

THE UNIVERSITY OF TEXAS AT DALLAS



Electromagnetic Engineering I

EE 4301

Spring 2008 Assignment 14

Due Date and Time:

At the beginning of class, April 28, 2008

Reading:

N. N. Rao, *Elements of Engineering Electromagnetics*, **Sixth Edition**, Chapter 10

Problems:

Please write your answers to the following problems on engineering paper. No credit will be given for work handed in on other types of paper.

1. Sketch the array pattern for an array of 2 identical dipole antennas, both parallel to the Z axis. Also sketch the antennas. The antennas are positioned along the X axis, with a separation of $\lambda/2$, and are driven in phase ($\alpha = 0$). Your engineering paper is in the XY plane. What is the directivity of this array?
2. Repeat the preceding problem for 4 antennas that are equally spaced along the X axis, at intervals of $\lambda/2$.
3. Evaluate the effective area of a half-wavelength dipole antenna operating at the wavelength $\lambda = 2$ m, and compare your result to the effective area of a Hertzian dipole antenna with $h = .01\lambda$ operating at the same wavelength.
4. Show that the solid angle defined by an arbitrary surface area, as measured from a point P , is equal to the area on a sphere of radius 1 that is defined by the intersection of lines from P to the boundary curve that defines the edge of the area.
5. In spherical polar coordinates, the equation $\theta = \theta_0 = \text{constant}$ defines a "parallel" of constant latitude. For every angle $\theta_0 < \pi/2$, there is a polar cap consisting of the surface area between the north pole, $\theta = 0$, and the meridian defined by θ_0 . Show that the solid angle subtended by such a polar cap is

$$\Omega = 4\pi \sin^2(\theta_0/2).$$

This can serve as a (fairly crude) model of the main lobe of an antenna, if one takes $2\theta_0$ as the beamwidth.

6. Show that, if all of the power radiated by an antenna is concentrated in the main lobe in Problem 4, then the directivity is approximately equal to

$$D = \frac{1}{\sin^2(\theta_0/2)}.$$