ECE431 Homework 11
IIR Filter Design with MATLAB

Due Friday, December 7 at 3pm (sharp). Submit a pdf file containing your assignment using the Homework 11 Submission link under week 14 on the class web page.

11.1 Design a bandpass filter that has passband 1 Hz to 7 Hz and stopbands 0 to 0.5 Hz and greater than 9 Hz. The gain in the passband must lie between 0.9 and 1, and the stopband gain must be less than 0.1. The sampling frequency is 30 Hz. Use MATLAB to find the transfer function, plot the poles and zeros, and the frequency response magnitude and phase for the following prototype filters:
(a) Butterworth
(b) Chebyshev type I
(c) Eliptical
Verify that your filters satisfy the specifications. Compare and contrast these cases regarding filter order and response characteristics. Useful MATLAB commands include buttord, butter, zplane, freqz, cheb1ord, cheby1, ellipord, ellip.

11.2 Design a Butterworth bandstop filter to reject 60 Hz power line interference from ECG data sampled at 240 Hz. Assume your stopband is between 59 and 61 Hz and that 60 dB of attenuation is required. You require gain between 0.9 and 1 for frequencies less than 57 Hz and greater than 63 Hz.
(a) Find the transfer function and pole-zero plot for your filter.
(b) Compare the magnitude response of your design to that of the simple all-zero and pole-zero filters included in the ECG FIltering Example M-file on the web site. Verify that your design satisfies the specifications.
(c) Apply your filter to the clean and noisy ECG signals in the ECG Filtering Example data on the web site. Compare the distortion of the clean ECG wave to that of the simple all-zero and pole-zero filters demonstrated in class. Also compare the residual noise level when you filter the noisy ECG signal. (Use MATLAB command filter.)
(d) Construct a noisy ECG signal by adding a sinusoid of amplitude 200 and frequency 59 Hz to the clean ECG signal. Now compare the residual noise level for your filter and the all-zero filter.