Advanced Theory Of Communication

University of Tehran

Instructor: Dr. Ali Olfat Spring 2024

Homework 3

Due : 1403/1/21

Problem 1

Determine the signal space representation of the four signals $s_k(t), k = 1, 2, 3, 4$,shown in Fig.1, by using as basis functions the orthonormal functions $\phi_1(t)$ and $\phi_2(t)$. Plot the signal space diagram, and show that this signal set is equivalent to that for a four-phase PSK signal.

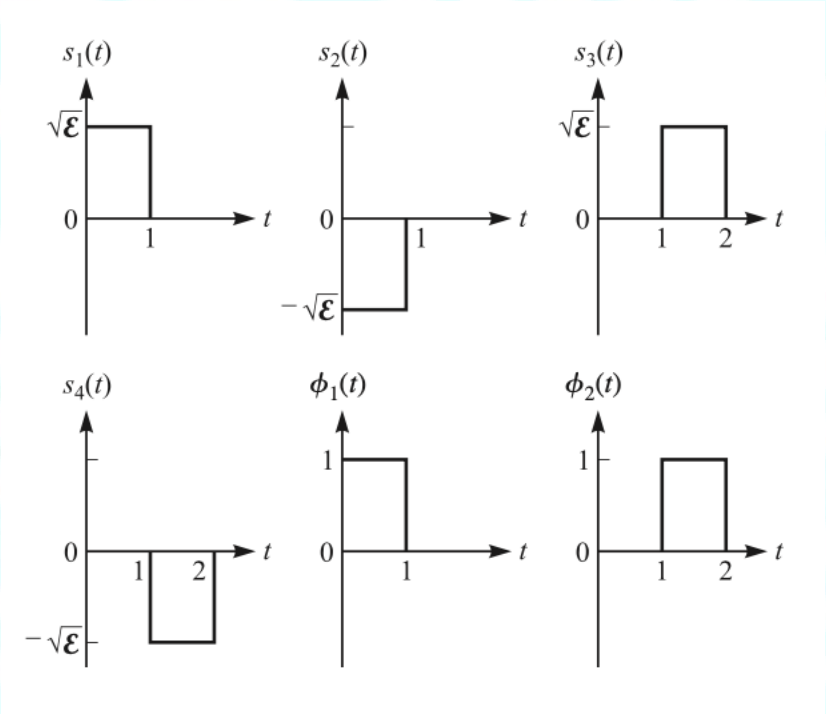

Figure 1:

Problem 2

$\pi/4$-QPSK may be considered as two QPSK systems offset by $\pi/4$ rad.

1. Sketch the signal space diagram for a $\pi/4$-QPSKsignal.
2. Using Gray encoding, label the signal points with the corresponding data bits.

Problem 3

Consider the octal signal point constellations in Fig.2.

1. The nearest-neighbor signal points in the $8-QAM$ signal constellation are separated in distance by A units. Determine the radii a and b of the inner and outer circles, respectively.
2. The adjacent signal points in the $8-PSK$ are separated by a distance of A units. Determine the radius r of the circle.
3. Determine the average transmitter powers for the two signal constellations, and compare the two powers. What is the relative power advantage of one constellation over the other? (Assume that all signal points are equally probable.)

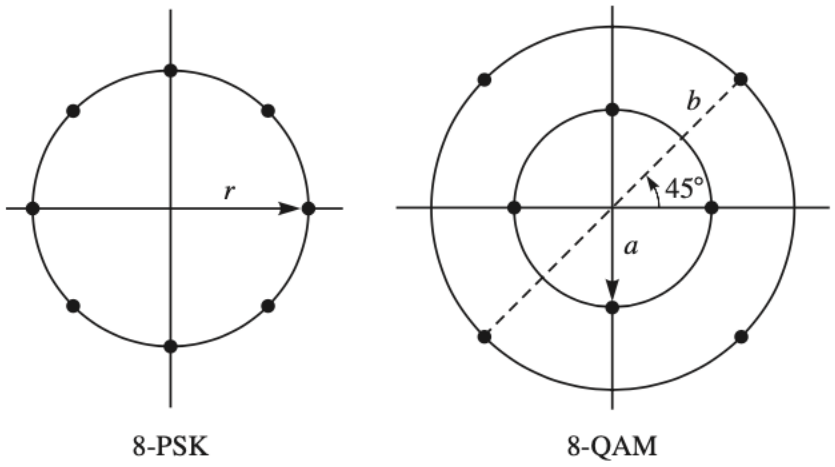

Figure 2:

Problem 4

Consider the 8-point QAM signal constellation shown in Fig.2.

1. Is it possible to assign 3 data bits to each point of the signal constellation such that the nearest (adjacent) points differ in only 1 bit position?
2. Determine the symbol rate if the desired bit rate is $90 Mbits/s$.

Problem 5

Consider the two 8-point QAM signal constellations shown in Fig.3. The minimum distance between adjacent points is $2A$. Determine the average transmitted power for each constellation, assuming that the signal points are equally probable. Which constellation is more power-efficient?

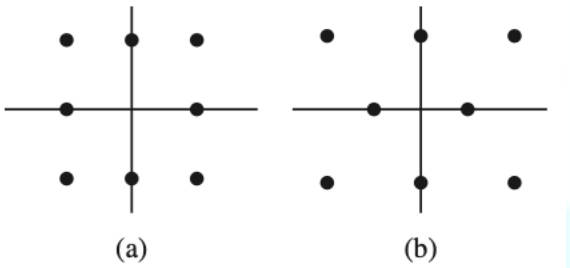

Figure 3:

Problem 6

In an MSK signal, the initial state for the phase is either 0 or π rad. Determine the terminal phase state for the following four input pairs of input data:

1. 00
2. 01
3. 10
4. 11

Problem 7

Determine the number of states in the state trellis diagram for

1. A full-response binary CPFSK with $h = \frac{2}{3}$ or $\frac{3}{4}$.
2. A partial-response $L = 3$ binary CPFSK with $h = \frac{2}{3}$ or $\frac{3}{4}$.

Problem 8

Specify a Gray code for the $16 - QAM$ signal constellation shown in Fig.4.

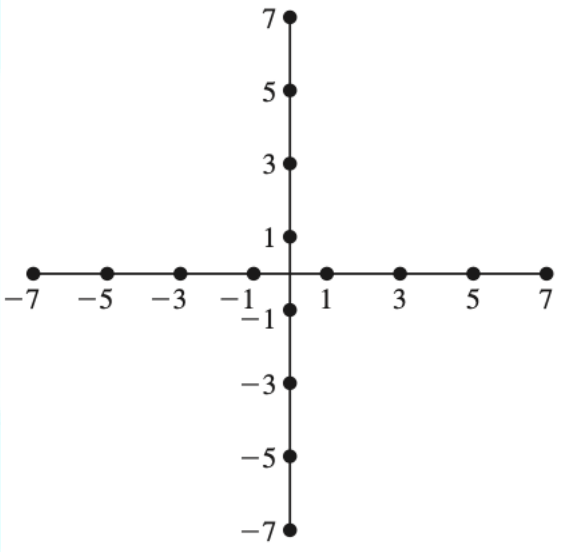

Figure 4:
