Relevant Reading: 4.1, 4.2, 4.3, 4.4, 4.5
Relevant Items in the DSP First CD: 4.1 to 4.7, 4.26 to 4.31, 4.40 to 4.52

1. A continuous-time signal is to be sampled, quantized, binary encoded and decoded. Suppose that the signal value distribution of the signal is approximately constant between -1 and +1, suppose the highest frequency component of the signal is slightly less than 1000 Hz, and suppose the goal is that the sampler/quantizer/binary encoder should produce as few bits per second as possible, subject to the requirement that the decoder produces a reproduction of the signal with MSE ≤ 0.002.

   (a) What sampling frequency f_s would you choose?

   (b) What quantizer level spacing Δ would you choose in order to guarantee MSE ≤ 0.002?
   You may assume that the MSE of the reconstructed continuous-time signal equals the MSE of the decoded samples. (When the sampling frequency is chosen high enough in part (a), this intuitive assumption can be shown to be valid.)

   (c) How many bits per second will the sampler/quantizer/binary encoder produce with the sampling rate chosen in part (a) and the level spacing chosen in part (b)?
   (Be sure to give the formula you use to calculate the answerer, so that you can receive partial credit if you substitute incorrect values from parts (a) and (b) into a correct formula.)

2. Textbook, Problem 4.4, p. 113.
   Express all discrete-time frequencies $\hat{\omega}$ in the range $[-\pi,\ \pi]$.

3. Textbook, Problem 4.6, p. 113.

4. Consider Problem 4.7 (a), p. 114. Verify that the signals

$$x_0(t) = 10\cos(200\pi t - \frac{\pi}{7}) \qquad \text{and} \qquad x_1(t) = 10\cos(1800\pi t + \frac{\pi}{7})$$

   are valid answers. Note that $x_1(t)$ illustrates case 2 of aliasing (folding).

   Find a third signal $x_2(t)$ that also results in the same samples and that illustrates case 1 of aliasing.

5. Textbook, Problem 4.8, p. 114.

6. Textbook, Problem 4.11, p. 115.

7. Textbook, Problem 4.15 (a), pp. 116-7.
   As you did in Problem 4.7 (a) above, provide three signals, $x_0(t)$, $x_1(t)$, and $x_2(t)$, in order to illustrate the two cases of aliasing discussed in class.