EE434 Biomedical Signal Processing Course
Homework # 1

Deadline: November 16th, 2023, 13:30

Download ecg_1.mat , ecg_2.mat and ecg_3.mat. The signals were sampled at 1000 Hz.

Question #1: About sampling rate, signal plotting, FFT, plotting the magnitude and phase spectrums of a signal, and the noise types.

a) Calculate how many samples are there for 1 second for the ECG data you downloaded?
b) Calculate the total recording times in seconds for each ECG data you downloaded?
c) For each ECG data you downloaded, plot a total of 3 seconds of ECG data based on time, starting from the beginning of the 2nd second to the end of the 4th second. How many samples do we have for these 3-second fractions?
d) Find out in which frequency band a typical ECG signal falls by searching on the internet or on books.
e) Now plot the magnitude and phase spectrums separately by calculating the FFT for each of these parts you have plotted.
    i. Can you tell what kind of noise each data has by looking at the magnitude spectrums? (Low? High? Band-limited? etc.)
    ii. Can you tell what kind of phase each data has by looking at the phase spectrums? (Zero phase?, Linear phase? Non-linear phase?)
f) Now, repeat parts (c) and (d), but this time starting from the beginning of the 5th second to the end of the 7th second.
g) Compare the magnitude and phase spectrums for these two different cases? Are they exactly same? If there is any difference what can be the reason?

Question #2:

Note: For this question use ecg_2.mat data.

a) Design a lowpass digital **FIR filter** using two window functions. Decide which ones you choose and why. Design the filter so that you get the cleanest ECG as possible. What filter specs provide you with the cleanest ECG? Convince the reader of your exam why your particular selection is the best. You may, for

example, compare a few different designs obtained by different specs. Plot the magnitude and phase spectra of these filters.

i. Apply each of the above designed filters to the ECG signal you downloaded. Is the signal denoised? Play around with the filter specs, and find out whether other specs may give you better denoised signal.
ii. Plot the filtered signal and the original signal on top of each other on the same plot (with a different color). Comment!
iii. Plot the filtered signal and the original signal **frequency spectrums** on top of each other on the same plot (with a different color). Compare them!

Note: When you make the plots please label all the axes, write their units, and give an explanatory title for each plot.

Load your homework as a pdf file using the name template:

HW-01-Your_School_ID.pdf