University of Massachusetts Lowell
Department of Electrical and Computer Engineering
16.520 Computer Aided Engineering Analysis
Problem Set 5

1. Given the datafile *impulse_response.dat* determine its 256 point discrete Fourier transform using the C-routines given in sfft.c (ie. srealfft and srealifft) or fft.f. The response file contains 256 ordered pairs in (int, float) format.

   a. Using gnuplot plot its magnitude and phase using linear axies

2. Using the impulse response given in problem 1 you are perform a low-pass and high-pass filtering of an input signal of an arbitrary time duration. The low-pass filter impulse response $h_{low}(n)$ is given in the data file (impulse_response.dat). The high-pass response h_{high} is obtained by modulation such that $h_{high}(n) = (-1)^n h_{low}(n)$.

   a. Using 512 point DFT and IDFT and the overlap-add method evaluate the concurrent output of the two filters for 4 blocks of the input signal $x(n)$ where each block is 256 points. You may use unit variance Gaussian white noise as the input signal. Your routine is of the form

   $$void\ sfastfilter(int * N,\ float * h,\ float * x,\ float * s)$$

   where N is the filter length, *h is the DFT of the filter, *x is the input and output, and *s is the data portion saved for the next block to be processed.

   b. Evaluate the effectiveness of your filters by plotting the average for spectrum obtained from each block of the output signal.

3. Consider the a white-noise signal input $x(n)$ into the LTI system having an impluse response equal to $h(n)$ with the output being $y(n)$. Using $h(n)$ from problem 1.

   a. Estimate the power spectrum $E(XX^*)$.

   b. Estimate the cross-power spectra $E(XY^*)$ and $E(YX^*)$.

   c. Using the result from (a) and (b) determine the magnitude and phase of the transfer function $H = E(YX^*)/E(XX^*)$.