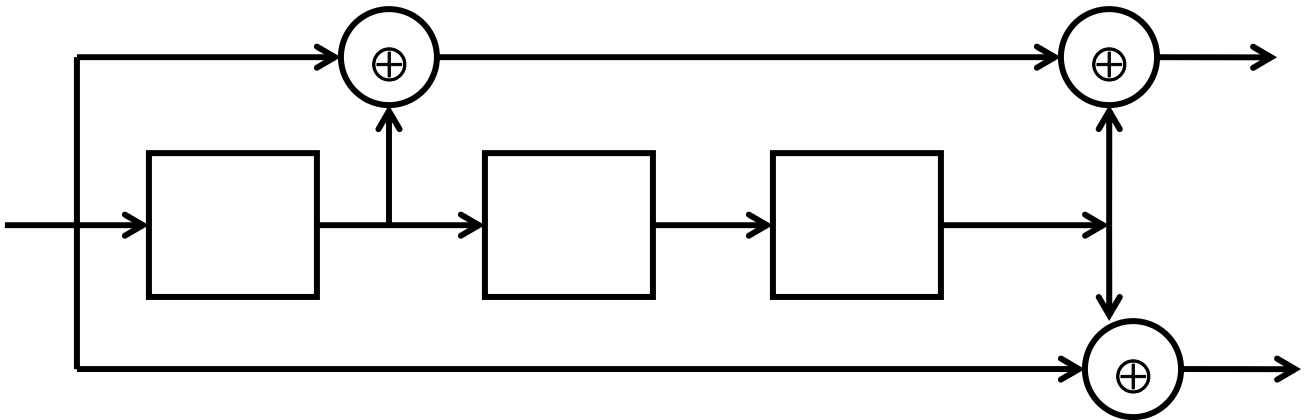


# ECE 154C

## Homework #7

Due May 27, 2009

1. Consider the rate  $\frac{1}{2}$  convolutional encoder shown below:



Assume that the encoder starts in the all-zero state and that the two outputs are multiplexed into a single output stream.

- What is the minimum Hamming weight of any non-zero codeword that starts in the all zero state and ends in the all-zero state?
- Draw a trellis diagram that describes the output of the encoder. The trellis should have two binary digits on each branch corresponding to the two outputs of the encoder.. Make the trellis large enough so that you show the output sequence for the 5 input (information) digits 0 1 1 1 0. What are the output digits for this input sequence?
- Assuming the encoded sequence was sent over a binary symmetric with bit error probability less than  $\frac{1}{2}$ , show the branch and state metrics for a Viterbi decoder corresponding to the received binary sequence 0 1 0 0 1 1 0 0 1 1 . What is the information sequence corresponding to the best path through the trellis. (If there is a tie, give one of these sequences.)
- Assume the encoded sequence was sent over a binary symmetric with bit error probability  $p$ . Write a computer simulation that yields the decoded bit error probability for the following values of  $p$ :  $p=0.01$ ,  $p=0.05$  and  $p=0.1$ .

- 2.** Assume that the code described in problem 1 is punctured to make a rate  $2/3$  code by dropping the coded binary digit that comes from bottom mod 2 adder for every other input bit.
- (a) What is the minimum Hamming weight of any non-zero codeword that starts in the all zero state and ends in the all-zero state? Make sure you try two different cases. The first case is where the code word leaves the all zero state on a branch that contains two output bits and the second case is where the code word leaves the all zero state on a branch that contains only one output bit.
- (b) Draw a trellis diagram that describes the output of the encoder. Make the trellis large enough so that you show the output sequence for the 5 input (information) digits 0 1 1 1 0. What are the output digits for this input sequence?
- (c) Assuming the encoded sequence was sent over a binary symmetric with bit error probability less than  $1/2$ , show the branch and state metrics for a Viterbi decoder corresponding to the received binary sequence 0 1 0 1 1 0 1 1 . What is the information sequence corresponding to the best path through the trellis. (If there is a tie, give one of these sequences.)
- (d) Assume the encoded sequence was sent over a binary symmetric with bit error probability  $p$ . Write a computer simulation that yields the decoded bit error probability for the following values of  $p$ :  $p=0.01$ ,  $p=0.05$  and  $p=0.1$ .
- 3.** Give generator matrix for the (24,12) code formed by adding an overall parity digit to the (23,12) Golay code. Using a computer find the number of code words of Hamming weight  $i$  for  $i = 0, 1, 2, \dots, 24$ .

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