S-72.245 Transmission Methods in Telecommunication Systems
Tutorial 10

Objectives

- To investigate coherent and incoherent binary systems and respective error rate analysis
- To identify the respective circuit block diagrams and signaling waveforms

Quizzes

Q10.1
Sketch signal constellations for a) 8-PAM b) 8-QAM c) 8-PSK

Q10.2
Explain by your own words what is a signal constellation diagram?

Q10.3
Symbol error ratio for 8-PSK in AWGN channel can be determined by

$$P(E) = 2Q\left(\sqrt{\frac{2E_{avg}}{N_0}}\sin\frac{\pi}{8}\right), E_{avg} = A_c^2 D/2 = E_b \log_2 M \ .$$

Decision signal is characterized by A_c=1 and noise rms-value of 97.7 dBμV. What is the respective symbol error rate?

Matlab assignments

M10.1 Design a digital implementation of the transmitter and receiver filters *GT(f)* and *GR(f)* such that their product satisfies

$$GT(f)GR(f) = Xrc(f)$$

where *Xrc(f)* is the raised-cosine frequency response characteristic enabling the ISI at the sampling time $t=nT$ to be zero. *GR(f)* is the matched filter to *GT(f)*.

Hints:

1) Raised-cosine frequency response *Xrc(f):*

$$X_{rc}(f) = \begin{cases} T, & 0 \le |f| \le \frac{1-\alpha}{2T} \\ \frac{T}{2}\left[1 + cos\frac{\pi T}{\alpha}\left(|f| - \frac{1-\alpha}{2T}\right)\right], & \frac{1-\alpha}{2T} < |f| \le \frac{1+\alpha}{2T} \\ 0, & |f| > \frac{1+\alpha}{2T} \end{cases}$$

where 1/T is the symbol rate.

2) The simplest way to design and implement the transmitter and receiver filters in digital form is to employ FIR filters with linear phase (symmetric impulse response).

M10.2 Consider a channel-distorted pulse *x(t*, at the input to the equalizer, given by the

expression

$$x(t) = \frac{1}{1 + (2t/T)^2}$$

where *1/T* is the symbol rate. The pulse is sampled at the rate *2/T* and is equalized by a zero-forcing equalizer. Determine the coefficients of a five-tap zero forcing equalizer.