4) sound the alarm if the current distance and relative speed would result in a collision in one second.

**3.3** (5 points) You perform 100 measurements of the echo return time $t_i$ with the vehicle stationary and an obstacle at a fixed distance $d$. Use the random variability of the values of $t_i$ in an equation to compute one standard deviation in $t_i$.

**3.4** (10 points) Use the result from the previous section and $c$ = speed of sound to derive equations for the following:

(1) one standard deviation of $d_i$

(2) the relative speed $s_i$ using two successive measurements $t_i$ and $t_{i-1}$

(3) one standard deviation of $s_i$

**3.5** (5 points) If you average the last 5 values to provide a better estimate of the distance and relative speed, by how much are the estimates of distance and relative speed improved?

**3.6** (5 points) What is the maximum obstacle distance that the system can measure? (assume that the speed of sound is 1 ft/ms)