Problem Set 1 (due Friday, September 21)

0. (due now!) Follow the instructions on the webpage below to join the class mailing list.

`https://lists.ccs.neu.edu/bin/listinfo/csg250`

1. (10 points) Applying low-pass and bandpass filters to a digital signal

A square periodic signal is represented as the following sum of sinusoids:

$$s(t) = \frac{2}{\pi} \sum_{k=0}^{\infty} \frac{(-1)^k}{2k+1} cos((2k+1)\pi t).$$

(Note that this is just a rewriting of the formula we discussed in class.)

(a) Suppose that the signal is applied to an ideal low-pass filter with bandwidth 15 Hz. Plot the output from the low-pass filter and compare to the original signal. Repeat for 5 Hz; for 3 Hz. What happens as the bandwidth increases.

(b) Suppose that the signal is applied to a bandpass filter that passes the frequencies from 5 to 9 Hz. Plot the output from the filter and compare to the original signal.

For your plots, use an appropriate plotting tool. One such tool is gnuplot, available in Unix.

2. (4 points) Bandwidth, signal element, and SNR

A digital signaling system is required to operate at 38.4 Kbps. If a signal element encodes a 8-bit word, what is the minimum required bandwidth of the channel. What signal-to-noise ratio is required to achieve the desired capacity on the bandwidth that you have computed?

3. (6 points) Effect of transmission frequency and distance on attenuation

Under the free-space path-loss model, find the transmit power required to obtain a received power of 1 dBm for a wireless system with isotropic antennas (gain = 1) and a carrier frequency $f = 5$ GHz, assuming a distance $d = 10$ m. Repeat for $d = 100$ m, keeping $f = 5$ GHz. Repeat for $f = 50$ GHz, keeping $d = 10$ m.

4. (5 points) Received power using half-wave dipoles

Problem 5.9.

5. (7 points) Modulation schemes and E_b/N_0

Problem 6.2.

6. (5 points) Telephone channel bandwidth

Problem 6.6.

7. (5 points) Sampling

Problem 6.10.

8. (8 points) Delta modulation

Problem 6.13.