Aalto University
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OPEN-BOOK EXAM
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S-72.1140 Transmission Methods in Comm. Systems

1. (6p.) In a binary PPM (pulse position modulation) scheme, a half-width pulse $p(t)$ is sent with a different delay, depending on whether "1" or "0" is scheduled. The transmitted waveform is

$$\begin{array}{ll} p(t), & \text{if "1" is sent} \\ p(t-\frac{T_b}{2}), & \text{if "0" is sent} \end{array}$$

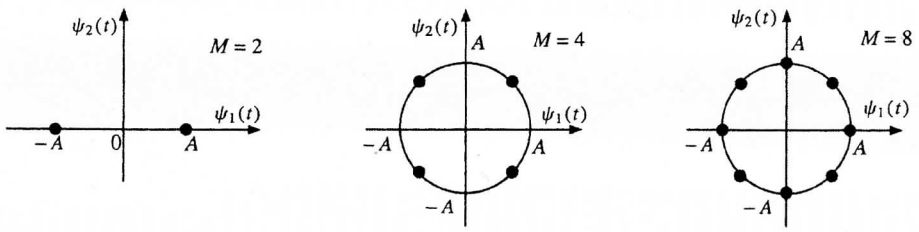
where $p(t) = u(t) - u(t - T_b/2)$, i.e., $p(t)$ equals 1 in the interval $[0, \frac{T_b}{2}]$, and 0 elsewhere. The channel noise is AWGN with constant PSD of $\mathcal{N}/2$.

   (a) Determine the optimum receiver architecture for this system.

   (b) Sketch the optimum receiver filter response in the time domain.

   (c) If "1" and "0" are equally likely, write an expression for the probability of error.

2. (6p.) The three figures below have to do with certain digital modulation schemes.



   Explain briefly what the "dots" represent in this kind of figures. Compare the cases $M = 2$ and $M = 8$. How are they different? What can you say about the advantages or disadvantages of these two transmission methods compared to one another?

3. (a) (3p.) The information in an analog voltage waveform is to be transmitted over a PCM system so that the maximum quantization error is ± 0.1 % of the peak value. The bandwidth of the analog signal is 100 Hz, and the amplitude range is from -10 to +10 V. What is the theoretical minimum channel bandwidth required for transmission of this PCM signal. Quantization is uniform, and the sampling process must not cause any information loss about the waveform.

   (b) (3p.) Baseband transmission schemes using different pulse shapes can be compared, for example, by evaluating their power spectral densities (PSD). What kind of desirable or undesirable characteristics of a particular pulse shape can be revealed by this kind of analysis?

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4. (6p.) Consider a message signal

$$m(t) = \sin 110\pi t \sin 450\pi t.$$

   Assume that we want to communicate $m(t)$ in a bandwidth-efficient way by using SSB modulation. Find the LSB and USB signals in this case. The carrier frequency is 3 kHz.