9.18 For a dipole antenna of length $l = \lambda/4$,

(a) Determine the directions of maximum radiation.

(b) Obtain an expression for $S_{\max}$.

(c) Generate a plot of the normalized radiation pattern $F(\theta)$.

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 $l = \lambda/4$, $S(\theta)$ becomes

$$S(\theta) = \frac{15I_0^2}{\pi R^2}\left[\frac{\cos\left(\frac{\pi}{4}\cos\theta\right) - 0.707}{\sin\theta}\right]^2.$$

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

$$\theta_{\max_1} = 90^\circ, \qquad \theta_{\max_2} = 270^\circ.$$

(b) From the numerical results, it was found that $S(\theta) = 15I_0^2/(\pi R^2)(0.0858)$ at $\theta_{\max}$. Thus,

$$S_{\max} = \frac{15I_0^2}{\pi R^2}(0.0858).$$

(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),

$$F(\theta) = \frac{1}{0.0858}\left[\frac{\cos\left(\frac{\pi}{4}\cos\theta\right) - 0.707}{\sin\theta}\right]^2.$$

The normalized radiation pattern is shown in Fig. P9.18.

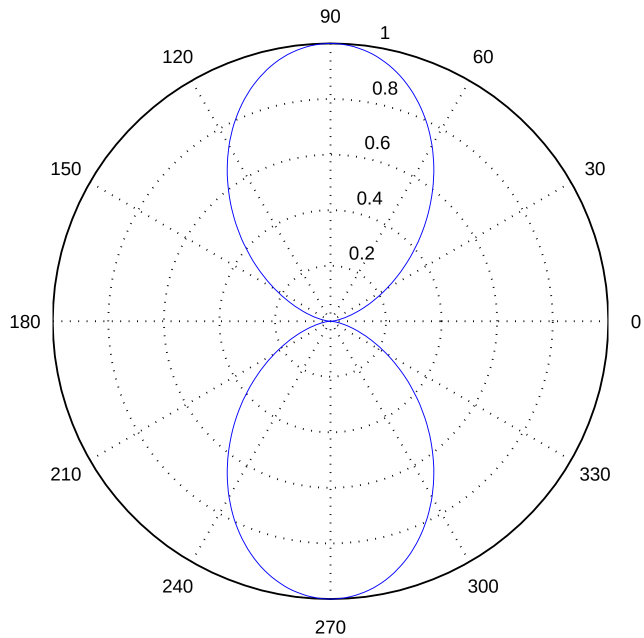

Figure P9.18: Radiation pattern of dipole of length $\lambda/4$.