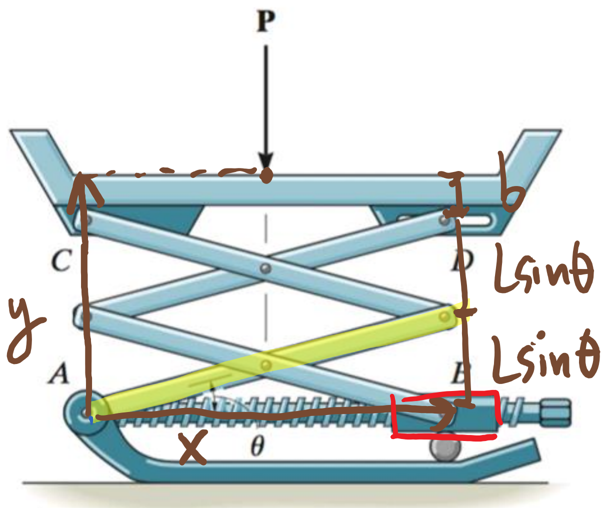
Announcements

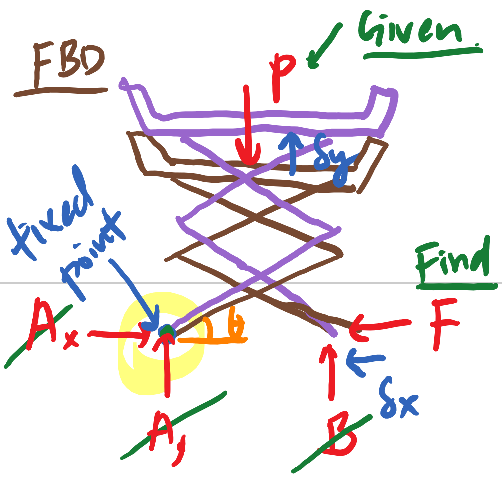
- CBTF Quiz 7 – last day!
- Last day of office hours and Piazza help: Wed, Dec. 13
- No discussion sections next week
- TAM 211 final exam starts next Thursday (12/14)

❑ Upcoming deadlines:

- Saturday (12/9)
  - ME HW27
- Tuesday (12/12)
  - PL HW26

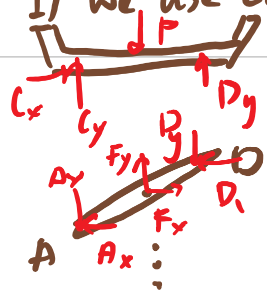
The scissors jack supports a load **P**. Determine the axial force in the screw necessary for equilibrium when the jack is in the position shown. Each of the four links has a length L and is pin-connected at its center. Points B and D can move horizontally.





$\Rightarrow$

If we use EoE to solve, analysis on individual members are needed.



Virtual work Eq

$$\delta U = 0 = \vec{P}\cdot\delta\vec{y} + \vec{F}\cdot\delta\vec{x}$$

$$\vec{y} = 2L\sin\theta + b$$

$$\vec{P} = -P\hat{j}$$

$$\delta\vec{y} = 2L\cos\theta\,\delta\theta + \cancel{0}\,\hat{j}$$

$$\vec{F} = -F\hat{i}$$

$$\delta\vec{x} = -L\sin\theta\,\delta\theta\,\hat{i}$$

$$\delta\vec{x} = -L\sin\theta\,\delta\theta\,\hat{i}$$

$$\vec{x} = L\cos\theta$$

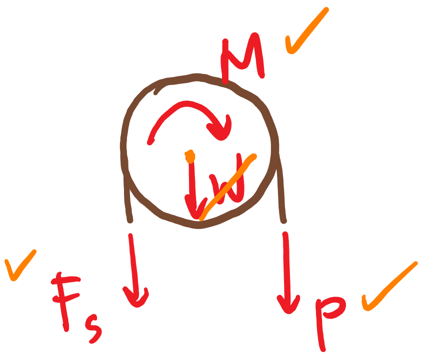
$$\Rightarrow \delta U = -P(2L\cos\theta\,\delta\theta) + (-F)(-L\sin\theta\,\delta\theta) = 0$$

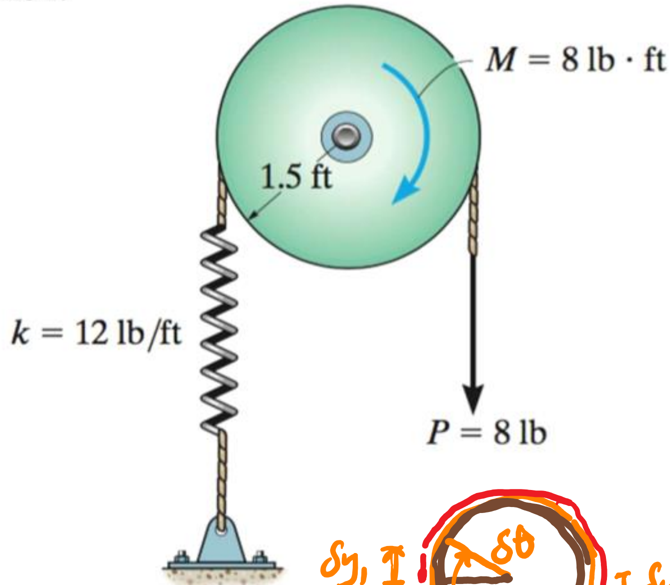
$$(-2PL\cos\theta + FL\sin\theta)\,\delta\theta = 0.$$

$$\Rightarrow \boxed{F = \frac{2P\cos\theta}{\sin\theta}}$$

The disk has a weight of 10 lb and is subjected to a vertical force P = 8 lb and a couple moment M = 8 lb ft. Determine the disk's rotation θ if the end of the spring wraps around the periphery of the disk as the disk turns. The spring is originally unstretched.

FBD





$$\delta U = 0 = \vec{F}_s \cdot \delta\vec{y}_1 + \vec{P} \cdot \delta\vec{y}_2 + M\delta\theta$$

$\delta y_1 = \delta y_2$ (same rope)

~relate δy with $\delta\theta$

~ arc length is $l = r\theta$, y = position along the disk edge.

$$y = r\theta$$

$$\delta y = r\delta\theta$$

$$\delta U = -F_s\delta y_1 + P\,\delta y_2 + M\delta\theta$$

$$= -F_s(r\underline{\delta\theta}) + P(r\underline{\delta\theta}) + M\underline{\delta\theta} = 0$$

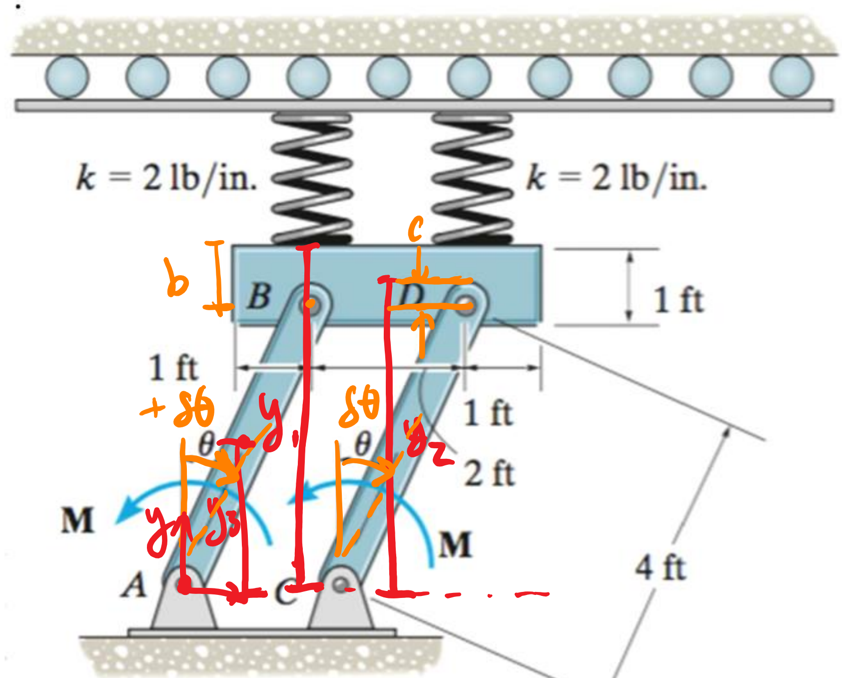
$$F_s = \frac{Pr + M}{r} = ks$$

$$s = y = r\theta$$

$$s = r\theta = \frac{Pr + M}{rK}$$

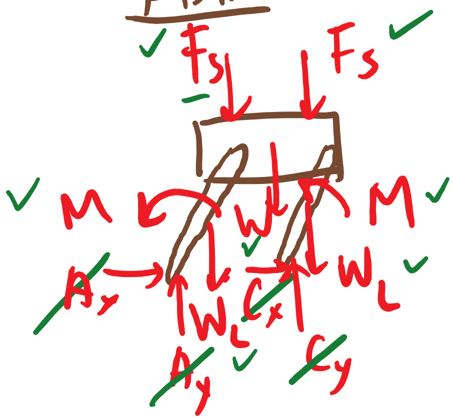
$$\boxed{\theta = \frac{Pr + M}{r^2 K}} \text{ rad.}$$

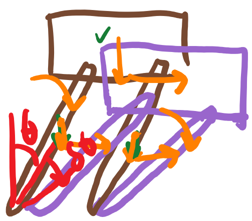
When $\theta = 20°$, the 50-lb uniform block compresses the two vertical springs 4 in. If the uniform links AB and CD each weigh 10 lb, determine the magnitude of the applied couple moments **M** needed to maintain equilibrium when $\theta = 20°$.



Given: θ, k, s, W, W_L

FBD





→ Moment is doing negative work

$y_1 = L\cos\theta + b \qquad \delta y_1 = -L\sin\theta\,\delta\theta$

$y_2 = L\cos\theta + c \qquad \delta y_2 = -L\sin\theta\,\delta\theta$

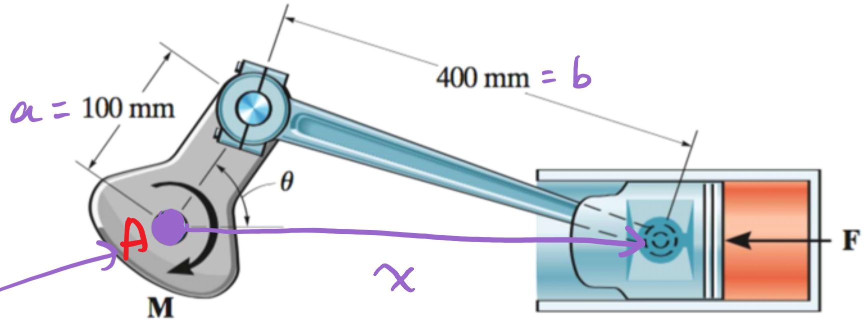
$y_3 = \frac{1}{2}\cos\theta \qquad \delta y_3 = -\frac{1}{2}L\sin\theta\,\delta\theta$

$$\delta U = (-2M\,\delta\theta) + (-W)(-L\sin\theta\,\delta\theta) + 2(-F_s)(-L\sin\theta\,\delta\theta) + 2(W_L)\left(-\tfrac{1}{2}L\sin\theta\,\delta\theta\right) = 0, \quad F_s = ks$$

$$\Rightarrow M = \tfrac{1}{2}L\sin\theta\,(W + 2ks + W_L) = \underline{52\ \text{lb}\cdot\text{ft}}$$

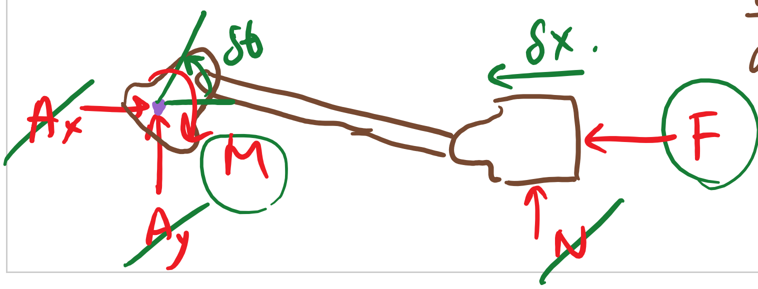
Friday, December 8, 2017 10:02 AM

The crankshaft is subjected to a torque of M = 50 N m. Determine the horizontal compressive force F applied to the piston for equilibrium when $\theta = 60°$.

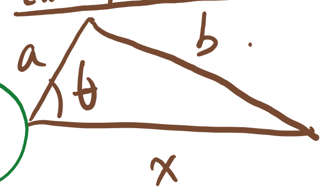


~ Use law of cos to relate x & θ, then differentiate the equation to relate δx & $\delta\theta$.

FBD



Law of cos



$$b^2 = a^2 + x^2 - 2ax\cos\theta$$

• differentiate:

$$0 = 0 + 2x\,\delta x - 2a\cos\theta\,\delta x - 2ax(-\sin\theta)\delta\theta$$

$$\delta x = \left(\frac{-2ax\sin\theta\,\delta\theta}{2x - 2a\cos\theta}\right)$$

Virtual work Equation:

$$\delta U = 0 = -M\,\delta\theta + (-F)\,\delta x$$

Given Find

$$= -M\,\delta\theta + (-F)\left(\frac{-2ax\sin\theta}{2x-2a\cos\theta}\right)\delta\theta = 0$$

$$\Rightarrow \left(-M + \frac{2Fax\sin\theta}{2x-2a\cos\theta}\right) = 0 \Rightarrow \boxed{F = 512\ N}$$