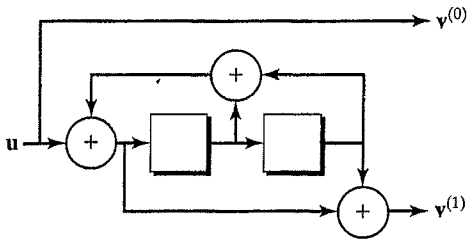
**ECE 695C, Homework #5, due date: 3/18/2012**

https://engineering.purdue.edu/~chihw/12ECE695C/12ECE695C.html

*Question 1:* Consider a rate-1/3 turbo code generated by two Recursive Systematic Convolutional codes. Both RSCs are identical and of the following form [Lin, Costello, 2nd Ed., Fig. 16.10, p. 793.]




Let $K$ denote the number of information bits that are fed into the turbo encoder. In this problem, we first assume $K = 1000$.

1. Write a MATLAB code of the turbo encoder that takes as input $K$ bits and outputs $3K$ bits. You should first use MATLAB to generate a random permutation (a random interleaver) and then fix that permutation throughout your program.

2. Write a MATLAB code of the turbo decoder that takes as input a $3K$-dimensional log-likelihood-ratio vector

$$\left(\log\frac{P_{Y_1|X_1}(y_1|0)}{P_{Y_1|X_1}(y_1|1)}, \log\frac{P_{Y_2|X_2}(y_2|0)}{P_{Y_2|X_2}(y_2|1)}, \cdots, \log\frac{P_{Y_{3K}|X_{3K}}(y_{3K}|0)}{P_{Y_{3K}|X_{3K}}(y_{3K}|1)}\right),$$

   and outputs the $K$ decoded bits based on running the BCJR algorithm with 18 outer iteration.

3. Assuming the information bits are all-zero and the channel is $Y_i = (-1)^{X_i} + \sigma N_i$, where $i = 1, \cdots, 3K$, $N_i$ is a standard Gaussian, and $\sigma > 0$ is a scalar. Use Monte-Carlo simulation to plot the bit-error-rate versus the signal-to-noise ratio curve. Your vertical axis is log(ber) and your horizontal axis is $20\log_{10}(1/\sigma)$.

4. Repeat the above questions for $K = 100$ and $K = 10000$.