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EED4106 Antenna and Propagation

Exp 2 - Calculation of Dipole Antenna Parametrers with MATLAB

Std Name :	Std ID :

Objective(s):

In this experiment, it is required to calculate the antenna parameters of a finite-length dipole using MATLAB. The dipole antenna is assumed to have a very small diameter which is ideally zero.

1.Current Distribution

The current distribution of a very thin dipole which is center-fed and the current vanishes at the end-points can be given as

$$I = \begin{cases} \hat{a}_z I_0 \sin\left[k\left(\frac{l}{2} - z'\right)\right] & 0 \leqslant z' \leqslant l/2 \\ \hat{a}_z I_0 \sin\left[k\left(\frac{l}{2} - z'\right)\right] & -l/2 \leqslant z' \leqslant 0 \end{cases}$$

2. Radiation Intensity

The radiation intensity of an antenna is given as

$$U = r^2 W_{av} \tag{1}$$

For finite-dipole antenna U is equal to

$$U = \eta \frac{|I_0|^2}{8\pi^2} \left[\frac{cos\left(\frac{kl}{2}\cos\theta\right) - \cos\left(\frac{kl}{2}\right)}{\sin\theta}\right]^2 \tag{2}$$

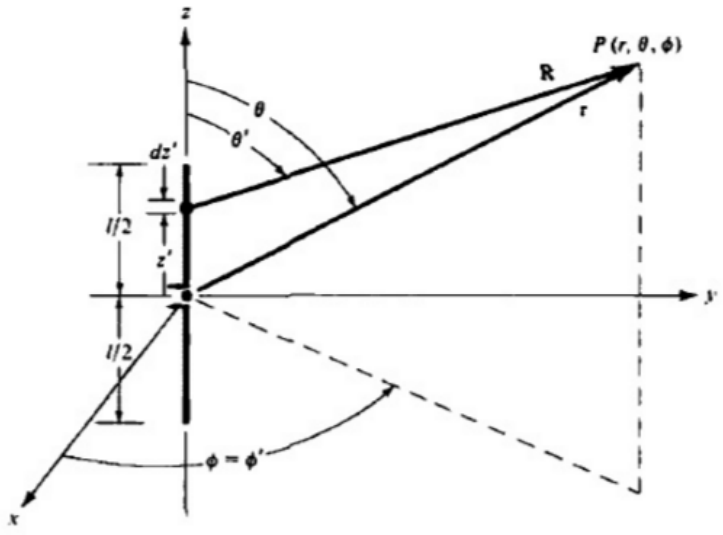

Figure 1: Finite-dipole geometry (Balanis, Antenna Theory 3rd edition)

3. Radiated Power

The total radiated power from an antenna is calculated by integrating the average Poynting vector over a sphere of radius r.

$$P_{rad} = \int_0^{2\pi} \int_0^{\pi} W_{av} r^2 \sin\theta d\theta d\phi \tag{3}$$

For finite-length dipole the total radiated power is given a

$$P_{rad} = \eta \frac{|I_0|^2}{4\pi} \int_0^{\pi} \frac{\left[cos\left(\frac{kl}{2}\cos\theta\right) - \cos\left(\frac{kl}{2}\right)\right]^2}{\sin\theta} d\theta \tag{4}$$

4. Radiation Resistance

The radiation resistance of an antenna is

$$R_r = \frac{2P_{rad}}{|I_0|^2} \tag{5}$$

5. Directivity

Directivity is a parameter that defines the directional properties of an antenna and it is given as

$$D_0 = 4\pi \frac{F(\theta,\phi)|_{max}}{\int_0^{2\pi}\int_0^{\pi} F(\theta,\phi)\sin\theta d\theta d\phi} \tag{6}$$

where

$$\begin{aligned} U &= B_0 F(\theta,\phi) \\ B_0 &= \eta \frac{|I_0|^2}{8\pi^2} \end{aligned} \tag{7}$$

Directivity of a finite-length dipole antenna is

$$D_0 = \frac{2F(\theta)|_{max}}{\int_0^{\pi} F(\theta)\sin\theta d\theta} \tag{8}$$

6. Input Resistance

The input resistance is the ratio of the voltage to the current at a pair of terminals. For a lossless antenna it is also equal to radiation resistance.

$$R_{in} = \frac{R_r}{\sin^2\left(\frac{kl}{2}\right)} \tag{9}$$