E 7.1

Binary PAM is used to transmit information over an unequlaized linear filter channel. When a=1 is transmitted, the noise free output of the demodulator is

$$x_m = \begin{cases} 0.3 & (m=1) \\ 0.9 & (m=0) \\ 0.3 & (m=-1) \\ 0 & (\text{otherwise}) \end{cases}$$

a) Design a three-tap zero-forcing equalizer so that the output is

$$q_m = \begin{cases} 1 & (m=0) \\ 0 & (m=\pm 1) \end{cases}$$

b) Determine q_m for $m=\pm 2$, ± 3 by convolving the impulse response of the equalizer with the channel response.

E 7.2

Repeat problem (E 7.1) using the MMSE as the criterion for optimizing the tap coefficients. Assume that the noise power spectral density is 0.1W/Hz.

E 7.3

A time-dispersive channel having an impulse response $h(t)$ is used to transmit four-phase PSK at a rate $R=1/T$ symbols/s. The equivalent discrete-time channel is shown in Figure 7.1. The sequence $\{\eta_k\}$ is white noise sequence having zero mean and variance $\sigma^2 = N_o$.

a) What is the sampled autocorrelation function sequence $\{x_k\}$ for this channel , where $\{x_k\}$defined by

$$x_k = \int_{-\infty}^{\infty} h^*(t)h(t+kT)dt$$

b) The minimum MSE performance of a linear equalizer and a decision feedback equalize having an infinite number of taps depends on the folded spectrum of the channel

$$\frac{1}{T}\sum_{n=-\infty}^{\infty}\left|H(\omega+\frac{2\pi n}{T}\right|^2$$

where $H(\omega)$ is the Fourier transform of $h(t)$.

Determine the folded spectrum.

c) Use your answer in (b) to express the minimum MSE of a linear equalizer in terms of the folded spectrum.

d) Repeat (c) for an infinite-tap decision equalizer.

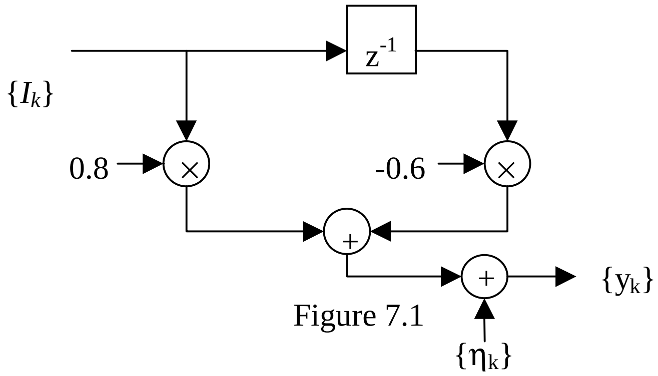

Figure 7.1

Homework-7 Deadline 08 April 2002 at 10.00

Homework return box is located at Otakaari 5, 2nd floor, near the E-wing. You can also return the answers to the assistant just before the class.

The real and imaginary parts of the filter coefficients $\{c_n(i)\}$ as well as the signal phase ϕ at the output of the linear equalizer can be adjusted iteratively towards their optimum values using the steepest descent algorithm,

$$\mathrm{Re}\{c_n(i)\} = \mathrm{Re}\{c_n(i)\} - \Delta \frac{\partial |e_k|^2}{\partial [\mathrm{Re}\{c_n\}]}$$

$$\mathrm{Im}\{c_n(i)\} = \mathrm{Im}\{c_n(i)\} - \Delta \frac{\partial |e_k|^2}{\partial [\mathrm{Im}\{c_n\}]}$$

$$\phi\{i+1\} = \phi(i) - \Delta_\phi \frac{\partial |e_k|^2}{\partial \phi}$$

where the error signal is defined as

$$e_k = z_k - \hat{b}_k = \left(\sum_{m=-M}^{M} c_m r_{k-m} \right) \exp(j\phi) - \hat{b}_k$$

Derive the results given in the handouts by setting this expression of e_k into the iteration equations shown above.

For definition of variables, please refer to lecture handouts.