Exam of Digital Communications

a.a. 2020-2021

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Exercise #1

A message signal $m(t) = \cos 2000\pi t + 2 \cos 4000\pi t$ modulates the carrier $c(t) = 100 \cos 2\pi f_c t$, where $f_c = 1$ MHz.

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

(b) Find the complex envelope for the modulated signal

Exercise #2

A message signal m(t) is transmitted by binary PCM. Let the signal to-quantization noise (SQNR) required be at least 50 dB. Determine the minimum number of bit required to encode each sample, assuming that m(t) is sinusoidal. With this value of quantization levels, determine the SQNR.

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}

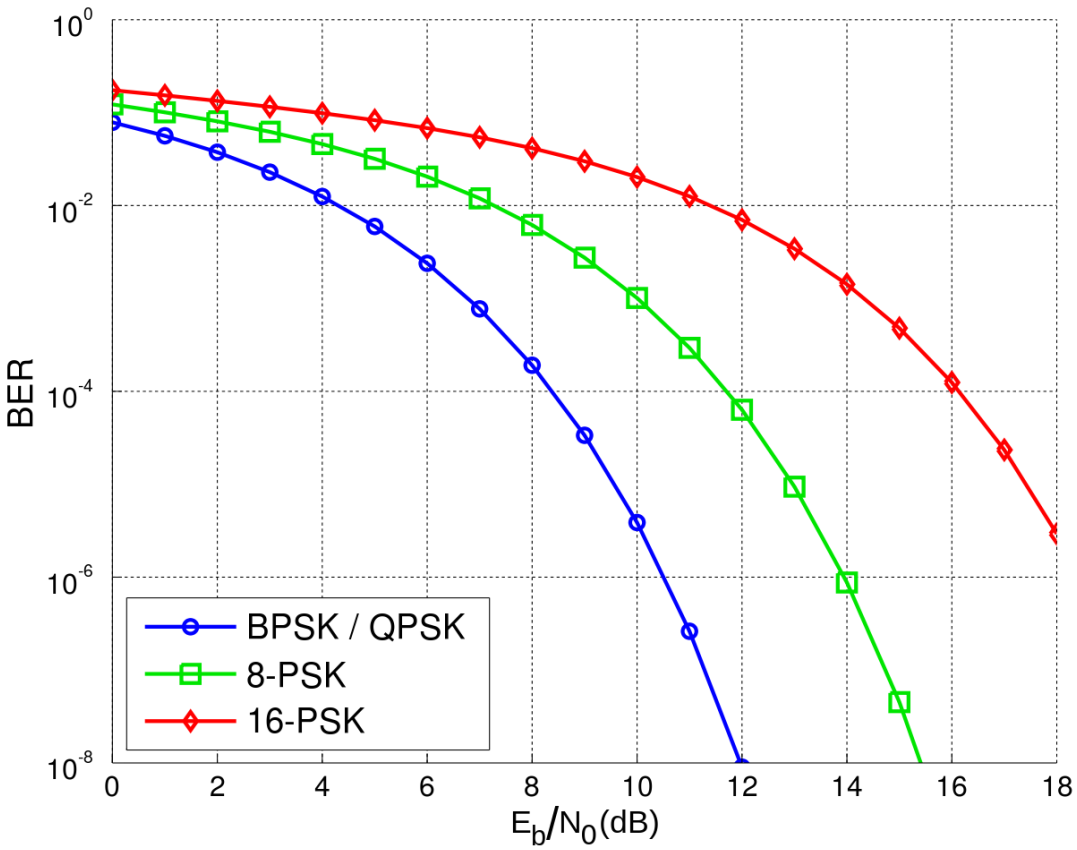
(b) Determine the optimum threshold

(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.

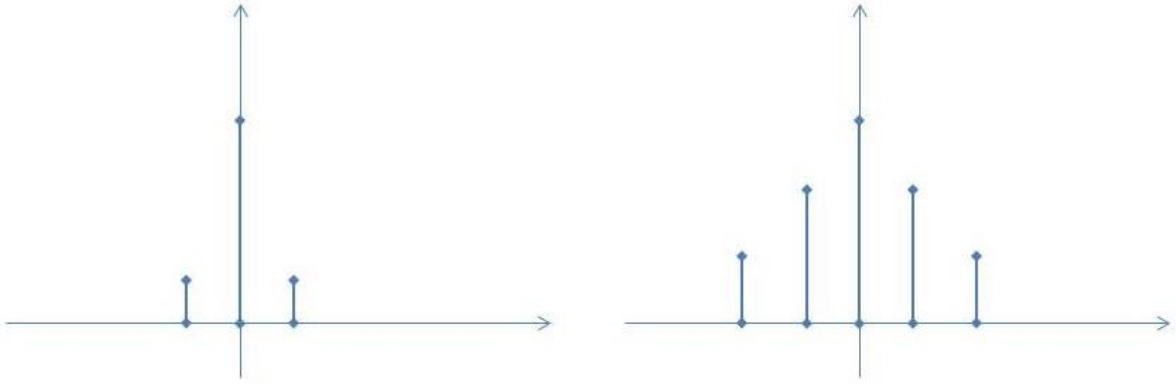
Exercise #4

If the maximum BER is 10(-4) and SNR is 12dB, 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?