Assignment 3

CSL 858

Due date: February 9, 2007 (Friday)

Topics: Channel Coding, CDMA

1. Consider a (7,4) linear block code with generator matrix

$$G = \begin{bmatrix} 0 & 1 & 0 & 1 \\ 1 & 0 & 1 & 1 \\ 0 & 1 & 1 & 0 \\ 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{1}$$

Given a 4-bit data block, $\underline{a}_{4\times 1}$, its corresponding codeword is given by $G\underline{a}$.

   (a) Find all the codewords of the code.
   (b) What is the minimum Hamming distance of the code?
   (c) Assuming an information data block of all 0's, find all minimum weight error patterns **e** that result in a valid codeword that is not the all-zero codeword.

2. Consider the convolutional code generated by the encoder shown in Figure 1. Define the state of the encoder as $S = S_2 S_3$.
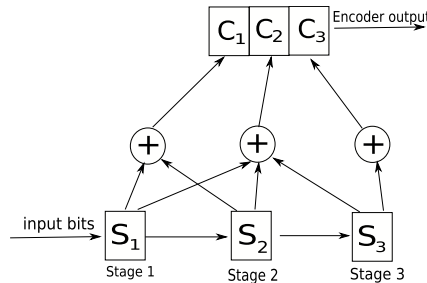

Figure 1: Convolutional Encoder

   (a) Sketch the trellis diagram of the code showing how the encoder transitions from one state to another for different input bits. Also indicate the output bits of the encoder corresponding different branches in the trellis.
   (b) For a received sequence $R = [001010001]$, find the path metric for the all-zero path. Assume that the receiver performs hard-decision decoding and that the probability of incorrectly decoding a received bit is $p = 10^{-3}$.

3. Sketch the transmitted CDMA signal $x(t)\phi(t)$ over two bit times $[0, 2T_s]$ assuming that $x(t)$ is BPSK modulated with carrier frequency 100 MHz and $T_s = 1$ μs. Assume that the first data bit is a 1 and the second data bit is a 0. Assume also that there are 10 chips per bit in the spreading code signal $\phi(t)$ and that the chips alternate between ± 1, with the first chip equal to $+1$.