ECE 440 – Spring 2019
Homework 4

Due before class on Friday 03/01

1. (**Drill** problem 7.1 in pg. 341.) A random process is defined by the sample functions $X_i(t) = A_i t + B_i$, where t is time in seconds, A_is are independent random variables for each i, which are Gaussian with 0 means and unit variances, and the B_is are independent random variables for each i uniformly distributed in $[-0.5, 0.5]$.
   (a) Sketch serval typical sample functions.
   (b) Is the random process stationary?
   (c) Is the random process ergodic?
   (d) Write down an expression for its mean at an arbitrary time t.
   (e) Write down an expression for its mean-squared value at an arbitrary time t.
   (f) Write down an expression for its variance at an arbitrary time t.
2. Problem 7.23 in pg. 346.
3. Problem 8.3 in pg. 391.
4. Specify which of the following statements are true, and explain your answers:
   - SSB modulation uses half as much bandwidth as DSB modulation, so the pre-detection SNR_T (after an ideal receiver filter, before demodulation) can be two times higher.
   - SSB uses half as much bandwidth as DSB, so the post-detection SNR_D (after demodulation) is two times higher.
   - The SNR at the receiver (pre and post-detection) can always be improved by increasing the transmitted power.
   - In practice, the noise is not white (it has different PSD for different frequencies), hence the SNR is better in some frequency bands than in others.
   - The amplitude (envelope) of the noise is irrelevant when we are demodulating angle modulated signals. The SNR only depends on the phase of the noise.
   - When using Frequency modulation, the low-frequency components of the message are subject to lower noise levels than high frequency components.
   - When using Phase modulation, the low-frequency components of the message are subject to lower noise levels than high frequency components.
5. When receiving an AM signal, what advantages does the coherent demodulator have over envelope detection?
6. Problem 8.23 in pg. 393.