GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING
Quiz - Fall 2013
ECE 4601: Communication Systems

Aids Allowed: Course text, calculator, math tables
Attempt all questions
Questions are of equal value

DATE: Wednesday October 2, 2013.
TIME: 4:35pm - 5:55pm
INSTRUCTOR: Prof. G.L. Stüber

1) Random Processes: Consider the random process

$$X(t) = W(t) + aW(t - t_o) \ ,$$

where $W(t)$ is a white Gaussian noise process with power spectral density $N_o/2$ watts/Hz, and the parameters a and t_o are constants.

a) 4 marks: Determine the autocorrelation of the process $X(t)$ and sketch it.

b) 3 marks: Determine the power spectral density of the process $X(t)$ and sketch it.

c) 2 marks: What is the total power in the process $X(t)$?

d) 1 marks: What is the power in the dc component of the process $X(t)$?

2) Random Processes: The random process

$$X(t) = A\cos(2\pi f_o t + \Phi) + W(t)$$

describes a sinusoidal process that is corrupted by an additive white Gaussian noise process $W(t)$ of known power spectral density $N_o/2$. The phase of the sinusoidal process, denoted by Φ, is a uniformly distributed random variable having the probability density function

$$f_\Phi(\phi) = \begin{cases} \frac{1}{2\pi} & , \text{ for } -\pi \leq \phi \leq \pi \\ 0 & , \text{ otherwise} \end{cases}$$

The amplitude A and frequency f_o are both constant but known.

a) 5 marks Determine the autocorrelation function of the process $X(t)$.

b) 5 marks Determine the power spectral density of the process $X(t)$.

3) Matched Filters: A communication system transmits binary information using the antipodal pulses $g(t)$ or $-g(t)$, where $g(t)$ is shown below

a) 3 marks Find the impulse response of the matched filter.

b) 3 marks Sketch the output of the matched filter when the pulse $g(t)$ is applied to the input. Show all important details.

c) 2 marks Suppose that two-sided noise power spectral density is $N_o/2 = 10^{-12}$ watts/Hz. What is the bit energy-to-noise ratio, E_b/N_o? Express your answer in dB units.

d) 1 marks What is the probability of bit error at the E_b/N_o in part b)?

