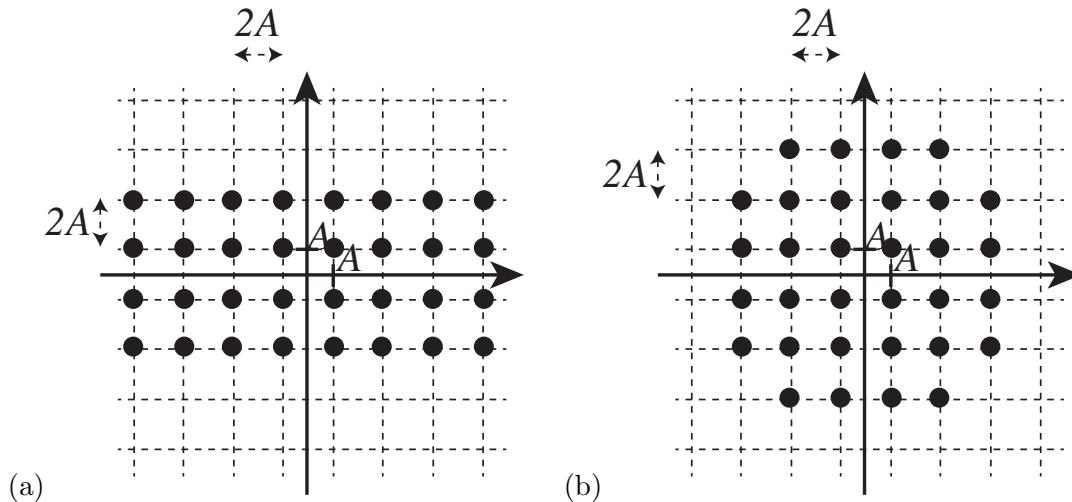


ESE 471 Spring 2021: Homework 4

- Find the average energy, as a function of constant A , of the following two $M = 32$ QAM schemes described in the constellation diagrams drawn below. The (a) scheme is rectangular 32-QAM, while the (b) scheme is called cross 32-QAM. Each symbol point is on a regular grid with grid line spacing of $2A$ as shown, centered at $(0, 0)$.



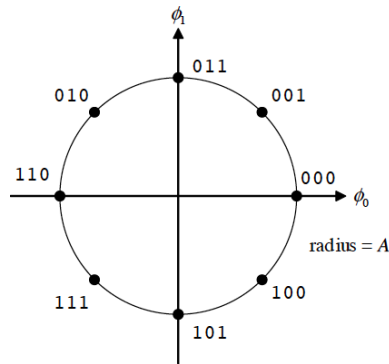
- For binary PAM, M -PAM, square QAM, PSK, binary non-coherent FSK, and M -ary FSK, make a table showing:
 - The dimension of the modulation;
 - The M or a set of possible M ;
 - The orthogonal waveforms;
 - The null-to-null bandwidth when using SRRC pulse shaping, as a function of α and T_s ; and
 - A drawing of one possible constellation diagram.
- In the lecture video “The Shift in FSK Depends on One Thing”, I derived conditions for the frequency shift required for the (approximate) orthogonality of two cosine waveforms at different frequencies. In this problem, derive the conditions for $\Delta\omega$ such that the following two waveforms are (approximately) orthogonal:

$$\begin{aligned}\phi_0(t) &= \sqrt{2}p(t) \cos(\omega_0 t) \\ \phi_1(t) &= -\sqrt{2}p(t) \sin[(\omega_0 + \Delta\omega)t]\end{aligned}$$

You may assume that the pulse shape is the rectangular pulse.

- Complete Rice Exercise 5.43, all parts except (b). As preparation, make sure to read Section 5.3.1 “Continuous-Time Realization”.

I’m copying the problem here and adding my own hints: Consider the 8-ary PSK constellation shown below. If the pulse shape is NRZ (rectangular) and the average energy is 2 Joules, complete the following.



- (a) Sketch a block diagram of the modulator. Be sure to specify the contents of the look-up tables.
- (c) Sketch a block diagram of the matched filter detector (receiver). Be sure to specify the impulse response of the matched filters.
- (d) Sketch the decision region boundaries for each point in the constellation. Hint: For PSK, this is all points in the (pie-shaped) area that is at an angle $\pm\pi/8$ radians from the symbol point in the constellation diagram.
- (e) Determine the estimated symbol sequence

$$\hat{\mathbf{a}} = \begin{bmatrix} \hat{a}_0(0) & \hat{a}_0(1) & \hat{a}_0(2) & \hat{a}_0(3) \\ \hat{a}_1(0) & \hat{a}_1(1) & \hat{a}_1(2) & \hat{a}_1(3) \end{bmatrix}$$

and the corresponding bit sequence for the matched filter outputs

k	0	1	2	3
$x(k)$	-1.30	+1.51	-0.90	+0.65
$y(k)$	+1.64	-1.49	-0.91	+0.07