Université Laval
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Département de génie électrique
et de génie informatique

GEL10280/64486: Communications numériques
2007 Examen final

Mercredi le 25 avril 2007; Durée: 13h30 à 15h20
Deux feuilles de documentation fournies; une calculatrice permise

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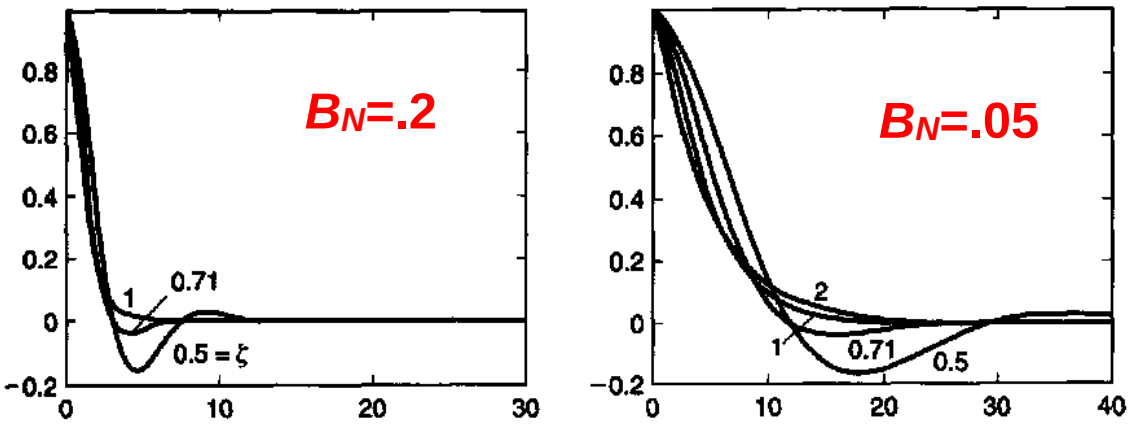
Problème 1 (15 points sur 100)

Consider a second order PLL with noise equivalent bandwidth of B_N=.05 and a damping factor ζ=.5. The loop filter is low pass with the following form

$$F(\omega) = \frac{\omega_1}{j\omega + \omega_1}$$

The phase at the input experiences a step increase of 1.25 radians.



What is the asymptotic error for B_N=.05 and ζ=.5?

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Problème 2 (10 points sur 100)

Voici quatre PLL.

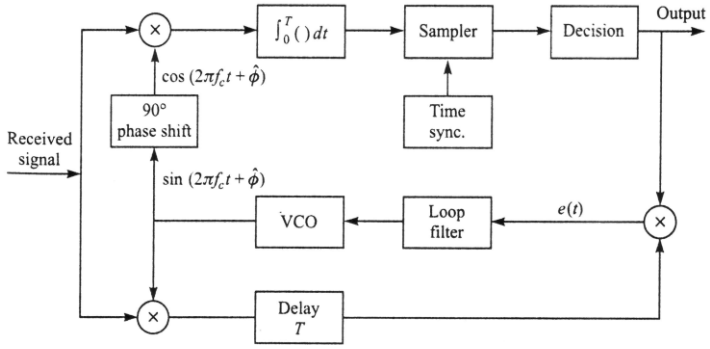
Four types of PLL are pictured to the right. Classify each PLL according to the method used to generate a reference phase:

A) Pilot tone

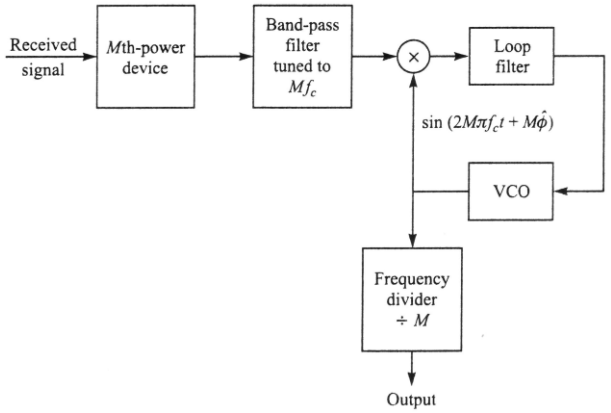
B) remodulation

C) squaring the received signal (or raising to a higher power)

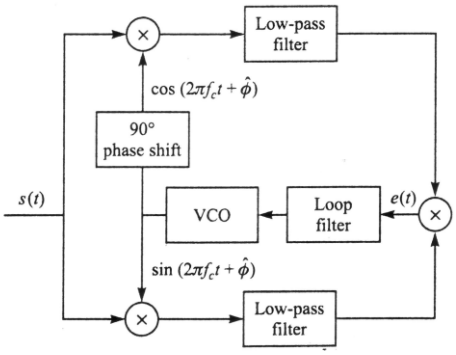
PLL i.



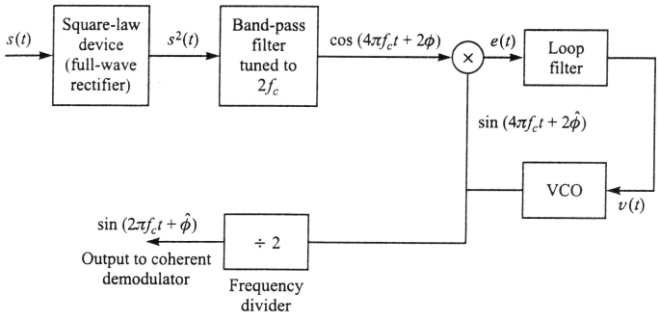
PLL ii.



PLL iii.



PLL iv.



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Problème 3 (20 points sur 100)

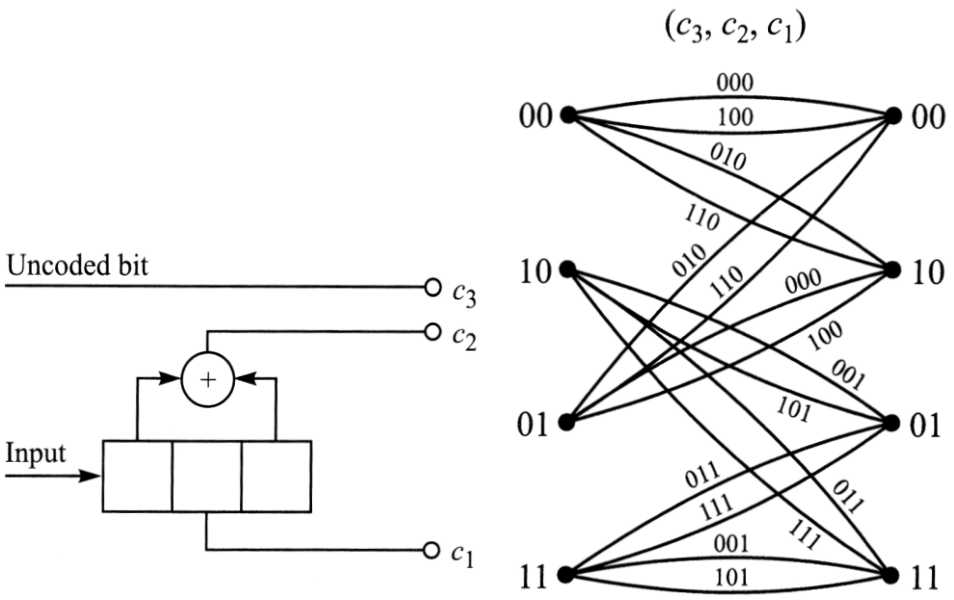
The following is the standard array and table of syndromes for a block code.

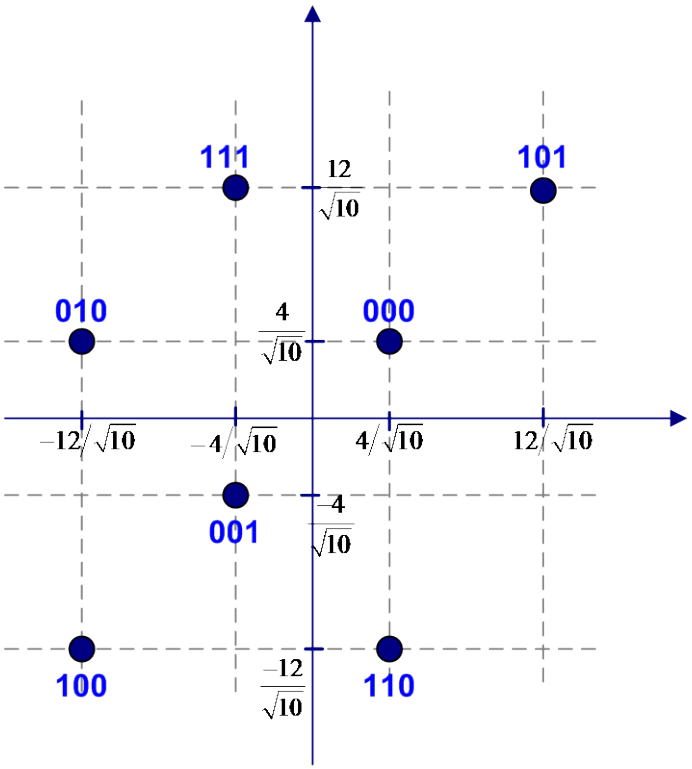
bits de message	001	010	011	100	101	110	111	**Syndrome**
000000	***110001***	***101010***	***011011***	***011100***	***101101***	***110110***	***000111***	**000**
000001	110000	101011	011010	011101	101100	110111	000110	**110**
000010	110011	101000	011001	011110	101111	110100	000101	**101**
000100	110101	101110	011111	011000	101001	110010	000011	**011**
001000	111001	100010	010011	010100	100101	111110	001111	**001**
010000	100001	111010	001011	001100	111101	100110	010111	**010**
100000	010001	001010	111011	111100	001101	010110	100111	**100**
001001	111000	100011	010010	010101	100100	111111	001110	**111**

A. How many error vectors can be corrected by the code?
B. How many bit errors can be corrected by the code?
C. Is the code systematic?
D. Is the code linear?
E. What is the minimal distance of the code?
F. What is the code rate?
G. For received sequence 010011, was there a transmission error?
H. With the information provided, can you sketch the encoder :
I. With the information provided, can you correct errors?
    a. If yes, how?
    b. If no, what additional information is needed?

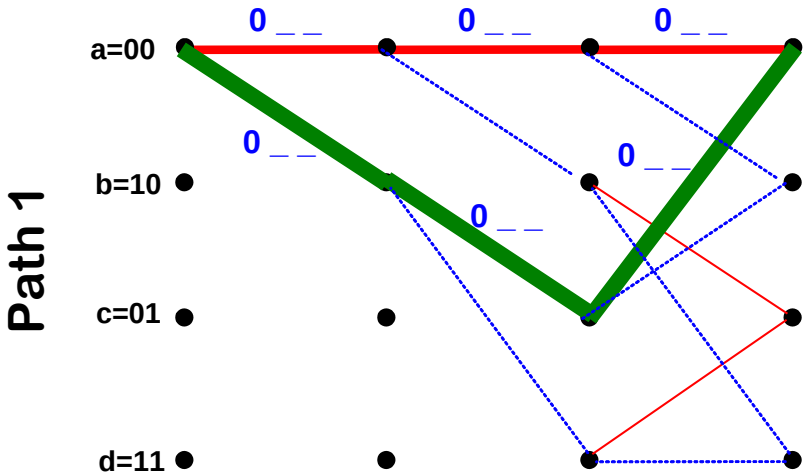
Problème 4 (30 points sur 100)

Consider the following TCM system for 8QAM

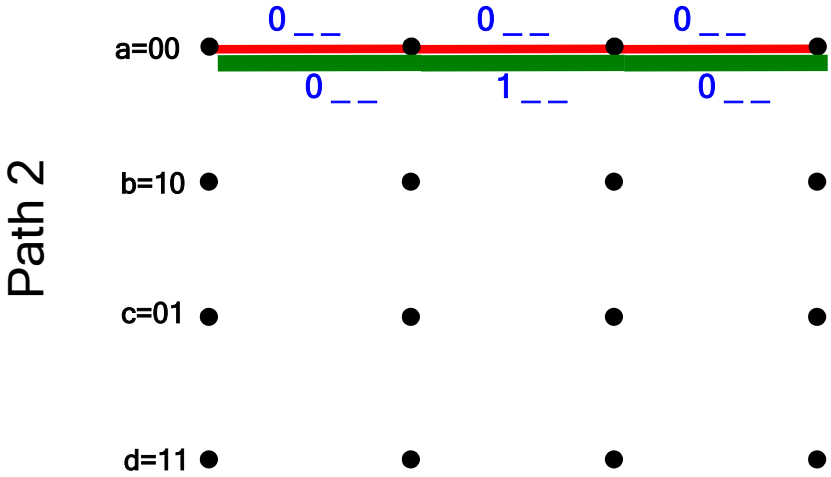




There are two possible paths for the path with the minimal distance. These paths are



-OR-



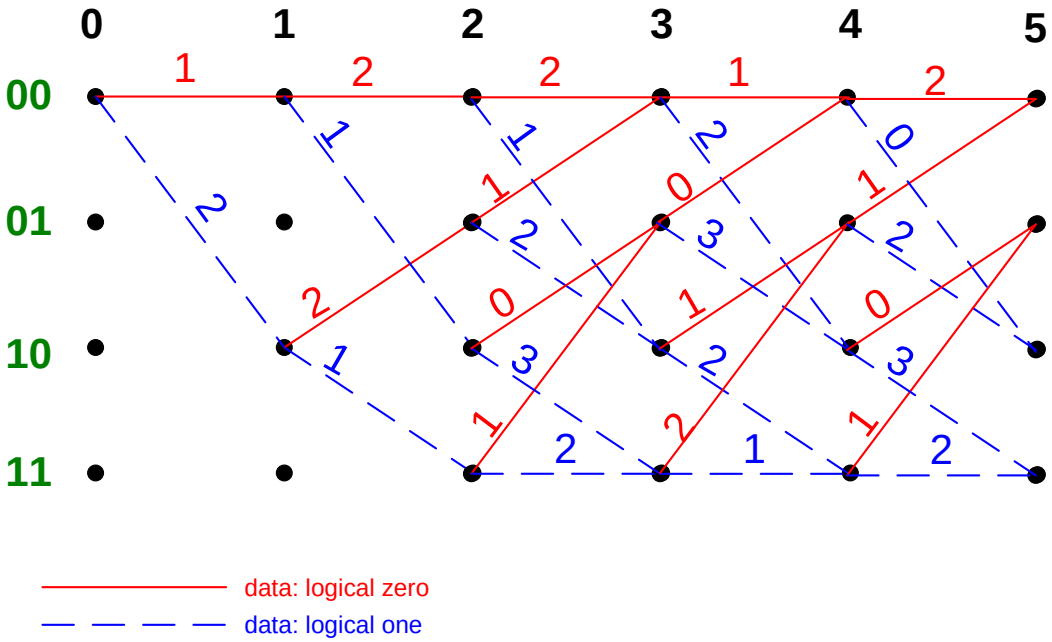
Note that each transition has a three-bit code word. The first bit of the code word, bit c_3, is equal to the first data bit, and this bit is provided for each transition.

A. (10 points) Complete the code words for each of the transitions in the two paths.

B. (20 points) Find the path metrics for the two paths using the square Euclidean distance.

Problème 5 (25 points sur 100)

Consider a convolutional code with the following decoder. The branch metrics are indicated for each transition. These metrics indicate the Hamming distance between the received code word and the valid code word for the given transition.



A. (15 points) What is the decoder output, that is, the sequence of five data bits?

B. (10 points) Were there any transmission errors? If yes, how many?