

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Electrical Engineering and Computer Science

Problem Set No. 10
Fall Term 2006

6.630 Electromagnetics

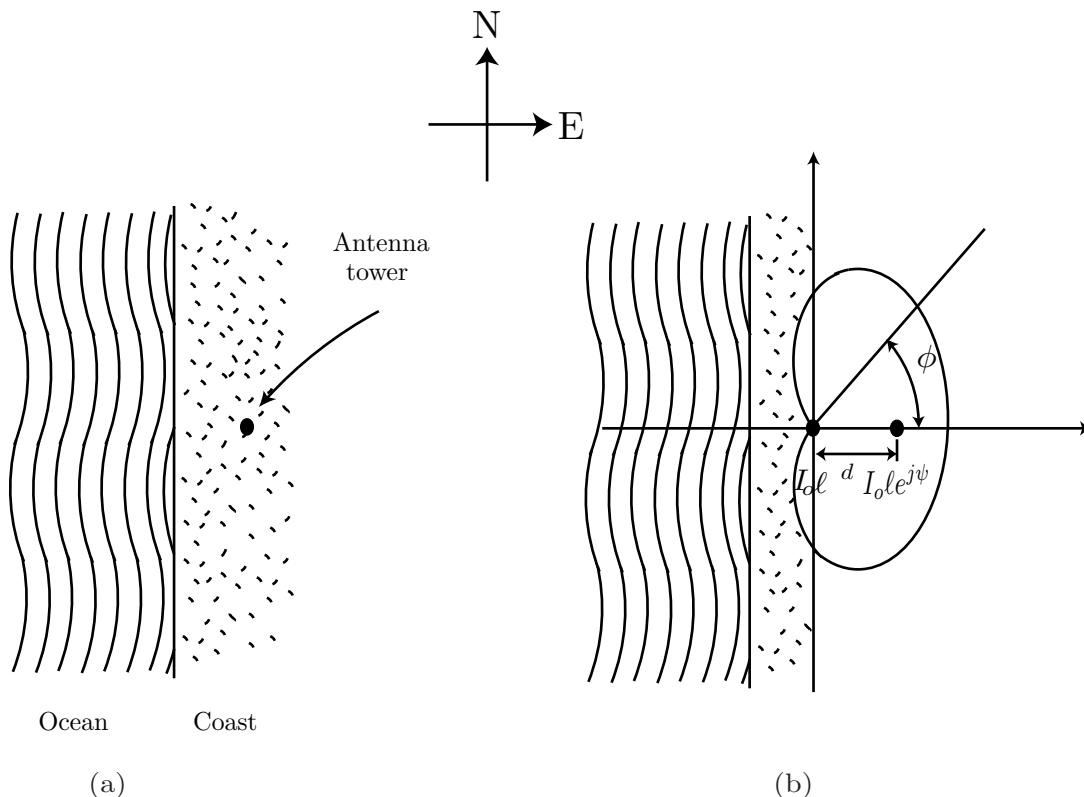
Issued: Week 11
Due: Week 12

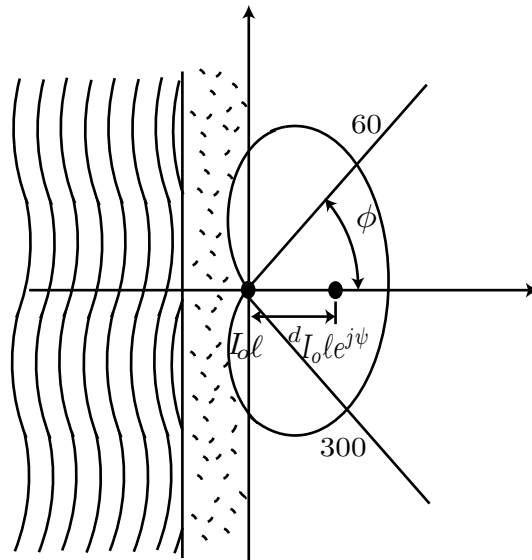
Quiz 2: Dec 5, Tuesday.

Problem P10.1

A radio station is located on the coast, west of a city, as shown in Figure1(a). The transmitting antenna tower may be modeled as a Hertzian dipole antenna of dipole moment $I_o \ell$.

- (a) The radio station was able to erect another antenna tower. Relative to the first antenna tower, at what distance d should the second tower be placed and with what phase difference ψ ($-\pi < \psi \leq \pi$) should it be fed, so that there is a null in the radiation pattern in the direction of the ocean and no "dead" spots in the reception areas as shown in Figure1(b).
- (b) As shown in Figure1(c), consider another radio station which must serve two cities, sending most of the power over the land area and little power in the direction of the ocean (a null at $\phi = 180^\circ$), with maximum radiation in the direction of the two cities ($\phi = \pm 60^\circ$), and no nulls, or "dead" spots, in the reception area ($|\phi| \leq 90^\circ$). Determine the spacing d of these two antenna towers and the relative phase difference ψ ($-\pi < \psi \leq \pi$) to satisfy these requirement.





(c)
Figure 1

Problem P10.2

- Construct a binomial array with 3 in-phase Herizian dipoles pointing in the \hat{z} direction. Specify the relative amplitude of excitation for each element.
- Sketch the radiation pattern on the xy -plane and identify the null positions.
- A 2D array is created using the binomial array from part(a). The array is shown in Figure 2. Sketch the group pattern and the total radiation pattern for an in-phase array and identify the null positions.

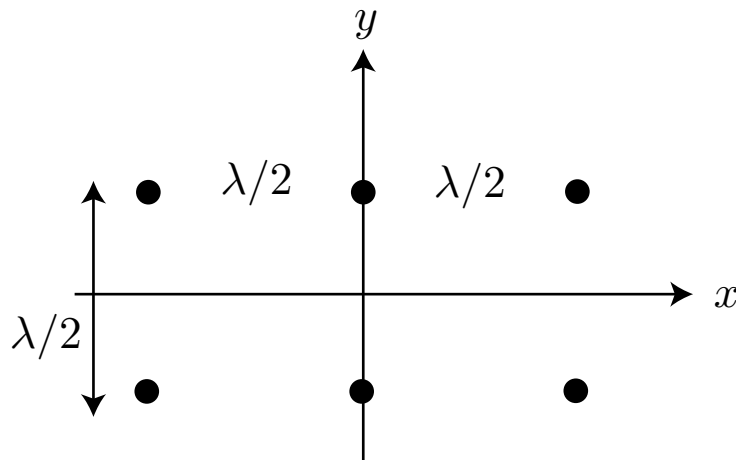


Figure 2

Problem P10.3

An electric dipole antenna (e.g. cellular phone) with dipole moment $I l$ is oriented in the \hat{z} direction and is placed at the corner of a wall as shown in Figure 3a. The ground and the wall are considered to be perfectly conducting and their areas are assumed to be infinite.

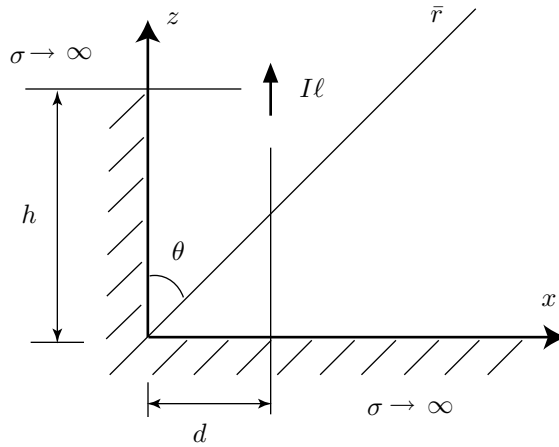


Figure 3a

- Find the three images of the dipole antenna. Indicate the coordinates and the orientations of the images.
- Explain why the radiation field from the dipole antenna is zero everywhere if $d = 0$.
- Let $h = 0$. The radiation pattern of the electric field $|E|$ is shown in Figure 3b, where the maximum value $|E|_{max}$ appears at $\theta = 90^\circ$, and the nulls appear at $\theta = 0$ and θ_o .

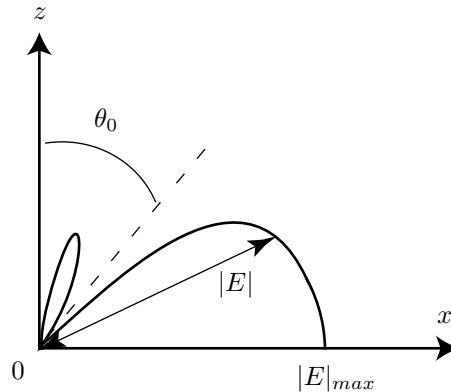


Figure 3b

- What is the value of θ_o ?
 - Find the distance d in terms of wavelength λ .
- Let $h = 0$. Find the value(s) of d in terms of wavelength λ such that the radiated power along the \hat{x} axis is zero.
 - What is the field in region $z < 0$, and what is the field in region $x < 0$?