EEG373 (Communication systems II), By : Prof. Mohab Mangoud

Assignment (2 & 3)

Question (1)

A communication system transmits one of the following signals:

$$s_i(t) = \cos(2\pi f_c t + i\frac{\pi}{4}) \qquad 0 \le t \le T$$

i=1,2,3,4 f_cT=I

1. Define the used basis functions.
2. Express the four signals in terms of the defined basis functions.
3. Sketch to scale the signals in S.S

Question (2)

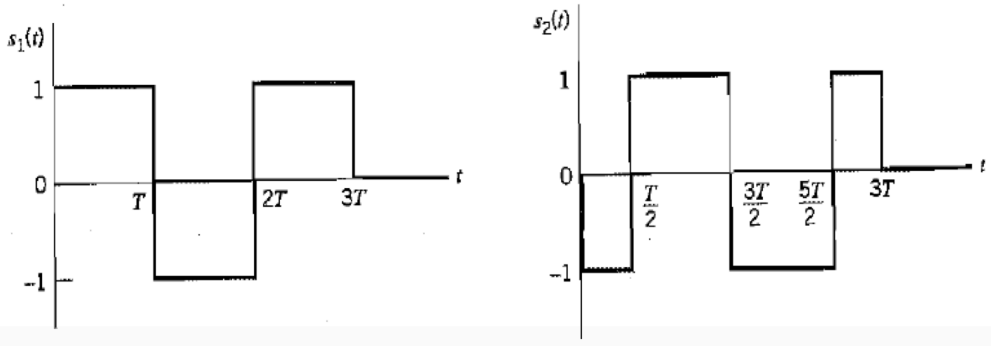
Figure P5.12 shows a pair of signals $s_1(t)$ and $s_2(t)$ that are orthogonal to each other over the observation interval $0 \le t \le 3T$. The received signal is defined by

$$x(t) = s_k(t) + w(t), \qquad 0 \le t \le 3T, \quad k = 1, 2$$

where $w(t)$ is white Gaussian noise of zero mean and power spectral density $N_0/2$.

(a) Design a receiver that decides in favor of signals $s_1(t)$ or $s_2(t)$, assuming that these two signals are equiprobable.

(b) Calculate the average probability of symbol error incurred by this receiver for $E/N_0 = 4$, where E is the signal energy.



Question (3)

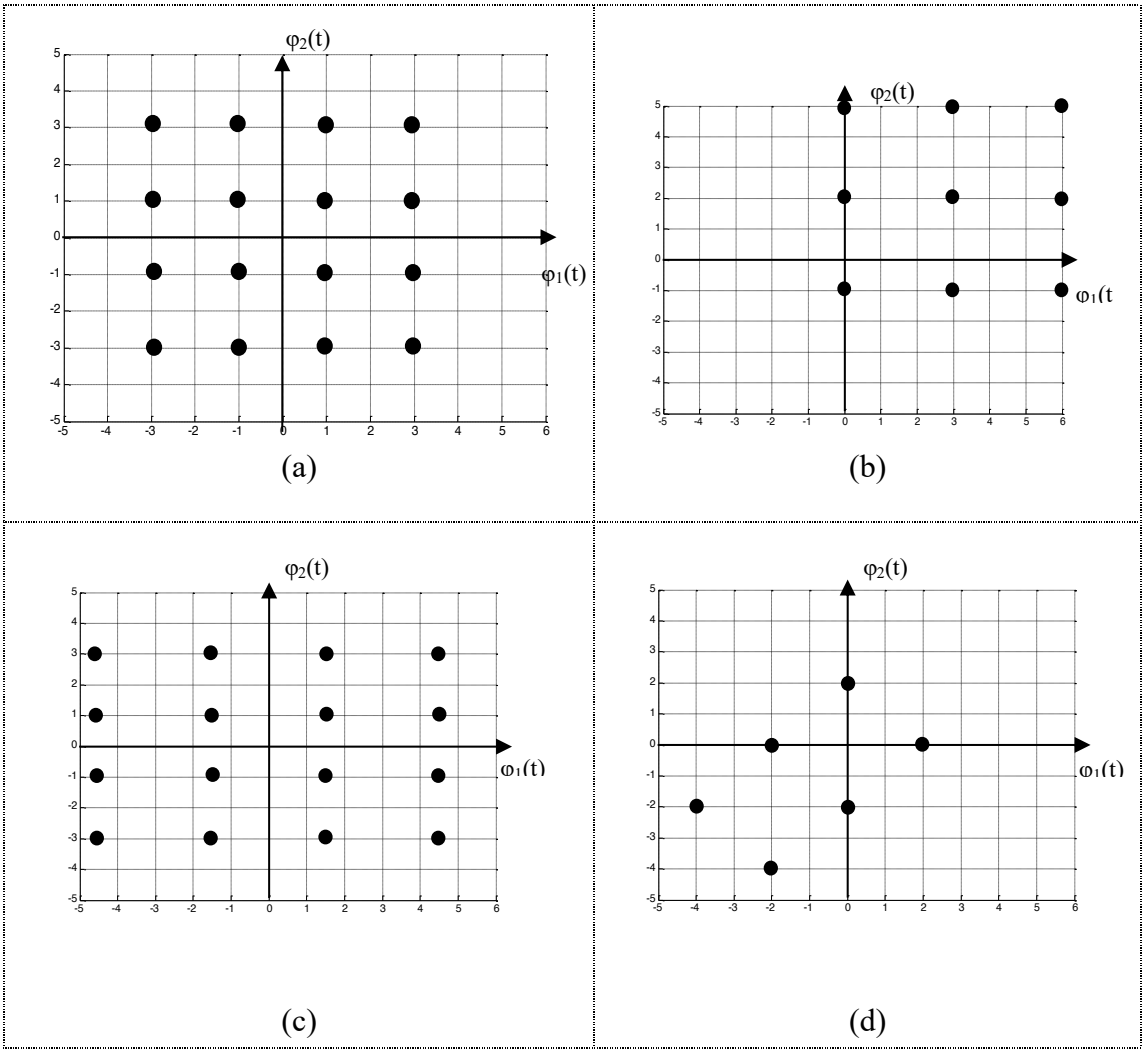


Figure (3)

For each of the four signal constellations in S.S. shown in Figure (3)

1. Define the D.Rs and D.Bs
2. Calculate the average transmitted energy.
3. Find an equivalent set of messages with the same probability of error but with minimum average energy.
4. Calculate the minimum average probability of error if the noise is assumed to be AWGN with zero mean and two- sided PSD= $\frac{N_0}{2}$ =0.25 w/Hz.
5. Suggest an implementation for the Receiver.

Question (4)

A communication system transmits one of four equally-likely messages defined by:

$S_1(t) = 4\cos(2\pi f_1 t) + 3\cos(2\pi f_2 t)$ $S_2(t) = 6\cos(2\pi f_1 t) + \cos(2\pi f_2 t)$

$S_3(t) = 7\cos(2\pi f_1 t) + 6\cos(2\pi f_2 t)$ $S_4(t) = 9\cos(2\pi f_1 t) + 4\cos(2\pi f_2 t)$

Signal duration =T= 2Sec $f_1 = 125.125\text{Hz}$ $f_2 = 225.125\text{Hz}$

1. Define the used basis functions.
2. Express the four signals in terms of the defined basis functions.
3. Sketch to scale the signals in S.S and define the D.Bs & D.Rs.
4. Calculate the average transmitted energy.
5. Find an equivalent set of messages with the same probability of error but with minimum energy and calculate the minimum average energy.
6. Define new basis functions to be used, such that their directions are the same as the D.Bs and then express the four signals in terms of the new basis functions.

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