University of Illinois at Urbana-Champaign
Department of Electrical and Computer Engineering

ECE 359: Communications I

Fall 2001

Problem Set 9

Narrow-Band Noise, Noise Analysis of Analog Modulation Schemes

Issued: Thursday, Nov. 15th. **Due:** Thursday, November 29th (beginning of lecture).

Reading from Haykin: Chapter 1, Sections 1.8–1.14, and Chapter 2, Sections 2.10–2.15.

Problem 9.1 (Optional)

A random process $X(t)$ is defined as

$$X(t) = A\cos(2\pi f_c t) \ ,$$

where A is a Gaussian random variable with zero mean and variance σ_A^2. This random process is applied to an ideal integrator producing the output random process

$$Y(t) = \int_0^t X(\tau)d\tau \ .$$

(a) Determine the pdf of the random variable $Y = Y(t_1)$ for some time instant $t_1 > 0$.

(b) Is $Y(t)$ stationary?

(c) Is $Y(t)$ ergodic?

Problem 9.2

Problem 1.23 from Haykin, p. 84.

Problem 9.3

Problem 1.26 from Haykin, pp. 84–85.

Problem 9.4

Problem 1.27 from Haykin, p. 85.

Problem 9.5

(a) Problem 1.30 from Haykin, p. 85.

(b) Problem 1.29 from Haykin, p. 85.

Problem 9.6 (Optional)

Consider a narrow-band Gaussian noise process $N(t)$ with zero mean and power spectral density

$$S_{NN}(f) = \begin{cases} \frac{N_0}{2}\,, & f_c - B \le f \le f_c + B\,, \quad -f_c - B \le f \le -f_c + B\,, \\ 0\,, & \text{otherwise.} \end{cases}$$

Find the probability density function of a sample of the envelope of $n(t)$, i.e., find $f_E(e)$ of the random variable $E = c(t)$, where $c(t)$ is the envelope of the band-limited random process $N(t)$.

Problem 9.7

Problem 2.46 from Haykin, p. 179.

Problem 9.8

Problem 2.51 from Haykin, p. 180.

Problem 9.9

Problem 2.54 from Haykin, p. 181.