HW4 Physics 321 Fall 2011

Use Octave (or Matlab) unless otherwise specified. Show/document all work. One way to do this for octave problems is to use a script file (e.g. hw1_prob1.m) to run (or record) your octave commands. A handy way to do that is to use Windows notepad (under Programs|Accessories) and keep it open as you are developing your commands, saving it and running it. Remember, if you " cd h: " then any .m file in h: can be run just by typing the file's name (without extension) e.g. hw1_prob1. This method also makes it easier to re-use a sequence of commands—such as reading in a wave file and taking the fft, etc. by copying from other files.

1. Generate a vector of 10,000 samples of single frequency sine wave data (make it at least 20 samples per cycle). Use the hamming and then the hanning windowing functions and make fftshift's of the fft. Make close up plots of the (positive frequency) peak in each case. Interpret the result in each case.

2. For the fork_512.wav file,

a) Try using the hanning windowing function to fft and fftshift it. Make a plot (horizontal axis real frequency in hertz) of a close up of the 512 Hz peak.

b) figure out a way (there are many possible) to put the same sound in the middle of a longer vector (say, 5 times longer than the original sound). Now fft and fftshift it and compare the result with the above. Keep a record of the commands you use and plot the two on a common graph in different colors. Note and explain the difference in the appearance of the wings of the peak.

2. a) Evaluate the following integrals by hand:

$$\int_{-3}^{+1} (x^3 - 3x^2 + 2x - 1)\delta(x + 2)dx$$

$$\int_{0}^{\infty} (\cos(3x) + 2)\delta(x - \pi)dx$$

$$\int_{-1}^{+1} exp(|x| + 3)\delta(x - 2)dx$$

b) Show, by hand, that $\delta(cx) = \frac{1}{|c|}\delta(x)$ where c is a real constant. Hint: since the interesting property of the delta is defined by the integral relationship, try integrating both sides from –infinity to +infinity.

3. a) Generate a unit impulse response function that has an exponential tail (something like exp(-n/10)). Make the response about 30 channels long.

b) Figure out how (there are many ways) to populate an input vector with unit impulses at random with an average spacing of about 20 indices.

c) Convolve the result of b) with the response of a). Plot the results.