Université Laval
Professeur: Leslie A. Rusch

Département de génie électrique
et de génie informatique

GEL4200/GEL7014: Communications numériques
2013 Examen Partiel

Wednesday 20 March 2013; Time: 13h30 à 15h20
No notes allowed; one calculator allowed

Problem 1 (30 points over 100)

A. (10 points) Give three advantages to using a raised cosine pulse.

B. (10 points) What is the definition of a power limited system? What is the definition of a bandwidth limited system? How can we use complexity (or system cost) to meet the needs of these two system types?

C. (10 points) Give the definition of binary orthogonal modulation. Give an example, other than OOK or FSK, of a binary orthogonal modulation.

Problem 2 (20 points)

Consider the use of MFSK by amateur radio operators who wish to bounce signals off the moon – communicate from point A to point B on earth by using a reflection of the signal from the moon. The signals are very weak, the information rate is very low (~500 b/s) and the bandwidth of their channe is ~2600 Hz. Suppose we use a raised cosine pulse with rolloff r=.3.

A. (10 points) If we use noncoherent MFSK, how many symbols can be in the constellation? What E_b/N_0 is required for BER=10^{-3}? See Figure 1 for BER.

B. (10 points) If we use coherent MFSK, how many symbols can be in the constellation? Figure 2 may be useful to find M. What E_b/N_0 is required for BER=10^{-3}?

Figure 1

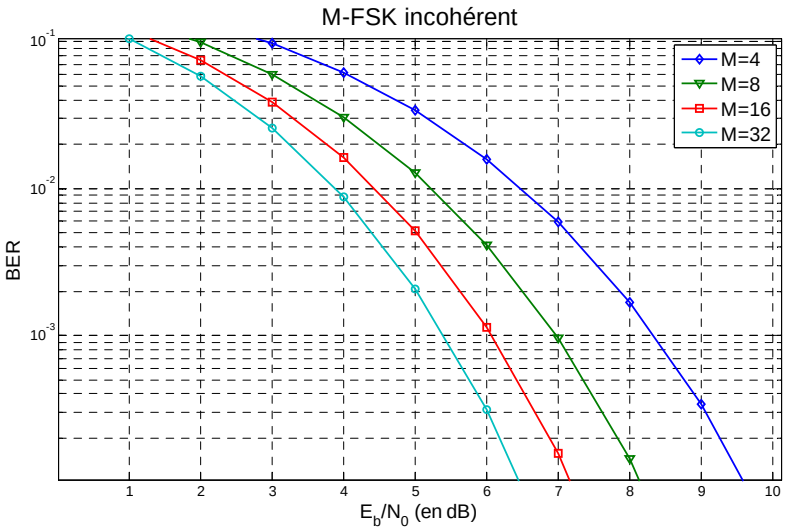
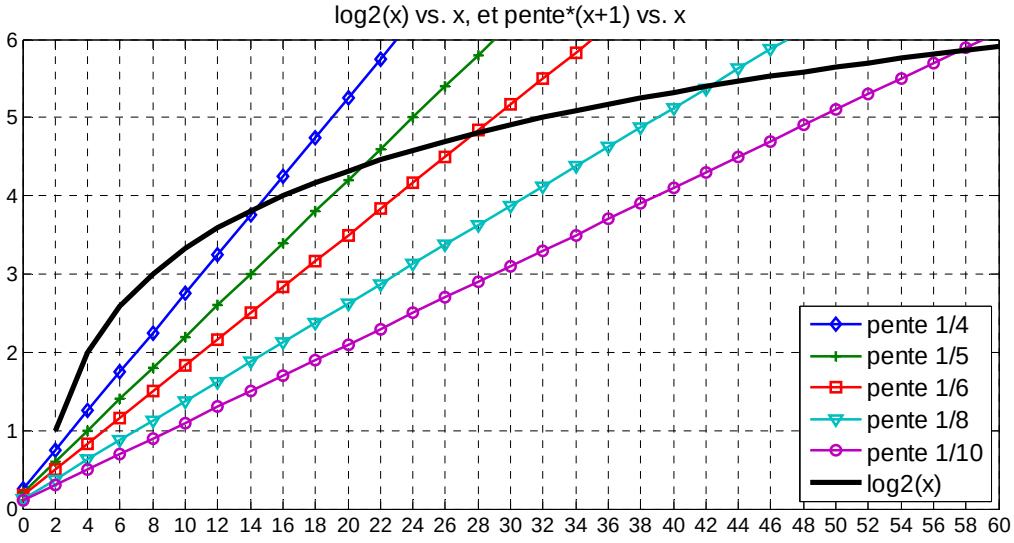
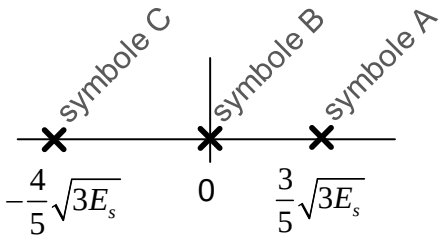


Figure 2



Problem 3 (30 points over 100)

Consider the following 3PAM system.



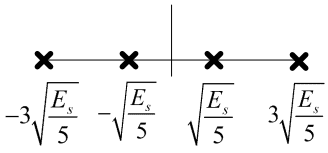
The system has $E_b/N_0 = 12$ dB, with E_s=25, and N_0=1.

A. (10 points) Suppose the symbols all have the same a priori probability. What is the decision threshold for each symbol?

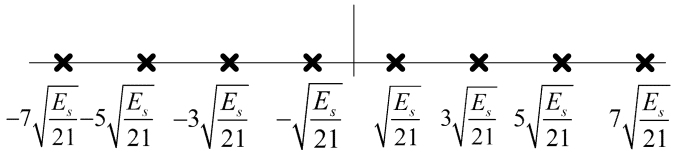
B. (20 points) Suppose that symbol A is 3 times more probable than symbols B and C (which have the same a priori probability). What is the decision threshold for each symbol?

Problem 4 (20 points over 100)

Consider the 3PAM system in problem 3 and the following 4PAM and 8PAM systems.



4PAM



8PAM

A. (5 points) For each modulation, 3PAM, 4PAM and 8PAM, are the given coordinates in the I/Q space or the signal space? Why?

B. (15 points) Consider the graph of « Plan de l'efficacité spectrale », the spectral efficiency plane. Find the coordinates of 3PAM, 4PAM and 8PAM for a bit error probability of 10^{-5}.