Başkent University
Electrical & Electronics Engineering Department
EEM-442 Communication Systems 2
Midterm Examination 2

Duration: 90 mins 04/05/2002

1. An analog signal is to be converted to a binary PCM signal and transmitted over a channel that is bandlimited to 100 kHz. Assume that 32 quantization levels are used and that the overall equivalent transfer function is of the raised cosine type with roll-off α = 0.6.

(a) Find the maximum PCM bit rate that can be used by this system without introducing ISI. *Note the difference between the bit rate and the symbol rate.*
(b) Find the maximum signal bandwidth that can be accomodated for the analog signal.
(c) Repeat parts (a) and (b) for an 8 level PCM signal.

2. Suppose a digital communication system employs Gaussian-shaped pulses of the form $x(t) = \exp(-\pi a^2 t^2)$. To reduce the level of ISI to a relatively small amount, we impose the condition that $x(T) = 0.01$, where T is the symbol interval. The bandwidth W of the pulse x(t) is defined as that value of W for which $X(W) / X(0) = 0.01$, where X(f) is the Fourier transform of x(t). Determine the value of W and compare this value to that of raised cosine spectrum with 100 % roll-off.

3. In the Manchester code, binary symbol 1 is represented by the doublet pulse s(t) shown in Fig.1, and binary symbol 0 is represented by the negative of this pulse. Derive the formula for the probability of error incurred by the maximum likelihood detection procedure applied to this form of signalling over an AWGN channel.

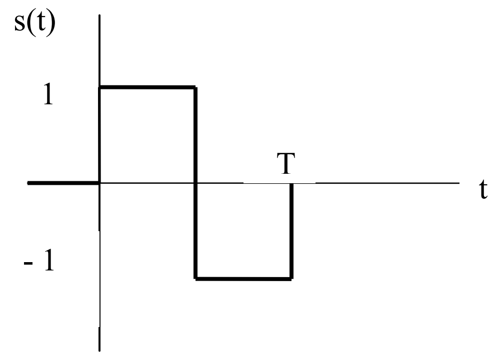

Fig.1

4. Just as in an ordinary QPSK modulator, the output of a $\pi/4$–shifted DQPSK modulator may be expressed in terms of its in-phase and quadrature components as follows:

$$s(t) = s_I(t)\cos(2\pi f_c t) - s_Q(t)\sin(2\pi f_c t)$$

Formulate the in-phase component $s_I(t)$ and quadrature component $s_Q(t)$ of the $\pi/4$ – shifted DQPSK signal. Hence, outline a scheme for the generation of $\pi/4$–shifted DQPSK signals.

Useful Formulas:

- Q-function: $Q(x) = (1/\sqrt{2\pi}) \int_x^{\infty} \exp(-t^2/2)dt$
- Fourier transform: $\exp(-\pi a^2 t^2) \leftrightarrow a^{-1} \exp(-\pi f^2/a^2)$
- Transmission bandwidth of a raised cosine spectrum:

  $B_T = W(1+\alpha)$, where $W = 1/2T$