13.69. **Model:** The disk is a rigid spinning body.
Visualize: Please refer to Figure P13.69. The initial angular velocity is 300 rpm or (300)(2π)/60 = 10π rad/s. After 3.0 s the disk stops.
Solve: Using the kinematic equation for angular velocity,

$$\omega_1 = \omega_0 + \alpha(t_1 - t_0) \Rightarrow \alpha = \frac{\omega_1 - \omega_0}{t_1 - t_0} = \frac{(0 \text{ rad/s} - 10\pi \text{ rad/s})}{(3.0 \text{ s} - 0 \text{ s})} = \frac{-10\pi}{3} \text{ rad/s}^2$$

Thus, the torque due to the force of friction that brings the disk to rest is

$$\tau = I\alpha = -fR \Rightarrow f = -\frac{I\alpha}{R} = -\frac{\left(\frac{1}{2}mR^2\right)\alpha}{R} = -\frac{1}{2}(mR)\alpha = -\frac{1}{2}(2.0 \text{ kg})(0.15 \text{ m})\left(-10\frac{\pi}{3} \text{ rad/s}^2\right) = 1.57 \text{ N}$$

The minus sign with $\tau = -fR$ indicates that the torque due to friction acts clockwise.