Extended Golay Code
EECS 869: Error Control Coding
Fall 2009

Complete the following tasks. You should submit an e-mail with one .m file attachment and a separate document with the two requested plots (use esp@eecs.ku.edu).

1. **Implement the Arithmetic Decoding Algorithm for the Extended Golay Code.** The arithmetic decoding algorithm for the (24,12,8) extended Golay code is found on p. 402 of the textbook and is labeled as **Algorithm 8.2**. You should implement this as a MATLAB function with the following syntax:

   ```
   c_hat = ExtendedGolayDecoderXXX(r);
   ```

   where $\mathbf{r}$ and $\hat{\mathbf{c}}$ are 1×24 MATLAB vectors containing ones and zeros. Although the author of your textbook has provided various MATLAB files for your use, for this assignment I expect you to submit your own original MATLAB code. You should submit your function via e-mail (use esp@eecs.ku.edu), and don't forget to replace `XXX` with your first name.

2. **Generate $P(E)$ and P_b Curves for the Extended Golay Code.** To generate $P(E)$ and P_b curves, we need the weight enumerator $A(z)$ and the message weight enumerator $\beta(z)$. The weight enumerator is given in Table 8.2 of the textbook, but you are on your own with $\beta(z)$. Provide a plot of $P(E)$ and P_b in the standard format we've used so far: probabilities displayed on the log scale, E_b/N_0 expressed in dB. You can assume the use of the binary symmetric channel (BSC), where the underlying channel is BPSK modulation with AWGN and hard decisions. This is the same channel we used in the previous project. Include a curve for uncoded BPSK as a reference, and use E_b/N_0 in the range of 0 to 10 dB.

3. **Plot the performance of the Extended Golay Code on a Capacity Plot.** Recall the capacity plot you made in HW#1 for the bandwidth and power constrained AWGN channel. Locate the position of the extended Golay code on that plot (mark it with an X or something). For the y-axis, you need the information rate of the system (in this case the system is BPSK modulation plus the code). For the x-axis, you need the value of E_b/N_0 needed to achieve arbitrarily low probability of error. For our purposes, lets say that arbitrarily low is 10^{-6}. In other words, take the plot you made in the previous task and see what value of E_b/N_0 is necessary for the P_b plot to cross below 10^{-6}. This is the value of E_b/N_0 you need for the x-axis of the capacity plot. How did the extended Golay code do in meeting the challenge set forth by Shannon?