GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING
Quiz - Fall 2012
ECE 4601: Communication Systems

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

DATE: Wednesday October 8, 2012.
TIME: 2:05pm - 2:55pm
INSTRUCTOR: Prof. G.L. Stüber

1) Random Processes: The power spectral density of a nonzero mean wide-sense stationary random process is given by

$$\Phi_{XX}(f) = 5\delta(f) + 10\text{sinc}^2(5f)$$

a) 2 marks: Sketch and fully dimension the power spectral density.

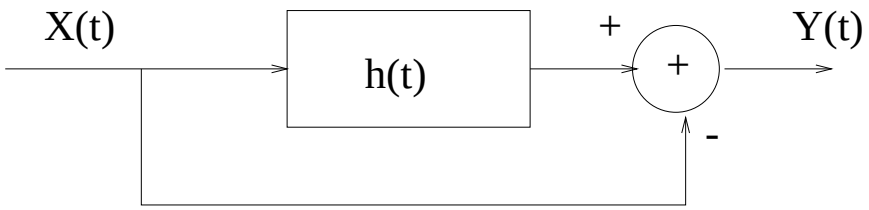
b) 2 marks: Find and sketch the autocorrelation function.

b) 2 marks: What is the power in the dc component of the random process?

c) 2 marks: What is the total power in the random process?

b) 2 marks: What is the smallest τ for which the random variables $X_1 = X(t)$ and $X_2 = X(t+\tau)$ are uncorrelated. *Hint:* $\mu_{X_1X_2}(\tau) = \phi_{X_1X_2}(\tau) - \mu_X^2$.

2) Random Processes: A random process $X(t)$ with autocorrelation function $\phi_{XX}(\tau)$ and power density spectrum $\Phi_{XX}(f)$ is input to the linear system shown below. The filter has impulse response $h(t)$ and transfer function $H(f)$. Express answers in terms of in terms of $h(t)$ or $H(f)$ as appropriate.



a) 4 marks Find the overall transfer function of the system, $H_{\text{eff}}(f)$, where $Y(f) = H_{\text{eff}}(f)X(f)$ in terms of $H(f)$.

b) 2 marks Find the power spectral density of the output $\Phi_{YY}(f)$?

b) 1 marks If $h(t) = \delta(t-1)$ and the input $X(t)$ is additive white Gaussian noise with a two-sided noise spectral density of $N_o/2$ watts/Hz, what is $\Phi_{YY}(f)$.

b) 3 marks Find the autocorrelation of the output $\phi_{YY}(\tau)$.

3) Error Probability: Suppose that multi-hop communication system is modeled as the serial concatenation of n identical binary symmetric channels (BSCs) each with crossover probability p as shown in the figure below. Since the overall channel has two inputs and two outputs, the overall channel can be modeled as a single BSC with crossover probability p_{eff}.

a) 4 marks: Find p_{eff} in terms of n and p.

b) 2 marks: If each hop uses binary antipodal signaling with pulses $g(t)$ and $-g(t)$, what is p in terms of E_b/N_o?

c) 4 marks: If $n = 2$ and $E_b/N_o = 6$ dB find p_{eff}.