S-38.211 Signal Processing in Communications	Stefan Werner
Exercise 1, October 8, 1997	phone: 451 2437 room: SG224
	email: stefan.werner@hut.fi

Figure 1 below shows a simple model of a binary PAM-system:

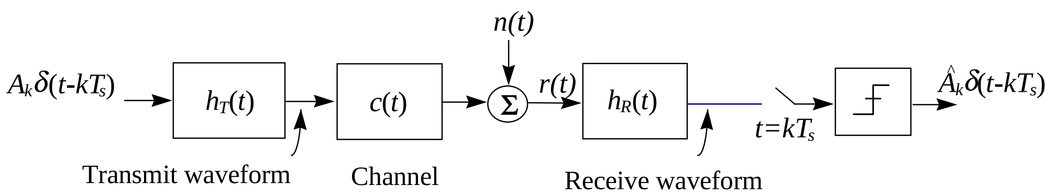

Figure 1: *Model of a binary PAM system*

The data $A_k \in \{\pm 1\}$ consists of independent identically distributed binary symbols, $h_T(t)$ is the transmit filter, $h_R(t)$ is the receiver filter, $c(t)$ is the channel impulse response, and $n(t)$ is AWGN with power spectral density $N_0/2$. If we assume an ideal channel $c(t)$, the received signal $r(t)$, can be expressed as

$$r(t) = \sum_{m=-\infty}^{\infty} A_m h_T(t - mT_s) + n(t) .$$

In these exercises we will study different choices of the filters $h_T(t)$ and $h_R(t)$.

Exercise 1-1

The spectra $H_1(f)$ and $H_2(f)$ of two pulse shaping filters $h_{T1}(t)$ and $h_{T2}(t)$, respectively, are shown in Figure 2.

a) Show that the spectra satisfy the Nyquist criterion.
b) Find the corresponding transmit pulse shapes h_{T1}(t) and h_{T2}(t).

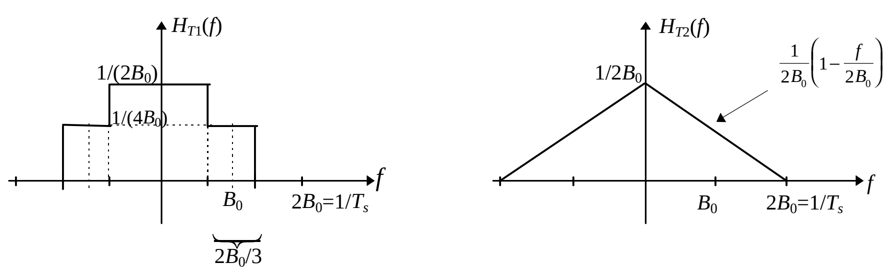

Figure 2: *Spectra of the pulse shapes in Exercise 1-1*

Exercise 1-2

Assume that the receive filter is matched to the transmit pulse shape. Figure 3 shows the convolution of the transmit filter and the receive filter. Find the transmit filter.

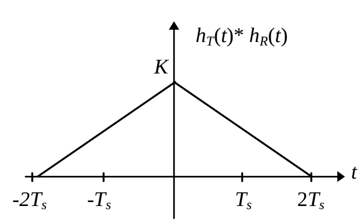

Figure 3: *Pulse shape in Exercise 1-2*

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Homework 1 (Return time: October 24, 1997)

In Figure 4, the spectrum for a pulse satisfying the Nyquist criterion is shown.

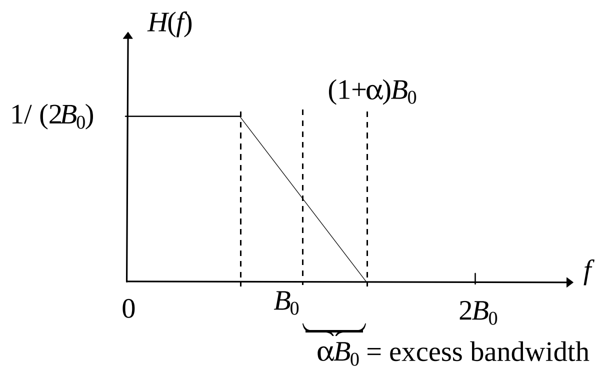

Figure 4: *Pulse spectrum satisfying the Nyquist criterion*

a) Derive the transmit waveform (no receiver).

b) Split the spectrum between the transmitter and the receiver and derive the pulse waveform.

c) What is the maximum α that can be used if the symbol rate is 2300 symbols per second and the total bandwidth is 3000 Hz without introducing ISI?

d) What is the maximum symbol rate that can be used if the total bandwidth is 3000 Hz?