EE4820: Biomedical Signal Processing
Z-transforms and Frequency Response

Department of Electrical and Computer Engineering
California State University, Los Angeles

DUE: Wed. April 27

1. Given the following relationship for a given linear system:

$$\begin{aligned} 4y[n] + 8y[n-1] - 7y[n-2] - 84y[n-3] - 201y[n-4] + 740y[n-5] - \ldots \\ 201y[n-6] - 84y[n-7] - 7y[n-8] + 8y[n-9] + 4y[n-10] &= x[n] \end{aligned}$$

   (a) Find the transfer function $H(z)$ for this system.
   (b) Plot the frequency response of $H(z)$ (both magnitude on a decibel scale and phase) vs frequency in Hz, given that the sampling rate was 1kHz.
   (c) This system is actually a frequency filter. Based on the frequency response, what type of filtering does this system perform?
   (d) What is the passband gain?
   (e) What is (are) the cutoff frequenc(ies)?

2. In this problem you will filter an ECG recording to obtain a clean ECG signal, like the one in Fig. 1

   (a) Load the ECG signal `x` in `ecg_fs250Hz.mat`.
   (b) View the ECG signal. What type of filter do you think is needed to retain just the ECG signal?
   (c) Examine the magnitude spectrum of `x`. Based on analyzing the spectrum, what cutoff frequency would you choose for your filter?
   (d) Create an appropriate filter to generate a signal like that shown in Fig. 1.
   (e) View the magnitude of the frequency response of your filter.
   (f) Filter the signal and show how the filter performed by looking both at the magnintude spectrum of the output as well as the signal output in time.

3. You are going to filter an ECG signal corrupted by 60Hz noise which is stored in the file `ecg60HzNoise.mat`.

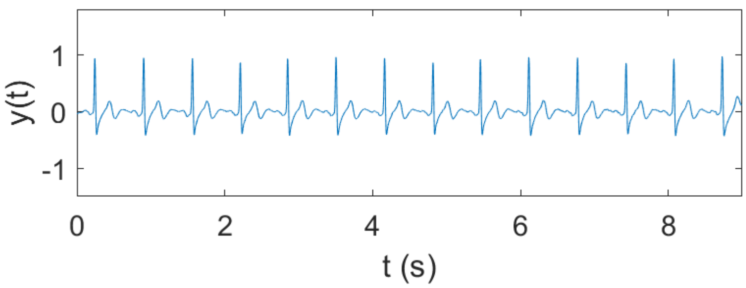

Figure 1:

(a) First, you need to determine the sampling rate. What is the sampling rate in Hz? Hint: How could you figure this out, given that we know there is strong 60 Hz noise present?

(b) Create a 512-order FIR filter to reject the 60Hz noise (I would suggest a 57-62Hz band-reject filter).

(c) Filter the ECG input signal and show the output signal in time as well as the output's magnitude spectrum.