ECE 123 **Midterm Review Problems** **Spring 2009**

The exam will be closed book. Calculators are OK. Some equations and constants will be given if necessary. Bring your own paper.

1. System problems from first week

(a) Define the *gain G* of a transmitting antenna in terms of its radiated flux.
(b) Define the *beam solid angle* Ω of an antenna and write the equation relating Ω *to G*.
(c) Define the *effective area* A of a receiving antenna in terms of the power it can extract from a radiation field.
(d) Derive the Friis-Shelkunov formula for the received power P_R on a link between two antennas, given the power transmitted P_T, the gain of the transmitting antenna G_T, the effective area of the receiving antenna A_R, and the distance R.
(e) You are located on top of Mount San Jacinto and you wonder if you can make a connection with your IS-95 cell phone to San Diego. You can actually see the base-station on Mount Soledad with binoculars and you know it is 125 km distant. You know that the base-station antenna beam is isotropic in azimuth and covers 30^0 in elevation. Your handset has a simple dipole antenna. The maximum handset transmitted power is 200 mw. The effective bandwidth is 14400 Hz and the base-station noise temperature is 1200K. Will the SNR at the base-station be adequate? (10dB is the minimum required)

2. Array problems from second week

You need a linear-array antenna which can scan a beam back and forth $\pm 30^0$ from broadside. The system will operate at a wavelength of 3 cm and the desired beamwidth is 1^0. The array axis will be horizontal, so the beam steers in azimuth, and the elements will be vertical dipoles. The constraint is to use as few elements as possible with no visible grating lobes at any time.
(a) How long must the array be?
(b) What will be its gain?
(c) What element spacing is required and how many elements are needed?

3. RF engineering problems from third week

(a) You would like to match an impedance of $Z_L = 25 + j\,10\ \Omega$ to a microstrip transmission line with $Z_0 = 50\ \Omega$. You would prefer to do the match with a short parallel stub of the same Z_0. How far from the load must you put the stub (in wavelengths) and how long must that stub be (in wavelengths)?
(b) You have a receiver which has a room temperature loss of 0.2 dB before the LNA. The LNA has a gain of 10 dB and a noise temperature of 50K. The following amplifier has a gain of 20 dB and a noise temperature of 200K. What is the total receiver noise temperature?

4. Electromagnetism problems from fourth week

There will not be any problems involving derivations from Maxwell's equations on the midterm exam, but there will be "electromagnetic" problems on the final exam.