EE 252
Len Tyler **April 15, 2005**

PROBLEM SET #3

Due 4:30 pm Friday, April 22, 2005

Reading assignment: *Stutzman & Thiele* 2.1–2.3, 2.5, 5.1
(Optional) *Kraus* 5.1–5.3, 5.5–5.8

Problems:

1. (10 point)
   (a) A hand-held receiver communicates with another receiver at 430 MHz, transmitting 1 W of power with an antenna gain of 0 dB. If the antennas on both receivers are identical, how far away from the transmitting receiver can the second receiver be and still maintain 1 μV of signal (peak) across 50 ohms?
   (b) How far away can the second receiver be if it's the Big Dish (46 m diameter circular aperture, aperture efficiency of 55%)?
2. (5 point) *Stutzman & Thiele*, Problem 5.1-4. Sketch the power pattern in azimuth and elevation, assuming the z-axis points upward.
3. (15 point) *Stutzman & Thiele*, Problem 5.1-8. Using Table 5-2 in *Stutzman & Thiele*, adjust the antenna length so that the input impedance is purely real.
   (a) Estimate the radiation resistance of the dipole using Table 5-1 in *Stutzman & Thiele*.
   (b) What is the SWR at the antenna feedpoint if the feedline is a 50Ω balanced line?
   (c) What percentage of the transmitter power will be reflected from the antenna at the feedpoint?
   (d) How much will this reduce the antenna gain?
4. (15 point) *Stutzman & Thiele*, Problem 5.1-12. In addition, for the same range of lengths as in 5.1-12(b), $L = 0$ to 3λ, plot the radiation resistance of the dipole using as a reference,
   (a) the current distribution maximum I_m, and
   (b) the input terminal current I_{in}.
5. (10 point) The goal of this exercise is to plot the field patterns of an ideal dipole.
   (a) Write down the definition of a field line.

(b) From the above definition, describe an algorithm which will (given a starting point) follow the field line through that point.

(c) Consider the electric fields associated with an ideal (infinitesimal) dipole aligned with the z-axis. Implement the algorithm described in (b) in Matlab and plot the electric field lines associated with this dipole at times (i) $t = 0$ and (ii) $t = T/4$, where T is the period. The plotted region should go from near the dipole out to about 3λ.

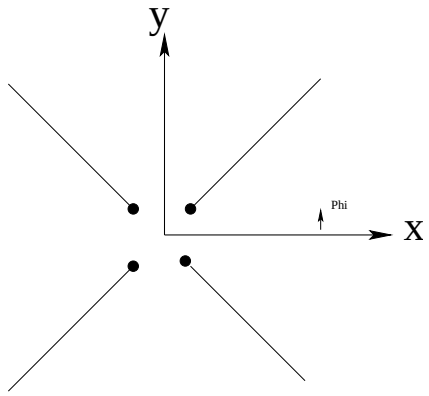
Note: Save your work on Matlab in an M-file, as you may need to expand on it in future homework assignments.

6. (15 point) A pair of $\lambda/2$ resonant dipoles are arranged at 45 degree with respect to the horizontal or vertical axis in x-y plane. A voltage V_1 is applied at the feed of the dipole 1 and a different voltage V_2 is applied at the feed of dipole 2. Our goal is to determine the relative amplitude of the applied voltages so that the dipoles can be used for finding the direction of incoming radar signals.

   (a) Give the normalized E_ϕ radiated field in the x-y plane. Your expression should be in terms of the angle ϕ and will contain an unknown constant.

   (b) Determine the unknown constant (a) so that the field vanishes at the angle ϕ_0. Give the value for this constant when $\phi = 0$ and $\phi = 30$.

   (c) Explain how you would operate this antenna to find the direction of an incoming signal.



Note: Sketch $\equiv$ hand drawing
Plot $\equiv$ Matlab plot