Exercise Lesson 3

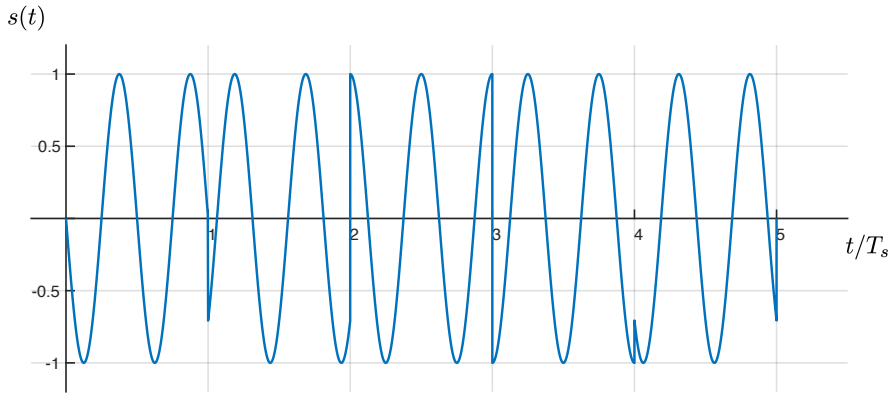
Problems from the compendium:

2.18, 2.16, 2.17a, 2.19a, Example 2.17 on page 64

Other problems:

3.1 Determine if the following statement is true or false.
"For 4-ary QAM with equally likely signal alternatives and a triangular pulse $g(t) = g_{tri}(t)$ *with amplitude* A *and duration* $6T_s/10$ *the average signal power is* $2A^2/10$*."*

3.2 Consider the following transmitted signal $s(t)$, where $T_s = 2\,\mu s$:



(a) Determine the signaling method, the message sequence $\mathbf{m}$, the carrier frequency f_c, and the bit rate R_b.

(b) For the signal constellation used above, draw the amplitudes A_ℓ and B_ℓ in a diagram (similar to Figure 2.10) and use some mapping of your choice to assign bits to the signal alternatives.
Determine the corresponding sequence of transmitted bits $\mathbf{b}$.

3.3 Consider a QAM signal constellation, with rectangular pulse shape of duration $T = T_s$,

$$s_\ell(t) = A_\ell\, g_{rec}(t)\, \cos(2\pi\, f_c\, t) - B_\ell\, g_{rec}(t)\, \sin(2\pi\, f_c\, t)\ , \quad \ell = 0, \ldots, 7\ ,$$

for which the $M = 8$ possible amplitude pairs are given as follows:

$$(A_0, B_0) = (+2, 0)\ ,\ (A_1, B_1) = (+1, +1)\ ,\ (A_2, B_2) = (0, +2)\ ,\ (A_3, B_3) = (-1, +1)\ ,$$

$$(A_4, B_4) = (-2, 0)\ ,\ (A_5, B_5) = (-1, -1)\ ,\ (A_6, B_6) = (0, -2)\ ,\ (A_7, B_7) = (+1, -1)\ .$$

(a) Draw the constellation diagrams for both conventional 8 PSK and for the QAM constellation defined above.

(b) You want to scale the amplitude of 8 PSK with some factor C to achieve equal average energy per bit $\bar{E}_s$ for both constellations. Determine the scaling factor C, assuming equally likely signal alternatives. Which constellation will then have a larger minimum squared Euclidean distance $\min_{i,j} D_{i,j}^2$?