

9.52 A linear array arranged along the z axis consists of 12 equally spaced elements with $d = \lambda/2$. Choose an appropriate incremental phase delay δ so as to steer the main beam to a direction 30° above the broadside direction. Provide an expression for the array factor of the steered antenna and plot the pattern. From the pattern, estimate the beamwidth.

Solution: Since broadside corresponds to $\theta = 90^\circ$, 30° above broadside is $\theta_0 = 60^\circ$. From Eq. (9.119),

$$\delta = kd \cos \theta_0 = \frac{2\pi \lambda}{\lambda} \frac{1}{2} \cos 60^\circ = 1.57 \text{ (rad)} = 90^\circ.$$

Combining Eq. (9.121) with (9.122) gives

$$F_{\text{an}}(\theta) = \frac{\sin^2\left(\frac{1}{2}12kd(\cos \theta - \cos \theta_0)\right)}{144 \sin^2\left(\frac{1}{2}kd(\cos \theta - \cos \theta_0)\right)} = \frac{\sin^2(6\pi(\cos \theta - 0.5))}{144 \sin^2\left(\frac{\pi}{2}(\cos \theta - 0.5)\right)}.$$

The pattern is shown in Fig. P9.52. The beamwidth is $\approx 10^\circ$.

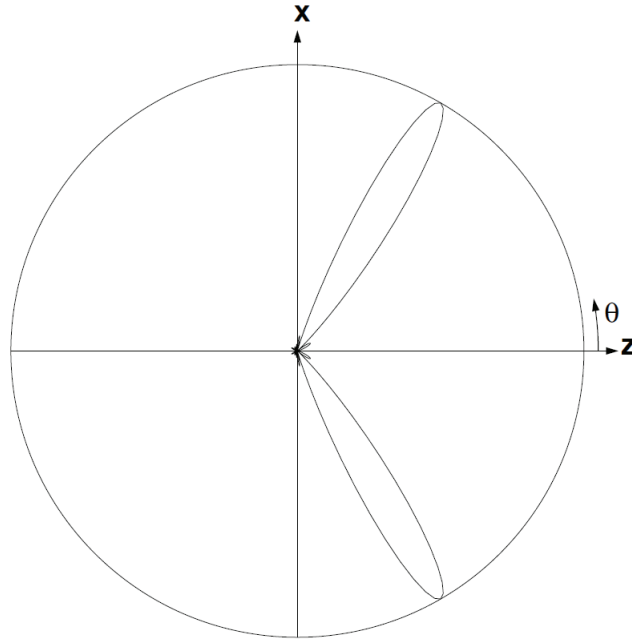


Figure P9.52 Array pattern of Problem 9.52.