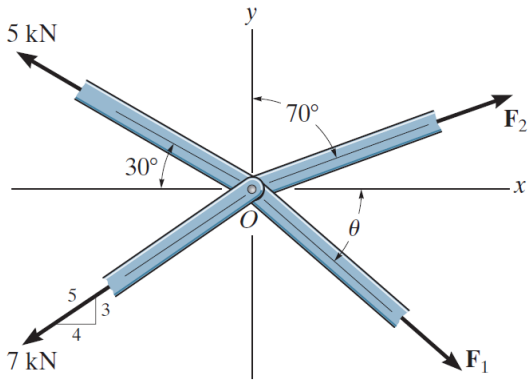
Problem 3-2

The members of a truss are pin connected at joint O. Determine the magnitude of $\mathbf{F}_1$ and its angle θ for equilibrium. Set $F_2 = 6$ kN.



Probs. 3–1/2

Solution

Begin by finding α, the angle that the 7 kN force makes with the x-axis.

$$\tan\alpha = \frac{3}{4} \quad \rightarrow \quad \alpha = \tan^{-1}\left(\frac{3}{4}\right) \approx 36.9^\circ$$

In order for the truss to be in equilibrium, the sum of the forces in each direction must be zero.

$$\sum F_x = 0: \qquad 6000\sin 70^\circ + F_1\cos\theta - 5000\cos 30^\circ - 7000\cos\alpha = 0$$

$$\sum F_y = 0: \qquad 6000\cos 70^\circ - F_1\sin\theta + 5000\sin 30^\circ - 7000\sin\alpha = 0$$

Solve for the terms with F_1.

$$F_1\cos\theta = 5000\cos 30^\circ + 7000\cos\alpha - 6000\sin 70^\circ \tag{1}$$

$$F_1\sin\theta = 6000\cos 70^\circ + 5000\sin 30^\circ - 7000\sin\alpha \tag{2}$$

Square both sides of each equation and then add them respectively to eliminate θ.

$$F_1^2(\cos^2\theta + \sin^2\theta) = (5000\cos 30^\circ + 7000\cos\alpha - 6000\sin 70^\circ)^2 + (6000\cos 70^\circ + 5000\sin 30^\circ - 7000\sin\alpha)^2$$

$$F_1^2(1) = (5000\cos 30^\circ + 7000\cos\alpha - 6000\sin 70^\circ)^2 + (6000\cos 70^\circ + 5000\sin 30^\circ - 7000\sin\alpha)^2$$

$$F_1 = \sqrt{(5000\cos 30^\circ + 7000\cos\alpha - 6000\sin 70^\circ)^2 + (6000\cos 70^\circ + 5000\sin 30^\circ - 7000\sin\alpha)^2}$$

$$\approx 4.31 \times 10^3 \text{ N}$$

Plug this value for F_1 back into equation (1) and solve for θ.

$$\cos\theta = \frac{5000\cos 30^\circ + 7000\cos\alpha - 6000\sin 70^\circ}{F_1} \quad \rightarrow \quad \theta \approx 4.69^\circ$$