ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE
School of Computer and Communication Sciences

Principles of Digital Communications: Summer Semester 2007

Assignment date: May 31, 2007
Due date: June 07, 2007

Homework 9

Problem 1. *(Nyquist Criterion)* Consider transmitting

$$S(t) = \sum_{i=-\infty}^{\infty} X_i \psi(t - iT)$$

across an AWGN channel, where $\psi(t)$ is a Nyquist pulse. We know that an optimal thing to do at the receiver front end is to send the received signal $R(t)$ through the filter with impulse response $\psi^*(-t)$ and sample the filter output $Y(t)$ at time $t = iT$.

(a) Show that in absence of noise, the filter output $Y(iT)$ equals X_i.

(b) Now assume that you transmit $S(t) = \sum_{i=-\infty}^{\infty} X_i p(t - iT)$ and let the received signal through a filter of real-valued impulse response $q(t)$. You would like to retain the property that the filter output at time $t = iT$ be X_i in absence of noise. Show that this is equivalent to

$$\int_{-\infty}^{\infty} p(kT + t)q(-t)dt \quad = \quad \delta(k)$$

(c) Show that the equivalent condition in the frequency domain is

$$\sum_{l=-\infty}^{\infty} p_{\mathcal{F}}(f - \frac{l}{T}) q^*_{\mathcal{F}}(f - \frac{l}{T}) \quad = \quad T \qquad \text{for} - \frac{1}{2T} \leq f \leq \frac{1}{2T}$$

Problem 2. Lecture notes Problem 2 *(Nyquist Pulses)* of Section 5.5

Problem 3. Lecture notes Problem 3 *(Nyquist Pulses)* of Section 5.5