

**1.12** Given two waves characterized by

$$y_1(t) = 3 \cos \omega t$$

$$y_2(t) = 3 \sin(\omega t + 60^\circ),$$

does  $y_2(t)$  lead or lag  $y_1(t)$  and by what phase angle?

**Solution:** We need to express  $y_2(t)$  in terms of a cosine function:

$$\begin{aligned} y_2(t) &= 3 \sin(\omega t + 60^\circ) \\ &= 3 \cos\left(\frac{\pi}{2} - \omega t - 60^\circ\right) = 3 \cos(30^\circ - \omega t) = 3 \cos(\omega t - 30^\circ). \end{aligned}$$

Hence,  $y_2(t)$  lags  $y_1(t)$  by  $30^\circ$ .

---