GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING
Quiz - Fall 2010
ECE 4601: Communication Systems

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

DATE: Wednesday October 6, 2010.
TIME: 11:05 - 11:55
INSTRUCTOR: Prof. G.L. Stüber

1) Random Processes: Suppose that $X(t)$ and $Y(t)$ are wide-sense stationary random processes with means μ_X and μ_Y, autocorrelation functions $\phi_{XX}(\tau)$ and $\phi_{YY}(\tau)$, power spectral densities $\Phi_{XX}(f)$ and $\Phi_{YY}(f)$, cross-correlation function $\phi_{XY}(\tau)$ and cross power spectral density $\Phi_{XY}(f)$.

Consider the sum process

$$Z(t) = X(t) + Y(t)$$

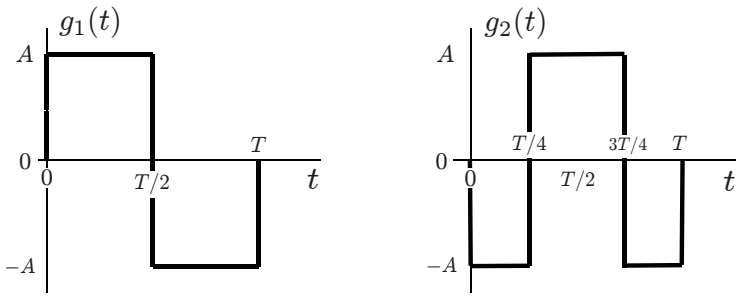
a) 4 marks: Derive an expression for the autocorrelation function of $Z(t)$ in terms of $\phi_{XX}(\tau)$, $\phi_{YY}(\tau)$ and $\phi_{XY}(\tau)$.

b) 3 marks: Suppose that $X(t)$ and $Y(t)$ are *uncorrelated* meaning that their crosscovariance function $\mu_{XY}(\tau) = \phi_{XY}(\tau) - \mu_X\mu_Y = 0$. What is the autocorrelation function of $Z(t)$?

c) 2 marks: Suppose further that $X(t)$ and $Y(t)$ are uncorrelated and $\mu_X = \mu_Y = 0$. What is the autocorrelation function of $Z(t)$?

d) 1 marks: What is the power spectral density of $Z(t)$ in part c)?

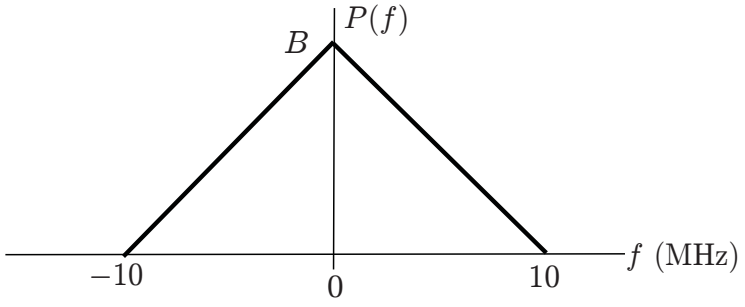
2) Matched Filters: Consider the two pulses $g_1(t)$ and $g_2(t)$ shown below.



a) 5 marks Determine and sketch the corresponding matched filters $h_1(t)$ and $h_2(t)$.

b) 5 marks Sketch the outputs of the two matched filters when the pulse $g_1(t)$ is applied at their input.

3) Pulse Shaping: Consider the overall pulse $P(f)$ shown below.



a)4 marks: Can this overall pulse be used to communicate with zero-ISI and, if so, at what baud rate R?

b)4 marks: Suppose that this pulse is used to construct a transmit filter $g(t)$ and corresponding receiver matched filter $h(t)$. Find an equation for $|G(f)|$ and sketch.

c)2 marks: What is the energy in the pulse $g(t)$ obtained in part b)?