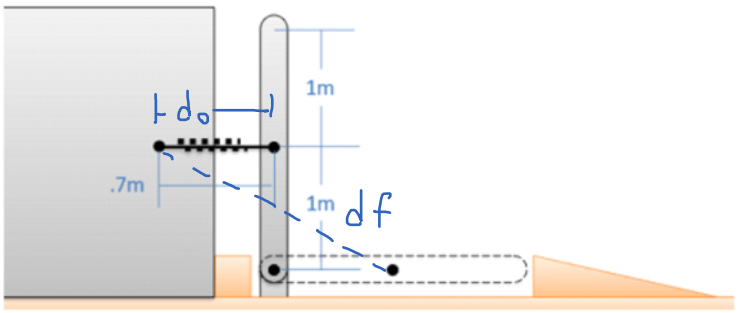
Problem 2

A system as shown below is used to passively slow the lowering of a gate. The gate can be approximated as a flat plate on it's edge with a mass of 25 kg and a height of 2m. Assume the spring is unstretched as shown in the diagram.

- What would the angular velocity of the gate be without the spring?
- If we want to reduce the angular velocity at the bottom to 25% of it's original value what should the spring constant be?



$d_o = .7m$

$d_f = \sqrt{1^2 + 1.7^2} = 1.97m$

a)

$$W = \Delta KE + \Delta PE$$

$$0 = \frac{1}{2} I_o \omega_f^2 - \frac{1}{2} I_o \omega_i^2 + mg\Delta h$$

$$I_o = \frac{1}{12} m l^2 + mr^2 = \frac{1}{12}(25)(2m)^2 + (25)(1m)^2 = 33.33\ kgm^2$$

$$0 = \frac{1}{2}(33.33\ kgm^2)(\omega_f)^2 + (25)(9.81)(-1)$$

$$\omega_f = 3.84\ rad/s$$

b)

$$\frac{\omega_f}{4} = .96 \text{ rad/s}$$

$$W = \Delta KE + \Delta PE$$

$$0 = \frac{1}{2} I_o (.96 \text{ rad/s})^2 + mg\Delta h + \frac{1}{2} k x_f^2 - \cancel{\frac{1}{2} k x_i^2}^{\,0}$$

$$0 = \frac{1}{2}(33.33)(.96)^2 + (25)(9.81)(-1) + \frac{1}{2}(k)(1.97-.7)^2$$

$$0 = 15.32 - 245.25 + \frac{1}{2}(1.27)^2 k$$

$$\boxed{k = 285.1 \text{ N/m}}$$