Dipole Antennas

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1 Small Dipole

Problem 1. Let the current distribution of a small dipole ($\lambda/50 < l \leq \lambda/10$) be

$$\mathbf{I} = \begin{pmatrix} I_x \\ I_y \\ I_z \end{pmatrix}, \tag{1.1}$$

$$I_x = 0, \quad I_y = 0, \quad I_z = \Delta\left(\frac{2z}{l}\right) \tag{1.2}$$

where

$$\Delta(t) = \begin{cases} 1 - |t| & |t| < 1 \\ 0 & \text{otherwise} \end{cases} \tag{1.3}$$

and

$$\mathbf{A} = \begin{pmatrix} A_x \\ A_y \\ A_z \end{pmatrix} = \begin{pmatrix} \int \frac{I_x e^{-jkR}}{R} dx \\ \int \frac{I_y e^{-jkR}}{R} dy \\ \int \frac{I_z e^{-jkR}}{R} dz \end{pmatrix} \tag{1.4}$$

Find $\begin{pmatrix} A_r \\ A_\theta \\ A_\phi \end{pmatrix}$. *Hint: Use* $R \approx r$.

Problem 2. Find the electrical and magnetic components **E** and **H**

Problem 3. For Far-field region ($rk >> 1$), show that

$$\mathbf{E} \approx \begin{pmatrix} 0 \\ j\eta \frac{kI_0 l \sin\theta}{8\pi r} e^{-jkr} \\ 0 \end{pmatrix}, \quad \mathbf{H} \approx \begin{pmatrix} 0 \\ 0 \\ j\frac{kI_0 l \sin\theta}{8\pi r} e^{-jkr} \end{pmatrix} \tag{3.1}$$

Hint: Use the far-field approximations, $R \approx r - z\cos\theta$ *for phase variations and* $R \approx r$ *for amplitude variations.*

Problem 4. Repeat problems 8 to 12.

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2 Finite Length Dipole

Problem 5. Repeat the analysis in the previous section for

$$\mathbf{I} = \begin{pmatrix} 0 \\ 0 \\ I_0 \sin\left[\frac{kl}{2}\Delta\left(\frac{2z}{l}\right)\right] \end{pmatrix} \tag{5.1}$$