BioE 101 Lab 1 Prelab

Due 2/2/18 in 340 HMMB homework box, but recommended to have been done before your lab section

1. What is the SNR in dB of a measurement that has a signal power of 1 mW and a noise power of 1 μW? For your convenience, remember that SNR is defined as:

$$SNR = \frac{P_{signal}}{P_{noise}},\ SNR_{dB} = 10\log(SNR)$$

2. When quantizing a signal through an ADC, the process can introduce error (nonlinearity) because of the finite resolution of the ADC.

   (a) If you have a signal in the range of -10V to 10V (20V peak-to-peak) that is expressed with 12 bits, what is your quantization error (Q.E)? Quantization error is also commonly referred to as quantization noise. For your convenience, the equation for QE is below.

$$QE = \frac{\Delta x}{2^B} = \frac{x_{max} - x_{min}}{2^B}$$

   where x is your signal and B is the number of bits of your ADC.

   (b) The V_{pp} (peak-to-peak voltage) of the thermal noise of the signal going into the ADC is 200 mV. How much larger is the thermal noise compared to the quantization noise? Do you think quantization noise would be much of an issue compared to thermal noise?

   (c) Your Arduino is 10 bits and can only take in voltages from 0V to 3.3V. What is your quantization error?

3. During this lab you will be plotting the Fourier transform of the signal acquired from your sensor. For each function below, sketch $g(t)$ and its Fourier transform $G(f)$. f is in Hz. For your convenience, you might find these helpful:

$$X(f) = \int_{-\infty}^{\infty} x(t)e^{-i2\pi ft}\,dt,\ \cos(x) = \frac{e^{ix} + e^{-ix}}{2},\ \int_{-\infty}^{\infty} e^{-i2\pi ft} = \delta(f)$$

   (a) $g(t) = \cos(2\pi f_1 t)$

   (b) $g(t) = \cos(2\pi f_1 t) + 1$

   (c) $g(t) = \cos(2\pi f_1 t) + \cos(2\pi f_2 t)$ where $f_2 > f_1$ For graphing purposes, let $f_1 = 60$Hz and $f_2 = 1$kHz

4. Go through the Python tutorial notebook (ipynb file) posted in the Lab 1 folder on bCourses. Once you've downloaded the notebook, open up a terminal and `cd` to the folder where you downloaded the ipynb file. To open up the notebook, enter in `ipython notebook <filename>` or `jupyter notebook <filename>` where <filename> is the name of the notebook file. Wait a while as your computer brings up the notebook in a browser. Then go ahead and read through the notebook carefully. If you're already comfortable with Python, then feel free to just skim. There is nothing to turn in for 4.