Wright State University
Department of Mechanical and Materials Engineering

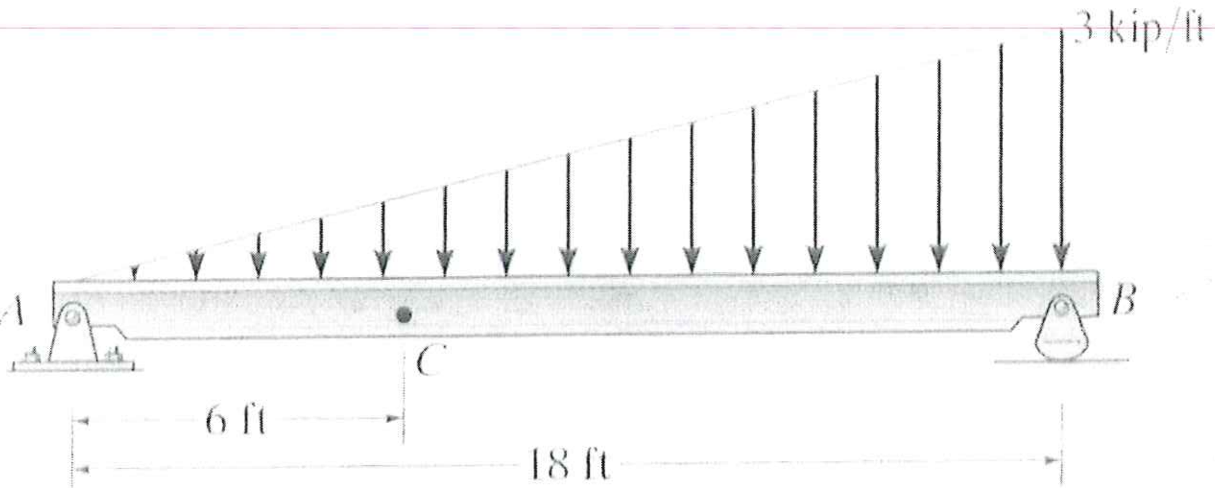
ME 212: Statics, Fall 2007

FINAL EXAM

Open Book, Closed Notes, Do not write on this sheet, Show all work

1. (20 points) Determine the shear force and moment acting at a section passing through point C in the beam.

6/29
GOT THIS RIGHT
18
16
14
12
10
5

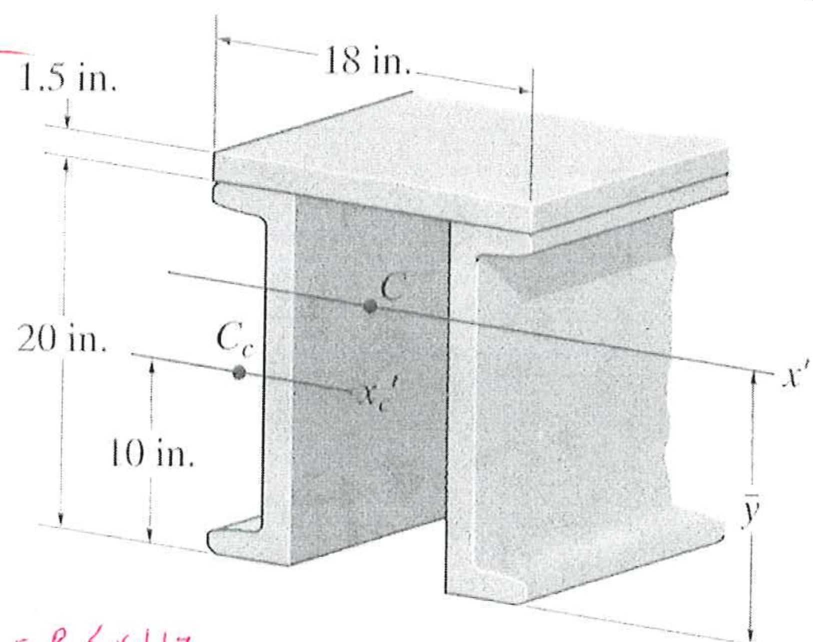


2. (25 points) Determine the moment of inertia for the beam's cross-sectional area about the centroidal x' axis. Each channel has a cross-sectional area of $A_c = 11.8$ in^2 and a moment of inertia about a horizontal axis passing through its own centroid, C_c, of $\bar{I}_{x_c'} = 349$ in^4.

11/29
25
22
19
16
13
10

RAW SCORES

102	55
100	54
99	51
97	49
93	49
90	47
87	46
86	36
77	35
74	24
70	23
7	20
6	20
8	15
7	



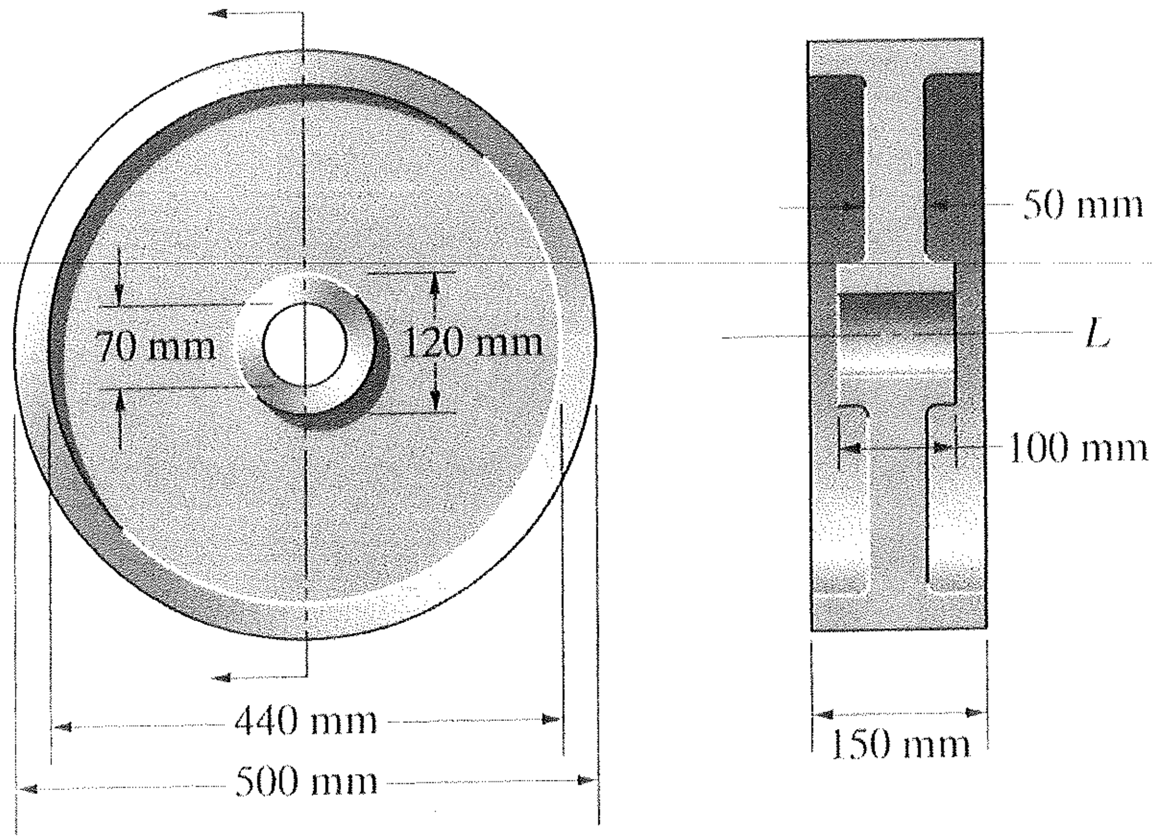
A.S. = R.S × 1.17

$\bar{X}_{A.S.} = 70.5$

$\bar{X}_{RAW} = 60.2$

3. (30 points) Determine the moment of inertia of the 14-kg flywheel about the axis L.

3/29

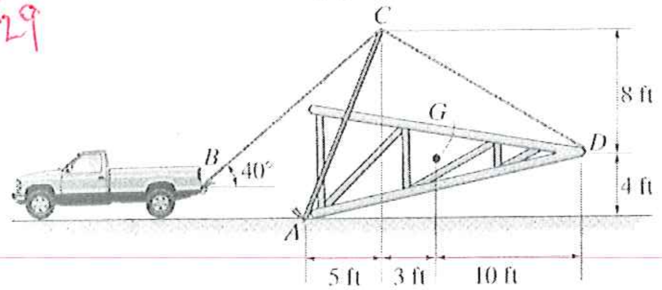


30
27
24
21
18
15
12
9

4. (5 points each) Draw the free-body diagrams necessary to solve the following situations.

(a)

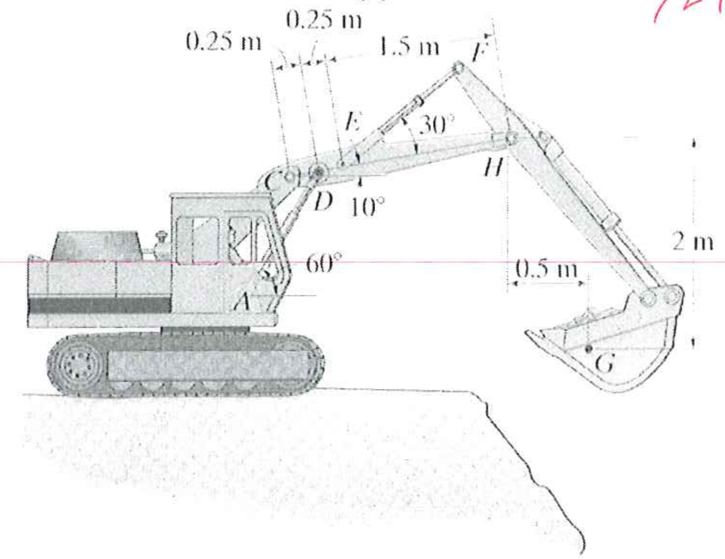
3/29



The tower truss has a weight of 575 lb and a center of gravity at G. The rope system is used to hoist it into the vertical position. If rope CB is attached to the top of the shear leg AC and a second rope CD is attached to the truss, determine the required tension in BC to hold the truss in the position shown. The base of the truss and the shear leg bears against the stake at A, which can be considered as a pin. Also, compute the compressive force acting along the shear leg AC.

(b)

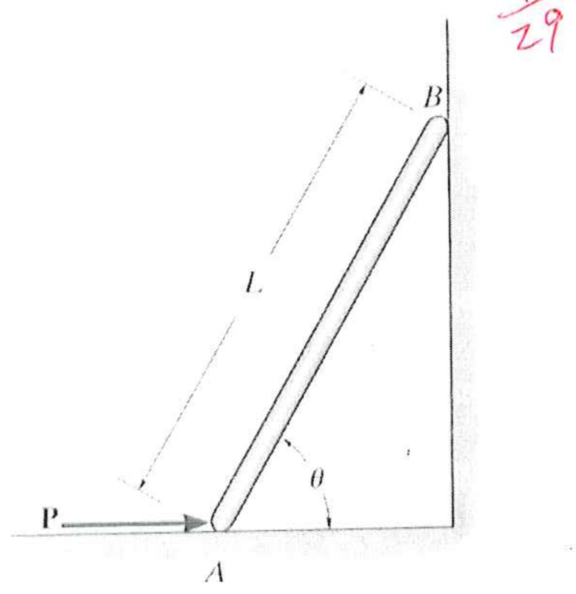
13/29



Determine the force created in the hydraulic cylinders EF and AD in order to hold the shovel in equilibrium. The shovel load has a mass of 1.25 Mg and a center of gravity at G. All joints are pin connected.

(c)

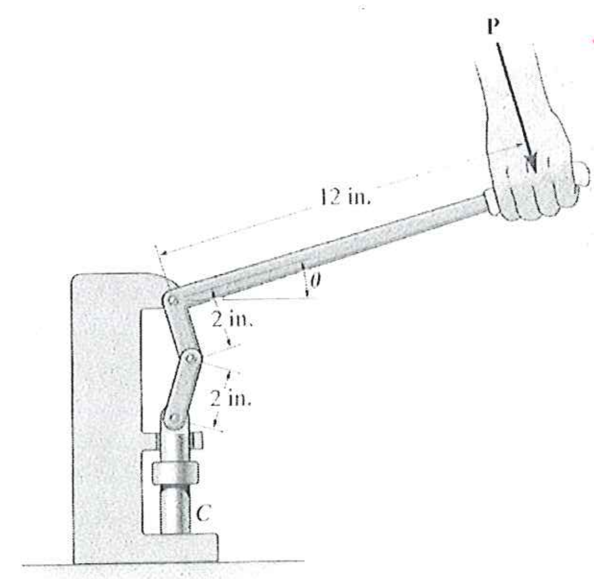
13/29



The thin rod of weight W rests against the smooth wall and floor. Determine the magnitude of force **P** needed to hold it in equilibrium.

(d)

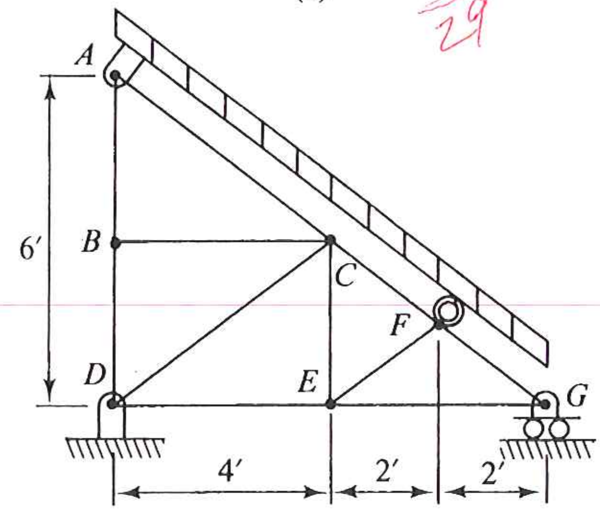
11/29



If a force of **P** = 30 lb is applied perpendicular to the handle of the toggle press, determine the compressive force developed at C if $\theta = 30°$.

(e)

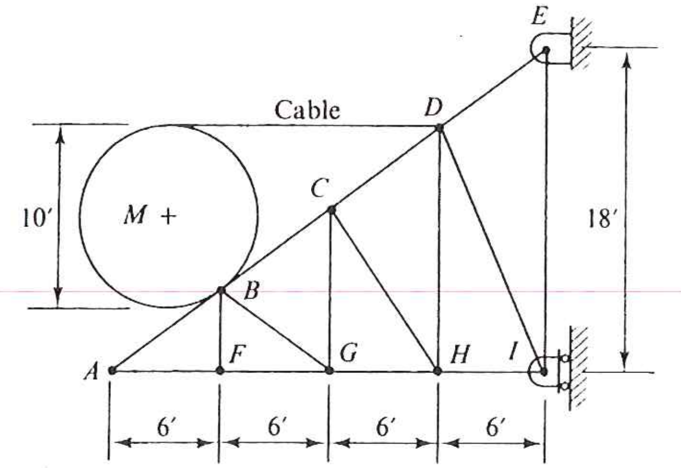
6/29



The gravel chute is supported by a truss at points *A* and *F*. The chute and contents, when full, weigh 300 lb per running foot. Determine the forces in members *CE* and *EF* of the truss.

(f)

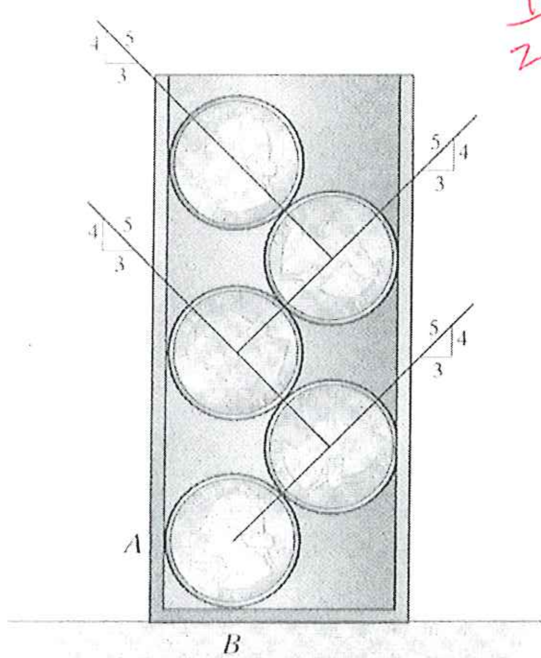
8/29



The 5000-lb drum *M* is supported by the truss and a cable which is wrapped around the drum and fastened to the truss at *B* and *D*. Compute the forces in members *BC*, *GC*, and *GH* using method of sections.

(g)

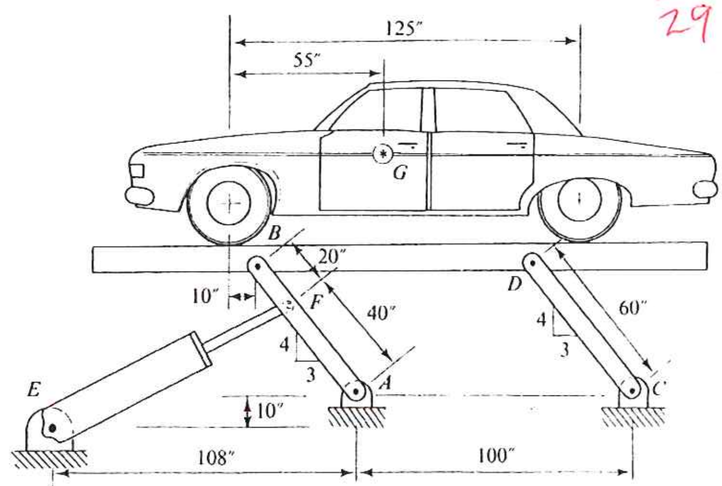
11/29



Five coins are stacked in the smooth plastic container shown. If each coin weighs 0.0235 lb, determine the normal reactions of the bottom coin on the container at points *A* and *B*.

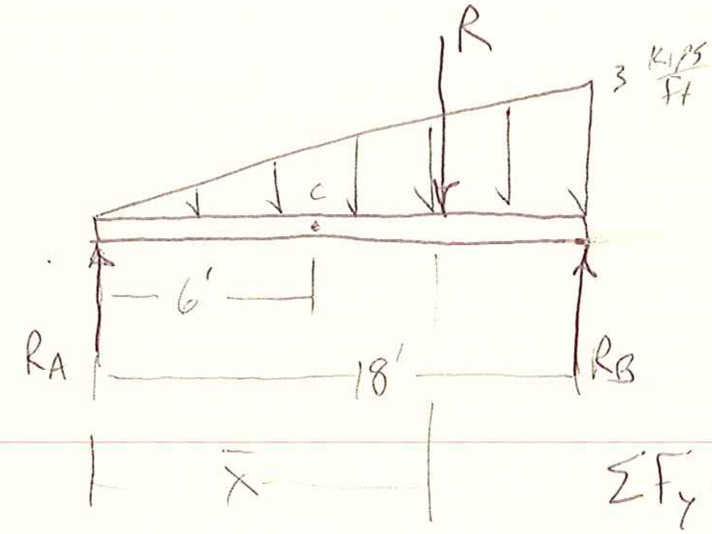
(h)

4/29



The hydraulic automobile hoist consists of two identical frames like the one shown. The hydraulic piston is centered between the two frames. A 4000-lb automobile is supported in the position shown (2000 lb on each frame). Determine the force on the piston rod *EF* on each of the two members *AB*, and the bearing reaction at *A* on *AB*.

PROB. 7-10 HIBBLER p. 348



$$R = \frac{1}{2}(18^{ft})(3\,\tfrac{kip}{ft}) = 27^{kip}$$

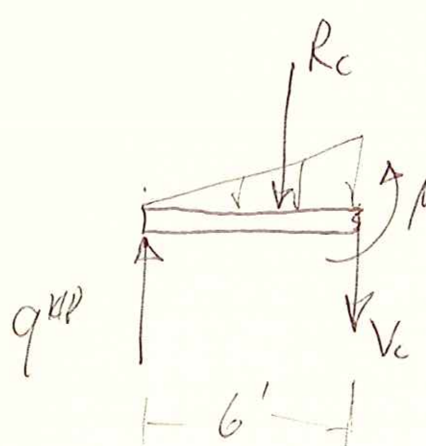
$$\bar{x} = \frac{2}{3}(18^{ft}) = 12^{ft}$$

$$\Sigma F_y = 0: \quad R_A + R_B = 27$$

$$\Sigma M_A = 0 \; +\circlearrowleft: \quad -(12^{ft})(27^{kip}) + (18^{ft})(R_B) = 0$$

$$R_B = 18^{kip}, \quad R_A = 27 - 18 = 9^{kip}$$

FBD A/C:



$$R_c = \frac{1}{2}(6^{ft})(1\,\tfrac{kip}{ft}) = 3^{kip}$$

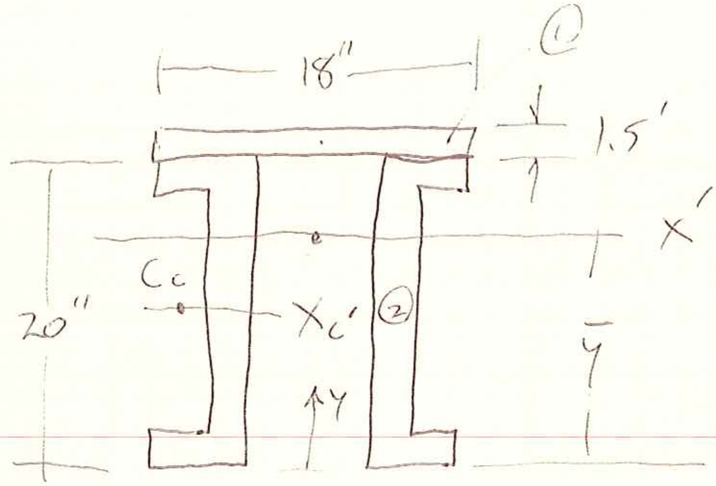
$$\Sigma F_y = 0: \quad 9 - 3 - V_c = 0$$

$$\boxed{V_c = 6^{kips}}$$

$$\Sigma M_c = 0: \quad -(6^{ft})(9^{kip}) + \frac{1}{3}(6^{ft})(3^{kip}) + M_c = 0$$

$$\boxed{M_c = 48^{kip\text{-}ft}}$$

PROB. 10-35, HIBBLER, P. 534



FIND $I_{x'}$

$A_c = 11.8^{IN^2}$, $\bar{I}_{xc'} = 349^{IN^4}$

FIRST FIND $\bar{Y}$:

$$\bar{Y} = \frac{\Sigma \bar{y}_i A_i}{\Sigma A_i}$$

$$\bar{y}_1 = 20 + \tfrac{1}{2}(1.5^{IN}) = 20.75^{IN}$$

$$A_1 = (1.5^{IN})(18^{IN}) = 27.0^{IN^2}$$

$$\bar{y}_2 = 10^{IN}, \quad A_2 = 2(11.8^{IN^2}) = 23.6^{IN^2}$$

$$\bar{Y} = \frac{(20.75^{IN})(27^{IN^2}) + (10)(23.6)}{(27) + (23.6)} = \frac{796.2}{50.6} = 15.73^{IN}$$

$\bar{Y} =$ ~~[illegible]~~ 15.73^{IN}

AREA 1 $\quad (I_{x'})_1 = \bar{I}_1 + A_1 d^2$

$$\bar{I}_1 = \tfrac{1}{12} b h^3 = \tfrac{1}{12}(18^{IN})(1.5^{IN})^3 = 5.062^{IN^4}$$

~~$(I_{x'})_1 = (5.062) + (27^{IN^2})(20 - 15.73^{IN})^2 = 497.3^{IN^4}$~~

$I_{x',c} = 2(\bar{I}_c + A_c d^2)$

$I_{x',c} = 2[(349 \text{ IN}^4) + (11.8 \text{ IN}^2)(15.73 - 10 \text{ IN})^2]$

$I_{x,c} = 1473 \text{ IN}^4$

$I_{x'} = (I_{x'})_1 + (I_{x'})_c = 497.3 + 1473 \text{ IN}^4$

$I_{x'} = 1970 \text{ IN}^4$

$(I_{x'})_1 = (5.062) + (27 \text{ IN}^2)(20 - 15.73 + \frac{1.5}{2})^2 = 685.4 \text{ IN}^4$

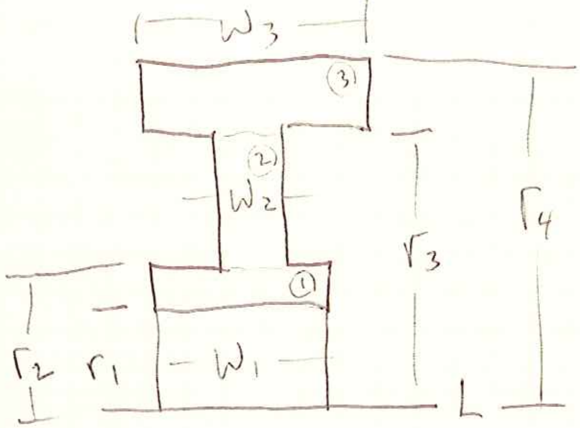
$(I_{x'})_c = 2(\bar{I}_c + A_c d^2)$

$(I_{x'})_c = 2[(349 \text{ IN}^4) + (11.8 \text{ IN}^2)(15.73 - 10)^2] = 1473 \text{ IN}^4$

$I_{x'} = (I_{x'})_1 + (I_{x'})_c = 685.4 + 1473 \text{ IN}^4$

$I_{x'} = 2158 \text{ IN}^4$

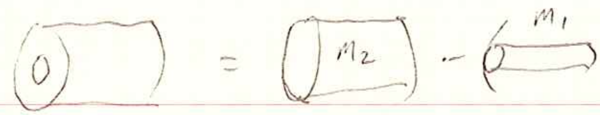
PROB, 8. 164 | BEDFORD p. 427



$M = 14^{kg}$

FIND I_L

$I_L = I_1 + I_2 + I_3$



$I_1 = \frac{1}{2} m_2 r_2^2 - \frac{1}{2} m_1 r_1^2$

NEED DENSITY OF MATL:

$V_T = V_1 + V_2 + V_3$

$V_1 = \pi(r_2^2 - r_1^2) W_1 = \pi\left[(60^{mm})^2 - (35)^2\right](100^{mm})$

$V_1 = 7.461 \times 10^5 \ mm^3$

$V_2 = \pi(r_3^2 - r_2^2) W_2 = \pi\left[(220)^2 - (60)^2\right](50)$

$V_2 = 7.037 \times 10^6 \ mm^3$

$V_3 = \pi(r_4^2 - r_3^2) W_3 = \pi\left[(250)^2 - (220)^2\right](150)$

$V_3 = 6.644 \times 10^6 \ mm^3$

$V_T = 1.443 \times 10^7 \ mm^3$

$M = \rho V \qquad \rho = \frac{M}{V_T} = \frac{14^{kg}}{1.443 \times 10^7 mm^3} = 9.704 \times 10^{-7} \ \frac{kg}{mm^3}$

$m_2 = \rho V_2 = \rho \cdot \pi r_2^2 W_1 \ , \quad m_1 = \rho V_1 = \rho \cdot \pi r_1^2 W_1$

PROB. 8.164 CONT.

~~$m_3 = \rho V_3 = \rho \cdot \pi r_3^2 w_2 , \quad m_4 = \rho V_4 = \rho \cdot \pi r_4^2$~~

$$I_1 = \frac{1}{2} m_2 r_2^2 - \frac{1}{2} m_1 r_1^2$$

$$= \frac{1}{2} \cdot \pi \rho r_2^2 w_1 \cdot r_2^2 - \frac{1}{2} \pi \rho r_1^2 w_1 \cdot r_1^2$$

$$= \frac{\pi}{2} \rho w_1 (r_2^4 - r_1^4)$$

$$I_2 = \frac{\pi}{2} \rho w_2 (r_3^4 - r_2^4)$$

$$I_3 = \frac{\pi}{2} \rho w_3 (r_4^4 - r_3^4)$$

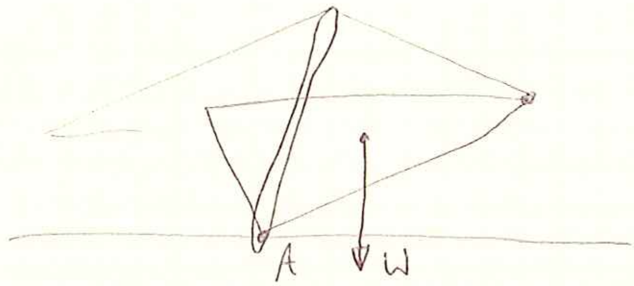
$$I_1 = \frac{\pi}{2}\left(9.704 \times 10^{-7} \frac{\text{kg}}{\text{mm}^3}\right)(100^{\text{mm}})\left[(60)^4 - (35^{\text{mm}})^4\right] = 1747. \ \text{kg} \cdot \text{mm}^2$$

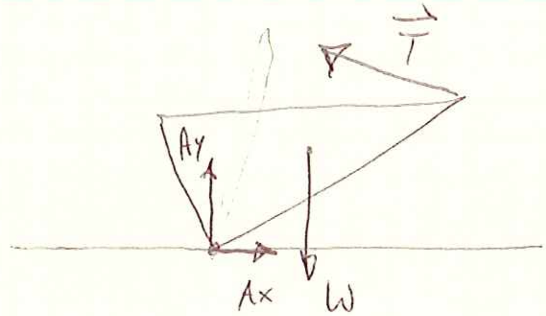
$$I_2 = \frac{\pi}{2}(9.704 \times 10^{-7})(50)\left[(220)^4 - (60)^4\right] = 1.775 \times 10^5 \ \text{kg} \cdot \text{mm}^2$$

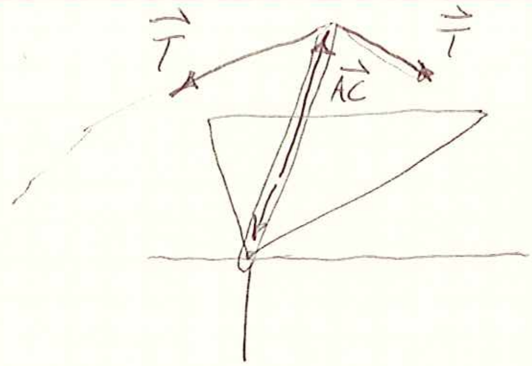
$$I_3 = \frac{\pi}{2}(9.704 \times 10^{-7})(150)\left[(250)^4 - (220)^4\right] = 3.575 \times 10^5 \ \text{kg} \cdot \text{mm}^2$$

$$I_L = 5.368 \times 10^5 \ \text{kg} \cdot \text{mm}^2 \left(\frac{\text{m}}{1000 \ \text{mm}}\right)^2 = \boxed{0.5368 \ \text{kg} \cdot \text{m}^2}$$

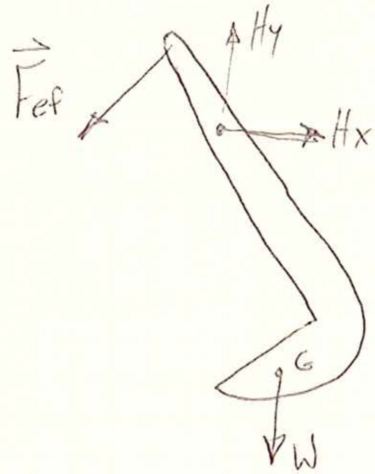
PROB. 6-103 HIBBLER p. 321

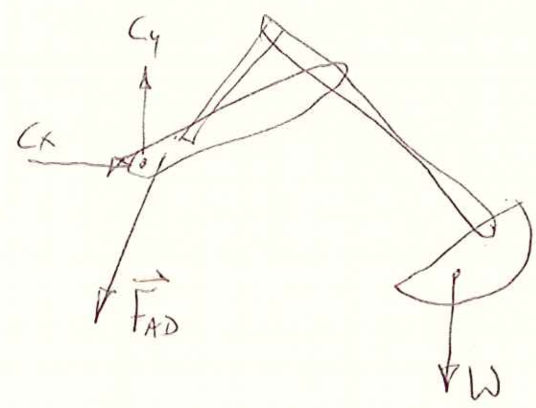




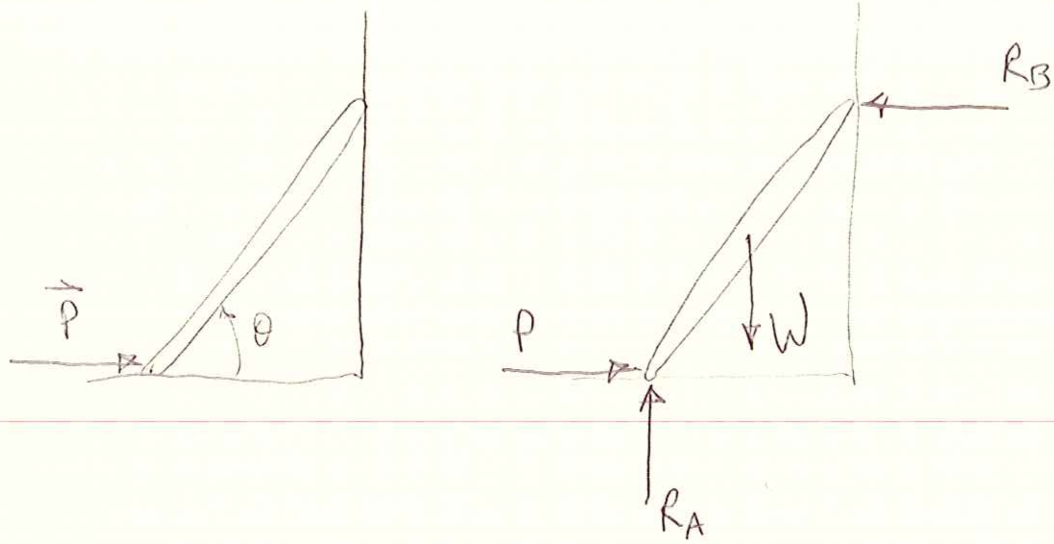


PROB. 6-111 HIBBLER p. 323

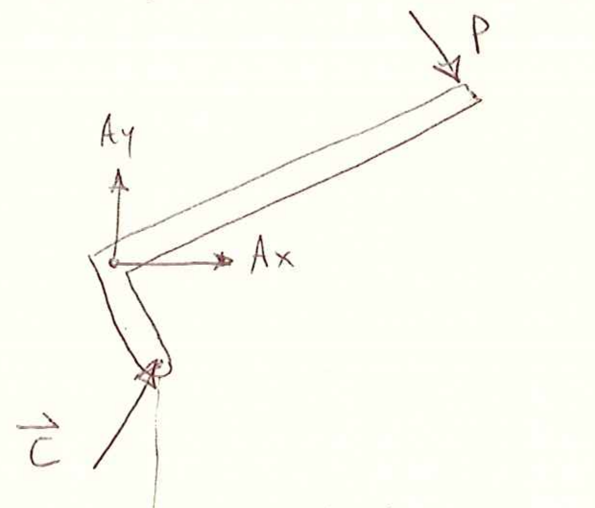




PROB. 11-1 HIBBLER p. 584

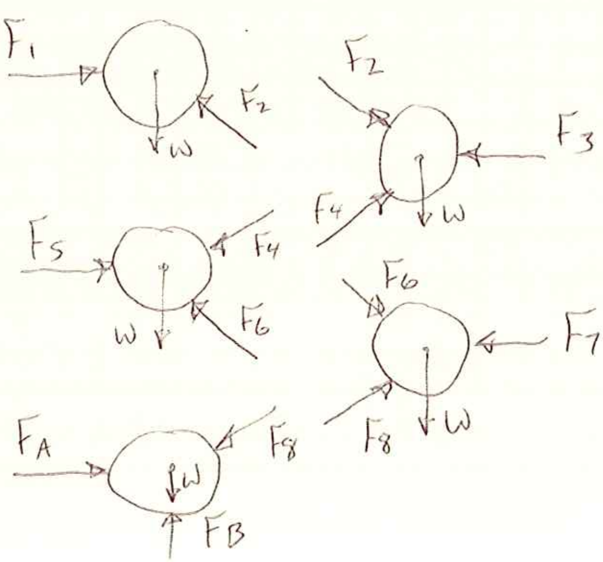


PROB. 11-8 HIBBLER P. 585



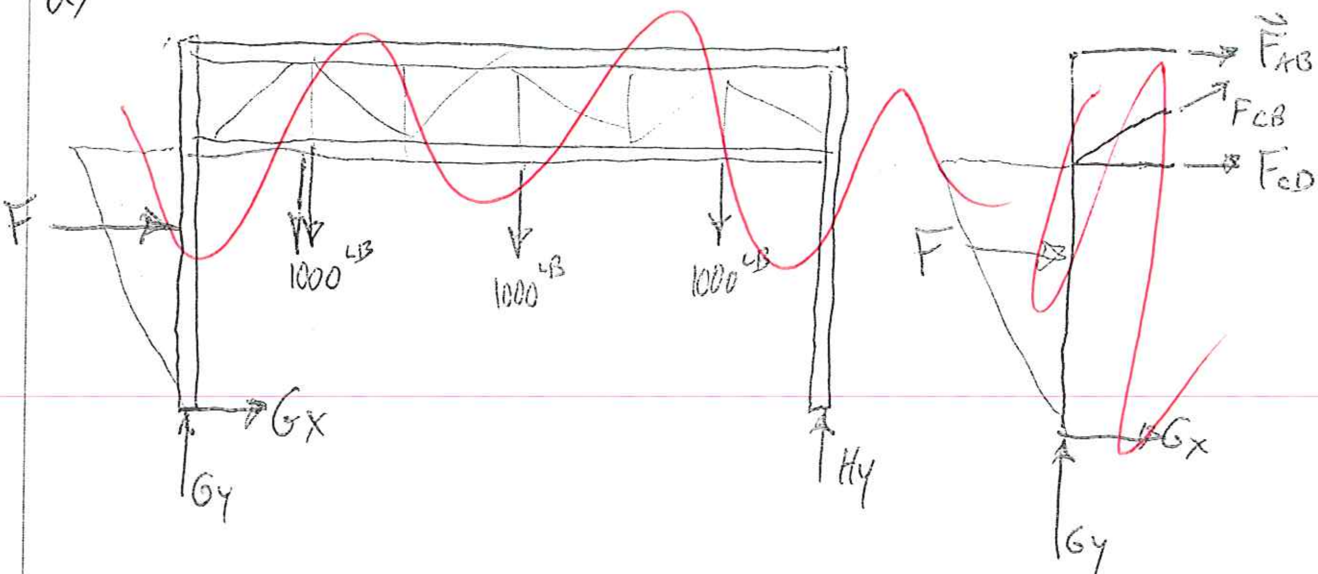
PROB. 6-105 HIBBLER P. 322

PROB. 11-10 HIBBLER P. 586



PROB. 3 CONT.

d)



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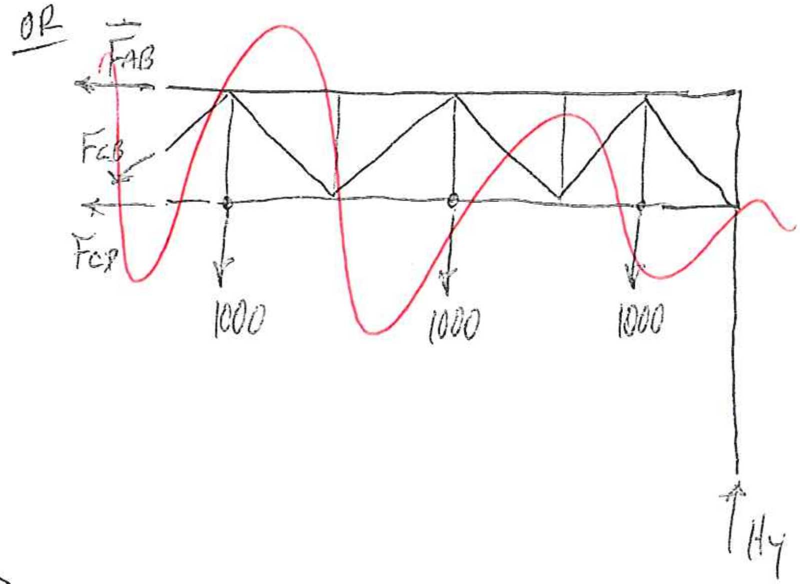
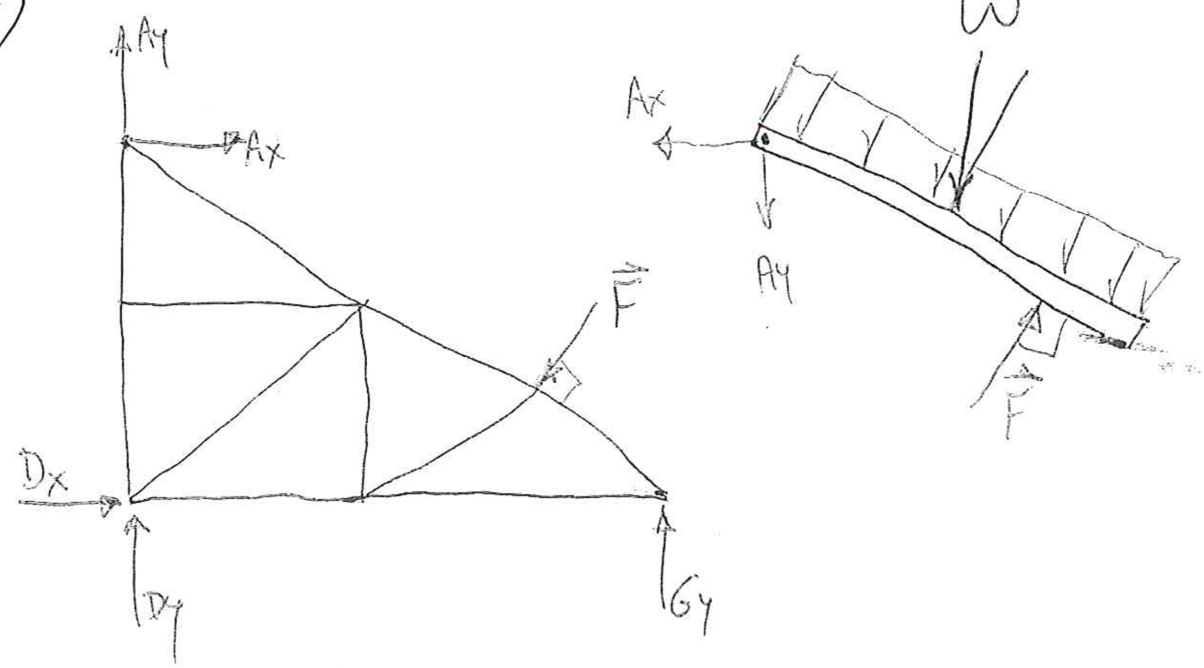
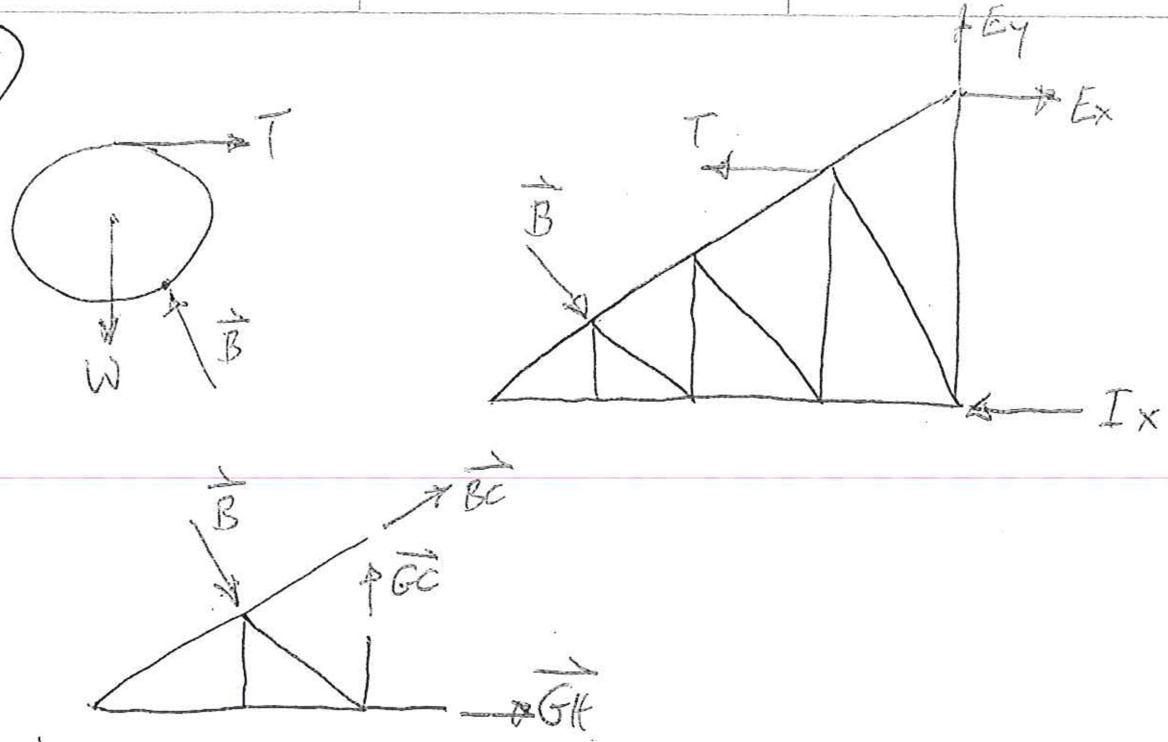


e)

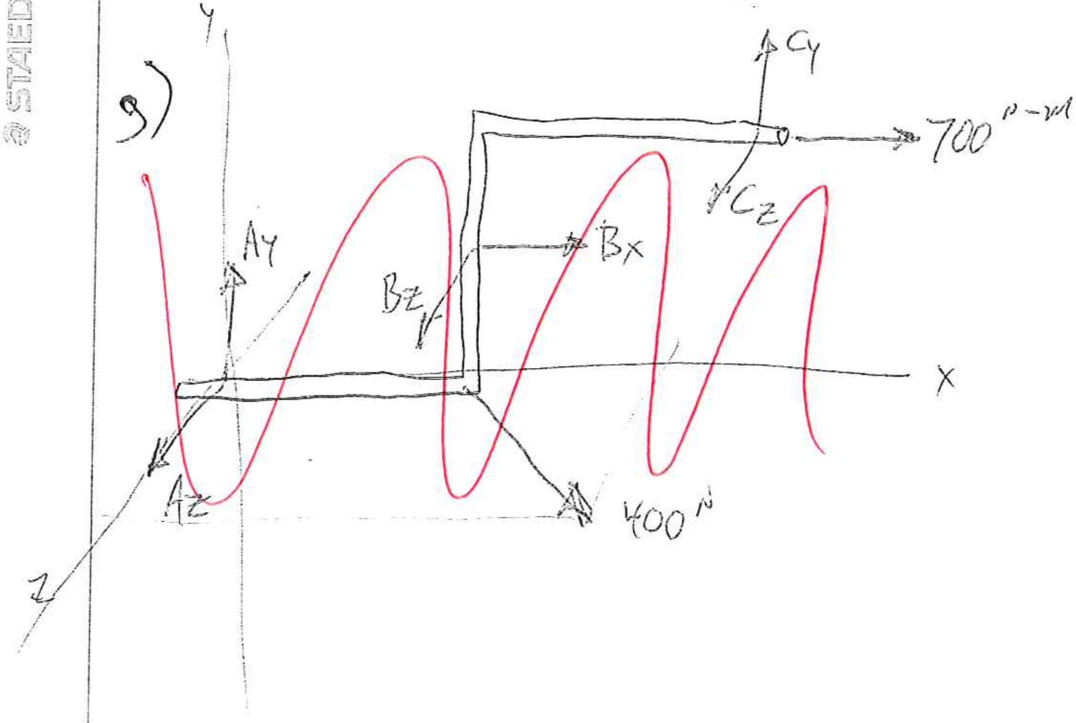


PROB. 3 CONT.

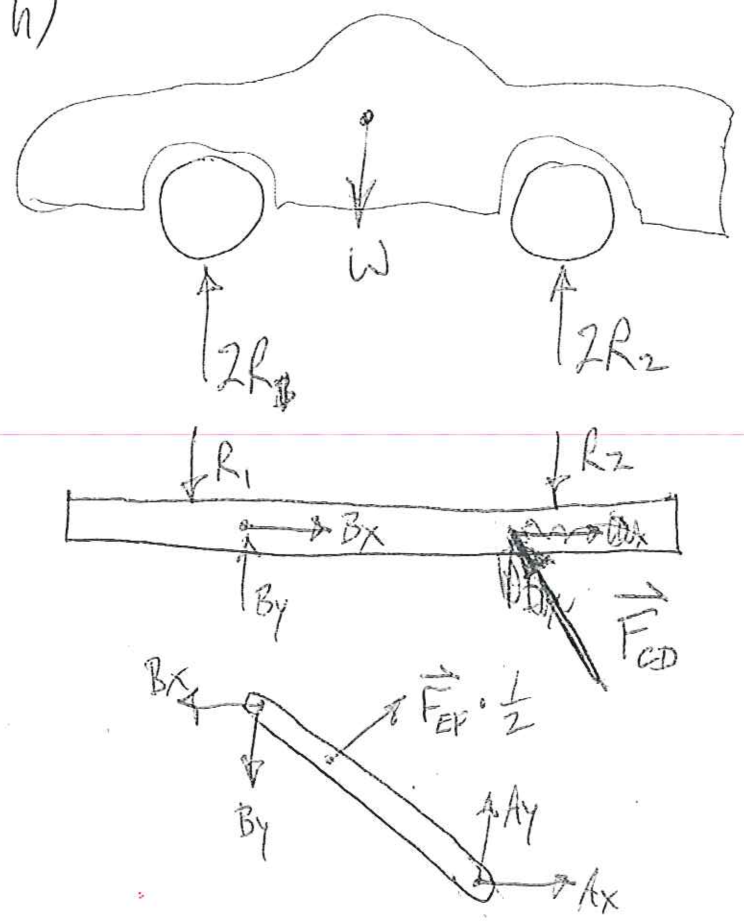
f)



g)



h)


W
2R1
2R2
R1
R2
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By
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Dy
$\vec{F}_{CD}$
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Ay
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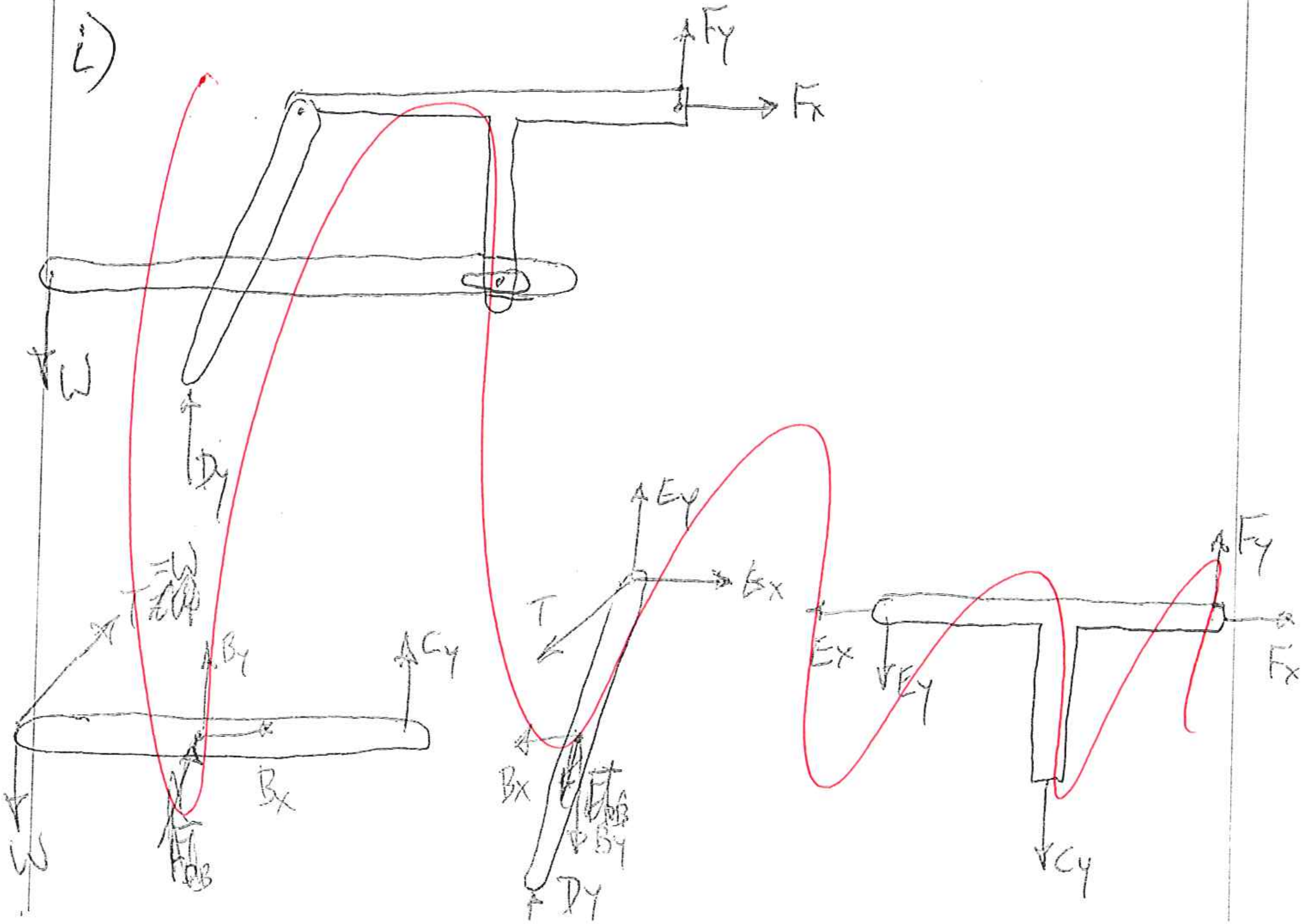
i)


Fy
Fx
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W
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