EE 452 ANTENNAS AND PROPAGATION  
Spring 2004  

HW 4  

Note: Work independently. According to Bilkent University policy, the act of cheating is punishable by up to two semesters of suspension from the school.

1) Current distribution on a wire antenna having length $l$ and lying on the y-axis is given approximately as:  

$$  
I_y(x' = 0, y', z' = 0) = \begin{cases} 
\dot{y}I_y \sin \left( k \frac{l}{2} - y' \right), & 0 \leq y' \leq l/2 \\
\dot{y}I_y \sin \left( k \frac{l}{2} + y' \right), & -l/2 \leq y' \leq 0 
\end{cases} 
$$

when it is fed by a matched source located at the origin.

a) Write the electric field and magnetic field in the far zone in terms of $\theta$ and $\phi$. You may directly use the expressions for the wire antenna lying on the z-axis and transform them accordingly.

b) Find the minimum distance for the far-field approximation to be valid within $\pi/8$ phase error.

c) Find the expression for the radiation intensity.

d) For $l = \lambda/2$, $\lambda$, and $2\lambda$, plot the normalized radiation intensity on the y-z cut. (It is better to use polar plots.) What happens to radiation as the length of the wire increases?

2) Assume that the wire antenna in the previous question has a length $1/10$ of the wavelength.

a) Plot the normalized radiation intensity on the y-z cut using the expression found in 1.c.

b) Assume that new approximation is used for the current density as

$$  
I_y(x' = 0, y', z' = 0) = \begin{cases} 
\dot{y}I_y \left( 1 - \frac{2}{l} y' \right), & 0 \leq y' \leq l/2 \\
\dot{y}I_y \left( 1 + \frac{2}{l} y' \right), & -l/2 \leq y' \leq 0 
\end{cases} 
$$

Find the expression for the radiation intensity and plot it again on the y-z cut (normalize) to compare with the previous approximation.

3) An infinitesimal magnetic dipole of current $I_m$ and length $l$ is symmetrically placed about the origin along the z-axis.

a) Find the electric field and the magnetic field in the far zone.

b) Find the radiation intensity and compare it with the radiation intensity of the infinitesimal electric dipole located similarly.