Engineering 7811 Assignment 3 Part 1 Due: Mon. Feb. 13, 2012

1. The magnitude of the far-field electric field intensity for a particular antenna array radiating into free-space is given by

$$E = \cos\left[\frac{\pi}{4}(\cos\theta - 1)\right]\frac{e^{-jkr}}{r}\ , \qquad 0 \le \theta \le \pi.$$

Obtain the HPBW in a "vertical" plane. (a) Use Matlab to obtain the normalized power pattern and determine and indicate on the plot the half-power points. (b) Determine the time-average power density in the x-y plane. (c) Derive the radiation intensity and normalized radiation intensity (the answer you get should be obvious).

2. (a) Derive the expression for the $\vec{H}$-field far-field for a small loop carrying a current I_0 as given in equation (2.54) of the class notes. (b) Use (a) to derive the far-field $\vec{E}$-field as given in equation (2.55) of the notes. (c) Detemine the radiation intensity and the directivity for the loop. (d) Consider a particular loop which is 2.0 cm in diameter and made of 12-guage aluminum wire. Determine the efficiency and EIRP of the loop when it is operating at 13.56 MHz and carrying a current of 10 mA. Be sure to verify that the loop is a good conductor at the given frequency before determining its efficiency.

3. For a particular ground-mapping radar application, the desirable radiation intensity of the radar antenna for $0 \le \phi \le 2\pi$ is approximated as

$$U_n(\theta) = \begin{cases} 1\ ; & 0^\circ \le \theta < 20^\circ \\ 0.342\csc(\theta)\ ; & 20^\circ \le \theta < 60^\circ \\ 0\ ; & 60^\circ \le \theta \le 180^\circ \end{cases}.$$

Determine the maximum directivity in dB.

4. The radiation intensity of a certain antenna is given by $U = \cos^4\theta\sin^2\phi$ for $0 \le \theta \le \pi/2$ and $0 \le \phi \le 2\pi$. It is zero elsewhere. (a) Determine the directivity and its maximum value in dB. (b) Find the elevation plane half-power beamwidth. (c) Also, sketch U for the y-z plane on a polar plot as well as on a rectangular grid where in the latter case U is the ordinate and θ is the abscissa.