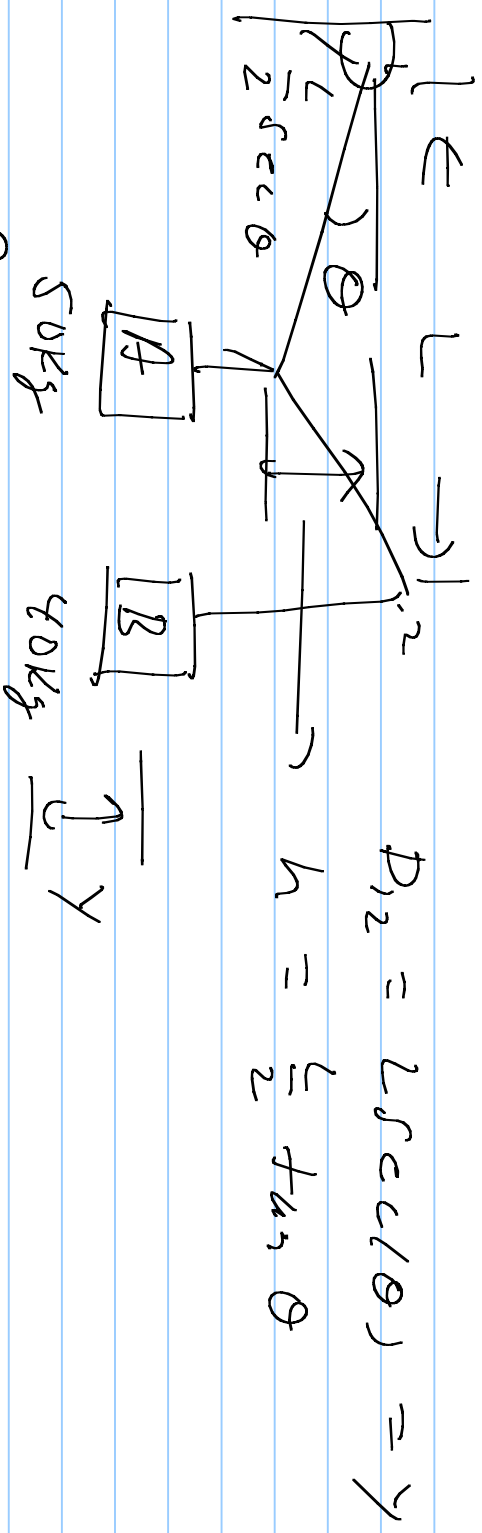


EGR 180

f13

11-30



$$D_{12} = L \sin(\theta) = y$$

$$h = \frac{L}{2} \tan \theta$$

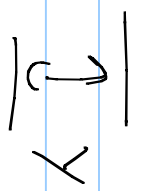
P_A

50kg



P_B

40kg



$$P_A = m_A g \frac{L}{2} \tan \theta$$

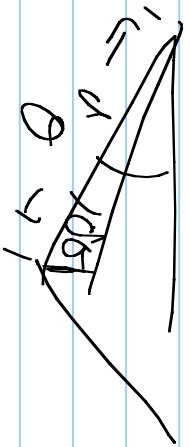
$$P_B = m_B g L \sin \theta$$

$$P = m_A g \frac{L}{2} \tan \theta + m_B g L \sin(\theta)$$

$$\begin{aligned} \frac{dP}{dT} &= 0 = \frac{L}{2} m_A g \sec^2 \theta - m_B g L \sec \theta \tan \theta \\ &= \frac{L}{2} g \sec(\theta) [m_A \sec \theta - 2m_B \tan \theta] \end{aligned}$$

$$m_A \sec \theta = 2m_B \tan \theta$$

$$\begin{aligned} \frac{m_A}{2m_B} &= \sin \theta = \frac{SD}{8g} = \frac{5}{8} \Rightarrow \theta = 2 \sin^{-1} \left(\frac{5}{8} \right) \\ &= 38.7^\circ \end{aligned}$$



$$\begin{aligned} dh &= d_1 \sin \theta - d_2 \sin(\theta - \delta) \\ &= \frac{L}{2} \tan \theta - \frac{L}{2} \tan(\theta - \delta) \\ &= \frac{L}{2} \sec^2 \theta \delta \end{aligned}$$

$$d = \frac{L}{2} \sec \theta$$

$$\delta R = \left[\begin{array}{c} \text{Diagram of a rod of length } L \text{ at an angle } \theta \text{ to the horizontal. The rod is pivoted at the top. The horizontal displacement is } \delta R. \end{array} \right] \delta \theta = L \sec(\theta) - L \sec(\theta - \delta \theta)$$

$$dW_H = -m_H g \frac{L}{2} \delta \theta \cdot \sec^2 \theta$$

$$dW_B = m_H g L \sec \theta \tan \theta \delta \theta$$

11-45)

$P_s = \frac{1}{2} k x^2 = \frac{1}{2} k [10 \sin \theta - 5]^2$
 $P_g = m g h = 100 \cdot 5 \cos \theta = 500 \cos \theta$
 $P = \frac{1}{2} k [10 \sin \theta - 5]^2 + 500 \cos \theta$

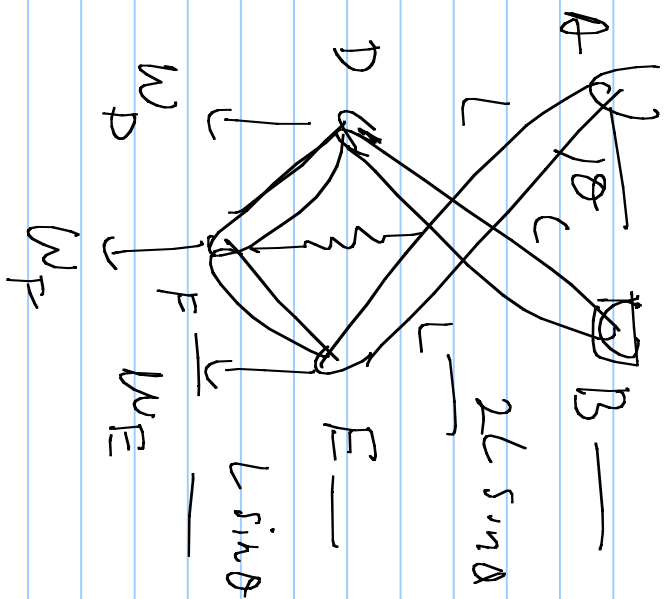
$$\frac{dP}{d\theta} = 0 = K [10 \sin \theta - 5] [10 \cos \theta] - 500 \sin \theta = 0$$

$$K = \frac{500 \sin \theta}{10 \cos \theta} = \frac{50 \sin \theta}{\cos \theta (2 \sin \theta - 1)}$$

$$\sin \theta = .6, \quad \cos \theta = .8$$

$$K = \frac{(10)(.6)}{(1.8)(.12-1)} = \frac{6}{.116} = 37.5 \text{ lbs/ft}$$

11-49)



$W_D = W_E = W_F = 80 \text{ lb}$
 $L = 2'$ $K = 350 \text{ lb/ft}$



$h_F = 2L - 3L \sin \theta$
 $h_D = L - L \sin \theta$
 $D_{CF} = 2L \sin \theta$
 $X = D_{CF} - 2$

$$W_D h_D + W_E h_D + W_F h_F + \frac{1}{2} K X^2 = P$$

$$7L - 7L \sin \theta$$

$$80 [2L - 2L \sin \theta + 2L - 2L \sin \theta + 3L - 3L \sin \theta] + \frac{1}{2} k [2L \sin \theta - 2]^2 = P$$

$$\frac{dP}{d\theta} = -560L \cos \theta + k [2L \sin \theta - 2] (2L \cos \theta) = 0$$

$$= 2 \cos \theta [2k [2L \sin \theta - 2] - 560] = 0$$

$$2L \sin \theta - 2 = \frac{560}{2k} = \frac{280}{350} = \frac{4}{5}$$

$$2L \sin \theta = 2.8$$
$$\sin \theta = 1.4 \Rightarrow \theta = \sin^{-1}(1.4) = 44.4^\circ$$

$$\frac{d^2P}{ds^2} = \left[560L \sin \theta - 24L \sin \theta (2L \sin \theta - 2) \right. \\ \left. + 4KL^2 \cos^2 \theta \right] \theta = 90^\circ$$

$$= 560L - 24L(2L - 2)$$

$$= L[560 - 700(2)] < 0 \quad \text{unstable}$$

> 0 stable

Virtual work - 12pts Easy

Potential Energy - 12pts Difficult

Stability - 12pts Impossible