NAME (please print) ____

STUDENT (SID) NUMBER ________________________

UNIVERSITY OF CALIFORNIA, BERKELEY

College of Engineering
Electrical Engineering and Computer Sciences

EECS 145M: Microcomputer Interfacing Lab

LAB REPORTS:

1 ________	2 ________	3 ________
8 ________	9 ________	10 ________
21 ________	22 ________	23 ________
24 ________	26 ________	

Total of top 4 Long Lab Grades	________	(400 max)
Total of top 4 Short Lab Grades	________	(100 max)
Lab Participation	________	(100 max)
Mid-Term #1	________	(100 max)
Mid-Term #2	________	(100 max)
Final Exam	________	(200 max)
Total Course Grade	________	(1000 max)

COURSE LETTER GRADE

Spring 2005 FINAL EXAM (May 14)

Answer the questions on the following pages completely, but as concisely as possible. The exam is to be taken ***closed book***. Use the reverse side of the exam sheets if you need more space. Calculators are OK.

Partial credit can only be given if you show your work.

FINAL EXAM GRADE :

1 ________ (40 max) 2 ________ (25 max) 3 ________ (25 max)

4 ________ (50 max) 5 ________ (60 max)

TOTAL ________ (200 max)

PROBLEM 1 (total 40 points) Describe briefly how the following devices work (not just their definition):

1a (10 points) Digital to Analog converter (ladder or R-2R, your choice)

1b (10 points) Analog comparator

Initials ____

1c (10 points) Flash 8-bit A/D converter

1d (10 points) Half-flash 16-bit A/D converter

PROBLEM 2 (total 25 points)
You have just tested an 8-bit D/A circuit by making measurements of its output glitches. You find that after a change in input at time *t*, the output glitch begins no earlier than *t* + 10 ns and is gone after *t* + 30 ns. The output ranges from $V_1 = 0$ volts to $V_{255} = 2.55$ volts.

Design a circuit that eliminates glitches and has accurate conversion at 0 Hz.

You have available the following components:

- A digital circuit that has 8 inputs and one output (normally low). If the input bits change at time t, the output goes high from (t + 5 ns) to (t + 5 ns + t_d). You need to choose the value of t_d.
- A sample-and-hold amplifier with an analog input, and analog output, and a digital control line. When the control line is low, the analog output $V_0(t)$ is equal to the analog input $V_1(t)$. When the control line is made high at time t_h, the analog output is initially held at $V_1(t_h)$, but has an output droop rate of 100 mV per second.

Do the following:

2a (15 points) Draw a block diagram of your circuit design, showing and labeling all essential components and connections.

2b (10 points) Briefly describe the operation of your circuit after a change in input.

PROBLEM 3 (total 25 points)

You have a 16-bit successive approx A/D converter with 10 μs conversion time.

3a (10 points) What is the maximum frequency sinewave that changes less than 1/2 LSB during the conversion time?

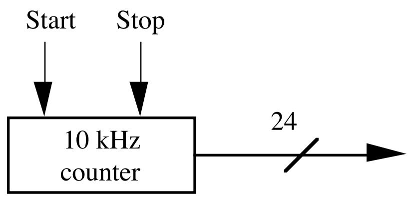
3b (10 points) If you use a sample-and-hold amplifier, what is the time jitter requirement that would result in accurate sampling at the maximum conversion rate?

3c (5 points) Assuming the solution to 3b, what is the maximum frequency that can be accurately sampled (as limited by the Nyquist sampling theorem)?

PROBLEM 4 (total 50 points):

Design a system for timing the swimming events in the Summer Olympic Games.

- There are 16 swimmers and the pool has 16 lanes. Each swimmer starts at the one end of the pool and, at the sound of a gunshot, jumps in and swims to the opposite end of the pool in their own lane
- When they reach the opposite end of the pool, the swimmers touch a plate mounted at the water line which briefly closes an electrical contact.
- The athletic event is started by an electronic starter's pistol, which makes a brief electrical contact when the trigger is pulled
- Your system detects the contact closure of the starter's pistol and immediately sends a pre-recorded gunshot sound to 16 speakers, each located behind a swimmer. (this gives each swimmer a fair start and also avoids using chemical explosives).
- There are 16 24-bit counter/timers, one for each lane. Each can be set to zero by the high-to-low edge of a "Start" input pulse, increases by one count every 100 μs, and is stopped by the high-to-low edge of a "Stop" input pulse. The start and stop input lines float high when disconnected and can be brought low by connecting to ground.



- Your microcomputer has three 16-bit digital input ports, one 16-bit digital output port, and one analog output port.
- You have a power amplifier and 16 speakers
- You have 17 set/reset latches whose output state changes on a high-to-low edge of the inputs

The requirements for your design are:

- The system must record the time for every swimmer to an accuracy of 100 μs even if several swimmers touch their plates in the same 100 μs.
- The lane numbers and time for each swimmer (in units of s) are to be written to the computer display screen and to a file as soon as possible after the swimmer finishes.

Initials ____

4a (25 points) Sketch your design, showing and labeling all essential components and lines. (You only need to show two touch plate switches, timing circuits and speakers.)

4b (25 points) Describe the events (hardware and software) that must take place from the start of the race to when the last swimmer finishes and the results are displayed.

PROBLEM 5 (total 60 points):

You have the following:

- a computer with an analog input/output port that can operate at a chosen rate up to 10^6 samples/s
- a loudspeaker that can convert an electrical waveform into an acoustic waveform. It has a frequency response that is above zero for frequencies between 20 Hz and 20 kHz, and essentially zero for frequencies below 10 Hz and above 40 kHz.
- a microphone that can accurately convert an acoustic waveform into an electrical waveform for frequencies between 10 Hz and 40 kHz.

5a (10 points) Design a system for determining the acoustic response of the speaker to an impulse electrical input. Sketch your design, showing and labeling all essential components and lines

5b (10 points) List the steps you would need to determine the acoustic response of the speaker to an impulse electrical input, sampled at 100 kHz.

5c (25 points) List the necessary steps for determining the digital filter b[i] so that if an analog electrical waveform $a(t)$ is sampled at 100 kHz, filtered with b[i], and the filter output is sent to the loudspeaker, then the acoustic waveform of the loudspeaker is a close representation of $a(t)$ for frequencies between 20 Hz and 20 kHz.

5d (15 points) Sketch the block diagram of a system that implements the procedure of part 5c. Show and label all essential components and lines.