

EE 703: Digital Message Transmission
 Instructor: Saravanan Vijayakumaran
 Indian Institute of Technology Bombay
 Autumn 2013

Quiz 1: **12 points + 3 bonus points**

Date: August 27, 2013

The last question will be graded only if the first three questions are answered correctly.

1. [4 points] Consider a passband signal $y_p(t)$ centered at $\pm f_c$ given by

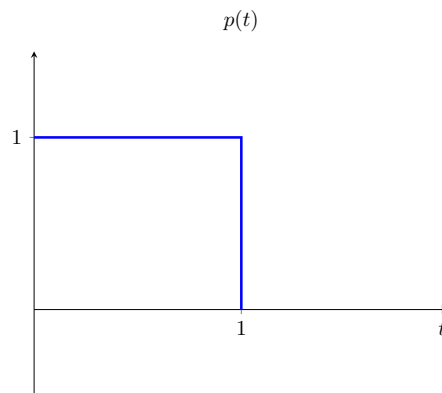
$$y_p(t) = \underbrace{\sqrt{2}y_c(t) \cos 2\pi f_c t}_{z_i(t)} - \underbrace{\sqrt{2}y_s(t) \sin 2\pi f_c t}_{z_q(t)}.$$

Show that $z_i(t)$ and $z_q(t)$ are orthogonal.

2. [4 points] Let $p(t) = I_{[0,1)}(t)$ be a pulse of unit amplitude and duration. Find an orthonormal basis for the following signals.

$$\begin{aligned} s_1(t) &= p(t) + jp(t-1) \\ s_2(t) &= p(t) - jp(t-1) \\ s_3(t) &= p(t) + jp(t) \end{aligned}$$

Give the signal space representation of $s_1(t), s_2(t), s_3(t)$ in terms of the orthonormal basis derived.



3. [4 points] Consider a random bit X which is equally likely to be 0 or 1. It is passed through a cascade of two binary symmetric channels each having crossover probability p . Let the output be Y .
- What is the probability of $X = 0$ given $Y = 0$?
 - What is the probability of $X = 1$ given $Y = 0$?



4. [3 bonus points] Give an example of a discrete-time random process which is wide sense stationary but not strict sense stationary.