

Mobile Communication Networks

Exercices 4

1. Plot the resulting modulated signal of the binary sequence "1001110101", using three periods of a carrier (amplitude A , frequency $1/T$) per symbol, for:
 - a. OOK
 - b. BPSK
 - c. QPSK
 - d. DBPSK
2. Using 16QAM to transmit a binary sequence, if the symbol rate (i.e. number of symbols / second) is 1200 symb/s:
 - a. How many bits can be transmitted in one second?
 - b. Name a modulation that could be used to increase the bit rate two times?
 - c. What would be the drawback of using that modulation (assume that the total transmit power and the available bandwidth remain the same)?
3. Consider a wireless communication system in which the bit stream of binary source modulates a carrier with carrier frequency of 10MHz. The transmission rate is 6 kbps, over a channel with transmission bandwidth of 2 kHz. For each one of the digital modulations ASK, BPSK, 64QAM, FSK, 8PSK:
 - a. Which parameters of the carrier are used to encode the source bit stream?
 - b. How many bits does each symbol represents?
 - c. How many symbols per second are transmitted (i.e., what is the symbol rate)?
 - d. Does the symbol rate respects the theoretical limit (considering a noiseless channel)? If not, what would be the minimum necessary transmission bandwidth?
 - e. Does the bit rate respect the Shannon channel capacity constraint? Why?
4. Consider a transmission of a binary sequence, with data rate $R_b = 12\text{Kbps}$ using a 16QAM modulation scheme.
 - a. What is the symbol rate?
 - b. If we change the modulation scheme from 16QAM to 64QAM, what will be the new data rate?

5. Consider a channel with a 4000 Hz bandwidth and a signal-to-noise ratio of 15 (where the noise is white thermal noise).
- What is the maximum spectral efficiency that can be achieved by a transmission over this channel, with arbitrary low bit error rate (recall the Shannon capacity formula.)?
 - If we transmit over this channel using 2000 QPSK symbols / second, what is the corresponding bit rate and spectral efficiency?
6. Consider a transmission using a channel bandwidth $B_c = 1\text{Mhz}$, with a symbol rate $R_s = 1\text{Msymbol /sec}$. In this scenario, what are the spectral efficiencies if we use as digital modulation:
- BPSK
 - QPSK
 - 4FSK
 - 16-QAM
 - 1024-QAM
 - 8-PSK
 - ASK