EE 123 DIGITAL SIGNAL PROCESSING, Spring 2009
Homework # 9, Due April 23, Thursday

1. Problem 5.36, Oppenheim and Schafer, 2nd ed.

2. Problem 5.40, Oppenheim and Schafer, 2nd ed.

3. Problem 5.66, Oppenheim and Schafer, 2nd ed.

4. Design digital filters that meet the specifications below by following the geometric principles discussed in class that relate pole/zero locations to the magnitude response. Assume a sampling period of 200 Hz and make sure your filters are within 0.5 dB of the specifications. You can start with an initial guess, use the MATLAB function `freqz` to see the frequency response, and move the poles and zeros until the specifications are met.

   a) A 2-pole/2-zero low-pass filter with the 3-dB cutoff at 30 Hz.

   b) A 2-pole/2-zero high-pass filter with the 3-dB cutoff at 80 Hz.

   c) A 2-pole/2-zero notch filter a 20-dB gain reduction centered at 50 Hz.

   d) A 2-pole/2-zero band-pass filter with the 3-dB pass band between 40 Hz and 60 Hz.

5. The continuous-time periodic signal $x_c(t)$ has sinusoidal components at 20, 50, and 85 Hz:

$$x_c(t) = \cos(40\pi t + 30^\circ) + \sin(100\pi t - 140^\circ) - \cos(170\pi t - 140^\circ)$$

   a) Sample the signal at 200 Hz to obtain $x[n]$. Plot one second of the sampled signal $x[n]$ and its spectrum (use the MATLAB function `fft`).

   b) Pass 10 seconds of $x[n]$ through each of the four filters designed in Problem 4 above (you can use the MATLAB function `lsim`) and plot the last second of the resulting output signal and its spectrum.