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, March 3, 2004

PROBLEM 1 (16 points)
Describe the operation of the following circuits

1a (8 points) Edge-triggered D-type flip-flop

1b (8 points) Sample-and-Hold Amplifier

Name (Last, First) ____________________________ Student ID number _________________

Problem 2 (46 points)
Design a system for measuring the frequency of a sinewave $V(t) = V_0 \sin(2\pi ft)$ over a measurement time of one second.

You are to use the following

- A microcomputer with a 16-bit digital input port and a 16-bit digital output port. Data can be written or read in 1 microsecond.
- A 32-bit counter circuit whose output increases by one count every 10 nanoseconds. In addition, the circuit generates a "data available" signal that is high only when the output bits are stable.
- A comparator circuit that you will use to detect the zero crossing of the sinewave (don't worry about hysteresis).
- Four octal (meaning eight per chip) D-type flip-flops that are triggered by a low-to-high edge of their digital control lines
- Five octal tri-state drivers that are transparent when the control line is low. (Hint: use one for the comparator and the other four for the 32 bits of counter data)
- An AND circuit and a SET/RESET latch (a high signal on the SET input makes the output high and a high signal on the RESET input makes the output low)

Since the computer is much slower than the counter, you will need to use the AND and SET/RESET circuits to strobe valid counter data onto the D-type flip-flops. You can use the input port to read the status of the comparator and the D-type flip-flops. Assume that you can detect occasional system interrupts and repeat the measurement when necessary.

2a (12 points) Draw a block diagram of your design, showing and labeling all essential components and signal lines.

Name (Last, First) ____________________________ Student ID number _________________

2b (12 points) List the program steps that measure the time between cycles for one second, compute the frequency in Hz, and write the result to the screen every second. Include both hardware events and program code as needed. ("Legal" C code not required- just describe what the each program command needs to do)(Don't worry about system interrupts here)

2c (12 points) Draw a timing diagram (signal value vs. time) for the important signals.

2d (5 points) What are the minimum and maximum frequencies that your design can measure?

2e (5 points) At the minimum and maximum frequencies, what are the uncertainties in the frequency measurement? (Hint: you do not need to use the formal error propagation formula, just consider the range of measured values for a fixed input frequency.)

Problem 3 (8 points)
What problem would arise if the counter did not provide a "data available" signal? How would you solve the problem?

Problem 4 (30 points)

In this course we studied several types of A/D converters:
TR Tracking
SA Successive Approximation
DS Dual Slope or Integrating
FL Flash
HF Half-flash

4a (5 points) Which produce their output in a continuous manner?

4b (5 points) Which require a "start conversion" command?

4c (5 points) Which can be used at very high rates (> 100 MHz) at moderate resolution (8 bits)?

4d (5 points) Which can provide high resolution (16 bits) at intermediate rates (<20 kHz)?

4e (5 points) Which have an accuracy that does not depend on the accuracy of internal resistors?

4f (5 points) Which require a sample-and-hold amplifier for full accuracy at their maximum conversion rate?