Problem Set 2

1. ***Filtering EEG*** – use data from Lab 4 (chb_sample.mat)

    a. Design a high-pass filter with a cut-off of 1Hz, like what you might use to remove nonstationarity. Use `freqz` to plot the frequency response.

    b. Design a stop-band filter with cut-offs of 40Hz and 70Hz, like what you might use to remove 60Hz noise. Use `freqz` to plot the response.

    c. Zero-phase filter one channel of the data and plot the first 20s of the raw and the two filtered signals. Recall that the sampling rate is 256Hz.

    d. Plot the amplitude spectra for the raw and filtered signals.

2. ***Filtering LFP*** – use data from Lab 5 (ec014_639_samp.mat)

    a. Design a band-pass filter centered on the theta band (~8Hz). Use `freqz` to plot the frequency response.

    b. Zero-phase filter one channel of the data and plot the first 10s of the raw and filtered signals.

    c. Run a Hilbert transform (`hilbert`) on the band-pass filtered signal. Plot the amplitude and phase on top of the filtered signal. Does it look reasonable?

3. ***Phase locking of spikes to LFP*** – use data from Lab 5 (ec014_639_samp.mat)

    In addition to hippocampal local field potentials (LFP), this data also contains the spike times of 83 neurons (`Tlist`) and the animal's (1D) position along a linear track (`pos`).

    a. Create a histogram of the theta-phase at the spike times of neurons 4 and 73. Are these neurons phase locked? Hint: The bins/indices that correspond to spike times for neuron N are `round(Tlist{N}*256).`

    b. Plot the theta-phase vs position for the spike times of neuron 53. Does this neuron's response suggest that the relationship between theta-phase and spikes is fixed? What about neuron 73?