EE -275 Digital Signal Processing & Filtering
FINAL EXAM (EXAM No. 2)
November 28, 2006
EXAM Due: By Friday December 8, 10:00 am

Do all Problems.
All problems same points.

NAME ____

1.___________________________

2.___________________________

3.___________________________

4.___________________________

5.___________________________

1. **FFT and Windows**

Sample the signal

$x(t) = \cos 2\pi 10t$ at $t = nT_o$ where $f_o = 1/T_o = 1000hz$ to get the discrete signal $x[n]$. Generate a total of 2048 samples, starting from $t = 0$.

Do the following:

(a) Determine the period N and the associated frequency ω_o of $x[n]$.

(b) Take a 2048-pt fft and look at the absolute value of the spectrum $X[k]$. Does it have a peak at the expected value of k? You may want to use the "stem" function when needed. Also the "data cursor" when trying to determine $x - y$ coordinates of points on a Figure.

(c) Now apply a 2048-pt Hamming window to the data. Take the fft and see if the spectrum is "better" than the one above.

(d) Generate the same sampled signal, but now generate 20,480 samples. Repeat the above two steps. Comment.

2. **Window Properties**

In Matlab, look at the information on the Window Design and Analysis Tool by invoking "doc wintool". Also, bring up the GUI by typing "wintool". *wintool* by default brings up by default a 64-pt Hamming window.

Do the following:

(a) Examine 64-pt, symmetric sampling "Rectangular", "Hamming", "Hann" (same as Hanning) windows, for Mainlobe width, Relative sidelobe attenuation and Leakage factor. Comment.

(b) Now examine the Kaiser window. You will need the "Beta" parameter here. Let "Beta" vary from .01 to say 100. Comment how the Kaiser window, for different values of Beta, relates to the windows above.

3.**Analysis of cardiogram data - heart1**

Go to http://www.cems.uvm.edu/~mirchand/classes/EE275/images/ and copy cardio.mat somewhere in your computer. Go to MATLAB and do "load cardio". You will see three files: heart1, heart2 and heart3. While typically these may be many minutes of data, you have here only 2048 points. The original continuous signal was sampled at 1 msec (1000 hz), so you have 2.048 seconds of data for each signal. You will be working with heart1, heart2 and heart3 in problems 3, 4 and 5 respectively.

The goal is to determine as well as possible, the period of the spikes in the data. The frequency of these spikes will be referred to as the "dominant" frequency. We will try to determine this frequency using the fft.

Do the following:

(a) Plot the time series $x[n]$ = heart1 and using the data cursor, determine the period of the spikes. Is it the same for the whole data set? Determine the approximate frequency ω_o of the spikes in the signal $x[n]$ and the frequency in hz of the corresponding analog signal.

(b) Do a 1000 pt. fft and obtain the DFT $X[k]$. Given that you have measured the peirod in part (a), determine the corresponding value of k where you should typically expect a peak. Is that what happens when you do the fft? If not, is there any information in the spectrum that identifies the frequency of the spikes.

(c) Apply a window and see if that helps.

(d) Do a 2048 pt. fft and see what that does.

(e) Comment

4.**Analysis of cardiogram data- heart2**

Have a look at heart2 and the 2048 points in the data. Call it $y[n]$. Identify the period of the spikes. The goal again is to determine the "dominant" frequency in the data using the fft. The data has been sampled at 1000 hz.

Do the following:

(a) Determine the frequency ω_o of the signal $y[n]$ and the frequency in hz of the corresponding analog signal.

(b) Do a 1000 pt. fft on $x[n]$ and check to see if it identifies the period of the spikes.

(c) Apply a window and see if that helps.

(d) Do a 2048 pt. fft and see what that does.

(e) Comment

5.**Analysis of cardiogram data- heart3**

Repeat problem 4 for heart3.