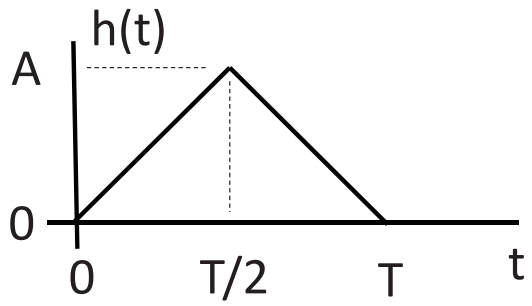
GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING
Quiz - Fall 2014
ECE 4601: Communication Systems

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

DATE: Thursday October 2, 2014.
TIME: 12:05pm - 1:25pm
INSTRUCTOR: Prof. G.L. Stüber

1) Matched Filters: Consider the matched filter $h(t)$ shown below



a) 3 marks: Sketch the pulse $g(t)$ that the filter $h(t)$ is matched to.

b) 2 marks: What is the energy of the pulse $g(t)$ in terms of A and T?

c) 3 marks: Construct a pulse $p(t)$ that is *orthogonal* to $g(t)$ and having the same energy as $g(t)$. *The solution is not unique.*

d) 2 marks: The pulse $g(t)$ is applied to input of the filter $q(t)$ that is matched to $p(t)$, and the output is sampled at time T. What is its value?

2) Random Processes: Suppose that white Gaussian noise process $X(t)$ having a power spectral density of $N_o/2$ watts/Hz is input to a linear time invariant filter $h(t)$, having transfer function $H(f)$, and the output is $Y(t)$. The output power spectral density is observed to be

$$\Phi_{YY}(f) = \frac{N_o a}{a^2 + (2\pi f)^2}$$

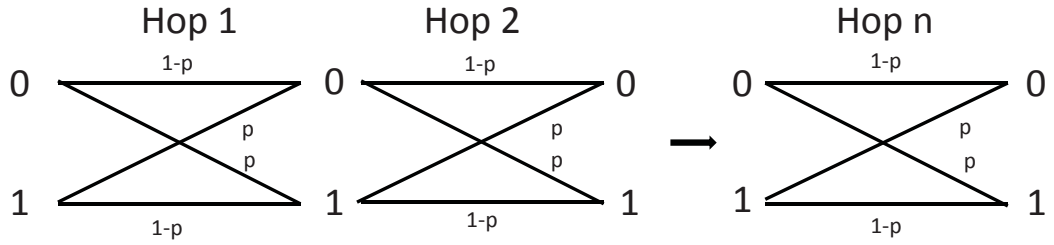
a) 2 marks What is the output autocorrelation function $\phi_{YY}(\tau)$?

b) 3 marks Find the filter transfer function $H(f)$ and impulse response $h(t)$.

c) 2 marks What is the total power in the output process $Y(t)$?

d) 3 marks What is the joint probability density function of the random variables $Y_1 = Y(t_1)$ and $Y_2 = Y(t_1 + 1/a)$?

3) Error Probability: A multi-hop communication system consists of the serial concatenation of n binary symmetric channels each having crossover probability p as shown below, where the number of hops, n, is odd.



a) 5 marks: What is the end-to-end probability of bit error in terms of n and p?

b) 3 marks: Evaluate the expression obtained in part a) with $n = 5$ and $p = 0.01$.

c) 2 marks: Suppose that each hop uses on-off keying, where a "1" is transmitted as a pulse $g(t)$ and a "0" is transmitted as nothing. What is the required E_b/N_o in decibel (dB) units required to give $p = 0.01$?