

**9.17** For a dipole antenna of length  $l = 3\lambda/2$ ,

- (a) Determine the directions of maximum radiation.
- (b) Obtain an expression for  $S_{\max}$
- (c) Generate a plot of the normalized radiation pattern  $F(\theta)$ .
- (d) Compare your pattern with that shown in Fig. 9-17(c).

**Solution:**

(a) From Eq. (9.56),  $S(\theta)$  for an arbitrary length dipole is given by

$$S(\theta) = \frac{15I_0^2}{\pi R^2} \left[ \frac{\cos\left(\frac{\pi l}{\lambda} \cos \theta\right) - \cos\left(\frac{\pi l}{\lambda}\right)}{\sin \theta} \right]^2.$$

For  $l = 3\lambda/2$ ,  $S(\theta)$  becomes

$$S(\theta) = \frac{15I_0^2}{\pi R^2} \left[ \frac{\cos\left(\frac{3\pi}{2} \cos \theta\right)}{\sin \theta} \right]^2.$$

Solving for the directions of maximum radiation numerically yields two maximum directions of radiation given by

$$\theta_{\max_1} = 42.6^\circ, \quad \theta_{\max_2} = 137.4^\circ.$$

(b) From the numerical results, it was found that  $S(\theta) = 15I_0^2/(\pi R^2)(1.96)$  at  $\theta_{\max}$ . Thus,

$$S_{\max} = \frac{15I_0^2}{\pi R^2} (1.96).$$

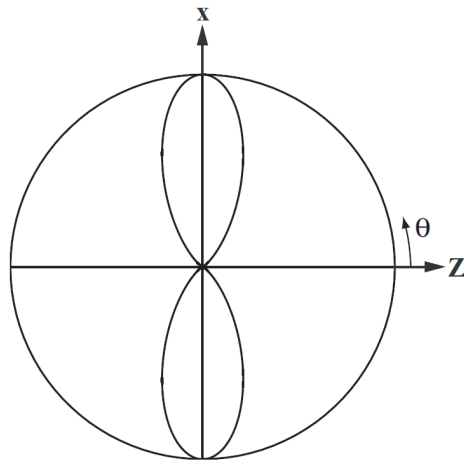
(c) The normalized radiation pattern is given by Eq. (9.13) as

$$F(\theta) = \frac{S(\theta)}{S_{\max}}.$$

Using the expression for  $S(\theta)$  from part (a) with the value of  $S_{\max}$  found in part (b),

$$F(\theta) = \frac{1}{1.96} \left[ \frac{\cos\left(\frac{3\pi}{2} \cos \theta\right)}{\sin \theta} \right]^2.$$

The normalized radiation pattern is shown in Fig. P9.17, which is identical to that shown in Fig. 9.17(c).



**Figure P9.17:** Radiation pattern of dipole of length  $3\lambda/2$ .

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