Name (Last, First) ____________________________ Student ID number _________________

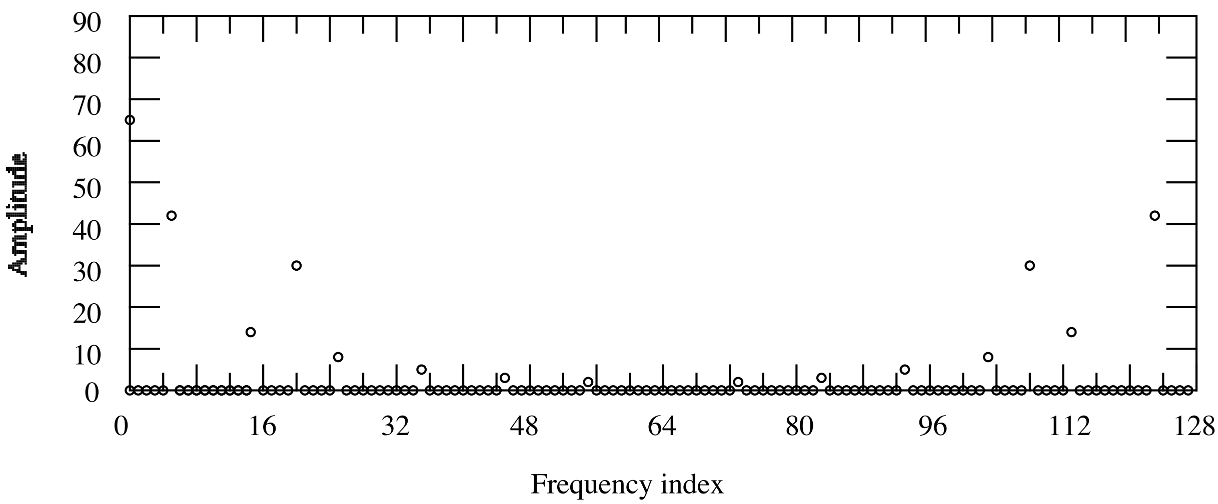
UNIVERSITY OF CALIFORNIA

College of Engineering
Electrical Engineering and Computer Sciences Department

EECS 145M: Microcomputer Interfacing Laboratory

Spring Midterm #2 (Closed book- equation sheet provided- calculators OK)
Full credit can only be given if you show your work.
Wednesday, April 13, 2005

Problem 1 (15 points)
You sample exactly 5 cycles of a 15 Hz symmetric square wave (after anti-alias filtering) and compute the FFT. The magnitudes of your FFT coefficients are plotted in the figure below. Explain the non-zero values at n = 5, 15, 20, 25, 35, 45, 55, 73, 83, 93, 103, 108, 113, and 123. (You do not need to explain the amplitudes, just why they are non-zero.)



PROBLEM 2 (15 points) Design a Butterworth anti-aliasing low pass filter that meets the following requirements:

- Gain > 0.90 for frequencies below 20 kHz
- Gain < 0.001 for frequencies that alias below 20 kHz
- The sampling frequency is 100 kHz
- The filter has the minimum number of components (lowest order)

PROBLEM 3 (35 points)

A colleague has taken 16,348 (=2^{14}) samples of a bandwidth-limited nontrivial waveform for one second, takes the fast Fourier transform (FFT), ***and then deletes the data***. After informing you of this, you ask "Did you use a raised cosine window?". Your colleague replies "What is a raised cosine window?", tells you that it is not possible to take the data again, and asks whether you can fix the available FFT.

3a (10 points) Describe in words how your colleague's FFT is related to the true frequency spectrum of the waveform.

Name (Last, First) ____________________________ Student ID number _________________

3b (15 points) How can you use your colleague's FFT to compute the FFT that would have been produced if the data had first been windowed with a raised cosine?

3c (10 points) Describe in words how the FFT computed in part 5b is related to the true frequency spectrum of the waveform.

PROBLEM 4 (35 points)
Design a system for the assembly line testing of D/A converters.
The design requirements are as follows:

- Sixteen 12-bit D/A converters are plugged into the system and the absolute accuracy, relative accuracy, and differential linearity measured completely under computer control

The components available are as follows:

- One 16-bit D/A converter with ±1/2 LSB absolute accuracy
- Sixteen 12-bit D/A converters (to be tested)
- All D/A converters need a steady input for a steady output
- Sixteen comparators
- A microcomputer with two 16-bit output ports and one 16 bit input port
- The output and input ports are operated in transparent mode (no handshaking)

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 necessary to determine the maximum absolute error, the maximum linearity error, and the maximum differential linearity error for each 12-bit D/A converter.

4c. (5 points) With what accuracy (in units of 1 LSB) can this system measure the quantities in part 4b?