EE 484

Homework 5

Due 6:00 p.m. on Wednesday, March 2, 2016

Work all 2 problems.

Note: For any Matlab exercises you should submit your Matlab code along with the rest of your solution to the given problem.

Problem 1. This is a Matlab exercise. Consider the carrier signal, denoted as $s(t) = A \cdot sin(2\pi f_c t)$ and a message waveform $m(t) = M \cdot \cos(2\pi f_m t + \phi)$. Let $x(t) = [1 + m(t)] \cdot s(t)$ represent an amplitude modulated (AM) signal.

a. Let $t = n\Delta t$, $f_c = 10$ Hz, $f_m = 1$ Hz, and $\phi = \pi/4$, then generate a plot of $x(n) = x(n\Delta t)$ in Matlab for A = 1.0 and M = 0.5, M = 1.0, and M = 1.5. Plot $x(n)$ for five cycles of the message waveform in each case. Choose Δt so that your plot consists of 1000 samples.

b. Derive the Fourier Transform of x(t) analytically.

c. Generate and plot the magnitude of the Fourier Transform of $x(n)$ in Matlab for the three cases of M identified in part a. Include the frequency axis in each plot.

d. Which of the three values of M is most suitable for transmission of information and why?

Problem 2. This is a Matlab exercise.

a. Generate the complex signal $s(n) = A \cdot cos(2\pi f_c \Delta t \cdot n) + jA \cdot sin(2\pi f_c \Delta t \cdot n)$, for $f_c = 10$ Hz, A=1.0, $\Delta t = 0.001$, and $1 \leq n \leq 100,000$. Plot this signal with the in-phase components (real parts) on the x-axis and the quadrature components (imaginary parts) on the y-axis. What is the magnitude of this signal?

b. Generate the complex noise sequences $k_1(n) \sim N(0, 0.2)$, $k_2(n) \sim N(0, 1.0)$, $k_3(n) \sim N(0, 2.0)$, for $1 \leq n \leq 100,000$. As above, plot this noise sequences with the in-phase values on the x-axis and the quadrature components on the y-axis.

c. Compute the magnitude of the noise sequences above and generate the histograms of each, with 100 bins. Plot these histograms with the signal magnitude along the x-axis and the number of occurrences along the y-axis. What distribution do these noise sequences follow?

d. Let $r_1(n) = s(n)+k_1(n)$, $r_2(n) = s(n)+k_2(n)$, and $r_3(n) = s(n)+k_3(n)$ be the complex signal plus noise vectors for each of the three difference noise sequences calculated above. Calculate the magnitude of each of these signals, then generate the histograms as above. Describe the distribution that each of these signals follows. What distribution(s) does the phase of the signals follow?