Université Laval
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Département de génie électrique
et de génie informatique

GEL10280: Communications numériques
2011 Partial Examen

Wednesday 2 March 2011; Time: 13h30 à 15h20
No documentation allowed; one calculator allowed

Problem 1 (30 points out of 100)

A. (10 points) Suppose we have N symbols in our constellation and the Gram Schmidt process creates M < N basis vectors. What relationship exists between the symbols? How can we exploit this relationship to reduce the complexity of our receiver?

B. (10 points) Discuss the differences between the ratios SNR et Eb/N0. In what circumstances would you use each one? You can use the example of a telephone line (as seen in class) to highlight the differences.

C. (10 points) How is BPSK better/worse than DPSK? Discuss there performance relative to each of the three performance criteria for a communications systems.

Problem 2 (15 points out of 100)

Consider the plot of the spectral efficiency plane, or the « Plan de l’efficacité spectrale ».

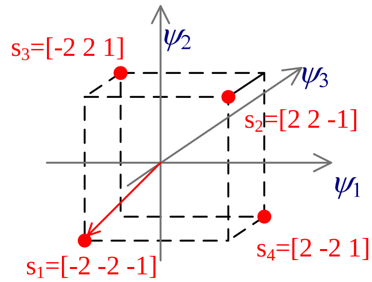
I have created a new modulation format LAR that is equally efficient as MPSK. The penalty for 8LAR with respect to QPSK is 5 dB, while the penalty for 16LAR with respect to QPSK is 8 dB.

Find the coordinates of 8LAR and 16LAR on the spectral efficiency plane.

Problem 3 (30 points out of 100)

The coefficients for 4 symbols in the « I/Q » space are

$$
\begin{aligned}
s_1 &= [-2 \quad -2 \quad -1] \\
s_2 &= [\ \ 2 \quad\ \ 2 \quad -1] \\
s_3 &= [-2 \quad\ \ 2 \quad\ \ 1] \\
s_4 &= [\ \ 2 \quad -2 \quad\ \ 1]
\end{aligned}
$$



A. (10 points) Give the coordinates in signal space.

B. (10 points) Find the minimum distance $D_{\min}$

C. (10 points) Give an approximation for the error probability in terms of E_b/N_0 .

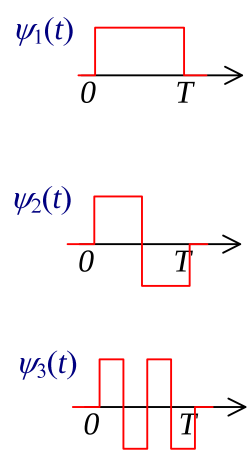
Problem 4 (25 points out of 100)

Suppose the basis vectors for the symbols in Problem 3 are

$$
\psi_1(t) = \begin{cases} 1/\sqrt{T} & 0 \le t \le T \\ 0 & ailleurs \end{cases}
$$

$$
\psi_2(t) = \begin{cases} 1/\sqrt{T} & 0 \le t \le T/2 \\ -1/\sqrt{T} & T/2 < t \le T \\ 0 & ailleurs \end{cases}
$$

$$
\psi_3(t) = \begin{cases} 1/\sqrt{T} & 0 \le t \le T/4, \quad T/2 \le t \le 3T/4 \\ -1/\sqrt{T} & T/4 \le t \le T/2, \quad 3T/4 \le t \le T \\ 0 & ailleurs \end{cases}
$$



There is no carrier; the signals are all baseband.

A. (5 points) Is the modulation format orthogonal?

B. (15 points) What is the bandwidth (in terms of *T*) for each basis vector assuming an ideal Nyquist pulse? What is the bandwidth of the entire signal space?

C. (5 points) What is the bandwidth efficiency of the modulation format?