EE/Ma 127c Error-Correcting Codes — R. J. McEliece
draft of May 18, 2001 — 162 Moore

Details of Class Project #2
Due date: Week of June 4,, 2001

You (and/or your team; maximum of four students per team) are expected to produce a computer program to implement a turbo code, specified below.

• *The goal of the project is for you to to run simulations and produce a graph which shows the (approximate) relationship between* E_b/N_0 *and the decoded bit error probability for the turbo code, for* 1, 2, 4, *and* 8 *iterations, and for for* E_b/N_0 *ranging from 0 dB to 3dB, in increments of 0.5 dB.*

Details:

1. The code is a rate 1/3 parallel turbo code, with one systematic output stream and two coded streams, which both use the transfer function

$$G(D) = \frac{1 + D^4}{1 + D + D^2 + D^3 + D^4}.$$

2. The input stream $\mathbf{u} = (u_1, \ldots, u_k)$ is k bits long (k is specified below), and the output stream $(\mathbf{u}, \mathbf{x}_1, \mathbf{x}_2)$ is $3(k + 4)$ bits long. (The four dummy bits of $\mathbf{u}$ can be chosen to be zeros; the four dummy bits in $\mathbf{x}_1$ and $\mathbf{x}_2$ are chosen so as to terminate the trellis.)
3. The interleaver design is unspecified. However, you may wish to implement a "linear congruential" interleaver of the type described in class. I suggest you experiment with severl different interleavers to see which gives the best performance.
4. The information block size k must be at least 1024. However, longer block lengths should be just as easy to program and will give much better results. (Recall that Berrou used $k = 64K$.)
5. The heart of the decoding algorithm is the feedback loop between the APP (BCJR) decoders for the two component codes. APP decoder 1 will use as "channel evidence" the noisy version of u plus the noisy version of $\mathbf{x}_1$, and as *a priori* information the extrinsic APPs from decoder 2. Similarly, APP decoder 2 will use as channel evidence the noisy version of $\mathbf{u}$ plus the noisy version of $\mathbf{x}_2$, and as *a priori* information the extrinsic APPs from decoder 1.