Communications Engineering

Course No: 16:332:421 - (Fall 2006)

Solutions to Homework 6

1. The transmission bandwidth is $W = 1\,MHz$ and the source bit-rate is $R = 20\ Kbps$.

   (a) The processing gain is $N = W/R = 50$

   (b) The chip duration is $T_c = 1/W = 1\ \mu sec$

   (c) To achieve a bit-error performance similar to a single-user system, the direct-sequence codes of all the users must be mutually orthogonal to each other. Since the spreading codes are of length N, and from a binary alphabet $\{+1, -1\}$, the number of such orthogonal codes is N. Therefore 50 users can be supported.

2. Problem 7.10

   (a) The processing gain is $N = 2^m - 1 = 2^{19} - 1$.
   In dB, it is
   $$10log_{10}[N] = 10log_{10}[2^{19} - 1] \approx 57$$

   (b) To find the antijam margin for the probability of error to not exceed $p = 10^{-5}$, we first find the minimum required signal-to-noise ratio $(\frac{E_b}{N_o})_{min}$ for the DS-BPSK system as
   $$p = \frac{1}{2}\text{erfc}(\sqrt{(\frac{E_b}{N_0})_{min}}),$$
   For $p = 10^{-5}$, $(\frac{E_b}{N_o})_{min} = 10$ approximately solves the above equation (see example 7.3 on page 499 in the book).
   Then the jamming margin (in dB) is given as
   $$(\text{Jamming Margin})_{dB} = 10log_{10}[N] - 10log_{10}[(\frac{E_b}{N_o})_{min}] = 57 - 10 = 47dB$$