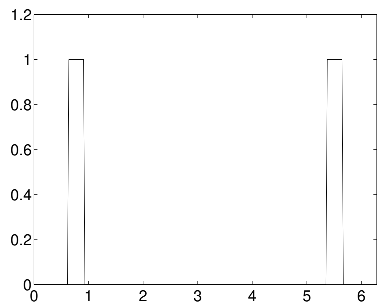
ELEC 431
Digital Signal Processing
Homework 11

Due Monday, March 31, 2002

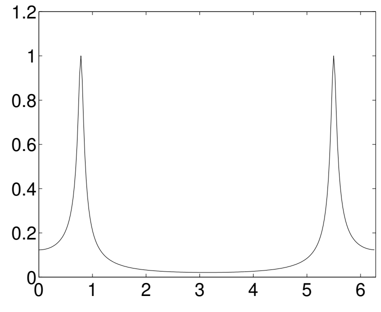
1. Consider the magnitude frequency response depicted below. Notice that the passband is approximately $\pi/8$ in width. If we want to reasonably approximate this frequency characteristic, what is the minimum length FIR filter that you would recommend. **HINT:** Think about how much frequency resolution you can achieve with a length N signal (i.e., think about DFT basis vectors).



Now consider another magnitude frequency response depicted below. This frequency response was generated using a two-pole IIR filter (two conjugate symmetric poles and two zeros at the origin).

a. Where are the pole locations the generated this filter? Verify in Matlab that your proposed pole locations produce the desired response characteristic.

b. If you wanted to approximate this IIR filter using an FIR filter, then what length FIR filter would you recommend and why?



2. 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 other 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 500Hz, and are approximately 8 seconds in duration. You can copy the data files clean_sig.mat and noisy_sig.mat from the ELEC 431 course webpage www.ece.rice.edu/~nowak/elec431. Given these signals, you must design a digital filter that will reduce noise in similar heart monitoring situations.

Your boss requests the following:

a. 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. (Follow design procedure from Homework 8.)

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.