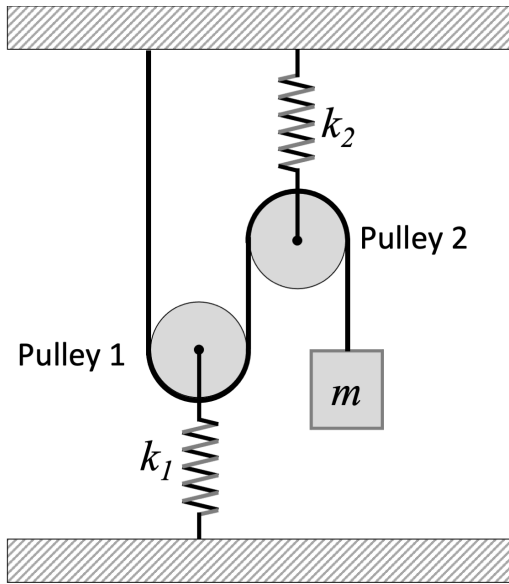


Problem 1 [10 marks] Find the natural angular frequency, ω_n , for the system shown. The pulleys are frictionless and have negligible mass. Values are: $m = 8 \text{ kg}$, $k_1 = 300 \text{ N/m}$, $k_2 = 400 \text{ N/m}$.



Rope has same tension (no stretch, frictionless pulleys).

FBD mass

unstretched
equilib. Δ
 $\sum F_x: -T = m\ddot{x}$
 $T = k_{eq}x$
 $m\ddot{x} + k_{eq}x = 0$
 $\ddot{x} + \frac{k_{eq}}{m}x = 0$
 $\omega_n^2 \leftarrow$

FBD pulley 1

$(m=0)$
 $\sum F_x: 2T + F_{s1} = 0$
 $F_{s1} = -k_1x_1$
 $\Rightarrow 2T = k_1x_1$
 movement of rope = $2x_1$

$$\omega_n = \sqrt{\frac{k_{eq}}{m}}$$

$$= \sqrt{\frac{1}{4m} \frac{k_1 k_2}{k_1 + k_2}}$$

$$\omega_n = 2.31 \text{ rad/s}$$

Extra workspace