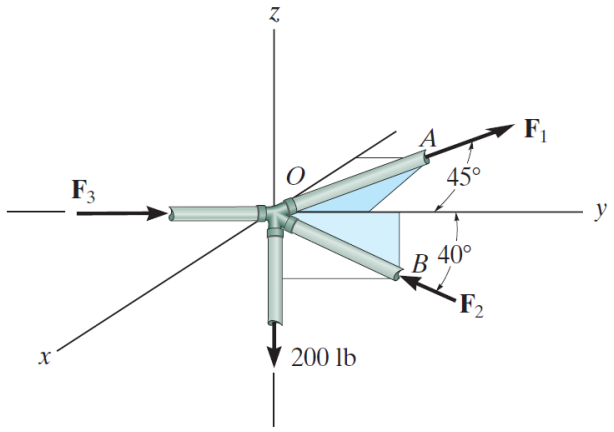
Problem R3-5

The joint of a space frame is subjected to four member forces. Member OA lies in the x–y plane and member OB lies in the y–z plane. Determine the force acting in each of the members required for equilibrium of the joint.



Prob. R3–5

Solution

Begin by writing each of the force vectors in component form.

$$\mathbf{F}_1 = F_1 \langle -\sin 45°, \cos 45°, 0 \rangle$$

$$\mathbf{F}_2 = F_2 \langle 0, -\cos 40°, \sin 40° \rangle$$

$$\mathbf{F}_3 = F_3 \langle 0, 1, 0 \rangle$$

$$\mathbf{F} = 200 \langle 0, 0, -1 \rangle \text{ lb}$$

In order for the joint to be in equilibrium, the sum of the forces must be zero.

$$\mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}_3 + \mathbf{F} = \mathbf{0}$$

$$F_1 \langle -\sin 45°, \cos 45°, 0 \rangle + F_2 \langle 0, -\cos 40°, \sin 40° \rangle + F_3 \langle 0, 1, 0 \rangle + 200 \langle 0, 0, -1 \rangle \text{ lb} = \mathbf{0}$$

$$\langle -F_1 \sin 45°,\ F_1 \cos 45° - F_2 \cos 40° + F_3,\ F_2 \sin 40° - 200 \rangle = \langle 0, 0, 0 \rangle$$

Match the components to get a system of equations and then solve it.

$$\left.\begin{aligned} -F_1 \sin 45° &= 0 \\ F_1 \cos 45° - F_2 \cos 40° + F_3 &= 0 \\ F_2 \sin 40° - 200 &= 0 \end{aligned}\right\} \quad \Rightarrow \quad \left\{\begin{aligned} F_1 &= 0 \text{ lb} \\ F_2 &\approx 311 \text{ lb} \\ F_3 &\approx 238 \text{ lb} \end{aligned}\right.$$