9.47 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 $\theta = 90°$, 30° above broadside is $\theta_0 = 60°$. From Eq. (9.125),

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

Combining Eq. (9.126) with (9.127) gives

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

The pattern is shown in Fig. P9.47. The beamwidth is $\approx 10°$.

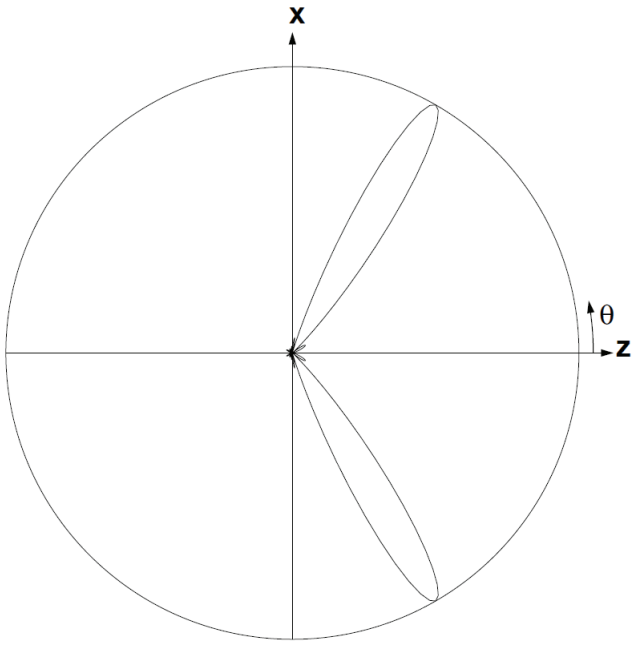

Figure P9.47 Array pattern of Problem 9.47.