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 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 $E_b/N_0$ ranging from 0 dB to 3 dB, 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 $u = (u_1, \ldots, u_k)$ is $k$ bits long ($k$ is specified below), and the output stream $(u, x_1, x_2)$ is $3(k + 4)$ bits long. (The four dummy bits of $u$ can be chosen to be zeros; the four dummy bits in $x_1$ and $x_2$ 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 several 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 $x_1$, and as a priori information the extrinsic APPs from decoder 2. Similarly, APP decoder 2 will use as channel evidence the noisy version of $u$ plus the noisy version of $x_2$, and as a priori information the extrinsic APPs from decoder 1.