College of Computer & Information Science
Northeastern University
CSG250: Wireless Networks

Spring 2007
Handout 1
12 January 2007

Problem Set 1 (due Tuesday, January 23)

(Problem numbers indicated below refer to the problems in the second edition of the course text. The problem numbers in parentheses refer to the problems in the first edition of the course text.)

1. (8 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 10 Hz; for 5 Hz. What happens as the bandwidth decreases.

(b) Suppose that the signal is applied to a bandpass filter that passes the frequencies from 4 to 8 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. (You may even be able to generate these plots using Excel).

2. (5 points) Shannon capacity theorem

Assume the following bandwidth & available channel capacity for the transmision media *twisted pair*, *coaxial cable*, and *optical fiber* of a certain grade, respectively: 4 Mbps & 3 MHz, 500 Mbps & 350 MHz, and 2 Gbps & 2 GHz. Assuming these numbers capture the fundamental limitation imposed by Shannon's capacity theorem, estimate the signal-to-noise ratio underlying the three media.

3. (6 points) Antenna gains and power attenuation

A wireless receiver with an effective diameter of 250 cm is receiving signals at 10 GHz from a transmitted that transmits at a power of 30 mW and a gain of 30dB.

(a) What is the gain of the receiver antenna?

(b) What is the received power if the receiver is 5 km away from the transmitter?

4. (5 points) Transmitting voice by radio waves

Problem 5.4 (Chapter 5, Problem 4).

5. (6 points) Parabolic antennas

A microwave transmitter with an output of 0.5 W at 2 GHz is used in a transmission system, where both the transmitting and receiving antennas are parabolas, each 1 m in diameter. Suppose the two antennas are directionally aligned and are 10 kms apart.

(a) What is the effective radiated power of the transmitted signal, in W and dB?

(b) What is the available signal power out of the receiving antenna?

6. (10 points) Height and line of sight

Problems 5.12 and 5.13 (Chapter 5, Problems 12 and 13).

7. (5 points) QAM demodulation

Problem 6.1 (Chapter 6, Problem 1).

8. (5 points) Pulse Code Modulation

Problem 6.12 (Chapter 6, Problem 11).