**ECE 3522: Stochastic Processes in Signals and Systems**

# Computer Assignment (CA) No. 9: Signal To Noise Ratio and Filtering

The assignments will now start to get a little more vague and integrate concepts. For example, in this assignment you must connect the concepts of signal power and variance.

The tasks to be accomplished are:

1. Create a function that generates a signal that consists of a sinewave plus Gaussian white noise:

sig = generate\_sine(frequency\_in\_Hz, duration\_in\_secs, sample\_frequency\_in\_Hz, snr\_db)

Assume the sinewave has an amplitude of +/- 1.0. What is its power? Generate a Gaussian white noise signal such that the signal to noise ratio of the summed signal is “snr\_db” measured in dB (e.g., 20log10(signal\_energy/noise\_energy).

1. For SNRs in the range [-30 db, +30 dB] in steps of 10 dB, compute and plot the first 16 lags of the autocorrelation function for a 500 Hz sinewave sampled at 8000 Hz.
2. At what SNR does the autocorrelation start to be measurably impacted by the additive noise?
3. For SNRs of -30 dB and +30 dB, compute a 8192 point FFT and plot the magnitude spectrum from [0, 4000 Hz]. Explain any differences you observe between the two plots.
4. Process the signal corresponding to a 30 dB SNR through a digital filter of the form:



Compute the autocorrelation signal for y[n], and plot the magnitude spectrum of the Fourier Transform of the autocorrelation function. Similarly plot the square of the magnitude spectrum of the original signal, y[n]. Plot these on the same scale and compare/contrast these plots. What did you learn from this? Explain any similarities you observe. How does this plot compare to that obtained in (4). Can you explain the differences in terms of the frequency response of the linear system used to filter the signal?