EE 484

Midterm

Due Monday, February 26, 2018

Work all 5 problems.

Problem 1. Determine which of the following systems is linear.

a. $y(t) = 2x(t)$.

b. $y(t) = A\cos x(t)$, A is a constant.

c. $y(t) = c_1 x(t-1) + c_2 x(t-2)$, $c_1, c_2 \neq 0$.

d. $y(t) = e^{j2\pi ft} x(t)$, $f > 0$.

Problem 2. Suppose that BPSK modulation is used for transmitting information over an AWGN channel with a power spectral density of

$$\frac{1}{2}N_0 = 10^{-10} \text{ W/Hz}.$$

The transmitted signal energy is

$$E_b = \frac{1}{2}A^2 T.$$

where T is the bit interval and A is the signal amplitude. Determine the signal amplitude required to achieve an error probability of 10^{-5} when the data rate is

a. 100 Kbps.

b. 1 Mbps.

c. 10 Mbps.

Note: For this problem you may utilize the Gaussian Q-function and its inverse in expressing your answers.

Problem 3. Assume that a repeat-back jammer is located $d = 30$ km away from the communicator. Assume further that the jammer can monitor any uplink transmission from the communicator to a nearby satellite. How fast must the communicator hop his frequency to evade the repeat-back jammer? Assume that the jammer can change its jamming frequency in zero time and that the only differential delay between the communicator's uplink signal and the jamming uplink signal is the propagation delay from the communicator to the jammer.

Problem 4. A receiver front end has a noise figure of 9 dB and a gain of 50 dB and a bandwidth of 5 MHz. The input signal power is 10^{-11} W. The antenna temperature is 175 K. Find $T_e,\ T_s,\ N_{out},\ SNR_{in}$ and SNR_{out} Recall $T_0 = 290$ K.

Problem 5. Using the same design as Problem 4 an additional amplifier is inserted in the system before the one described in Problem 4 (a preamplifier) so that now the antenna feeds energy to two networks in cascade. The preamp has a noise figure of 3 dB and a gain of 10 dB and a bandwidth of 5 MHz. For the cascaded system find $T_s,\ F_{out},\ N_{out}$ and SNR_{out}, where F_{out} is the overall or composite F.