S-72.227 Digital Communication Systems (Spring 2005)

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Digital transmission over a fading channel

1.

A Direct Sequence (DS) spread spectrum system is used to resolve the multipath signal components in a two-path radio signal propagation scenario. If the path length of the secondary path is 300 m longer than that of the direct path, determine the chip rate necessary to resolve the multipath components.

2.

A multipath fading channel has a multipath spread of $T_m = 1$ sand a Doppler spread $B_d = 0.01$ Hz. The total channel bandwidth at band-pass available fro signal transmission is $W = 5$ Hz. To reduce the effects of ISI, the signal designer selects a pulse duration $T = 10$ s. Suppose that a wideband signal is used for transmission and a RAKE-type receiver is used for demodulation. How many taps would you use in the RAKE receiver?

3.

The RAKE demodulator is the optimum demodulator based on the condition that the bit interval is much greater than the multipath spread, i.e., $T >> T_m$. What happen if this condition is not satisfied? What would you suggest to solve this problem (Draw a block diagram)?

Equalization in a wideband TDMA system

4.

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.

5.

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 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.

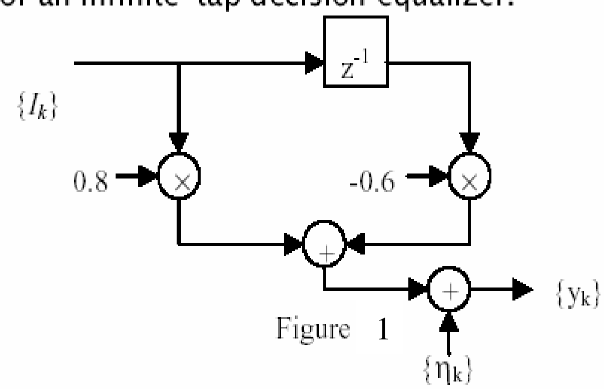

Figure 1