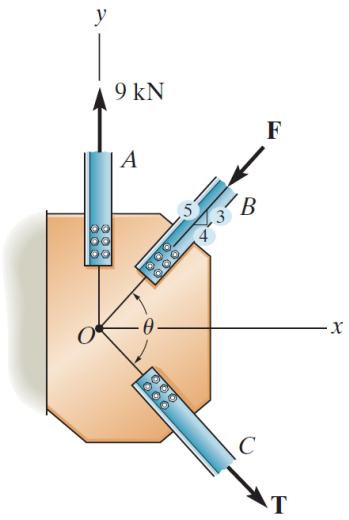
Problem 3-5

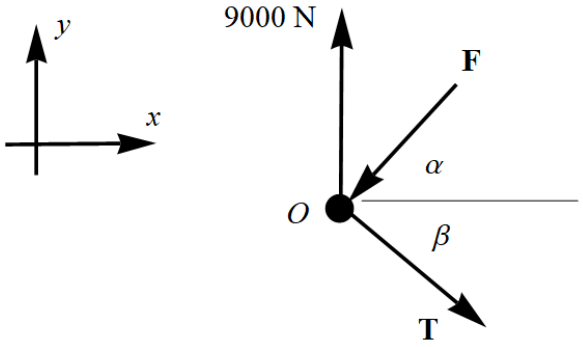
The members of a truss are connected to the gusset plate. If the forces are concurrent at point O, determine the magnitudes of **F** and **T** for equilibrium. Take $\theta = 90°$.



Probs. 3–5/6

Solution

Draw a free-body diagram for the plate.



Begin by finding α, the angle that **F** makes with the x-axis.

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

The angle β that **T** makes with the x-axis can now be found.

$$\beta = \theta - \alpha \approx 53.1°$$

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

$$\sum F_x = 0: \qquad T\cos\beta - F\cos\alpha = 0 \tag{1}$$

$$\sum F_y = 0: \qquad 9000 - F\sin\alpha - T\sin\beta = 0 \tag{2}$$

Solve equation (1) for F

$$F = \frac{\cos\beta}{\cos\alpha}T$$

and then substitute it into equation (2) to get T.

$$9000 - \left(\frac{\cos\beta}{\cos\alpha}T\right)\sin\alpha - T\sin\beta = 0$$

$$9000 = \left(\frac{\cos\beta}{\cos\alpha}\sin\alpha + \sin\beta\right)T$$

$$T = \frac{9000}{\frac{\cos\beta}{\cos\alpha}\sin\alpha + \sin\beta}\ \text{N} = 7.20\times10^3\ \text{N}$$

With this value of T,

$$F = \frac{\cos\beta}{\cos\alpha}T = 5.40\times10^3\ \text{N}.$$