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- calculators OK)
Wednesday, March 1, 2000

PROBLEM 1 (30 points) In Laboratory Exercise 2 you measured the human reaction time between a visual prompt on the display screen and the pressing of the return key. This is an imperfect design due to random delays in refreshing the display screen (60 Hz) and the use of a slow (9600 baud) serial port to detect the pressing of the return key. You decide to use a parallel I/O port, a mechanical push button for user input, and a high-power, bright LED (light emitting diode) for the visual prompt. Assume the following:

1 The first press of the button alerts the computer that the user is ready.
2 The computer program then waits a random time from 5 s to 10 s and then lights the LED.
3 The user presses the button a second time to respond to the LED prompt.
4 The maximum rating of the LED is 0.1 A at 0.6 V (forward biased diode). Assume that the LED comes to full brightness instantly when the power is applied.
5 You have a power amplifier (voltage gain = 1) to drive the LED.
6 The computer has a digital I/O port with eight bits of input and 8 bits of output ("0" = 0V, "1" = 5 V).
7 Your program can read a 1 kHz system timer
8 For problem 1, ignore system interrupts that would cause your program to pause.

1a. (15 points) Draw a block diagram of your system, showing and labeling all essential components, connections, and signals. (You may draw the power amplifier with a single input, a single output, and a common ground)

1b. (15 points) List the steps (hardware and software) that must take place for a single measurement of the reaction time.

PROBLEM 2 (10 points)

System interrupts can last longer than the shortest button push the user could make (even with contact bounce). This would cause your program to miss short button pushes entirely. Show how you would use a set-reset latch to prevent this. (SET = HI makes output HI; RESET = HI makes output LOW; SET = LOW and RESET = LOW keeps previous output).

PROBLEM 3 (30 points)

You have been using the system designed in problems 1 and 2 for some time and discover that there is a random component to the data due to system interrupts that prevent the computer from promptly detecting the second button push.

You decide to improve the system by using a dedicated 32 bit digital counter that counts pulses from a 1 MHz pulse generator.

Assume the following:

- The counter has two control lines
  A pulse on the "reset" line sets the counter to zero and starts counting
  A pulse on the "stop" line stops the counter
- The counter has 32 out put bits that can be read at any time
- You add a 32-bit digital input port

3a. (15 points) Draw a block diagram of your new system, showing and labeling all essential components, connections, and signals.

3b. (15 points) List the steps (hardware and software) that must take place for a single measurement of the reaction time.

PROBLEM 4 (30 points)

Design a system for simultaneously sampling (within a few ns) five different analog voltages, and digitizing the voltages with a single A/D converter that is read with a single digital input port.

Assume

- Your computer program determines when the five waveforms are sampled, and then sequentially digitizes and stores each signal.
- You have five analog switches. Each has an analog input, and analog output, and a digital control line ("0" = 0V = open; "1" = 5V = closed).
- You have five sample-and-hold amplifiers. Each has an analog input, and analog output, and a digital control line ("0" = LOW = 0V = sample, "1" = HIGH = 5V = hold)
- The A/D converter is started by making the "start conversion" line HIGH (5V)
- When conversion is complete, the A/D converter makes a "data available" line HIGH
- Making "start conversion" LOW makes "data available" LOW
- The computer has a digital I/O port with 16 lines of input and 16 lines of output.

4a. (15 points) Draw a block diagram of your system, showing and labeling all essential components, connections, and signals.

4b. (15 points) List the steps (hardware and software) that must take place to simultaneously sample the five analog voltages and read them into computer memory.