9.20 Repeat parts (a)–(c) of Problem 9.17 for a dipole of length $l = \lambda$.

Solution: For $l = \lambda$, Eq. (9.56) becomes

$$S(\theta) = \frac{15I_0^2}{\pi R^2}\left[\frac{\cos(\pi\cos\theta) - \cos(\pi)}{\sin\theta}\right]^2 = \frac{15I_0^2}{\pi R^2}\left[\frac{\cos(\pi\cos\theta) + 1}{\sin\theta}\right]^2.$$

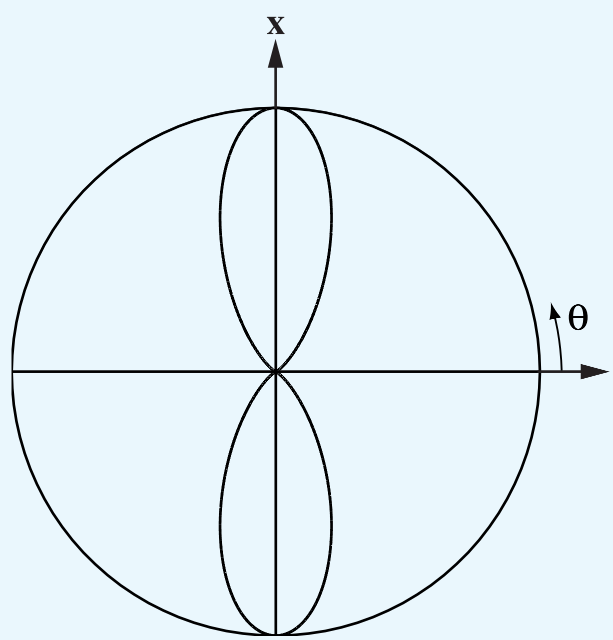

Figure P9.20 Radiation pattern of dipole of length $l = \lambda$.

Solving for the directions of maximum radiation numerically yields

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

(b) From the numerical results, it was found that $S(\theta) = 15I_0^2/(\pi R^2)(4)$ at $\theta_{\max}$. Thus,

$$S_{\max} = \frac{60I_0^2}{\pi R^2}.$$

(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),

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

The normalized radiation pattern is shown in Fig. P9.20.