GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING
Quiz - Fall 2011
ECE 4601: Communication Systems

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

DATE: Wednesday October 5, 2011.
TIME: 11:05 - 11:55
INSTRUCTOR: Prof. G.L. Stüber

1) Random Processes: Consider a wide sense stationary random process $X(t)$ having mean μ_X and autocorrelation function $\phi_{XX}(\tau)$ and power spectrum $\Phi_{XX}(f)$. The random process $X(t)$ is used to construct another random process $Y(t)$ as follows:

$$Y(t) = X(t) - X(t - 2T)$$

a) 1 mark What is the mean of $Y(t)$, μ_Y?

b) 4 marks What is the autocorrelation of $Y(t)$, $\phi_{YY}(\tau)$, in terms of $\phi_{XX}(\tau)$?

c) 3 marks What is the output power spectrum $\Phi_{YY}(f)$ in terms of the input power spectrum $\Phi_{XX}(f)$?

d) 2 marks What frequency components cannot be present in the output spectrum $\Phi_{YY}(f)$?

2) Matched Filters: Consider a communication system that transmits information using the pulse

$$g(t) = A[-u(t) + 2u(t - T/2) - u(t - T)]$$

a) 3 marks Determine and sketch the filter $h(t)$ that is matched to $g(t)$.

b) 5 marks Sketch the waveform at the output of the matched filter $y(t) = g(t) * h(t)$, labeling all important points. *Hint: Use graphical convolution (flipping and shifting).*

c) 2 marks What is the energy in the pulse $g(t)$?

3) Signal Representation: Consider the following pair of waveforms

$$\begin{aligned} s_1(t) &= u_T(t) \\ s_2(t) &= \sin(2\pi t/T)u_T(t) \end{aligned}$$

where $u_T(t) = u(t) - u(t-T)$ and $u(t)$ is the unit step function.

a) 4 marks: Find a complete set of orthonormal basis functions to represent this set of signals.

b) 4 marks: Find the signal vectors $\mathbf{s}_0$ and $\mathbf{s}_1$ and plot them.

c) 2 marks: What is the Euclidean distance between $\mathbf{s}_0$ and $\mathbf{s}_1$?