Wright State University
Department of Mechanical and Materials Engineering

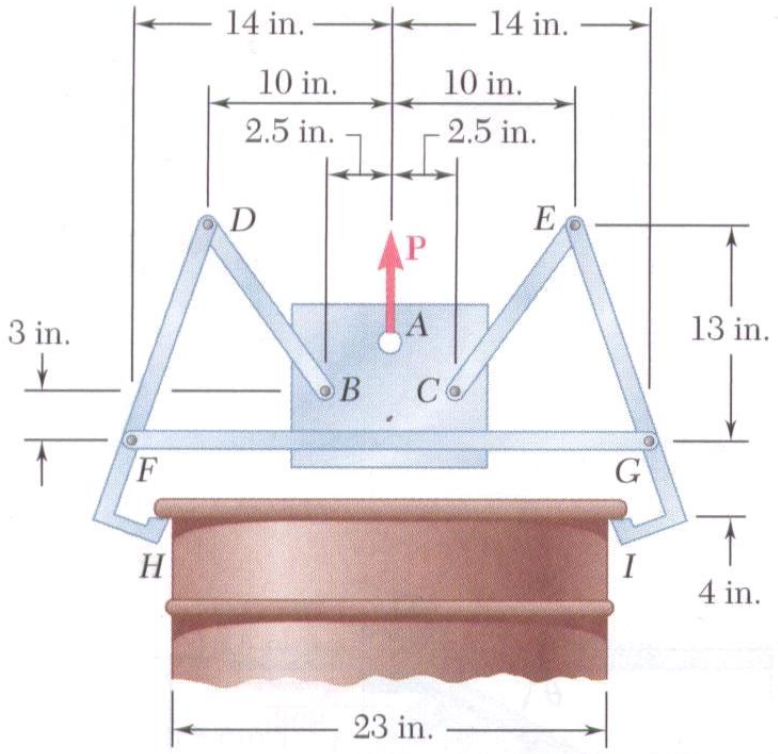
Fall 2017

ME 2120: STATICS

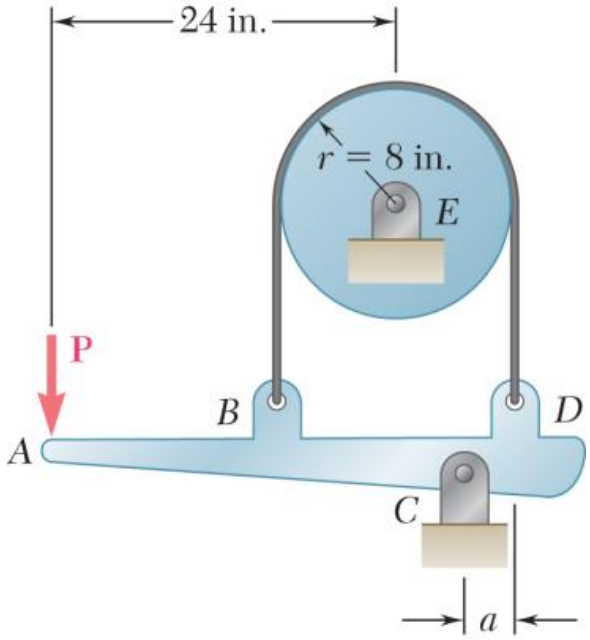
FINAL EXAM

OPEN BOOK, CLOSED NOTES, SHOW ALL WORK FOR PARTIAL CREDIT

Problem 1: (10 points) The drum lifter shown is used to lift a steel drum. Knowing that the weight of the drum and its contents is 110 lb, determine the forces exerted at *F* and *H* on member *DFH*.

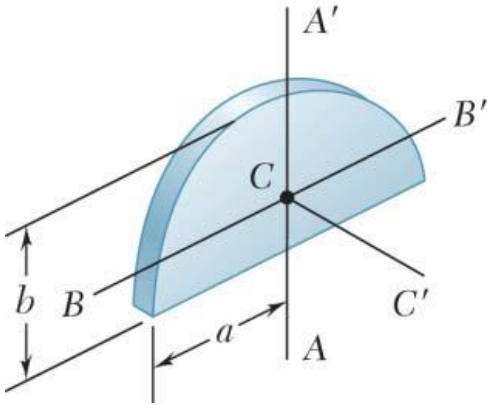


Problem 2: (10 points) A belt passes over a drum as shown. A force **P** of magnitude 25 lb is applied to the bar *AD*. Determine the maximum clockwise moment that can be applied to the drum at *E* without the belt slipping around the drum, knowing the coefficient of friction between the belt and the drum is 0.25, and that $a = 4$ inches.



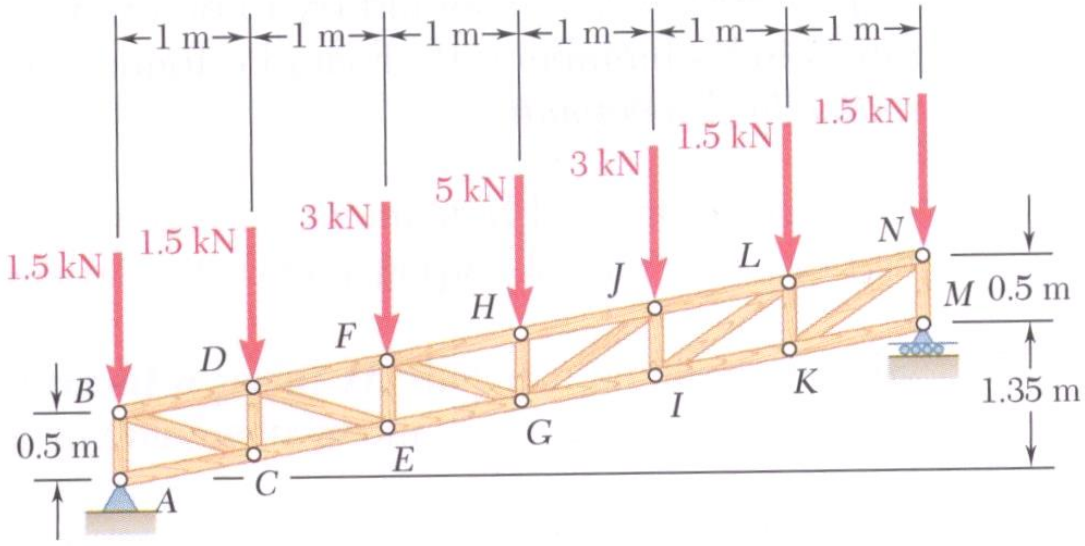
Problem 3: (7 points) A thin semicircular plate has a radius *a* and a mass *m*. Determine the mass moment of inertia of the plate with respect to the *AA'* axis. Make sure to put the final answer in the following format:

$$I_{\text{mass}} = (\text{Numerical Coefficient}) \times (\text{Mass}) \times (\text{Length-scale})^2$$

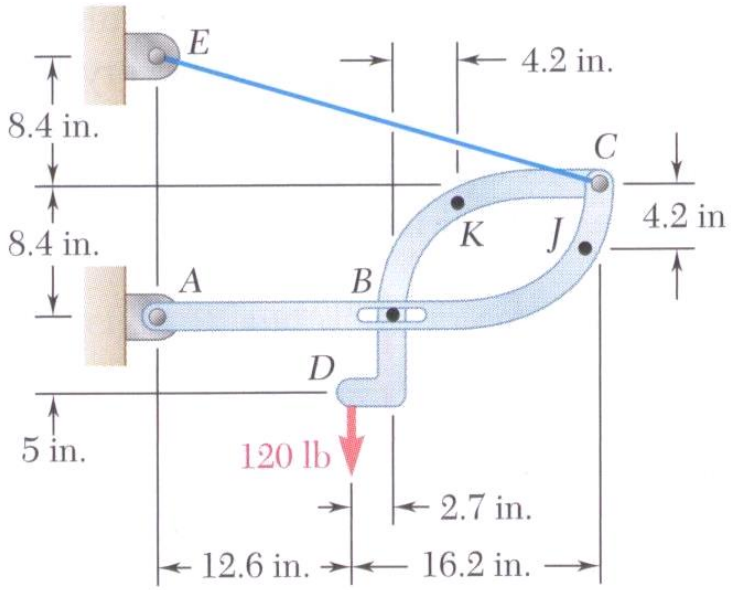


Problem 4 (1 point each, no partial credit): Draw the free-body diagram(s) for the following situations. **Do not solve for the numerical answers!**

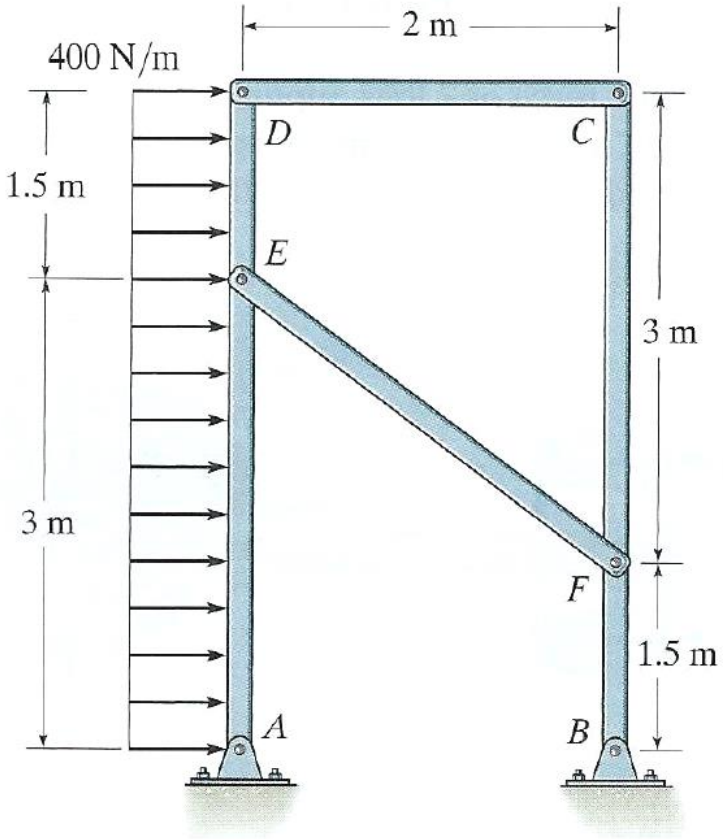
(a) A parallel chord Pratt truss is loaded as shown. Determine the force in members *CE*, *DE*, and *DF*.



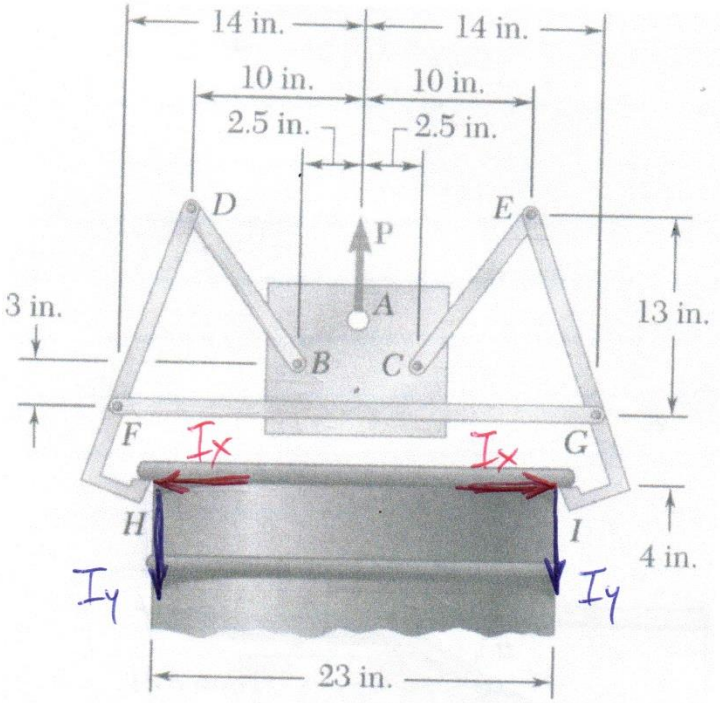
(b) Two members each consisting of straight and 8.4-in.-radius quarter-circle portions are connected as shown and support a 120-lb load at *D*. Determine the internal forces at point *J*.



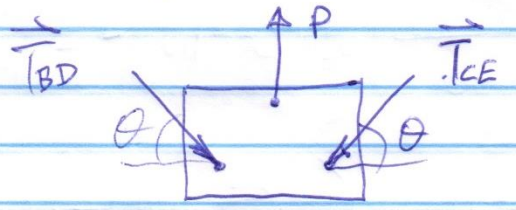
(c) Determine the horizontal and vertical components of force which pins at *A* and *B* exert on the frame.



Problem 1 (points): The drum lifter shown is used to lift a steel drum. Knowing that the weight of the drum and its contents is 110 lb, determine the forces exerted at F and H on member DFH.



$$\Sigma F_y = 0: \quad I_y = \frac{1}{2}P = \frac{1}{2}(110^{LB}) = 55^{LB}$$



$$\theta = \tan^{-1}\left(\frac{10}{7.5}\right) = 53.1^\circ$$

$$\vec{T}_{CE} = (-T_{CE}\cdot\cos 53.1^\circ)\hat{i} + (-T_{CE}\cdot\sin 53.1^\circ)\hat{j}^{LB}$$

$$\vec{T}_{CE} = (-0.6\,T_{CE})\hat{i} + (-0.8\,T_{CE})\hat{j}^{LB}$$

PROB. 1, CONT.

$$\vec{T}_{BD} = (T_{BD} \cdot \cos 53.1^\circ)\hat{i} + (-T_{BD} \cdot \sin 53.1^\circ)\hat{j} \text{ LB}$$

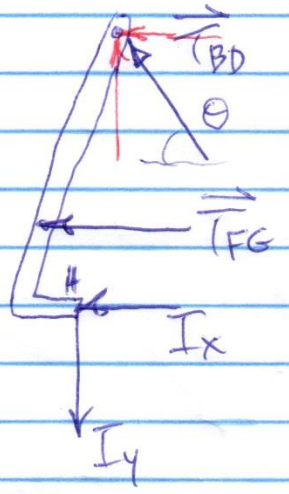
$$\vec{T}_{BD} = (0.6\,T_{BD})\hat{i} + (-0.8\,T_{BD})\hat{j} \text{ LB}$$

$$\Sigma F_y = 0: \quad P - 0.8\,T_{CE} - 0.8\,T_{BD} = 0$$

BY INSPECTION/SYMMETRY, $T_{CE} = T_{BD}$

$$P = 1.6\,T_{BD}$$

$$T_{BD} = \frac{1}{1.6}(110^{\text{LB}}) = 68.75^{\text{LB}}$$



$$\vec{T}_{BD} = (-T_{BD} \cdot \cos\theta)\hat{i} + (T_{BD} \cdot \sin\theta)\hat{j} \text{ LB}$$

$$\vec{T}_{BD} = (-68.75 \cdot \cos 53.1^\circ)\hat{i} + (68.75 \cdot \sin 53.1^\circ)\hat{j} \text{ LB}$$

$$\vec{T}_{BD} = (-41.28)\hat{i} + (54.98)\hat{j} \text{ LB}$$

$$\Sigma F_x = 0: \quad -41.28 - T_{FG} - I_x = 0$$

$$\Sigma F_y = 0: \quad 54.98 - I_y = 0 \qquad \boxed{I_y = 54.98^{\text{LB}}}$$

PROB. 1, CONT.

$\Sigma M_H = 0$ $\circlearrowleft$:

$(4^{IN})\, T_{FG} + (11.5 - 10^{IN})(44.98^{LB})$

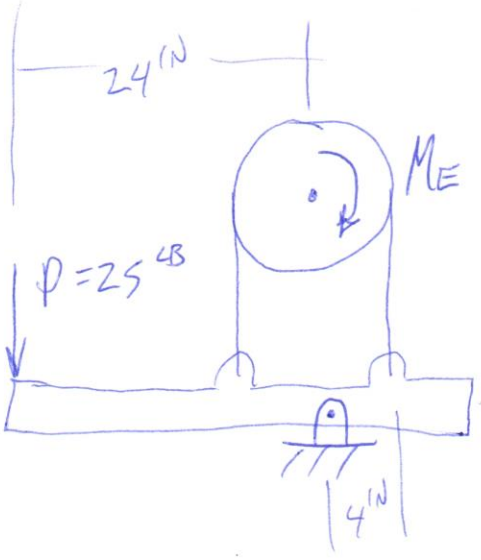
$+ (17^{IN})(41.28^{LB}) = 0$

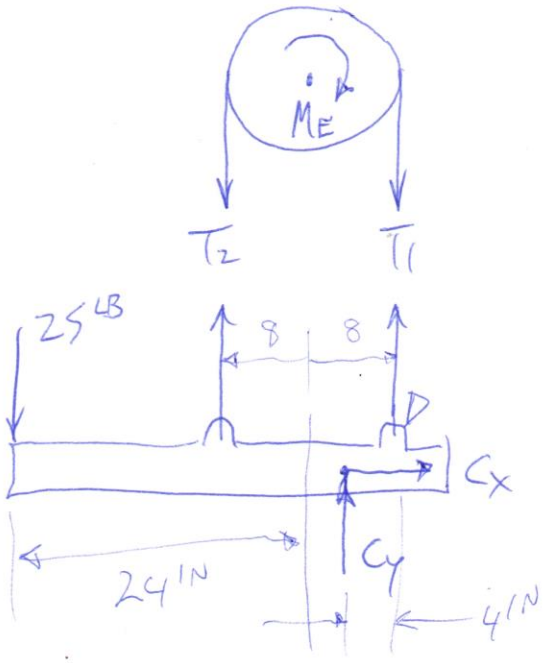
$\boxed{|\vec{T}_{FG}| = -196^{LB}\ (T)}$

$I_x = -41.28 - (-196)$

$\boxed{I_x = 155^{LB}}$

PROB. 8.115





FOR IMPENDING MOTION AROUND DRUM,

$$\frac{T_2}{T_1} = e^{\mu_K \beta}$$

$$\boxed{T_2 = T_1 \cdot e^{\pi \mu_K}} \quad (1)$$

$\Sigma M_E = 0$ $+\circlearrowleft$: DRUM

$$r \cdot T_2 - r \cdot T_1 - M_E = 0$$

$$\boxed{M_E = r(T_2 - T_1)} \quad (2)$$

$\Sigma F_x = 0$: BAR

$$\boxed{C_x = 0}$$

$\Sigma F_y = 0$: BAR

$$-P + T_2 + T_1 + C_y = 0 \quad (3)$$

$\Sigma M_D = 0 \circlearrowleft$: BAR

$$-(4^{IN})C_y - (16^{IN})T_2 + (32^{IN})(25^{LB}) = 0$$

$$C_y = 200 - 4T_2 \quad (4)$$

(4) INTO (3):

$$-25 + T_2 + T_1 + (200 - 4T_2) = 0$$

$$T_1 = 3T_2 - 175 \quad (5)$$

(5) INTO (1):

$$T_2 = (3T_2 - 175) \cdot \exp[\pi(0.25)]$$

$$T_2 = 6.58T_2 - 384$$

$$5.58T_2 = 384$$

$$T_2 = 68.8^{LB}$$

$$T_1 = 3(68.8) - 175 = 31.4^{LB}$$

$$M_E = (8^{IN})(68.8 - 31.4^{LB}) = 300^{IN \cdot LB}$$

PROB. 9.113

MASS m, RADIUS a, FIND $I_{AA'}$, MASS

$I_{MASS} = \rho t \cdot I_{AREA}$ FOR A THIN PLATE.

$$I_{AREA} = \frac{1}{8}\pi r^4$$

$$I_m = \rho t \cdot \frac{\pi}{8} r^4$$

$$m = \rho \cdot V = \rho \cdot t \cdot A$$

$$A = \frac{1}{2}\pi r^2$$

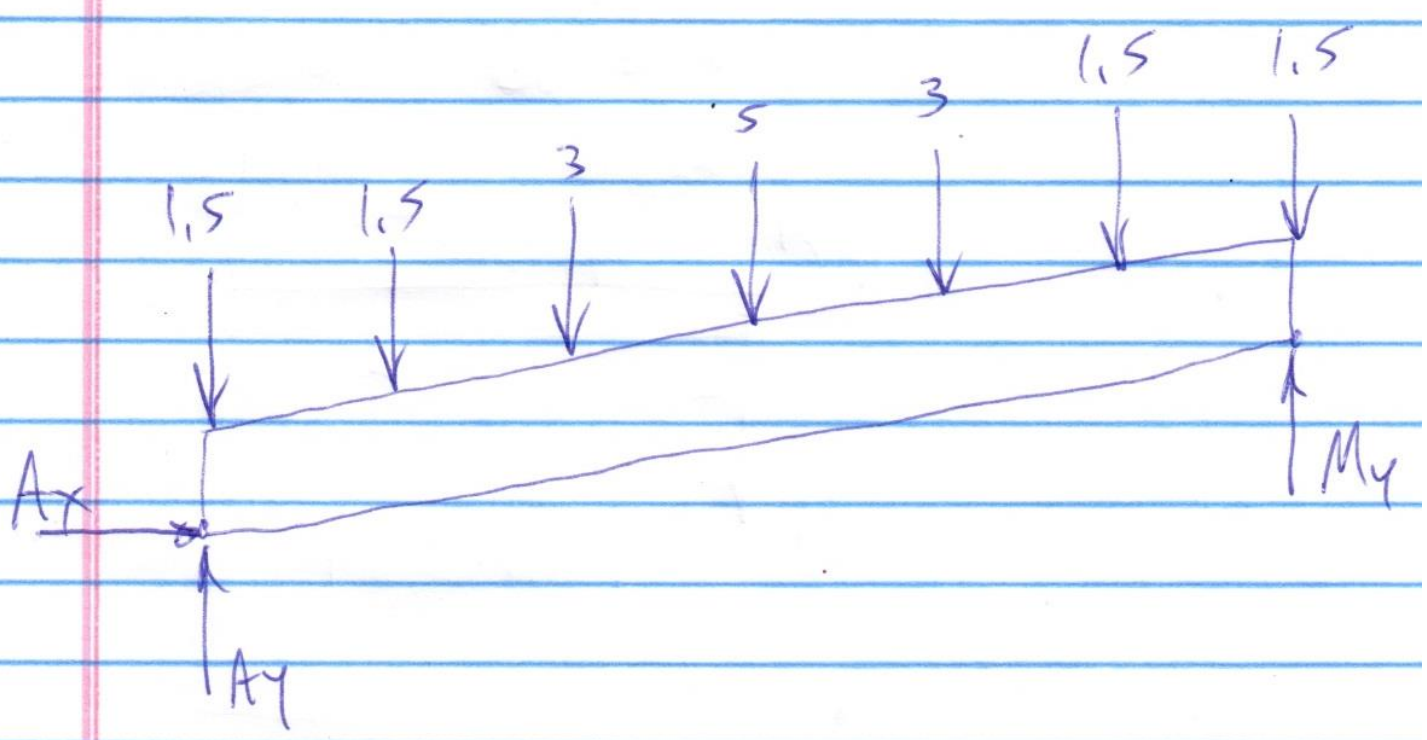
$$m = \rho t \cdot \frac{1}{2}\pi r^2$$

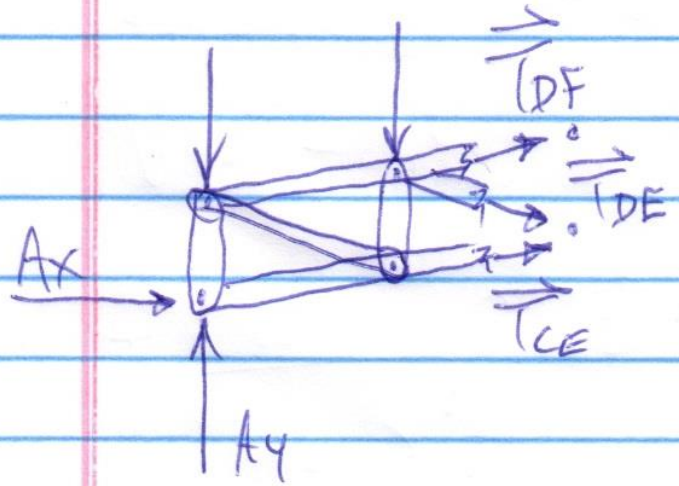
$$\rho t = \frac{2m}{\pi r^2}$$

$$I_m = \left(\frac{2m}{\pi r^2}\right)\left(\frac{\pi}{8} r^4\right)$$

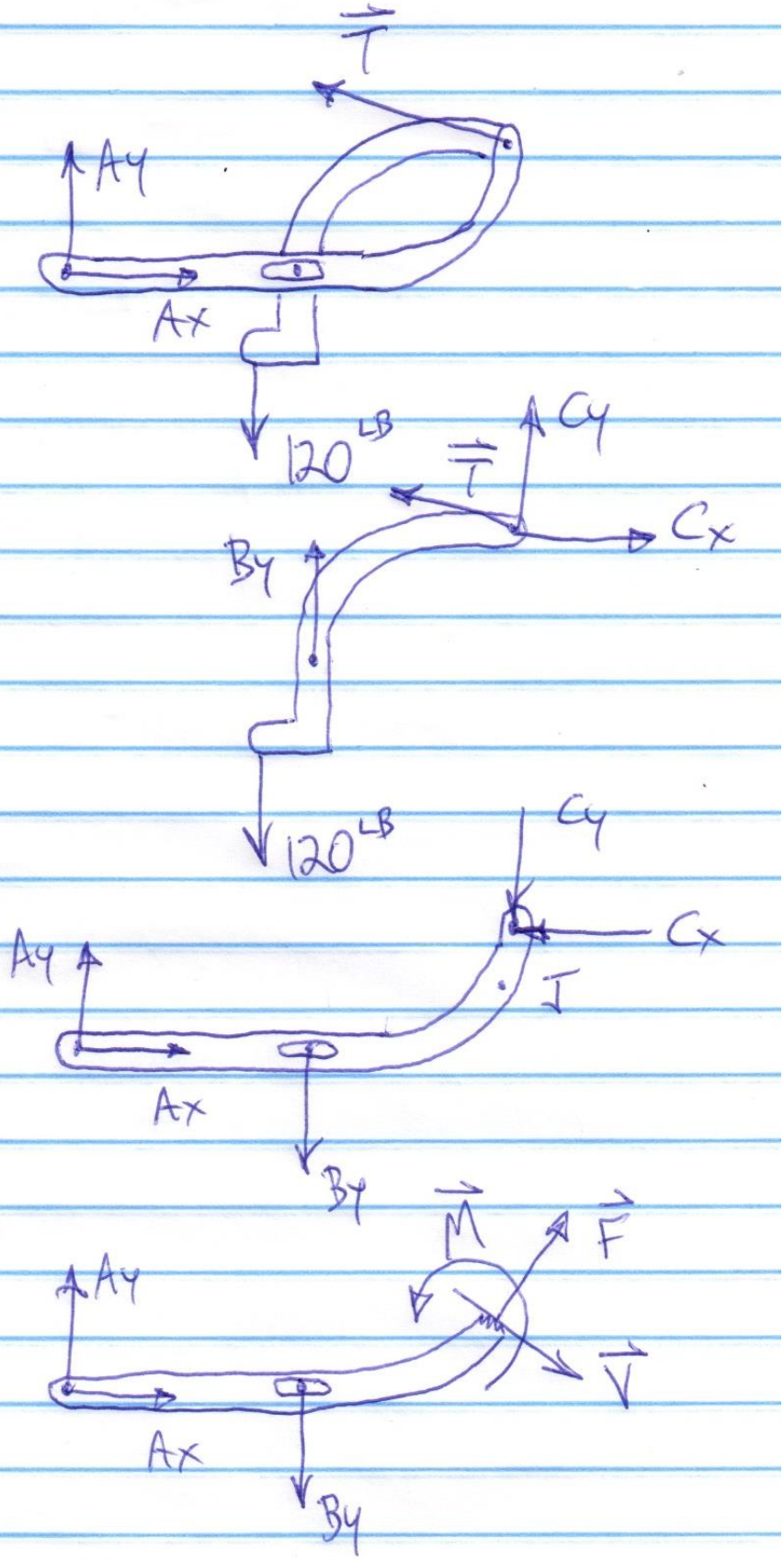
$$\boxed{I_m = \frac{1}{4} m r^2}$$

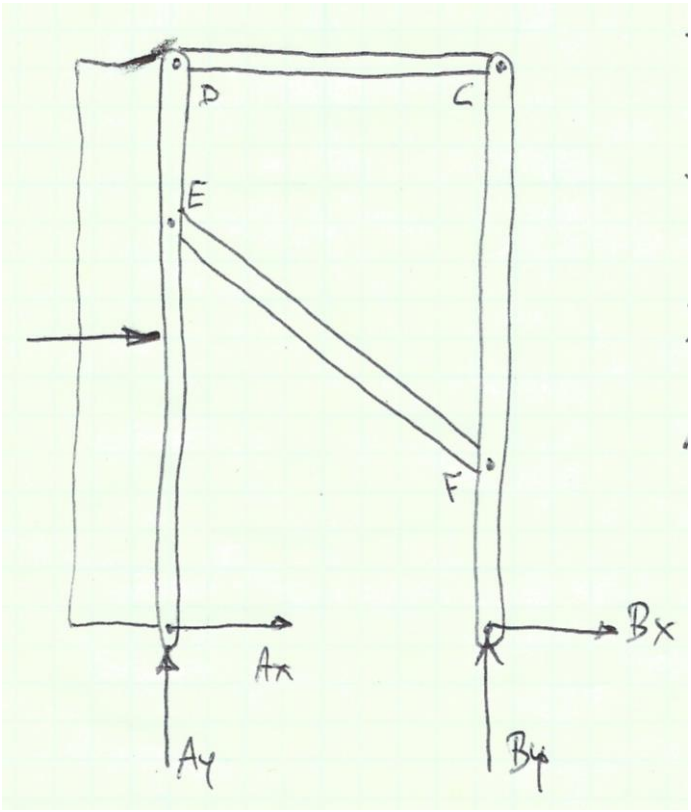
PART a)





PART b)

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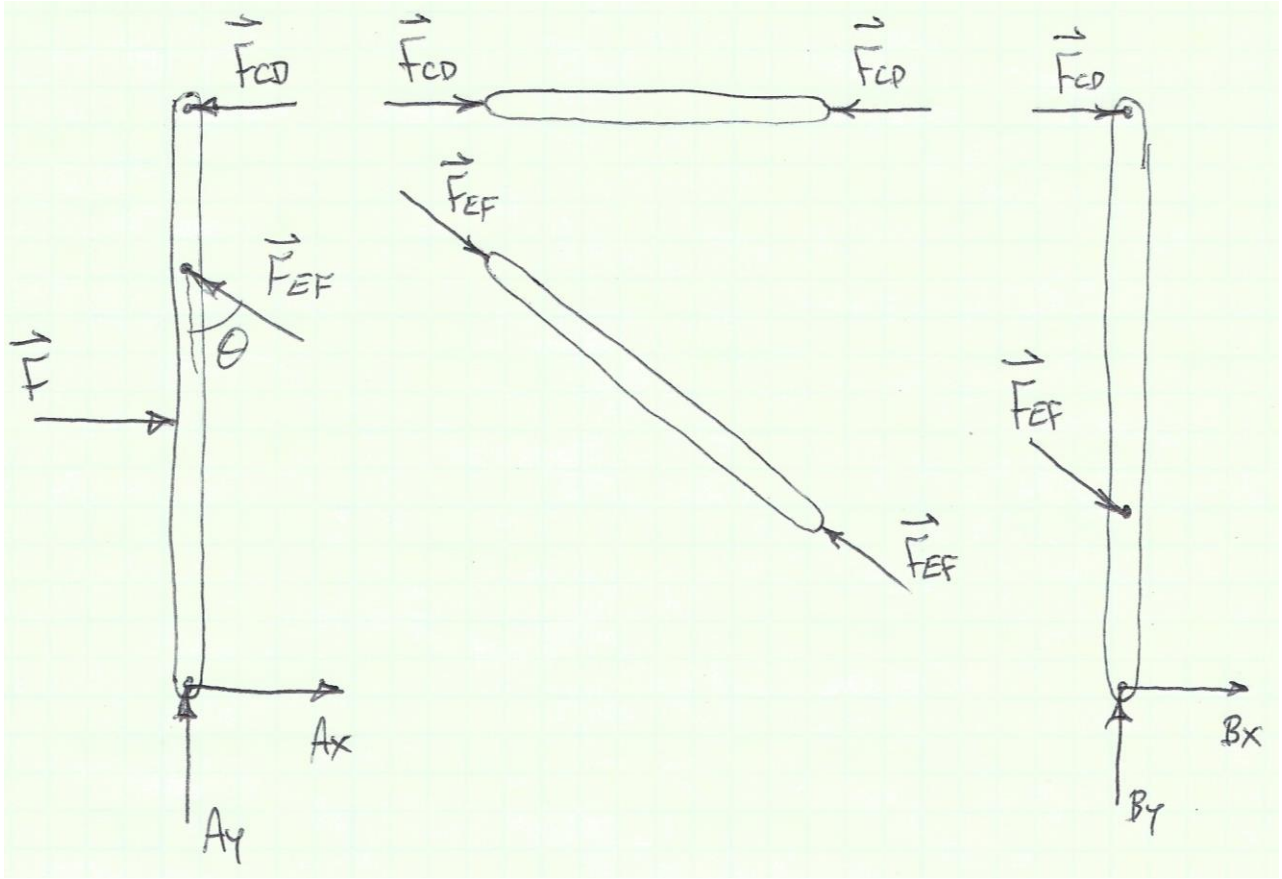
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