**Homework 2**

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**1. Spectral Analysis of Signals**

Consider the signal x(n)=sin(2\*pi\*f1\*n/fs)+sin(2\*pi\*f2\*n/fs), where f1=70, f2=80, fs=2000. Get the frequency spectrum of the signal by using 500-point and 2000-point Discrete Fourier Transform (DFT), respectively. Plot your results graphically and check the difference between the two, and then explain the possible reasons why the spectrum of the two cases is different.

Change the f2 to 200 and 200.5, respectively. Calculate the frequency spectrum of the two signals, plot your results and give your solution for improvement.

**2. DFT and Convolution**

For a linear system, its input signal and impulse response signal are given by data files ‘xn\_q2.mat’ and ‘hn\_q2.mat’, respectively. Use the standard computation method of convolution to find the response y[n] of the system and represent your results graphically.

For the linear system mentioned above, use DFT method to calculate the output signal y[n] and plot all your results graphically, which includes to respectively get the DFT X[f] and H[f] of x[n] and h[n], to compute the Frequency Domain output Y[f] by Y[f]=X[f]×H[f], and then to take the inverse DFT of Y[f] to get the output signal y(n) in time domain.

Plot the output signals of the two different methods in one figure. Check the figure to see if there was any difference between the output signals, and explain the possible reasons. Finally, give your solutions to obtain the same output y(n) using convolution and DFT.

**3. Frequency Response of a System**

The impulse response h(n) of a system is given by “hn\_q3.mat”, and the sampling frequency fs is 100Hz. Please answer the following questions:

(1) Please plot the amplitude and phase spectra of this system using Matlab. Observe the spectra and answer: What type of system is it? (low-pass, high-pass or band-pass) What is the cut-off frequency? Is it linear phase or non-linear phase within the passband frequency range?

(2) For an input signal x(n) saved in “xn\_q3.mat”, please calculate the output y(n) using Matlab. Plot the time waveforms of both x(n) and y(n), and summarize the changes after the signal pass through the system.

(3) Plot the amplitude spectrum of x(n) and y(n), respectively (please use hamming window prior to FFT). Compare the two spectra and answer: Does it agree with your observations in the time waveform comparison? Does it agree with the frequency response of this system?