Université Laval
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Département de génie électrique
et de génie informatique

GEL10280/64486: Communications numériques
2008 Examen final

Mercredi le 30 avril 2008; Durée: 13h30 à 15h20
Documentation fournie; une calculatrice permise

Problème 1 (15 points sur 100)

Consider a PLL with loop filter

$$F(\omega) = \frac{1}{j\omega + \sqrt{2}}$$

The VCO gain is K_0.

A. What is the asymptotic error with the input is a discontinuity in the phase (unit step function)?

B. What is the asymptotic error with the input is a unitary, linear variation in the phase (a *ramp*)?

C. How can the VCO gain, K_0, be exploited to improve the PLL performance?

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Problème 2 (10 points sur 100)

The following are the parity equations for a block code.

$$p_1 = m_1 + m_2$$
$$p_2 = m_2 + m_3$$
$$p_3 = m_1 + m_2 + m_3$$
$$p_4 = m_1 + m_3$$
$$U = \left[p_1 \; p_2 \; p_3 \; p_4 \; m_1 \; m_2 \; m_3 \right]$$

A. Give the generating matrix for this block code.

B. What is the minimal distance of the code?

C. Give the control matrix for this block code.

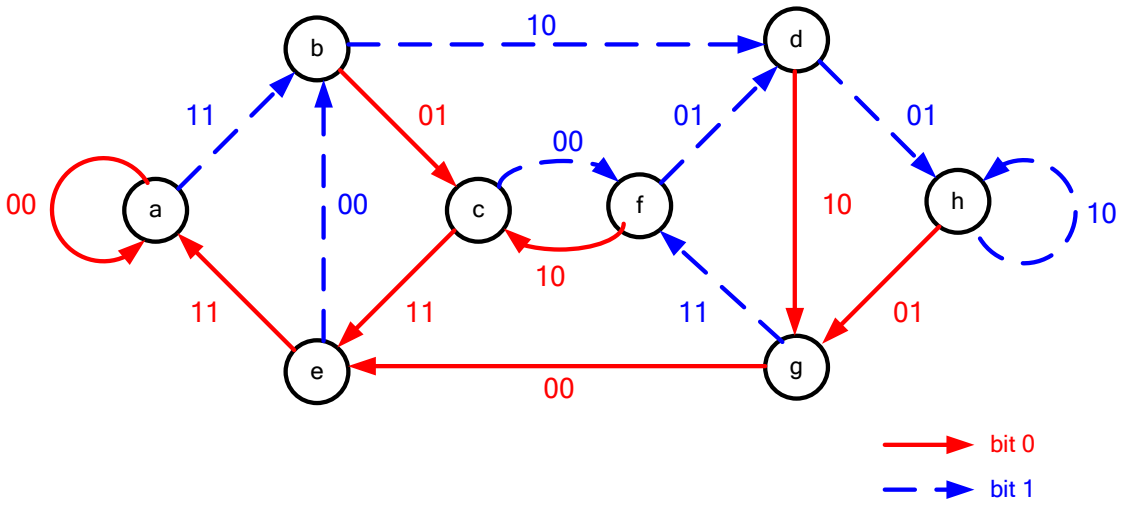
D. Give the syndrome table for all one-bit error sequences.

E. What is the output of the decoder when the sequence received is r = [1 1 0 1 0 1 1]?

Problème 3 (10 points sur 100)

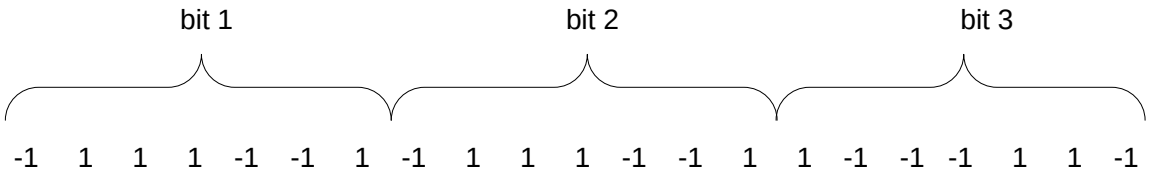
Here is the state diagram of a convolutional encoder with constraint length four. The output code words are indicated besides each possible transition. The initial state is “a”, the state where all registers contain a zero.

Give the encoded sequence with the data is 1 1 1 0 1 0 0 0.



Problème 4 (25 points sur 100)

Suppose the following spread spectrum signal is received.



The signal was encoded with the following PN sequence:

-1 -1 1 -1 1 1 1

This PN sequence had another "rotation" during the spreading of the signal.

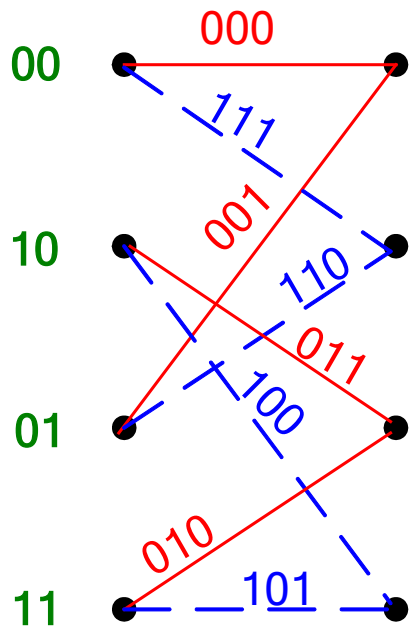
A. (5 points) What is the correct rotation to despread the signal?
B. (5 points) What are the transmitted data bits?

Suppose the channel has two reflections: the main return and a second path that arrives exactly two chip intervals after the main return. The second path has a amplitude of $\alpha < 1$ relative to the main return.

C. (15 points) What is the maximal value of the amplitude α to assure that the ISI from the second path is rejected by 10 dB after dispreading?

Problème 5 (30 points sur 100)

Consider the following encoding trellis for a convolutional code.



The following sequence is received.

111 001 110 110 101 010

Find the output of the Viterbi decoder, that is the maximum likelihood sequence estimate. Please use the pages provided for the decoder trellis. Place these pages in your exam booklet.

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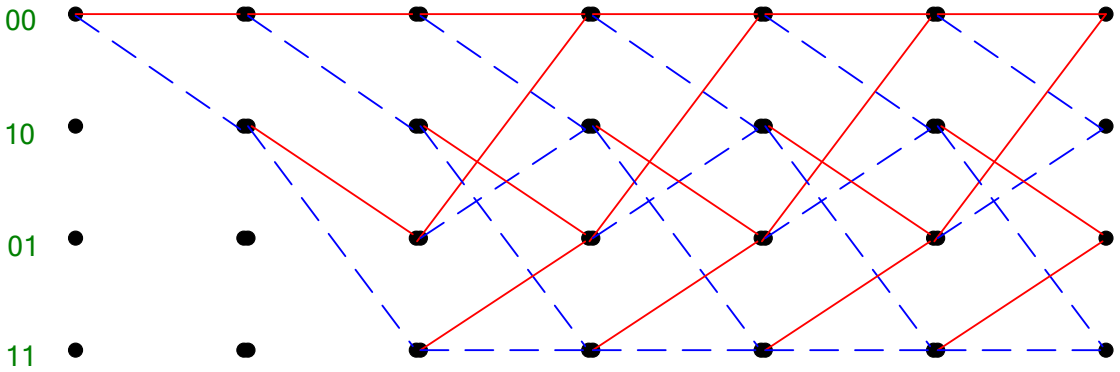

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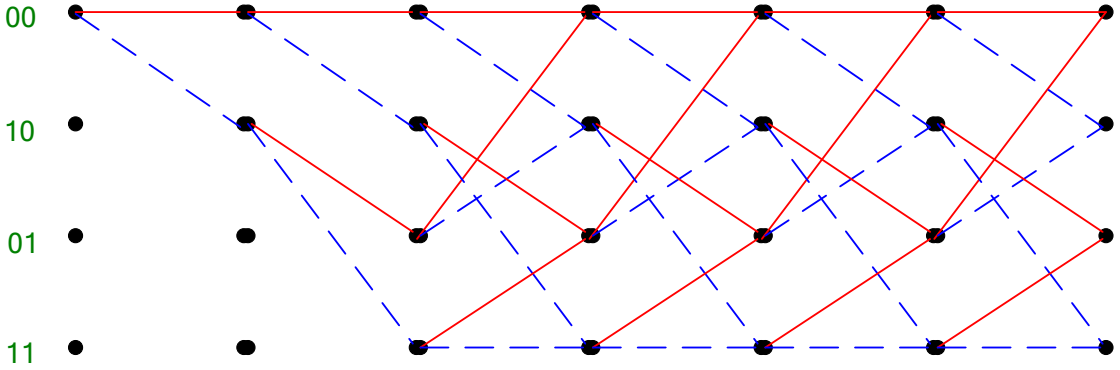

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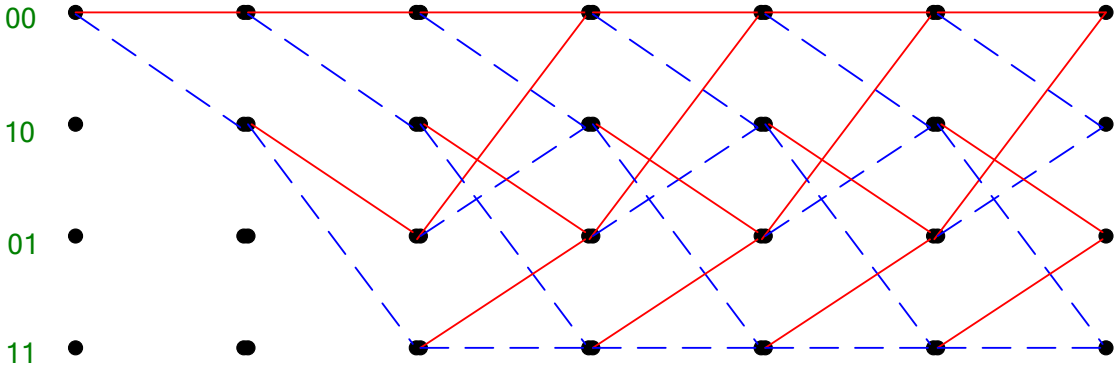

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