CSE 4215 :: Problem Set 1

1. For an arbitrary signal x(t), demonstrate (with equations) the operations of modulation and demodulation by a carrier frequency f_c. Explain, making reference to the Fourier transform, why low-pass filtering is required as part of the demodulation procedure.

2. Using examples, show how the MACA protocol avoids both the hidden terminal problem, and the exposed terminal problem.

3. The received power of a signal is measured as 5W, 0.04W, and 0.005W at distances of 1m, 5m, and 10m from the receiver, respectively. What is the path loss exponent?

4. Suppose a sinusoid with frequency f = 1 GHz is sent from a transmitter to a receiver. The transmit antenna is located 10m above the ground, and the receive antenna is located 2m above the ground. The two antennas are 200m apart. The power in the direct path is 1 μW at the receiver. Assume the ground is a good conductor and that the reflection coefficient is R = -1. Find a simplified expression for the signal observed at the receiver.

5. A receiver requires 0.01 mW of power to ensure reliable communication. Required range is 400 m, with a path loss exponent of 3. The transmit antenna has an antenna gain of 3 dB, and the receive antenna has antenna gain of 0 dB. Allow 10 dB for the fade margin, and 3 dB for other losses. What is the required power at the transmitter in dBm?

6. Give the following changes of units, or explain why such a transformation is not possible:

   a. 30 dBm in mW
   b. 0 W in dBm
   c. 0.01 W in dBm
   d. 0 dBm in W
   e. 3 dB in mW
   f. 3 mW in dB