Name (Last, First) ______________________________ Student ID number ________________

UNIVERSITY OF CALIFORNIA, BERKELEY

College of Engineering
Electrical Engineering and Computer Sciences Department

EECS 145M: Microcomputer Interfacing Laboratory

Spring Midterm #2 (Closed book- equation sheet provided- calculators OK)
Monday, April 21, 2003

PROBLEM 1 (12 points)

1a (6 points) Write the general equation for the finite impulse response (FIR) digital filter

1b (6 points) Write the general equation for the infinite impulse response (IIR) digital filter

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PROBLEM 2 (18 points) State the following theorems

2a (6 points) The Fourier convolution theorem

2b (6 points) The Fourier frequency convolution theorem

2c (6 points) The Nyquist sampling theorem

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Problem 3 (total 50 points)

3a. (10 points) If a 10 Hz sinewave is sampled at 1024 Hz for 0.5 second ($2^{10} = 1024$), what does the FFT look like? Sketch the approximate relative magnitude of the FFT coefficients in the space below, and label the horizontal axis with both FFT coefficient index and frequency (Hz).

3b. (10 points) If an 11 Hz sinewave is sampled at 1024 Hz for 0.5 second, what does the FFT look like? Sketch the approximate relative magnitude of the FFT coefficients in the space below, and label the horizontal axis with both FFT coefficient index and frequency (Hz).

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3c. (10 points) If a 500 Hz sinewave is sampled at 1024 Hz for 0.5 second, what does the FFT look like? Sketch the approximate relative magnitude of the FFT coefficients in the space below, and label the horizontal axis with both FFT coefficient index and frequency (Hz).

3d. (10 points) If a 524 Hz sinewave is sampled at 1024 Hz for 0.5 second, what does the FFT look like? Sketch the approximate relative magnitude of the FFT coefficients in the space below, and label the horizontal axis with both FFT coefficient index and frequency (Hz).

3e. (10 points) For each of the four FFT plots above, describe whether they were affected by aliasing or spectral leakage and if so, how they were affected and what you would do to fix the problem.

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Problem 4 (20 points) A colleague wants to measure the voltage gain of an analog filter at frequencies $f = 0$ Hz, f_0, $2f_0$, . . ., $f_{max} = N f_0$. The filter gain is zero above f_{max}. Your colleague connects a sinewave generator to the input of the filter, manually sets the frequency to each value, and uses an oscilloscope to record the input and output peak-to-peak voltages at each frequency. Observing this, you say that there is a much faster, automated way to do this using a pulse generator, periodic sampling, and Fourier analysis.

What procedure would you suggest? (Be sure to list all the steps required)