NAME (please print) ______________________________

STUDENT (SID) NUMBER ______________________

UNIVERSITY OF CALIFORNIA

College of Engineering
Electrical Engineering and Computer Sciences
Berkeley

EECS 145M: Microcomputer Interfacing Lab

LAB REPORTS:

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

Total of top 4 Lab Grades	________	(400 max)
Total of top 4 Question Sections	________	(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 2003 FINAL EXAM (May 23)

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. **In answering the problems, you are not limited to the particular equipment you used in the laboratory exercises.**

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

FINAL EXAM GRADE :

1 ________ (48 max)	2 ________ (24 max)	3 ________ (20 max)
4 ________ (17 max)	5 ________ (71 max)	6 ________ (20 max)

TOTAL ________ (200 max)

Initials ____

Problem 1 (total 48 points) Describe briefly the operation of the following devices:

1a (8 points) R-2R D/A converter

1b (8 points) Analog input port (like in the DT3010 board used in the 145M labs)

1c (8 points) Comparator with hysteresis

Initials ____

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

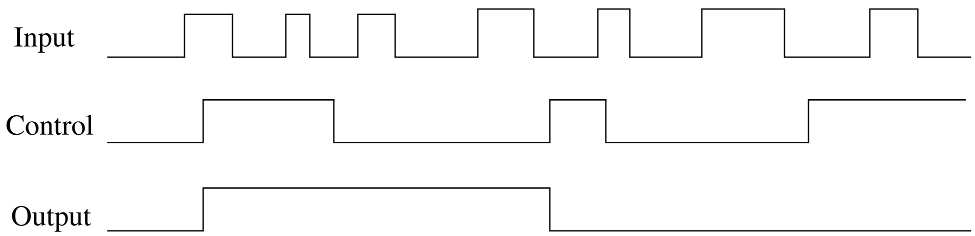
1e (8 points) Half-flash 16-bit A/D converter

1f (8 points) Anti-aliasing filter (describe operation in the frequency domain)

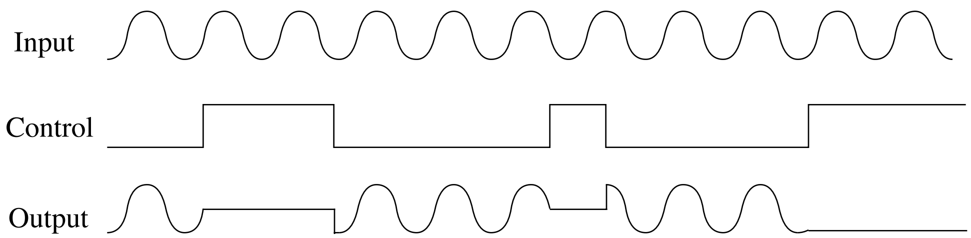
Initials ____

Problem 2 (24 points) In this course we have discussed four interfacing components that have one input signal, one control input, and one output signal. Timing diagrams for these four components as they would occur in typical use are shown below:

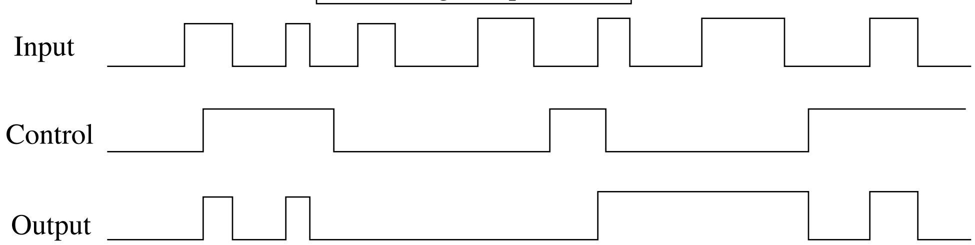
Interfacing component 1



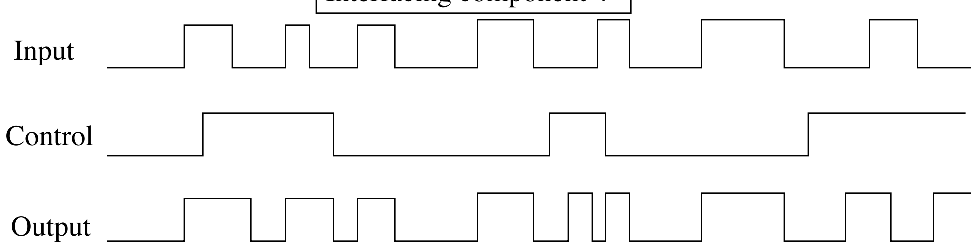
Interfacing component 2



Interfacing component 3



Interfacing component 4



For each interfacing component listed below in column one, enter its number in column two:

Name	Interfacing component number
Transparent latch	
Tri-state driver	
Edge-triggered flip-flop	
Sample-and-hold amplifier	

Problem 3 (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 4 (17 points)

In this course we studied six types of A/D converters:

TR Tracking
SA Successive Approximation
DS Dual Slope (or Integrating)
FL Flash
HF Half-flash
ΔΣ Delta-sigma

(each section will be graded as [number right minus number wrong] and zero if negative)

4a Which *do not* require a "start conversion" command

4b Which *do* require a "start conversion" command?

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

4d Which require $\ll N$ internal steps for conversion, where N is the number of bits?

4e Which require N internal steps for conversion, where N is the number of bits?

4f Which require $\gg N$ internal steps for conversion, where N is the number of bits?

4g Which have an accuracy that does not depend on the accuracy of internal resistors?

4h Which require a sample-and-hold amplifier for full accuracy at their maximum conversion rate?

Problem 5 (total 71 points):

Design a system for using the Fast Fourier Transform to detect a repeated signal on a background of white random noise. (Imagine that a civilization on a nearby star is trying to initiate communication with earth over the background noise of the universe by sending a single message over and over)

Assume the following:

- The message is repeated with a repetition period that is exactly equal to the message length
- Preliminary data indicate that the repetition period is approximately 2 seconds (±20% uncertainty)
- The highest frequency in the message is 1 MHz
- The random noise background is much larger than the signal and is not bandwidth limited.
- You have a computer equipped with a 16-bit analog input port and the sampling frequency is 4 million per second.
- You take a single data set, perform a single Fourier transform, and the available memory for the complex double-precision Fourier coefficients is limited to 1024 Mbytes
- Double precision numbers require 64 bits of storage

5a (16 points) Sketch your design, showing and labeling all essential components and lines.

5b (16 points) List the steps in the procedure for acquiring data and recovering *one period* of the message while rejecting noise as much as possible. (Be specific as to number of samples, use of FFT, rearranging coefficients, etc.)

5c (16 points) Sketch the magnitude of the Fourier transform coefficients for the case where the repetition period is 2.345 seconds. Label the horizontal axis with frequency index and Hz. (Note: the frequency range is so large that you will want to show two plots.)

5d (8 points) How does your design prevent aliasing?

5e (8 points) How does your design prevent spectral leakage?

5f (7 points) How accurately do you think that you can you determine the repetition period from your analysis? (Justify your answer)

Problem 6 (total 20 points): In problem 5 above you determined the period of the signal with improved accuracy. How could you use this information to take a new set of data with an improved data analysis. Describe how the magnitude of the Fourier coefficients differ from those of part **5c** above.