**ECE 123** **Assignment 4** **Spring 2009**

This problem set is due Tuesday May 12 at 11:00 AM.

There is a Matlab script on the web-site to help with part 2 below.

**1. Phased Array Design:** Design a linear phased array of isotropic radiators that has a gain of 13 dBi at broadside, and can be steered through the entire visible region without increasing any sidelobe above the level of the first sidelobe. Write a Matlab script to find the gain $G(\theta)$ for any beam steering angle, given N and $d/\lambda$.

**(a)** Find N and $d/\lambda$, to satisfy these specs.

**(b)** Prove that your design has met the specs by plotting $G(\theta)$ for $0 < \theta < 180^0$ with beam steering angles (off broadside) of 0, 45, 75, and $90^0$. Overplot all the gain patterns on the same axes for comparison.

**(c)** Make a 3-D plot of the pattern at these beam steering angles using the scheme you used in Assignment 1. Rotate the plot so the change in pattern is easy to see. You will need to use "axis equal" to prevent matlab from autoscaling each axis separately and distorting the pattern.

**2. The effect of element pattern:** The elements cannot really be isotropic radiators. Assume that they are actually dipoles oriented perpendicular to the array axis, i.e. in the x direction. The array pattern will no longer be symmetric about the z-axis. You can modify the 3-D plotting script, which scans the sphere in $(\theta,\phi)$ to normalize the gain. To get the integral simply do sum(G(θ,ϕ).*sin(θ))*dθ*dϕ, and normalize the gain until that integral = $4\pi$. You can plot gain in dB if you add a constant and make sure that the gain + constant doesn't go negative. Remember to use "axis equal".

**(a)** Make a 3-D plot of the pattern as before showing the broadside beam and the beam steered $45^0$ off broadside. Rotate it so the effect of the element pattern is clear.

**(b)** Find the peak gain of the array steered to broadside (it will increase over the array of isotropic radiators because the element pattern narrows the beam).

**(c)** Find the peak gain of the array steered to endfire (it will not increase because the element pattern has no effect on the endfire pattern).

**3. The Hansen-Woodyard Condition:** If the array is steered past endfire the gain can actually increase a useful amount. Try it using Matlab and find the maximum gain.