

**ECE 431**  
**Digital Signal Processing**  
**Homework 11**

Due Friday, December 8, 2006

You have started a new job at the engineering firm *Mobile Monitoring* in Heartland, USA, which specializes in mobile patient monitoring devices for ambulance, helicopter, and other types of rescue units. *Mobile Monitoring* is developing a new ECG monitor that measures the victim's heart signal. The difficult problem they face is that the heart signals are contaminated by high levels of noise, primarily due to electronics in the mobile unit and patient motion/vibration. Your boss asks you to design a digital filter that reduces these undesirable noises, while preserving the heart signal. She gives you a sample of a "clean" ECG signal and the same ECG signal with "noise" added. Both signals are sampled at 200Hz. You can copy the data files `clean_sig.mat` and `noisy_sig.mat` from the ECE 431 course webpage. Given these signals, you must design a digital filter that will reduce noise in similar heart monitoring situations.

Your boss requests the following:

- a. Assuming a sampling rate of 200Hz, what is the approximate heartrate in beats/minute?
- b. Plot the magnitude DFT of the clean and noisy signals, and use these plots to determine an effective noise filtering strategy (that is, determine DT filter specifications). Remember the goal is to remove noise, but preserve the signal as much as possible.
- b. Design an IIR filter using a CT Butterworth filter and the bilinear transformation.
- c. Design a FIR filter using the Parks-McClellan filter design method. Provide a brief (1-page or less) summary of the filter design.
- d. Compare the performance of the two filters. Compare the effect of the filters on both the clean and noisy signal. Plot the output signals of the two filters and discuss the results.