Université Laval
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Département de génie électrique
et de génie informatique

GEL64486: Communications numériques
1999 Examen Partiel

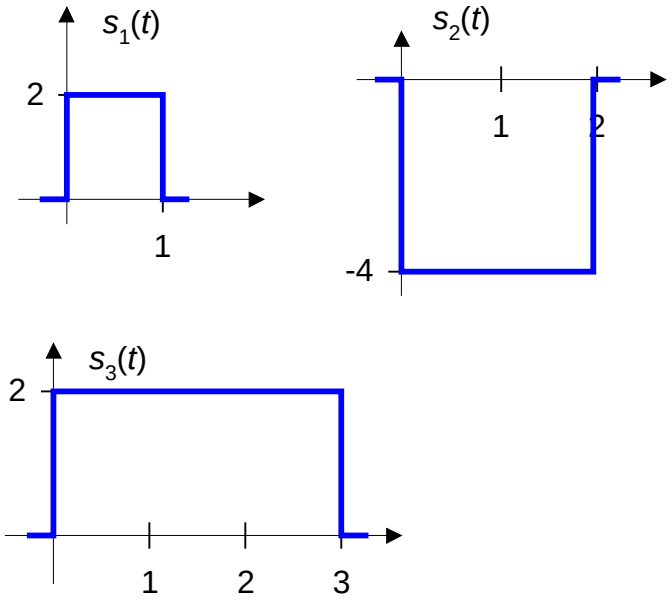
Mercredi le 25 février 1999; Durée: 9h30 à 11h20
Une feuille documentation permise; une calculatrice permise

Problem 1 (15 points out of 100)

A. (8 points) Find an orthonormal basis for the three signals given below.

B. (4 points) For each signal, give the vector representation in this basis.

C. (3 points) What is the minimal distance for these vectors?



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Problem 2 (30 points out of 100)

A telephone channel has a passband from 300 to 3300 Hz. We wish to design a modem that transmits at the symbol rate of 2400 symbols/sec, and a bit rate of 9600 bits/sec.

A. (10 points) Find a QAM modulation QAM to meet these criteria.

B. (10 points) Suppose that a RAISED COSINE pulse is used. What roll-off factor α should be used to take advantage of the entire available bandwidth?

C. (10 points) Give a sketch of the transmitted spectrum, indicating all important frequencies. Indicate the carrier frequency.

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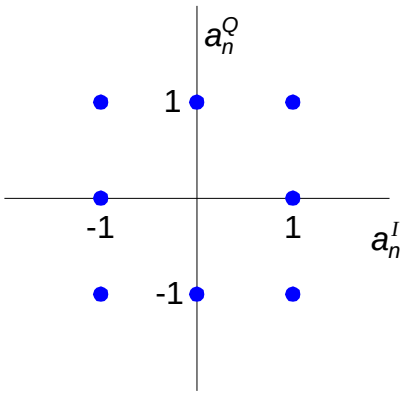
Problem 3 (20 points out of 100)

Consider the two QAM constellations given in figures (a) et (b).

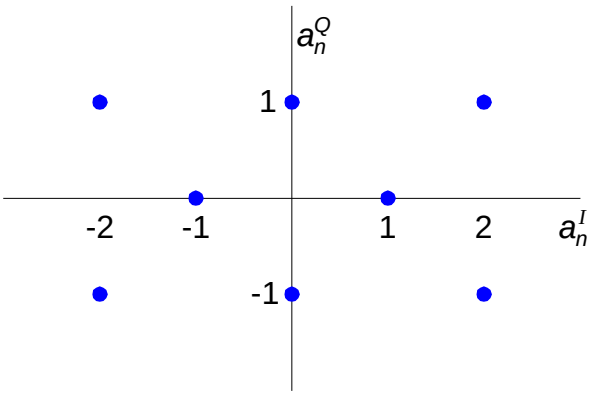
A. (10 points) What are the signal space coordinates of the symbols for each constellation, assuming the symbols all have the same probability?

B. (5 points) Which constellation is the most power efficient? Why?

C. (5 points) What is the asymptotic loss in dB for each constellation as compared with QPSK?



(a)



(b)

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Problem 4 (20 points out of 100)

A. (4 points) What three criteria are the most important in evaluating the performance of a communications system?

B. (4 points) In what was is QPSK better than BPSK?

C. (4 points) In what was is QPSK better than 16QAM??

D. (4 points) In what was is DPSK better than BPSK?

E. (4 points) In what way can controlled intersymbol interference be beneficial?

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Problem 5 (15 points out of 100)

Suppose that the signals $s_1(t)$ and $s_2(t)$ are orthogonal over the interval 0 to T. Additive white Gaussian noise (AWGN) $n(t)$ is correlated with each signal and then sampled. The samples are

$$n_1 = \int_0^T s_1(t)n(t)dt$$

$$n_2 = \int_0^T s_2(t)n(t)dt$$

Show that these noise samples are statistically uncorrelated, that is, that $E[n_1 n_2] = 0$