Exam of Digital Communications

a.a. 2020-2021

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Exercise #1

A message signal $m(t) = \cos 2000\pi t + 2 \cos 3000\pi t$ modulates the carrier $c(t) = 100 \cos 2\pi f_c t$, where $f_c = 1$ MHz.

(a) Sketch the spectrum of the lower SSB modulated signal

(b) Find the complex envelope for the modulated signal

Exercise #2

A signal has a bandwidth of 8kHz. It is sampled, logarithmically compressed and encoded into a PCM format using 8bits per sample. The PCM data is transmitted through an AWGN channel via M-level PAM. Determine the minimum bandwidth required for the transmission when

(a) M=4;
(b) M=8;
(c) M=16.

Exercise #3

In an additive white Gaussian noise channel with noise power spectral density of N0/2, two bits are transmitted by

$$s_1(t) = 0$$

$$s_2(t) = \begin{cases} A & 0 \le t \le T/2 \\ 0 & T/2 \le t \le T \\ 0 & \text{otherwise} \end{cases}$$

The two messages are transmitted with a priori probabilities p and (1-p), respectively.

(a) Determine the average energy transmitted per bit E_{avb}

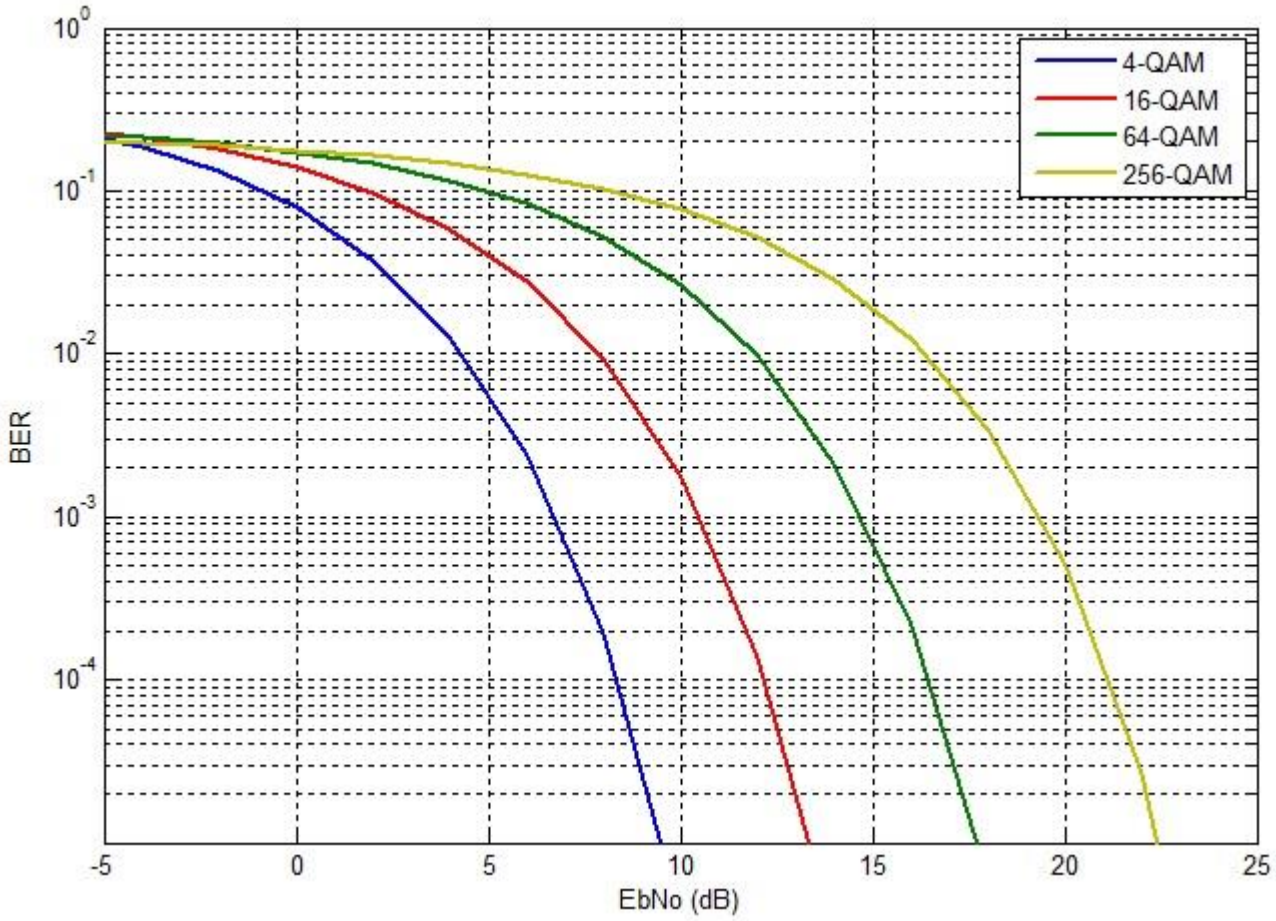
(b) Determine the optimum threshold

(c) Determine the structure of the optimal receiver (including the detector after the sampler)

(d) Determine the probability of error in case p=(1-p)=0.5.

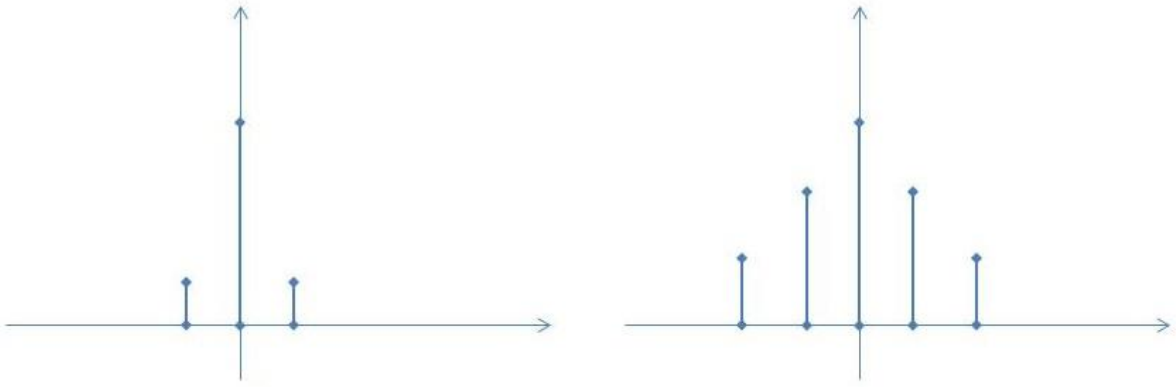
Exercise #4

If the maximum BER is 10(-4) and SNR is 15dB, which constellations guarantees the maximum bit rate? What is the maximum theoretical bit rate in case with no ISI if the bandwidth available is 3kHz?



Exercise #5

Let us consider two channels that are modeled as linear filter and AWGN. The impulse responses of the two channels are drawn below:



(a) (b)

(a) In which case is more important to use an equalizer at the receiver?
(b) When the equalizer is not used, how do you expect that the BER curve look like?