GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING
Quiz - Spring, 2009
ECE 4601: Communication Systems

Aids Allowed: Text, $8\frac{1}{2} \times 11$ crib sheet (one side)
Attempt all questions
Questions are of equal value

DATE: Thursday February 19, 2009.
TIME: 9:35 - 10:55
INSTRUCTOR: Dr. G.L. Stüber

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

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

a) 4 marks: Sketch and fully dimension the power spectral density and 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?

d) 2 marks: Given that the area under the main lobe of the sinc-squared function is approximately 0.9 of the total area, which is unity if the sinc-squared function has unity amplitude, find the fraction of total power contained in this process for frequencies between 0 and 0.2 Hz.

2) Consider a binary communication system that transmits information using the pulse

$$g(t) = A\sin(\pi t/T)\ , \quad 0 \le t \le T$$

according to the mapping rule

$$\begin{aligned} \text{“0”} &\longrightarrow -g(t) \\ \text{“1”} &\longrightarrow +g(t) \end{aligned}$$

The “0”s and “1”s are transmitted with equal probability, and the channel is an AWGN channel, with a two-sided noise power spectral density of $N_o/2$ watts/Hz.

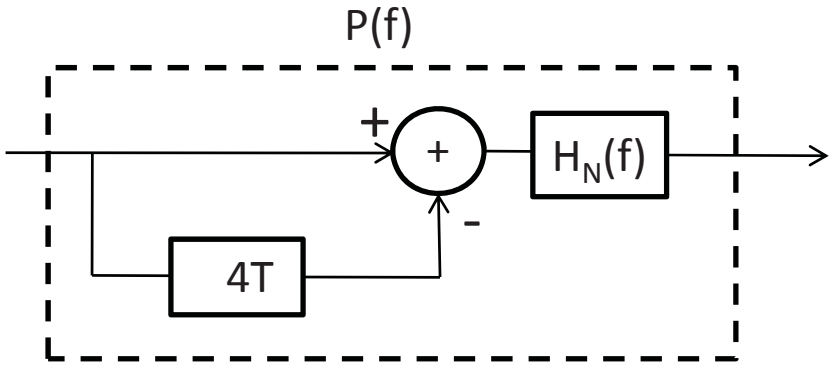
a) 3 marks Determine and sketch the filter $h(t)$ that is matched to $g(t)$.

b) 3 marks Determine and sketch the overall pulse $p(t) = g(t) * h(t)$ for the filter you found in part (a), labelling all important points.

c) 2 marks Determine the pulse energy, E, and the energy per bit, E_b.

d) 2 marks What is the probability of bit error in terms of E_b/N_o?

3) The overall pulse response $P(f)$ of a partial response system is generated by the figure below, where $H_N(f)$ is an ideal Nyquist (low-pass) filter with a bandwidth of $W = 1/(2T)$ Hz.



a) 6 marks What is the overall pulse response $P(f)$? Sketch the magnitude and phase response of $P(f)$, showing all important values.

b) 4 marks If matched filtering is used at the receiver, what are $|G(f)|$ and $|H(f)|$, where $|G(f)|$ and $|H(f)|$ are the magnitude responses of the transmitter and receiver filter, respectively?