

MASSACHUSETTS INSTITUTE OF TECHNOLOGY  
Department of Electrical Engineering and Computer Science

Problem Set No. 8  
Spring Term 2008

6.632 Electromagnetic Wave Theory

Issued: 04/17/2008 R  
Due: 04/24/2008 R

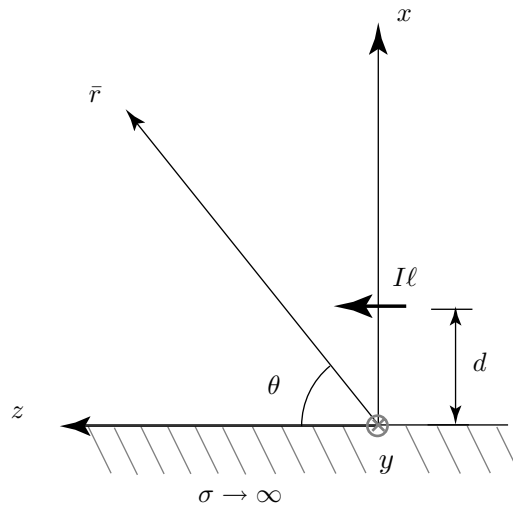
-----  
**Reading assignment:** Section 5.1 ; J. A. Kong, “*Electromagnetic Wave Theory*,” EMW Publishing, 2005.

**Note:** Quiz 2 will be held on May 8, 3-5pm at 26-314.

**Problem P8.1**

A Hertzian dipole with dipole moment  $I\ell$  is placed horizontal at a distance  $x = d$  from a perfect electric conductor (PEC) on the  $y-z$  plane as shown in the figure.

- (a) What is the electric  $\vec{E}(\vec{r})$  field in the far-field region?
- (b) What is the minimum distance  $d$  in terms of the wavelength  $\lambda = 2\pi/k$  that the dipole can be placed from the PEC such that the radiated power is maximized along the  $x$ -axis?
- (c) What is the time-average radiated power along the  $z$ -axis?
- (d) What is the total time-average radiated power?



Horizontal Electric Dipole

**Problem P8.2**

By the image theorem, a vertical monopole antenna on a conducting plane is equivalent to a dipole with the conductor removed. In radio broadcasting stations, the Earth is used as the conducting plane. Calculate the power and the gain for a monopole on a conducting plane.

**Problem P8.3**

In this problem, we consider several equivalent situations for a plane wave propagation in the  $\hat{z}$  direction. Let the electric field be  $\hat{x}$  directed.

$$\overline{E} = \hat{x}E_0e^{ikz}, \quad \overline{H} = \hat{y}\frac{1}{\eta}E_0e^{ikz}$$

and the region of interest be  $z > 0$ .

- (a) Put an electric current sheet with  $\overline{J}_s = A\hat{x}$ . What is the value of  $A$  so that the same field is preserved in the region of interest?
- (b) Put a magnetic current sheet with  $\overline{M}_s = B\hat{y}$ . What is the value of  $B$  so that the same field is preserved in the region of interest?
- (c) Replace the region  $z < 0$  with a perfect conductor. Place in front of the conductor an electric sheet with  $\overline{J}_s = C\hat{x}$  and a magnetic current sheet with  $\overline{M}_s = D\hat{y}$ . What is the value of  $C$  and  $D$  so that the same field is preserved in the region of interest?