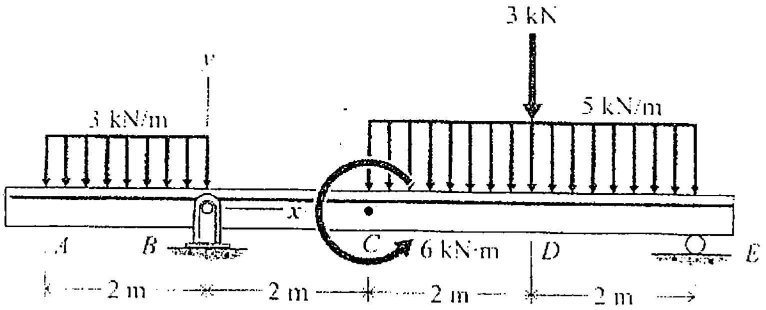
CIE200 Statics/F10 **Test #2** **NAME**________________

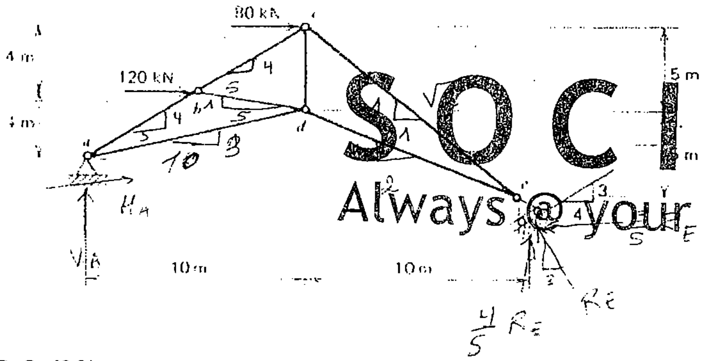
PROB-1-(25)

The beam is supported by a roller at E and pin at B. Determine the reactions at the supports.



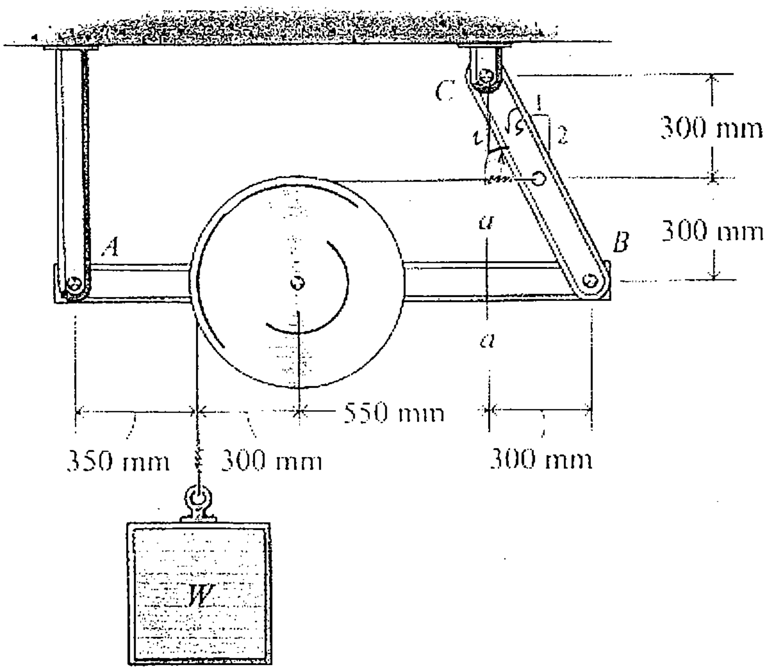
PROB-2-(30)

For the truss shown below determine the forces in all the members.



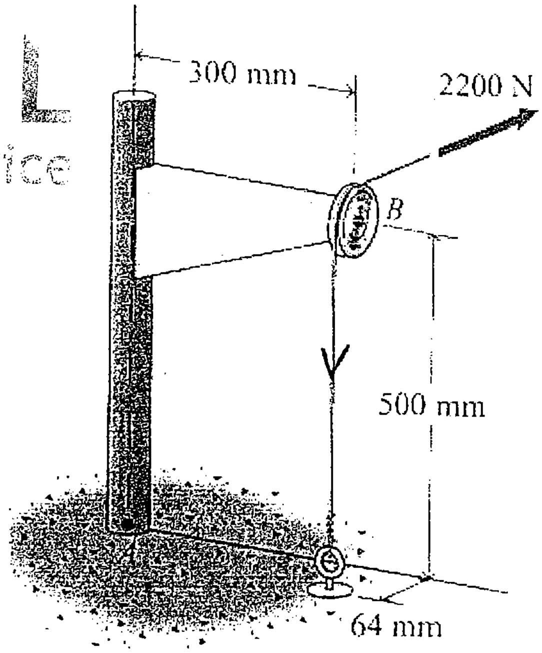
PROB-3-(30)

The weight of 1000 N is attached to the frame by a cable about pulley at D. Draw the Free Body diagram of member ADB of the frame showing magnitude and direction of the forces.



PROB-4-(15)

Determine the reactions at the fixed support at A.



Solution — Test #2

Prob-1-

$$\Sigma M_B) = 0 \Longrightarrow -(3)(2)(1) - 6 + (3)(4) + (5)(4)(4) - 6R_E = 0$$

$$\Longrightarrow \boxed{R_E = 13.33 \text{ KN}}$$

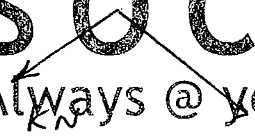
$$\Sigma F \uparrow = 0 \Longrightarrow -(3)(2) + V_B - 3 - (5)(4) + R_E = 0$$

$$\Longrightarrow \boxed{V_B = 15.67 \text{ KN}}$$

Prob-2-

$$\Sigma M_A) = 0 = 80 \times 8 + 120 \times 4 - \left(\frac{4}{5} R_E\right)(20) + \frac{3}{5} R_E (10-8)$$

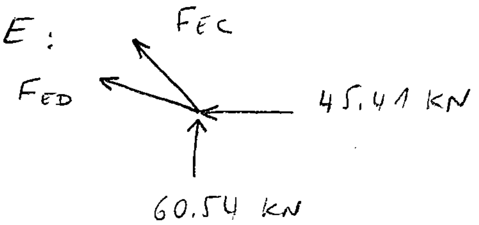
$$\Longrightarrow R_E = 75.68 \text{ KN}$$



$$\frac{4}{5} R_E = 60.54 \text{ KN} \qquad \frac{3}{5} R_E = 45.41 \text{ KN}$$

$$V_A = 60.54 \text{ KN} \downarrow \qquad H_A = 154.59 \text{ KN} \leftarrow$$

Joint E:



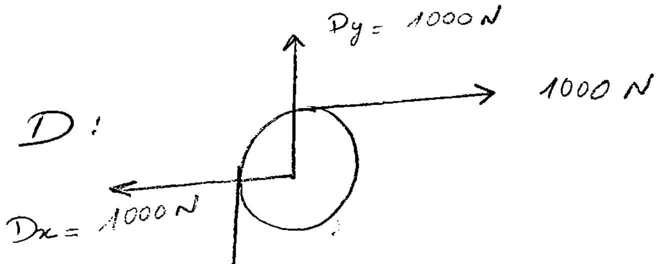
$$\Sigma \overrightarrow{F} = 0 = \frac{-2}{\sqrt{5}} F_{ED} - \frac{1}{\sqrt{2}} F_{EC} - 45.41$$

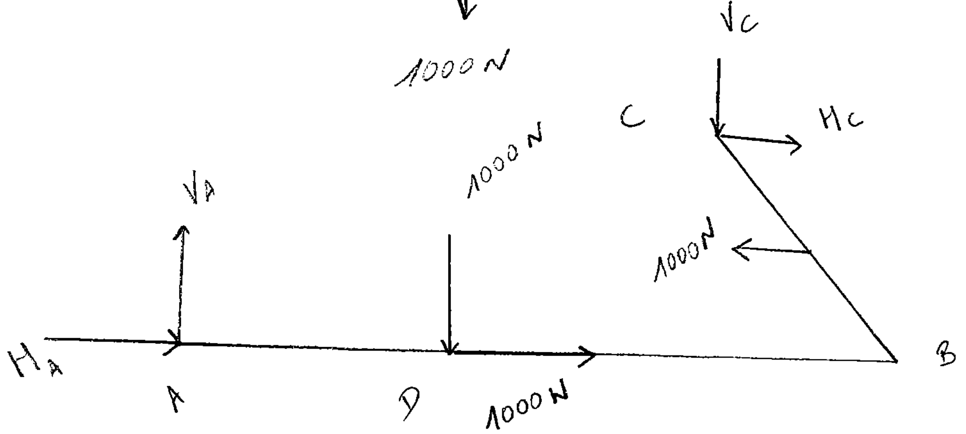
$$\Sigma F \uparrow = 0 = -\frac{1}{\sqrt{5}} F_{ED} + \frac{1}{\sqrt{2}} F_{EC} + 60.54$$

$$\Longrightarrow \boxed{\begin{aligned} F_{ED} &= 33.83 \text{ KN } (T) \\ F_{EC} &= -107.03 \text{ KN } (C) \end{aligned}}$$

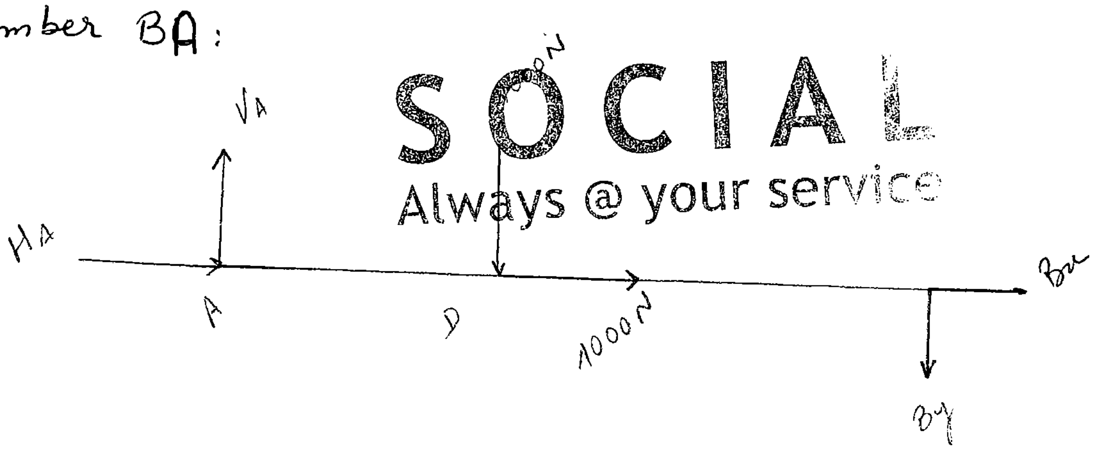
Prob -3-

Pulley D:





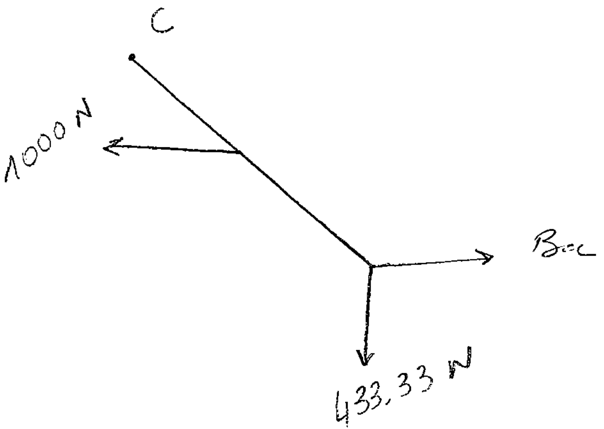
Member BA:



$$\Sigma M_A) = 0 \Rightarrow 1000(650) + B_y(1500) = 0$$

$$\Rightarrow \boxed{B_y = -433.33\ N}$$

Member BC:



$$\Sigma M_C) = 0 \Rightarrow 1000(300) + 433.33(300) - 600\,B_x = 0$$

$$\Rightarrow \boxed{B_x = 716.67\ N}$$

CIE 200 – STATICS

EXAM No. 1

A

Date: March 29, 2010

Before you start solving the problems, take note of the following:

1- **Make sure you understand the problem question clearly before you start solving.**

2- **Show all your calculations clearly and neatly. Points will be deducted for answers that are not supported by proper calculations.**

3- **Make sure to answer all questions on this booklet. Extra white paper is available, if needed.**

4- **ONLY USE THE FRONT PAGE FOR ANSWERS**

5- **Cheating results in an immediate zero on the exam and a warning issued by the Guidance Office.**

GOOD LUCK!

NAME: [redacted] **ID#:** 200902030

Problem#1: 20 (25 pts)

Problem#2: 15 (25 pts)

Problem#3: 25 (25 pts)

Problem#4: 25 (25 pts)

Total: 85 **(100 pts)**

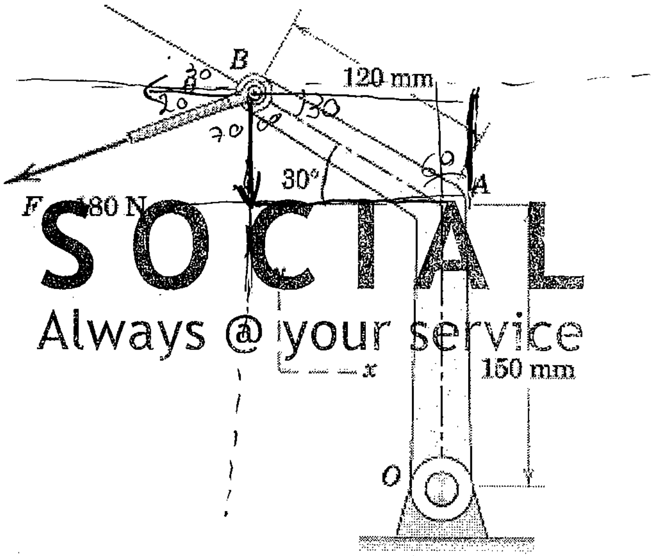
BONUS: 0 **(5pts)**

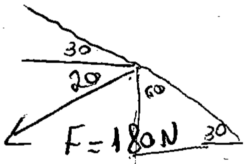
FINAL GRADE: 85/100

Lebanese American University Department of Civil Engineering

NAME: [redacted]

Problem#1: (25pts)
The 180-N force is applied to the end of body *OAB*. If $\theta = 50°$, determine the equivalent force–couple system at the shaft axis *O*.





$$\boxed{\begin{aligned} F_x &= -F \times \cos 20 = -169{,}14\ N \\ F_y &= -F \times \cos 70 = -61{,}56\ N \end{aligned}} \quad \text{on the point O}$$

value value

$$\oplus\ M_0 = |F_y| \times (0{,}120 \times \cos 30) + |F_x| \times (0{,}150 + (0{,}12 \times \cos 60) \ldots 0{,}5$$

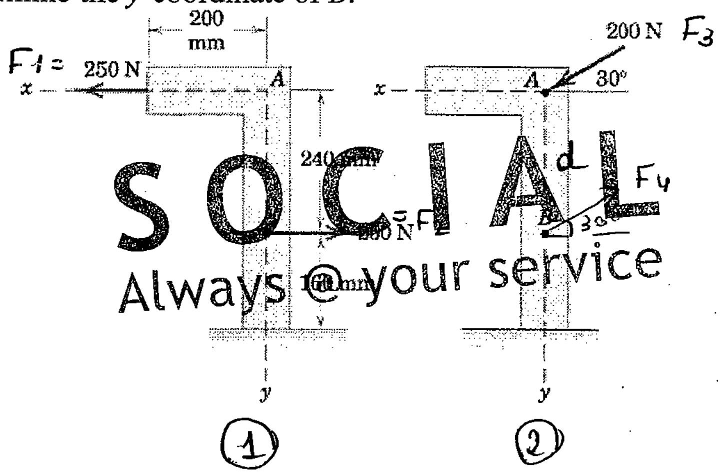
$$= 17{,}577 + 12{,}9276 = \boxed{30{,}5}\ N/m$$

Calculation mistake

-5

NAME: [redacted]

Problem#2: (25pts)
The angle plate is subjected to the two 250-N forces shown. It is desired to replace these forces by an equivalent set consisting of the 200-N force applied at *A* and a second force applied at *B*. Determine the *y*-coordinate of *B*.



$F_1 = 250\vec{i}$ $|F_1 + F_2|$ $F_1 + F_2 = 0$

$F_2 = -250\vec{i}$

$F_{3x} = 200\cos 30$ $F_{3x} + F_{4x} = 0$

$F_{3y} = 200\sin 30$ $F_{3y} + F_{4y} = 0$

$F_{4x} = ?$ $F_{4x} = -173{,}2\ N$

$F_{1y} = ?$ $F_{4y} = -100\ N$

$\tan^{-1}\left(\frac{F_y}{F_x}\right) = 30°$

(+) (1) M of the couple (1) $= \{250 \times 0{,}24\}$ N/m.

$d = y_B$.

(+) M of the couple (2) $= \{200 \times d\}$ N/m.

or (+) M of the couple (1) $=$ (+) M of the couple (2)

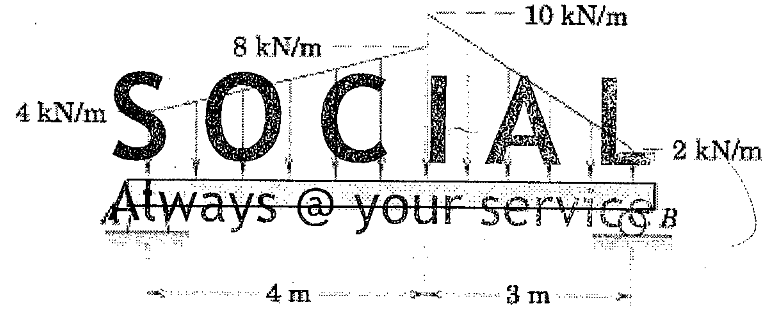
$250 \times 0{,}24 = 200 \times d$

$d = 0{,}3\ m = 300\ mm.$ X −10

Lebanese American University Department of Civil Engineering

NAME: [redacted]

Problem#3: (25pts)
Replace the distributed loading with an equivalent force, and specify its location on the beam measured from point A.

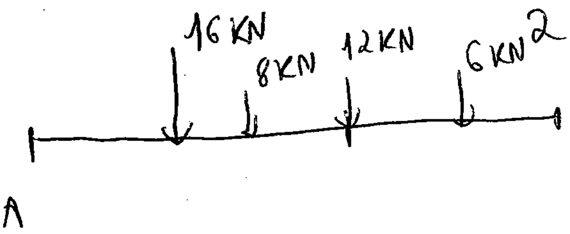


1st rectangle $F_1 = 4 \times 4 = 16\ KN$ $d_1 = 2\ m$ (from A)

1st triangle $F_2 = \frac{4 \times 4}{2} = 8\ KN$ $d_2 = 2{,}667\ m$ from (A)

2nd rectangle $F_3 = 2 \times 3 = 6\ KN$ $d_3 = 5{,}5\ m$ from (A)

2nd triangle $F_4 = \frac{8 \times 3}{2} = 12\ KN$ $d_4 = 5\ m$ from A



$\oplus \downarrow F_{Resultant} = 16 + 8 + 6 + 12 = 42\ KN$

$\oplus \downarrow \vec{F_R} = \{42 \vec{j}\}\ KN$

$\oplus \overset{\curvearrowright}{M_A} = F_1 \times d_1 + F_2 \times d_2 + F_3 \times d_3 + F_4 \times d_4$

$= (16 \times 2) + (8 \times 2{,}667) + (6 \times 5{,}5) + (12 \times 5)$

$\oplus \overset{\curvearrowright}{M_A} = 146{,}336\ KN/m$

or $\overset{\curvearrowright}{M_A}\oplus = d_F \times F$

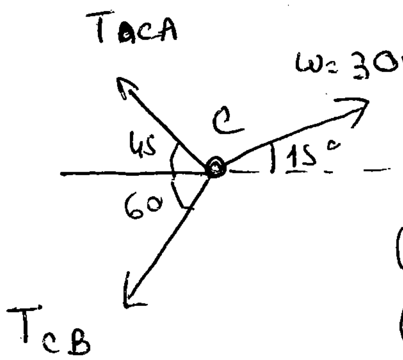
$d_{(\text{of } f \text{ from } A)} = \frac{\overset{\curvearrowright}{M_A}\oplus}{F} = \frac{146{,}336}{42} = 3{,}48\ m$

NAME: [redacted]

Problem#4: (25pts)
Three cables are joined at the junction ring *C*. Determine the tensions in cables *AC* and *BC* caused by the weight of the 30-kg cylinder.

$T_1 = ($tension on the corde AC)

$T_2 = ($Tension on the corde BC)



$W = 30 \times 10 = 300$ N

(1) $\xrightarrow{+} \sum F_x = 0$

$W \times \cos 15 - T_1 \times \cos 45 - T_2 \times \cos 60 = 0$

(2) $\uparrow + \sum F_y = 0$

$W \times \sin 15 + T_1 \times \sin 45 - T_2 \times \sin 60$

$W = 300$ N

$W = 30 \times 10 = 300$ N

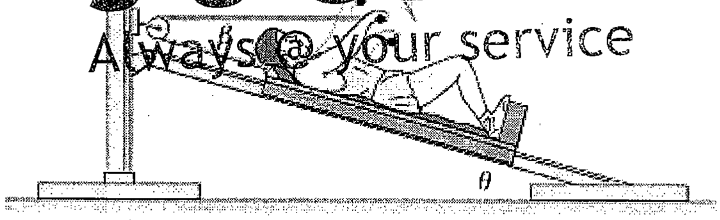
2 equations with 2 unknown.

$$\boxed{\begin{array}{l} T_1 = 219{,}6 \text{ N} \\ T_2 = 268{,}97 \text{ N} \end{array}}$$

NAME:____

BONUS QUESTION (5PTS)

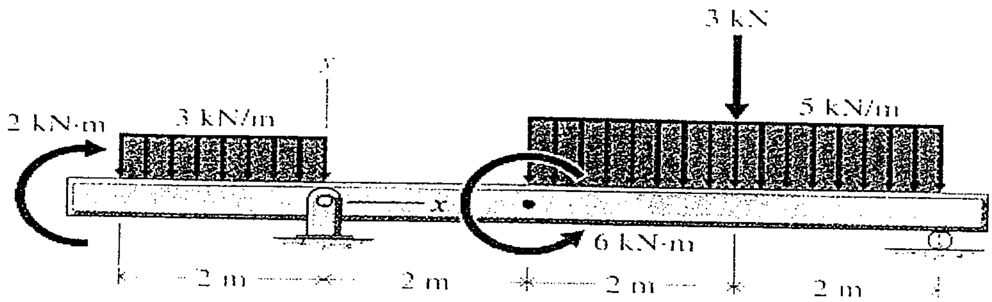
The exercise machine is designed with a lightweight cart which is mounted on small rollers so that it is free to move along the inclined ramp. Two cables are attached to the cart—one for each hand. If the hands are together so that the cables are parallel and if each cable lies essentially in a vertical plane, determine the force P which each hand must exert on its cable in order to maintain an equilibrium position. The mass of the person is 70 kg, the ramp angle θ is 15° and the angle β is 18°.



CIE200 Statics/F10 **Test #3** **NAME**____________________

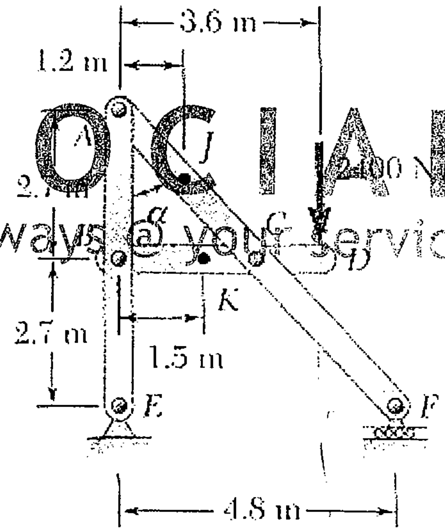
PROB-1-(30)

Draw the moment and shear diagrams for the beam shown below.



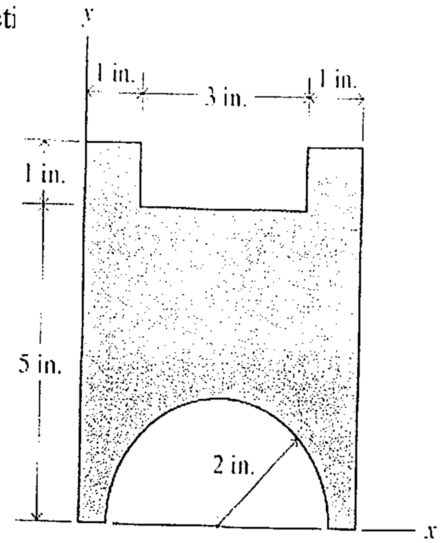
PROB-2-(30)

Find the internal normal force, shear force, and moment acting on a point at section K of member BCD and J of member ACF of the frame shown below.



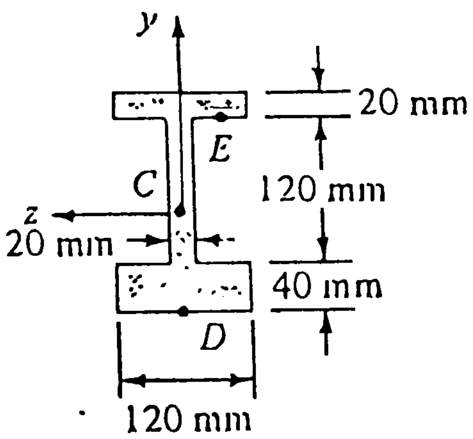
PROB-3-(15)

Determine the location of the centroid of the secti



PROB-4-(25)

Determine the moment of inertia about the x and y centroidal axes for the Channel beam shown below.



Solution   Test #3

Prob-1-

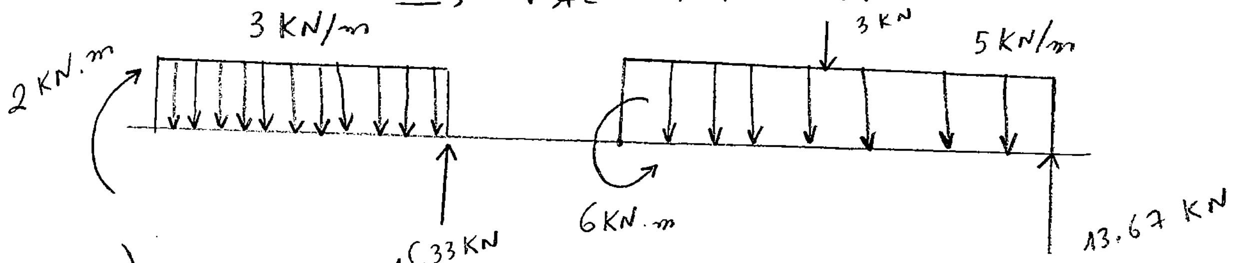
Let A be the pin and B the roller

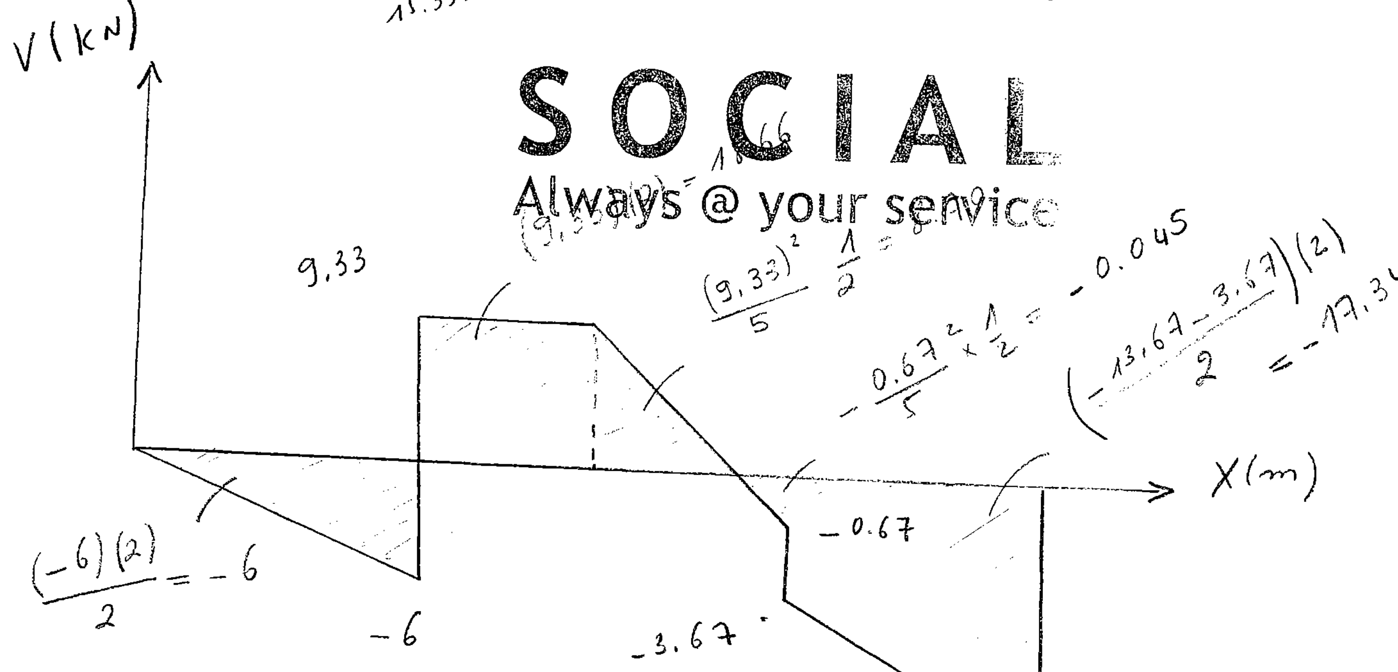
$$\Sigma M_A) = 0 \Rightarrow 2 - (3)(2)(1) - 6 + 3(4) + 5(4)(4) - 6R_E = 0$$

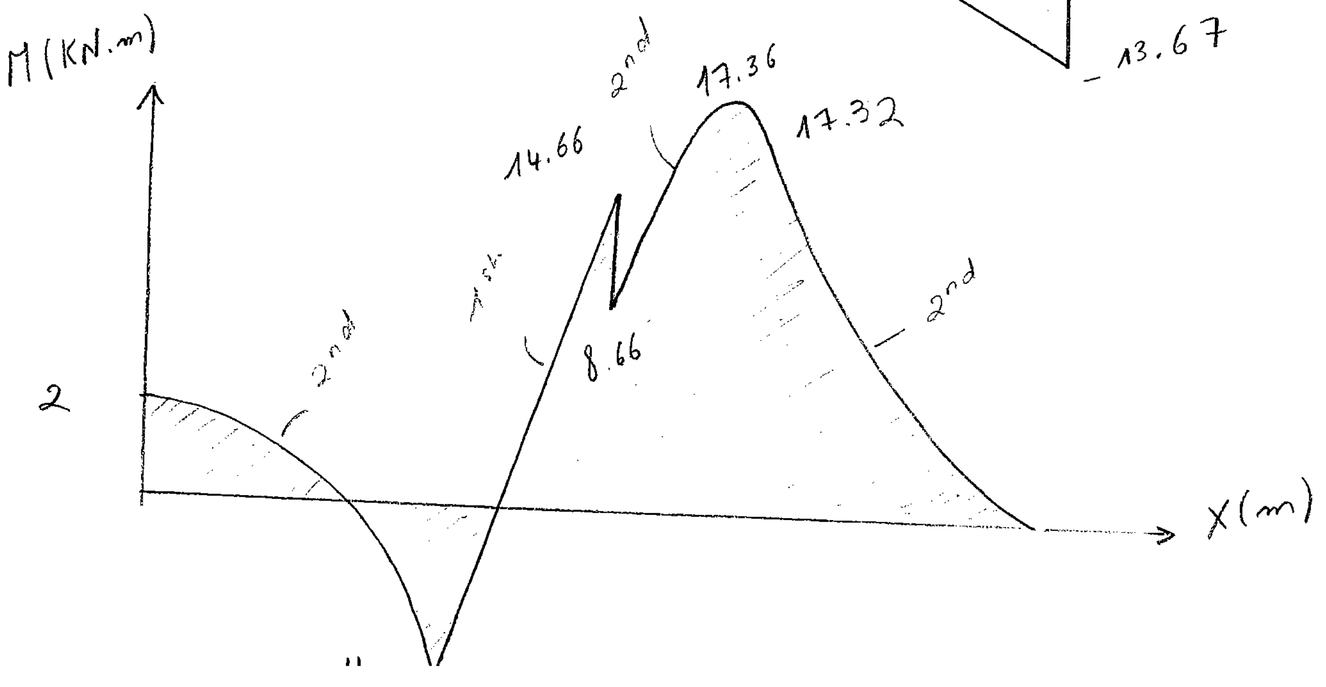
$$\Rightarrow R_E = 13.67 \text{ KN}$$

$$\Sigma F\uparrow = 0 \Rightarrow -(3)(2) + V_A - 3 - 5(4) + R_E = 0$$

$$\Rightarrow V_A = 15.33 \text{ KN.}$$







$$\sum \vec{F} = 0 \Rightarrow -V_y \cos 42.71 + N_y \sin 42.71 = 0$$

$$\sum F \uparrow = 0 \Rightarrow 1800 - V_y \sin 42.71 - N_y \cos 42.71 = 0$$

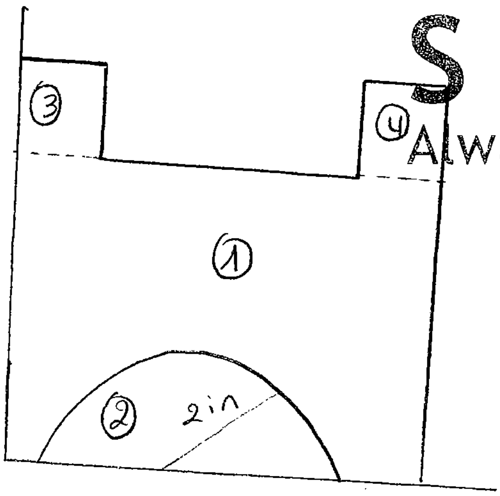
$$\Rightarrow \boxed{\begin{array}{l} V_y = 1220.92\,N \\ N_y = 1322.63\,N \end{array}}$$

$$\sum M_{cut}) = 0 \Rightarrow 1800\,(1.2) - M_y = 0$$

$$\Rightarrow \boxed{M_y = 2160\ N.m}$$

Prob -3-

By inspection $\bar{x} = \dfrac{1+3+1}{2} = 2.5$ in



$$\bar{y} = \frac{\sum y_i A_i}{\sum A_i} = \frac{(2.5)(5)(5) - \frac{4(2)}{3\pi}\left(\frac{\pi (2)^2}{2}\right) + 2\big(5.5\,(1)\big)}{25 - 2\pi + 2}$$

$$\bar{y} = 3.29 \text{ in}$$

Prob -4-

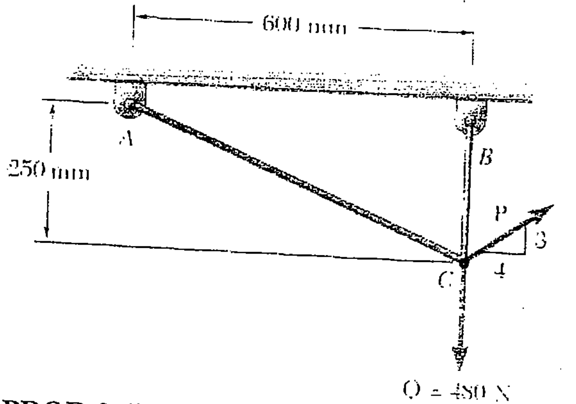
$$\bar{y} = \frac{\sum y_i A_i}{\sum A_i} = \frac{20 \times 40 \times 120 + 100 \times 120 \times 20 + 170 \times 20 \times 120}{40 \times 120 + 120 \times 20 + 20 \times 120}$$

$$\bar{y} = 77.5 \text{ mm.}$$

CIE 200 Statics/F10 **Test #1** **NAME**______________________

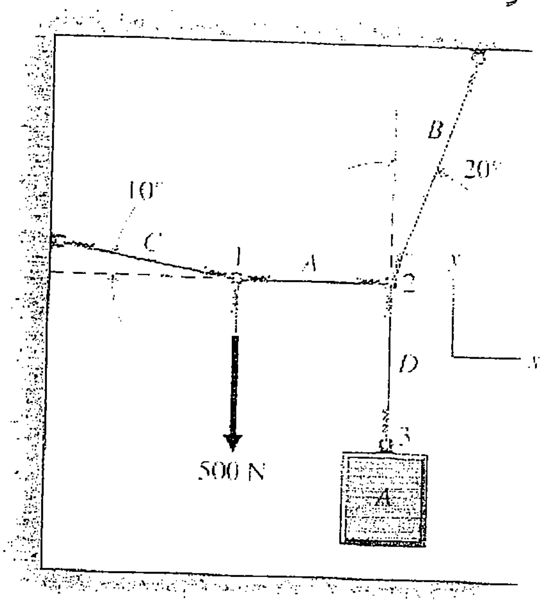
PROB-1-(15)

Two cables are tied together at C and loaded as shown. Knowing that P = 360 N. Determine the tension in the cables.



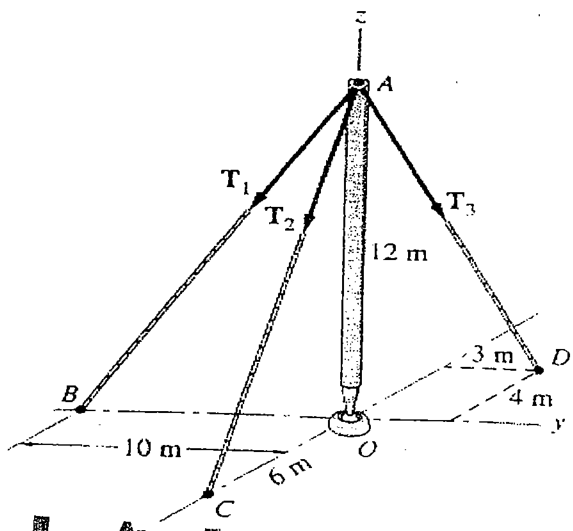
PROB-2-(25

The cable system shown in the Figure is being used to lift body A. The system is in equilibrium at the cable positions shown in the Figure when a 500-N force is applied at joint 1. Determine the tensions in all the cables and the mass of body *A* that is being lifted.



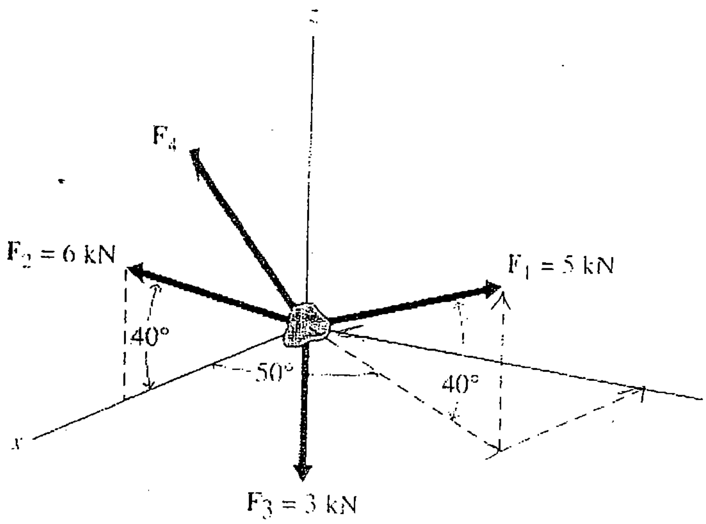
PROB-3-(30)

Three cable tensions T_1, T_2, and T_3 act at the top of the flagpole. Given that the resultant force for the three tensions is R = (-400k) N. Find the magnitudes of each of the cable tensions.



PROB-4-(30)

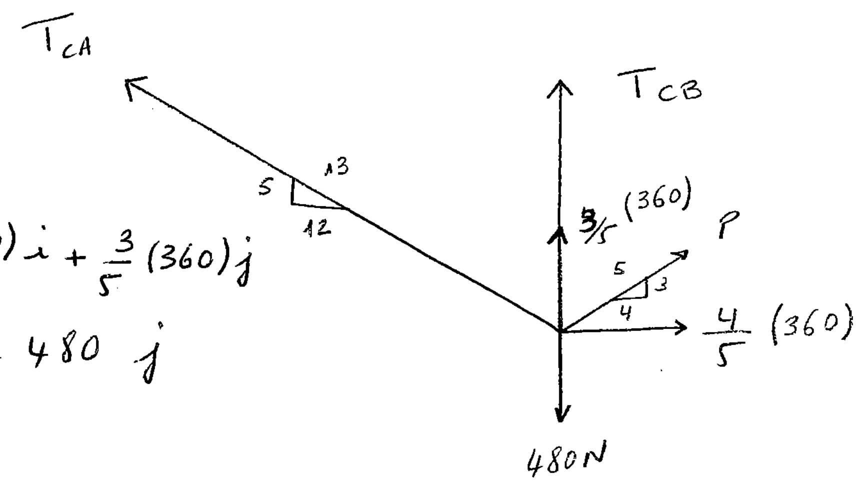
The particle shown in the Figure below is in equilibrium under the action of the four forces shown on the free-body diagram. Determine the magnitude and the coordinate direction angles of the unknown force F_4.



Solution

Test #1

Prob-1-



$P = \frac{4}{5}(360)\,i + \frac{3}{5}(360)\,j$

$Q = 0\,i - 480\,j$

$$\Sigma F_x = 0 \Rightarrow -\frac{12}{13}T_{CA} + \frac{4}{5}(360) = 0$$

$$\Rightarrow \boxed{T_{CA} = 312\,N}$$

$$\Sigma F_y = 0 \Rightarrow T_{CB} + \frac{3}{5}(360) - 480 + \frac{5}{13}(312) = 0$$

$$\Rightarrow \boxed{T_{CB} = 144\,N}$$

Prob-2-

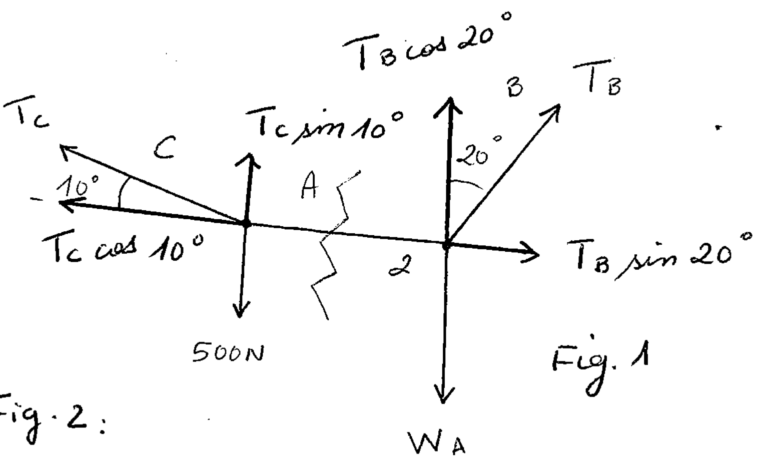


Fig. 1

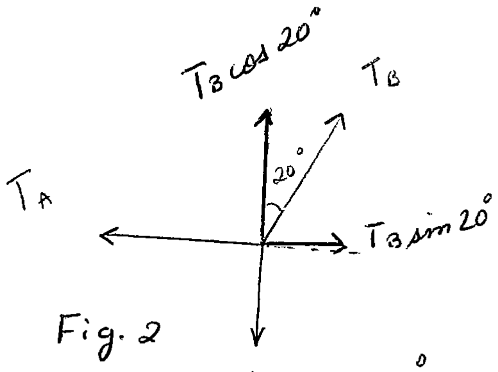


Fig. 2

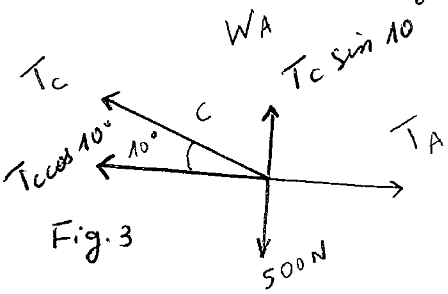


Fig. 3

From Fig. 2:

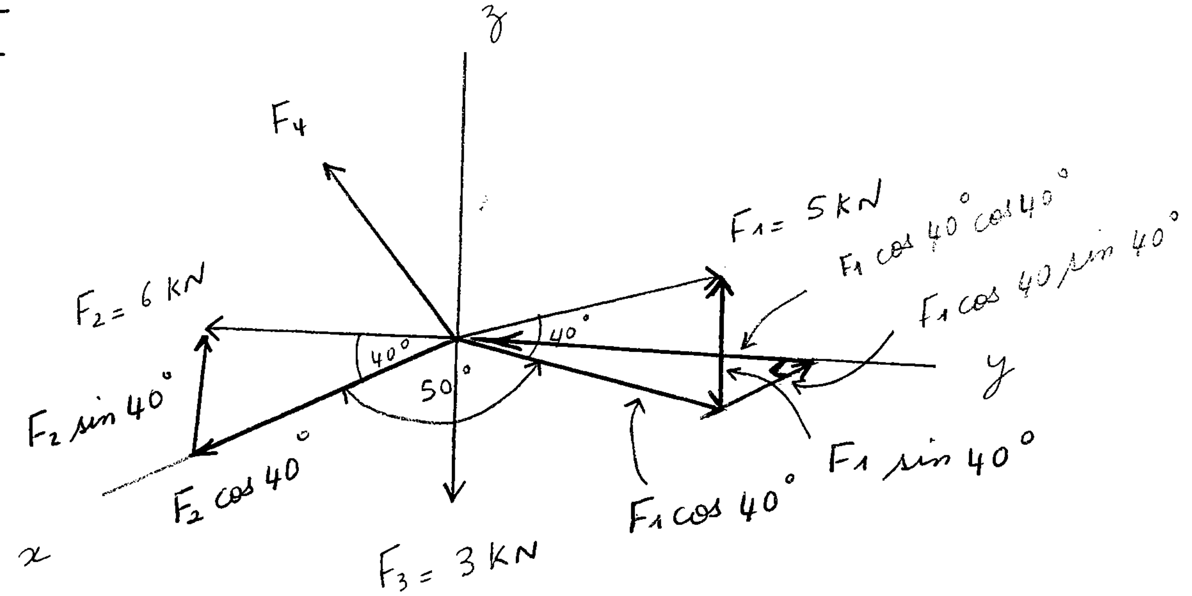
$$\begin{cases} \Sigma F_x = 0 \Rightarrow -T_A + T_B \sin 20° \\ \Sigma F_y = 0 \Rightarrow T_B \cos 20° - W_A = 0 \end{cases} \quad (1)$$

From Fig. 3:

$$\Sigma F_y = 0 \Rightarrow T_C \sin 10° - 500 = 0 \Rightarrow \boxed{T_C = 2879.39\,N}$$

$$\Sigma F_x = 0 \Rightarrow -T_C \cos 10° + T_A = 0 \Rightarrow \boxed{T_A = 2835.65\,N}$$

Prob - 4 -



$$\vec{R} = 0 \Longrightarrow \begin{cases} R_x = \Sigma F_x = 0 = 5 \cos 40° \sin 40° + 6 \cos 40° + F_4 \cos \alpha & (1) \\ R_y = \Sigma F_y = 0 = 5 \cos 40° \cos 40° + F_4 \cos \beta & (2) \\ R_z = \Sigma F_z = 0 = 5 \sin 40° - 3 + 6 \sin 40° + F_4 \cos \gamma & (3) \end{cases}$$

$(1) \rightarrow \quad F_4 \cos \alpha = -7.06$

$(2) \rightarrow \quad F_4 \cos \beta = -2.93$

$(3) \rightarrow \quad F_4 \cos \gamma = -4.07$

$$F_4 = \sqrt{(F_4 \cos \alpha)^2 + (F_4 \cos \beta)^2 + (F_4 \cos \gamma)^2} = 8.66\ KN$$

$$\boxed{F_4 = 8.66\ KN}$$

$$\cos \alpha = \frac{-7.06}{8.66} \Longrightarrow \boxed{\alpha = 144.61°}$$

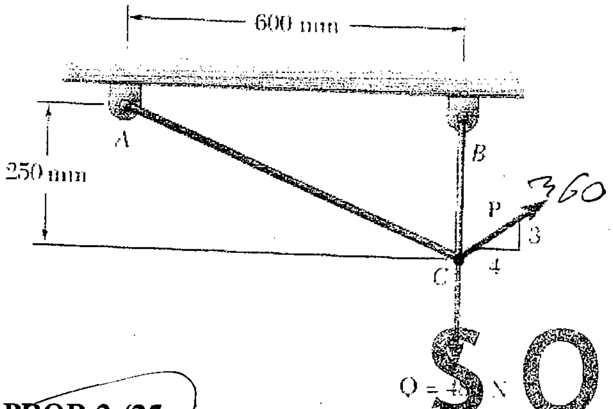
$$\cos \beta = \frac{-2.93}{8.66} \Longrightarrow \boxed{\beta = 109.78°}$$

$$\cos \gamma = \frac{-4.07}{8.66} \Longrightarrow \boxed{\gamma = 118.03}$$

CIE 200 Statics/F10 **Test #1** **NAME** [redacted]

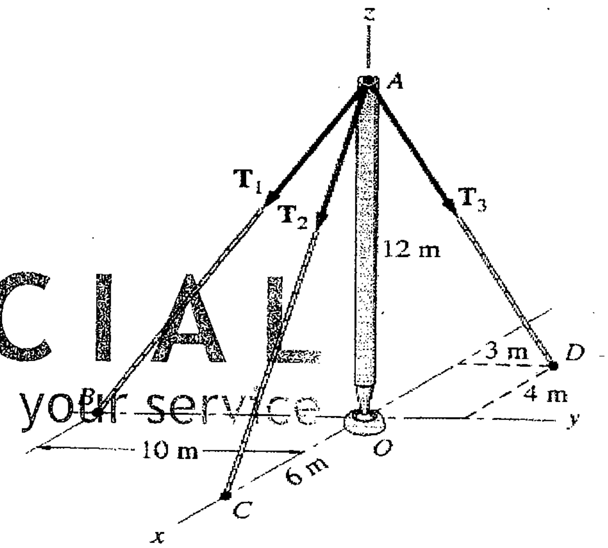
PROB-1-(15)

Two cables are tied together at C and loaded as shown. Knowing that P = 360 N. Determine the tension in the cables.



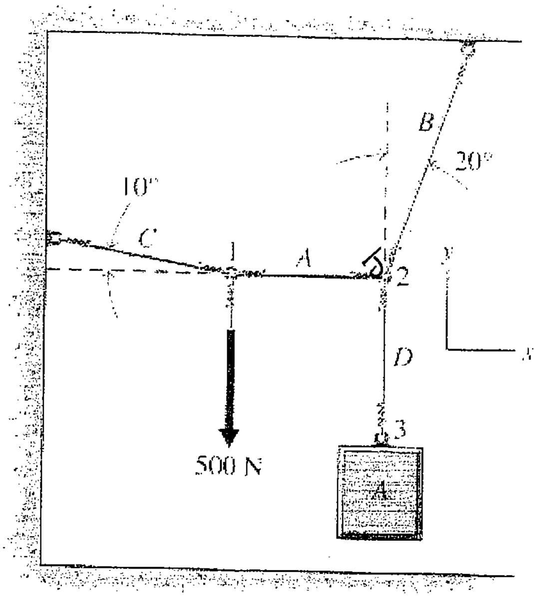
PROB-3-(30)

Three cable tensions T_1, T_2, and T_3 act at the top of the flagpole. Given that the resultant force for the three tensions is R = (-400k) N. Find the magnitudes of each of the cable tensions.



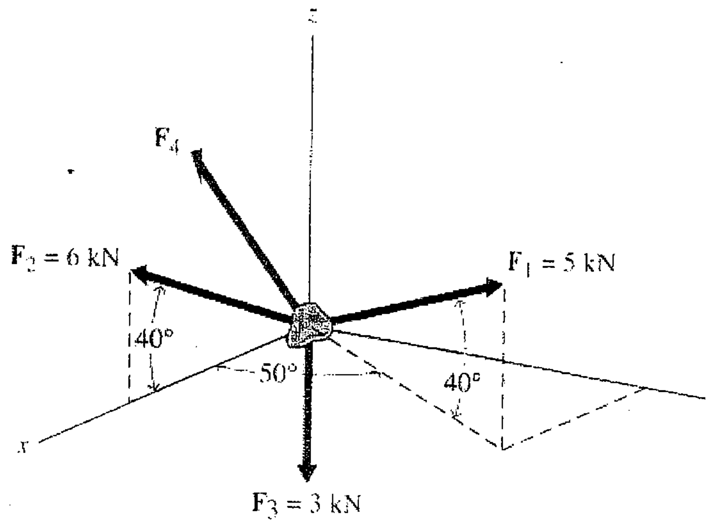
PROB-2-(25

The cable system shown in the Figure is being used to lift body A. The system is in equilibrium at the cable positions shown in the Figure when a 500-N force is applied at joint 1. Determine the tensions in all the cables and the mass of body *A* that is being lifted.



PROB-4-(30)

The particle shown in the Figure below is in equilibrium under the action of the four forces shown on the free-body diagram. Determine the magnitude and the coordinate direction angles of the unknown force F_4.



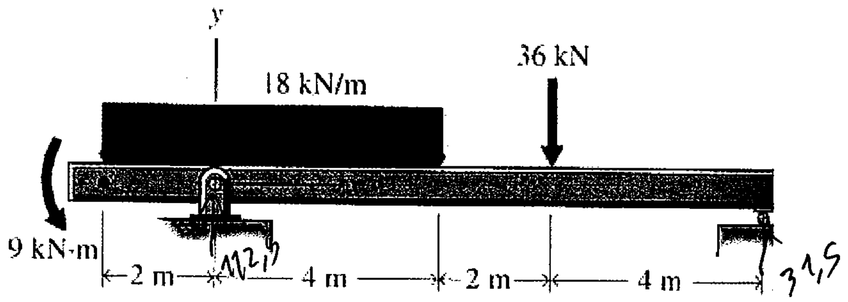
$I_{cercle} = \frac{\pi}{4} R^4$ | A_i cercle πR^2

$I_{\square} = \frac{1}{12}(w)(h)^3$ $\quad I_{\Delta} = \frac{1}{2} h(l)^3$

CIE200 Statics/F07 **Test #3** **NAME**__________________

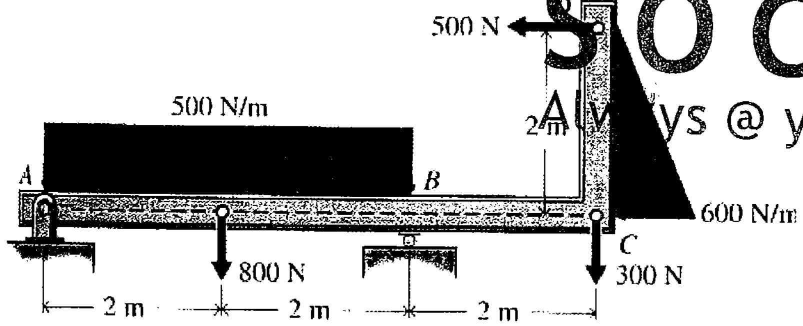
PROB-1-(30)

Draw the moment and shear diagrams for the beam shown below.



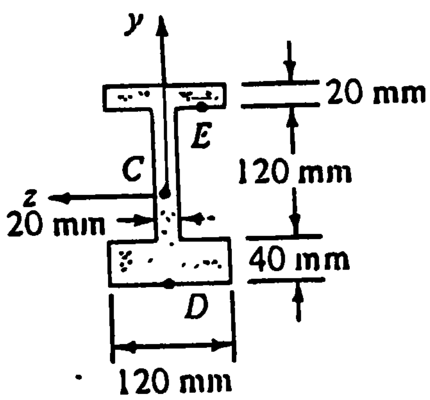
PROB-2-(25)

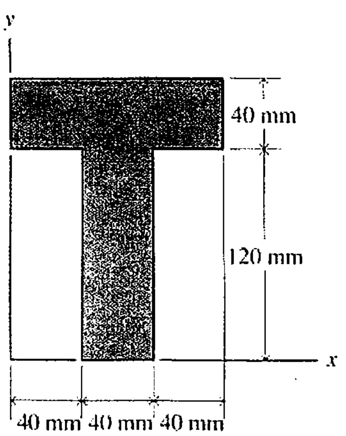
Find the internal normal force, shear force, and moment acting on a point at 3m to the right of pin A.



PROB-3-(20)

Determine the location of the centroid of the section shown to the right.

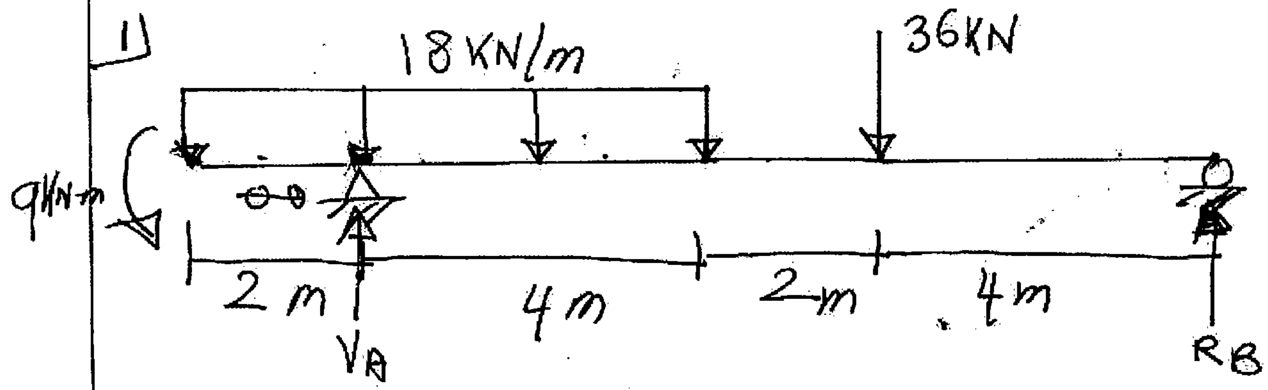




PROB-4-(25)

Determine the moment of interia about the x and y centroidal axes for the T-beam shown to the left.

1)

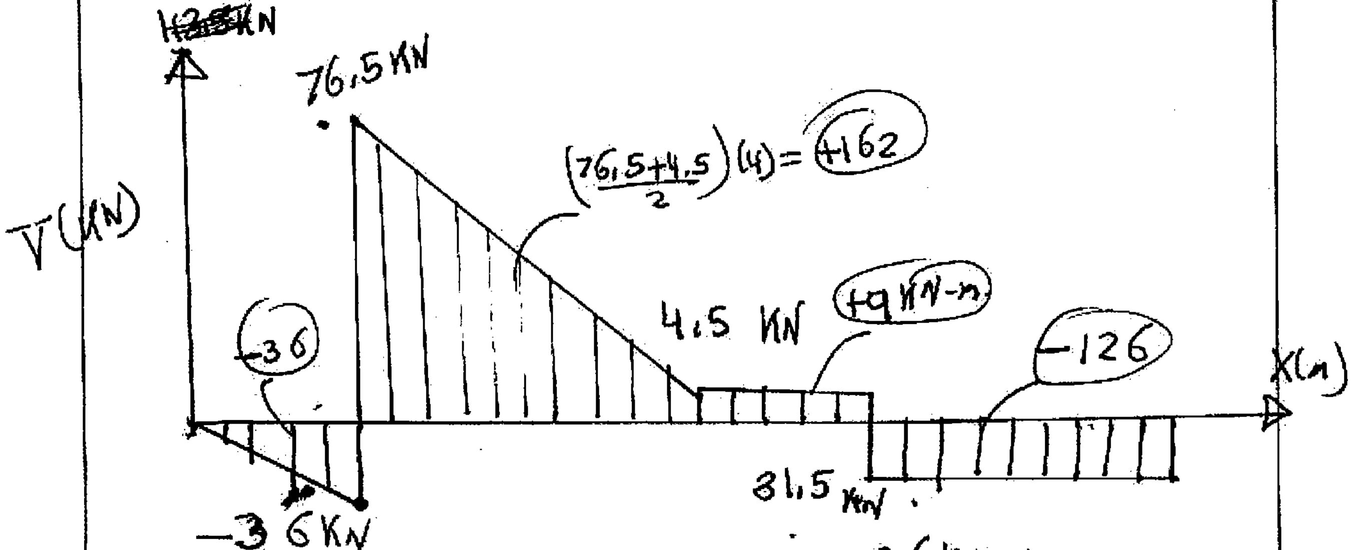


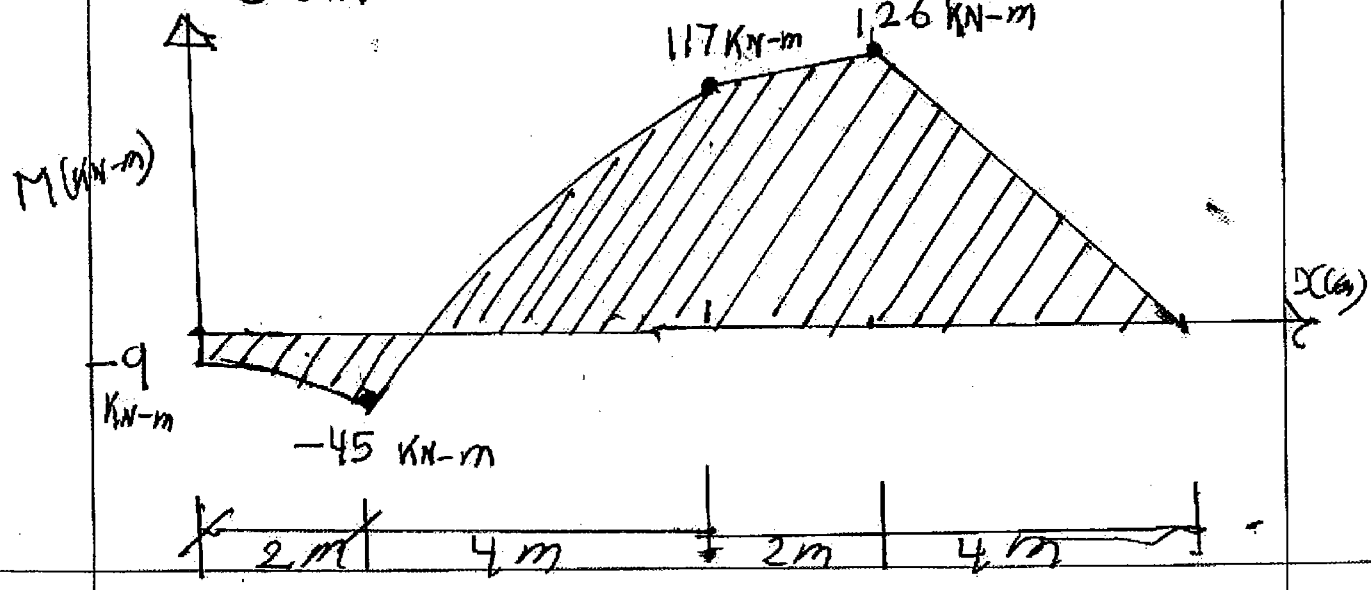
$$V_A = \frac{[(18)(6)][(6/2)+6]+(36)(4)+9}{10} = 112.5\ KN$$

$$R_B = \frac{[(18)(6)][(6/2)-2]+(36)(6)-9}{10} = 31.5\ KN$$

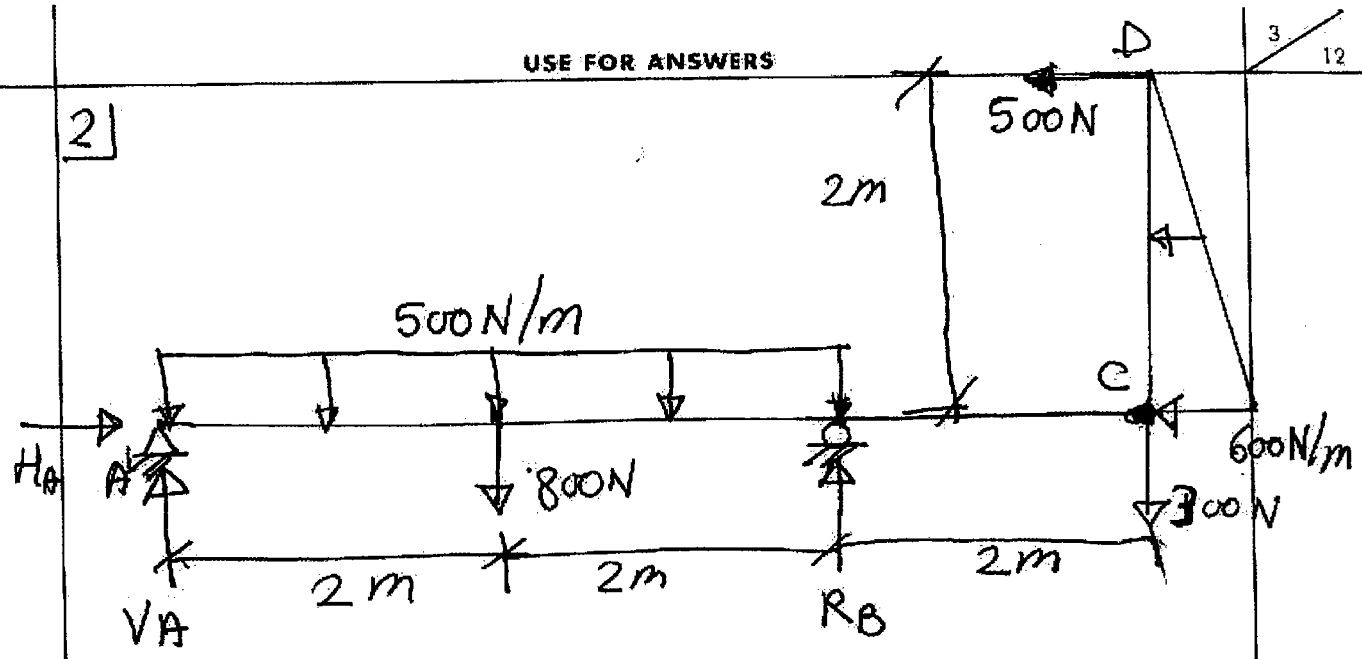
CHECK

$$\Sigma F\uparrow = 112.5+31.5-(18)(6)-36 = 0$$





2



$$\Sigma \overrightarrow{F} = 0 = H_A - 500 - \tfrac{1}{2}(600)(2) \Rightarrow \boxed{H_A = 1100\,N}$$

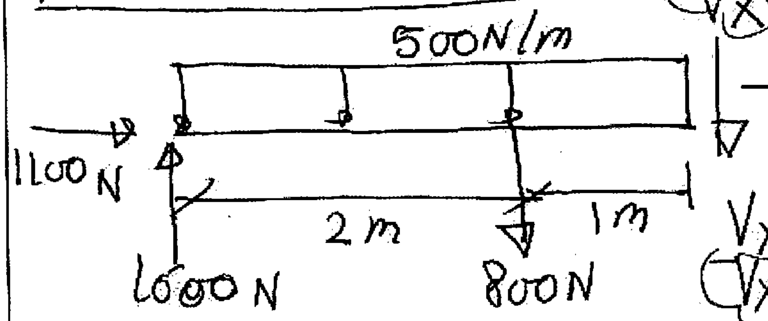
$$\Sigma M_A = 0 = (500)(4)(2) + (800)(2) + (300)(6)$$
$$- (500)(2) - \left[\tfrac{1}{2}(600)(2)\right]\left[\tfrac{1}{3}(2)\right] - 4R_B$$
$$\Rightarrow \boxed{R_B = 1500\,N}$$

$$\Sigma M_B = 0 = 4V_A - (500)(4)(2) - (800)(2) - (500)(2)$$
$$+ (300)(2) - \left[\tfrac{1}{2}(600)(2)\right]\left[\tfrac{1}{3}(2)\right]$$
$$\Rightarrow \boxed{V_A = 1600\,N}$$

CHECK

$$\Sigma F\uparrow = 1600 + 1500 - (500)(4) - 800 - 300 \equiv 0$$

X = 3m RIGHT OF A



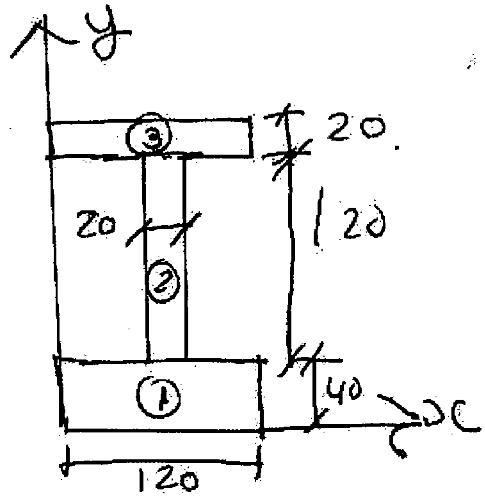
$V_X = -700N$, $M_X = 1750\,N\text{-}m$

$$\boxed{N_X = -1100\,N}$$

$$V_X = 1600 - 800 - (500)(3)$$
$$\boxed{V_X = -700\,N}$$

$$M_X = (1600)(3) - (800)(1) - (500)(3)(\tfrac{3}{2}) = \boxed{1750\,N\text{-}m}$$

3]



$\bar{x} = 60mm$

$$\bar{y} = \frac{\Sigma y_i A_i}{\Sigma A_i} = \cancel{(120)(40)(40/2)+}$$

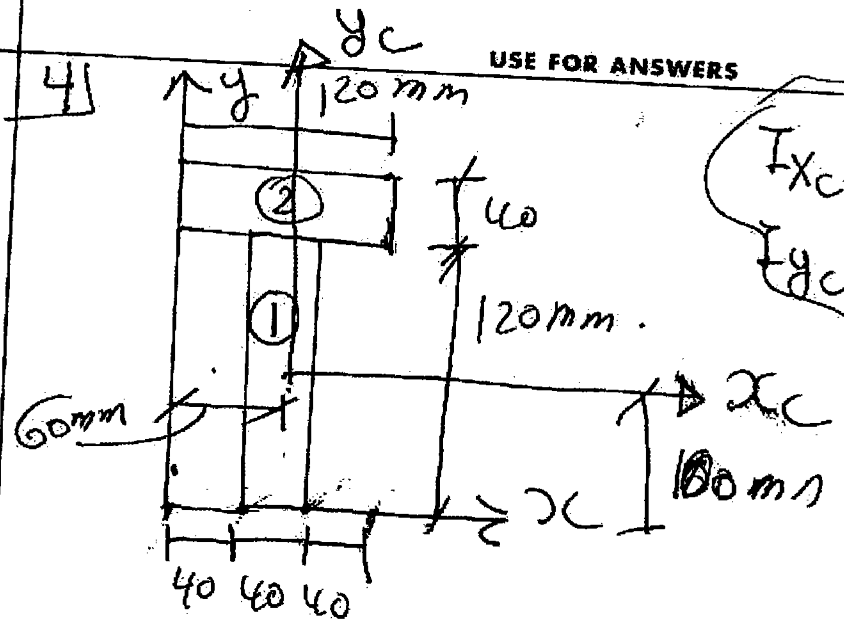
$$= \frac{(120)(40)\left(\frac{40}{2}\right) + (20)(120)\left(\frac{120}{2}+40\right) + (120)(20)\left(\frac{20}{2}+120+40\right)}{(120)(40) + (20)(120) + (120)(20)}$$

$$= \frac{744{,}000}{9600} = 77.5mm$$

USE FOR ANSWERS

7
12

4)



$I_{x_c} = 3176 \times 10^4 \, mm^4$

$I_{y_c} = 6.4 \times 10^6 \, mm^4$

$$\bar{y} = \frac{\Sigma y_i A_i}{\Sigma A_i} = \frac{(40)(120)(\frac{120}{2}) + (120)(40)[120 + (\frac{40}{2})]}{(40)(120) + (120)(40)}$$

$$= \frac{960{,}000}{9{,}600} = 100mm$$

$$\bar{x} = \frac{\Sigma x_i A_i}{\Sigma A_i} = \frac{(120)(40)[40 + (\frac{40}{2})] + (120)(40)(\frac{120}{2})}{9600}$$

$$= \frac{576{,}000}{9{,}600} = 60mm$$

$$I_{x_c} = \Sigma I_{ox_i} + \Sigma A_i (y_i - \bar{y})^2$$

$$= \left[\frac{1}{12}(40)(120)^3 + \frac{1}{12}(120)(40)^3\right]$$

$$+ \left[(40)(120)(60-100)^2 + (120)(40)(140-100)^2\right]$$

$$= 6409000 + 15{,}360{,}000 = 2176 \times 10^4 mm^4 = I_{x_c}$$

$$I_{y_c} = \Sigma I_{oy_i} + \Sigma A_i (x_i - \bar{x})^2$$

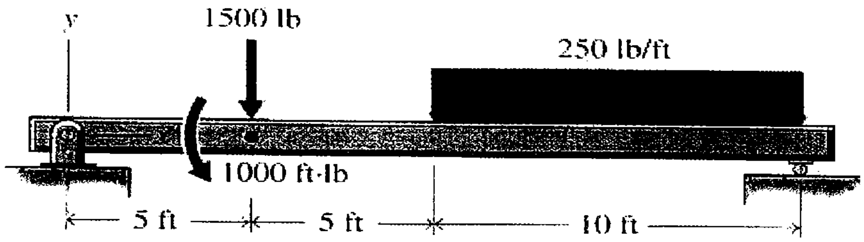
$$= \frac{1}{12}\left[(120)(40)^3 + (40)(120)^3\right] + 0$$

$I_{y_c} = 6409000 \, mm^4$

CIE200 Statics/F06 **Test #3** **NAME**____________________

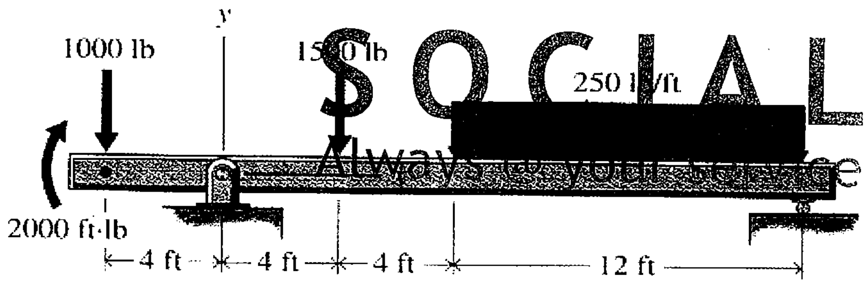
PROB-1-(30)

Draw the moment and shear diagrams for the beam shown below.

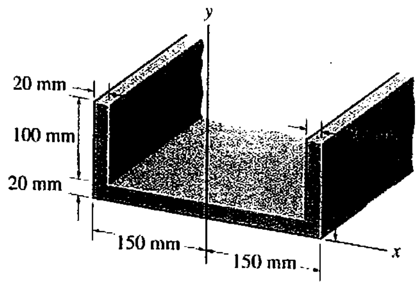


PROB-2-(25)

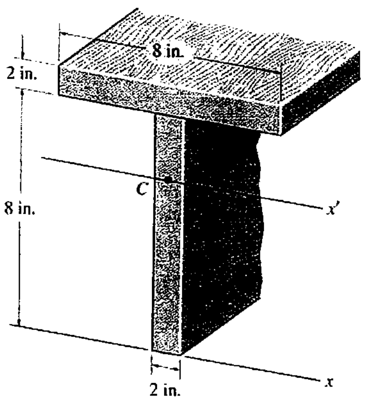
Find the internal normal force, shear force, and moment acting at point where x =10 ft.



PROB-3-(20)



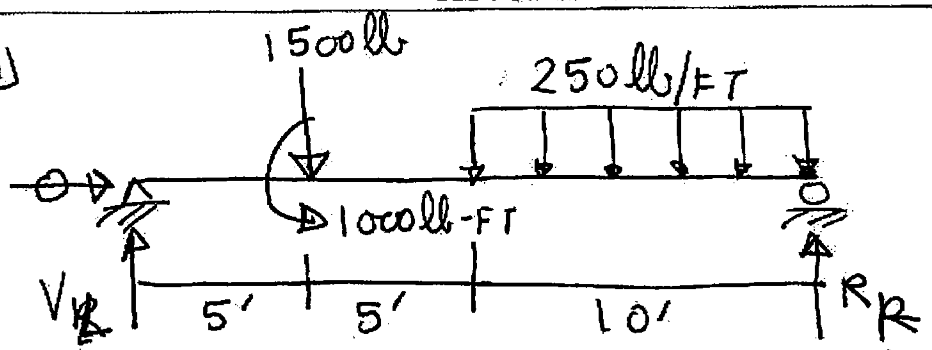
Determine the location of the centroid of the section shown to the left.



PROB-4-(25)

Determine the moment of interia about the *x* and *y* centroidal axes for the T-beam shown to the left.

1)

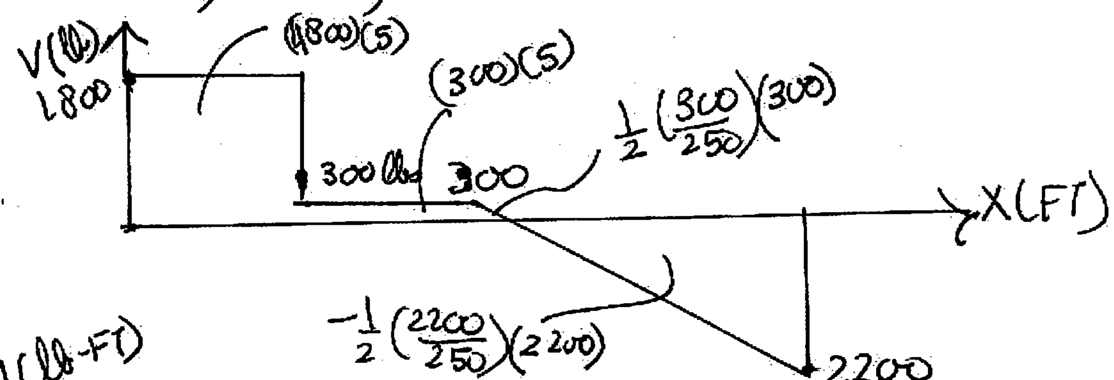


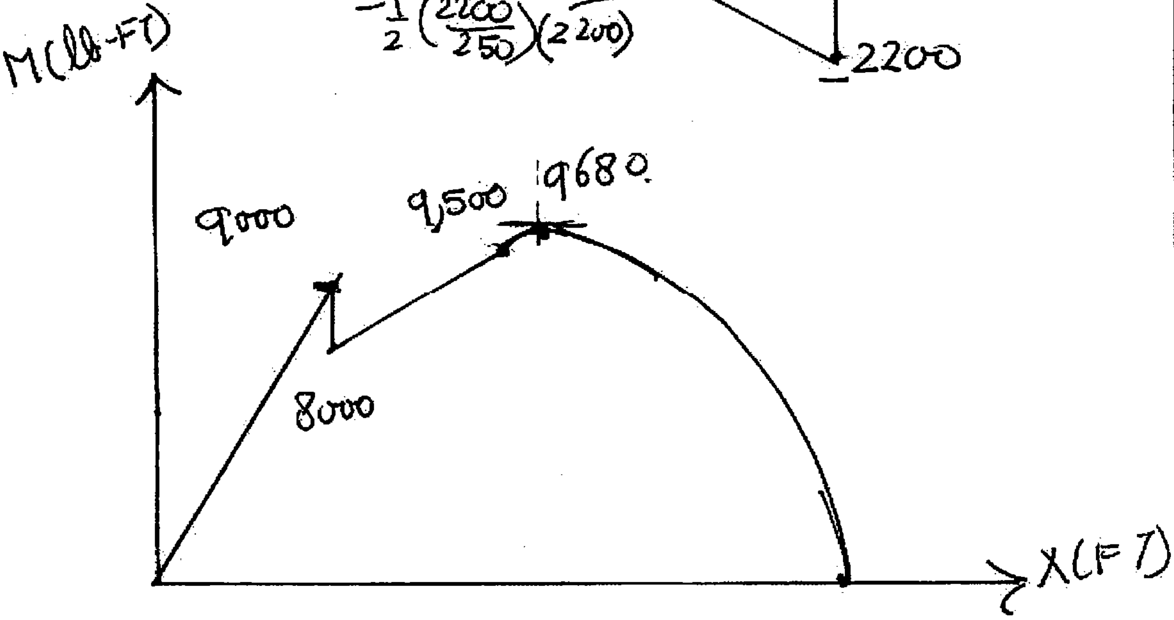
$$R_R = \{(1500)(5) + (250)(10)[(10/2)+10] \cancel{+}- 1000\}/20$$
$$= 2,200 \text{ lbs}$$

$$V_L = [1000 + (1500)(15) + (250)(10)(10/2)]/20$$
$$= 1,800 \text{ lbs}$$

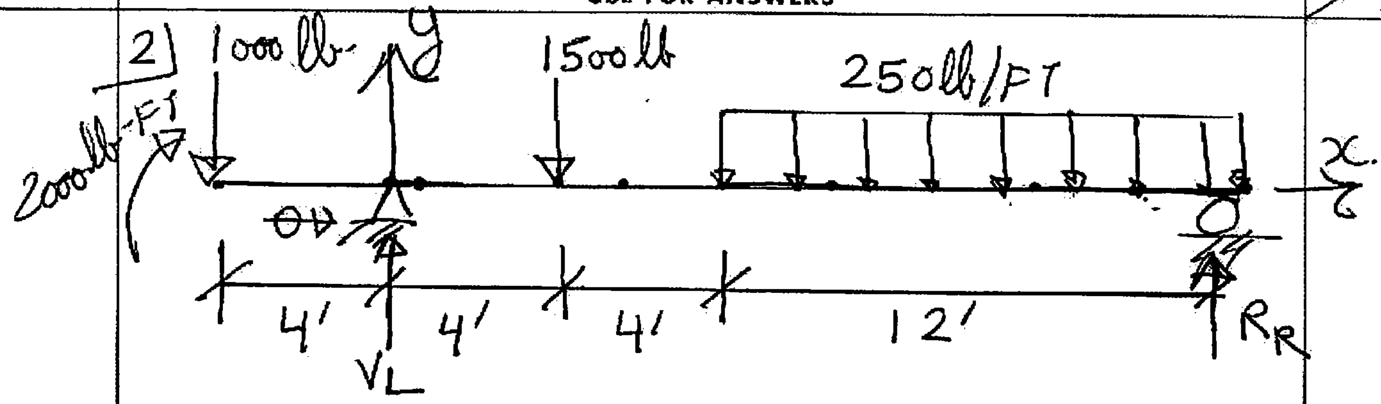
CHECK

$$\Sigma F\uparrow = 2,200 + 1,800 - 1500 - (250)(10) \equiv 0 \quad \underline{\underline{ok}}$$





2)



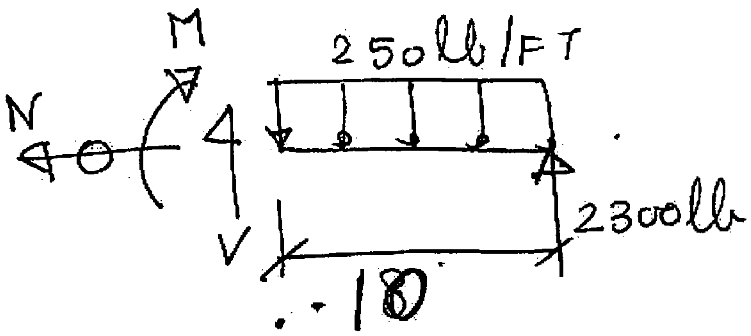
$$V_L = [-2000 + (1000)(24) + (1500)(16) + (250)(12)(12/2)]/20$$
$$= 3200 \text{ lbs}$$

$$R_R = \{2000 + (1500)(4) + (250)(12)[(12/2) + 8] - (1000)(4)\}/20$$
$$= 2300 \text{ lb}$$

CHECK

$$\Sigma F\uparrow = 3200 + 2300 - 1000 - 1500 - (12)(250) = 0 \quad \text{OK}$$

INTERNAL FORCES @ X=10'

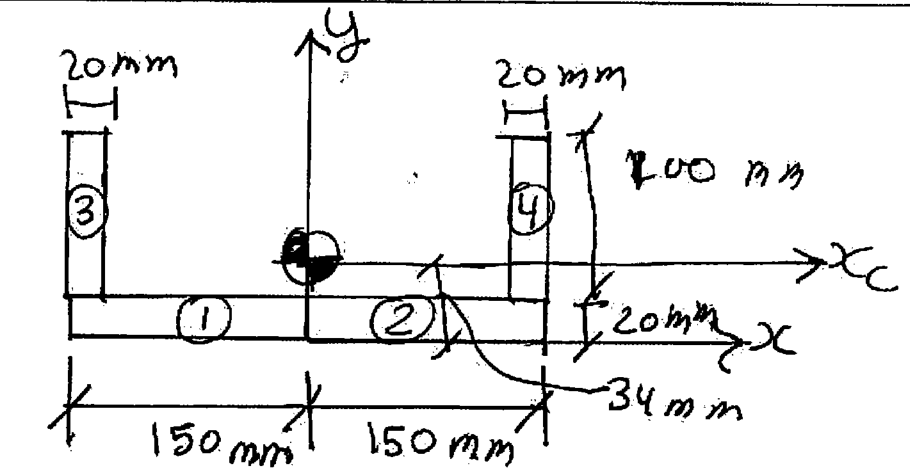


$$\boxed{N = 0}$$

$$\Sigma M_{CUT} = 0 = M + (250)(10)(10/2) - (2300)(10)$$
$$\Rightarrow \boxed{M = 10{,}500 \text{ lb-FT}}$$

$$\Sigma F\uparrow = 0 = V - (250)(10) + 2300$$
$$\Rightarrow V = +200 \text{ lb} \Rightarrow \boxed{V = 200 \text{ lb} \uparrow}$$

3)



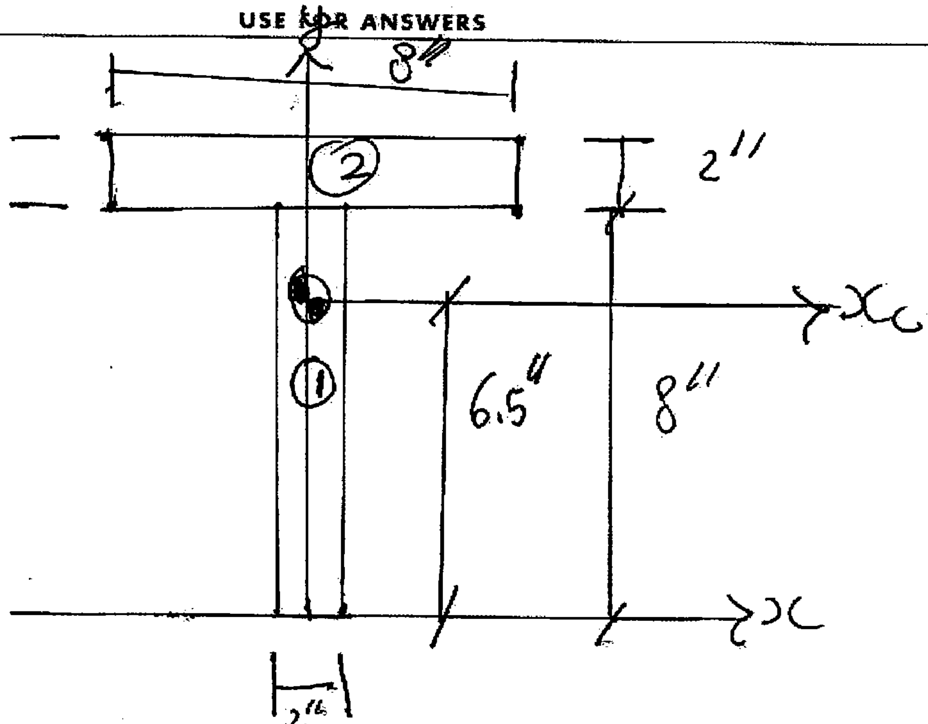
#	A_i	x_i	y_i	x_iA_i	y_iA_i
1	(150)(20)	$-150/2$	$20/2$	-225,000	30,000
2	(150)(20)	$+150/2$	$20/2$	+225,000	30,000
3	(100)(20)	$-150+(20/2)$	$20+(100/2)$	-280,000	140,000
4	(100)(20)	$150-(20/2)$	$20+(100/2)$	+280,000	140,000
	10,000			0	340,000

$$x_c = \bar{x} = \frac{\Sigma x_iA_i}{\Sigma A_i} = \frac{0}{10,000} = 0 \text{ (OK BY OBSERVATION)}$$

$$y_c = \bar{y} = \frac{\Sigma y_iA_i}{\Sigma A_i} = \frac{340,000}{10,000} = 34\,mm$$

$$C\,(0, 34)\,mm$$

4)



$C(0, \bar{y})$

#	A_i	y_i	$y_i A_i$	I_{ox}	Δy_i	$A_i \Delta y_i^2$
1	$(2)(8)$	$8/2$	64	$\frac{1}{12}(2)(8)^3$	2.5	$16(2.5)^2$
2	$(8)(2)$	$8+(2/2)$	144	$\frac{1}{12}(8)(2)^3$	2.5	$(16)(2.5)^2$
	32		208	90.67		200

$$\bar{y} = y_c = \frac{\sum y_i A_i}{\sum A_i} = \frac{208}{32} = 6.5'' \ ; \ \Delta y_i = |y_i - y_c|$$

$$I_{x_c} = \sum\left(I_{ox_i} + A_i \Delta y_i^2\right) = 90.67 + 200 = 290.67 \text{ IN}^4$$

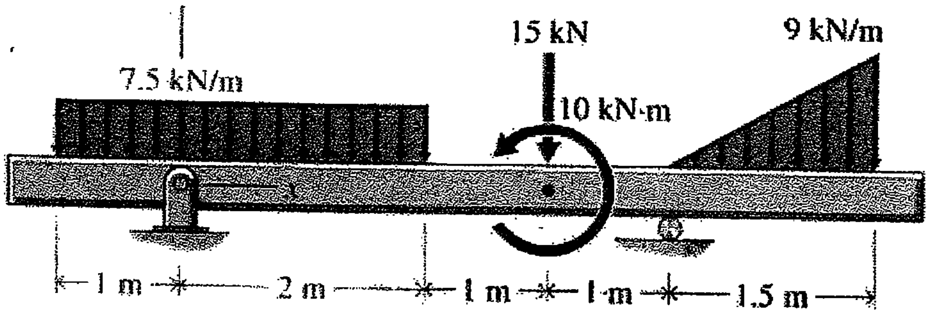
$$\Delta x_i = |x_i - x_c| = 0 \Rightarrow I_{y_c} = \sum\left(I_{oy_i}\right)$$

$$I_{y_c} = \frac{1}{12}(8)(2)^3 + \frac{1}{12}(2)(8)^3 = 90.67 \text{ IN}^4$$

CIE200 Statics/F09 **Test #3** **NAME**____________________

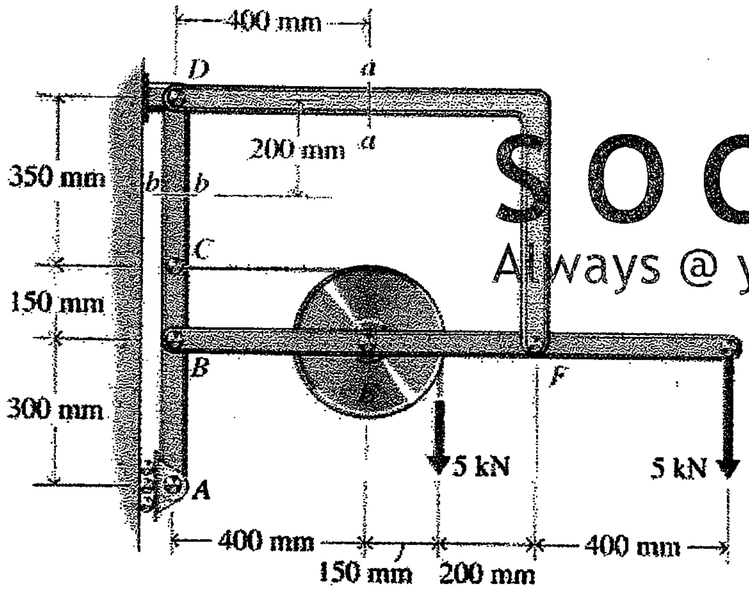
PROB-1-(30)

Draw the moment and shear diagrams for the beam shown below.



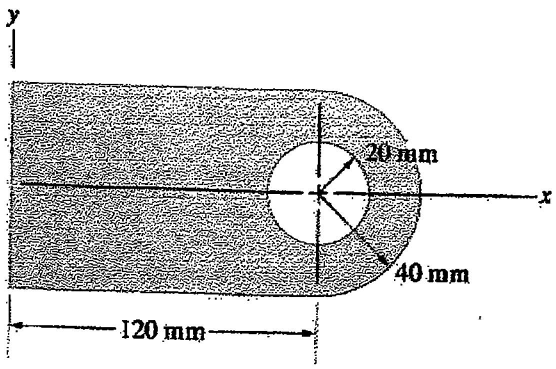
PROB-2-(25)

Find the internal normal force, shear force, and moment acting on a point at section b-b of member ABCD of the frame shown below.



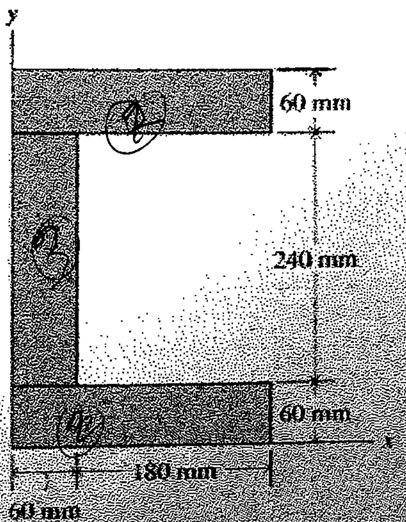
PROB-3-(20)

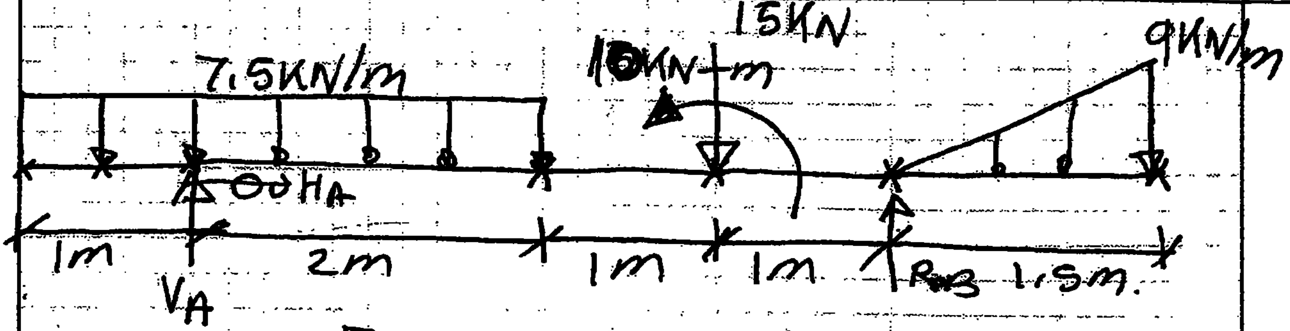
Determine the location of the centroid of the section shown below



PROB-4-(25)

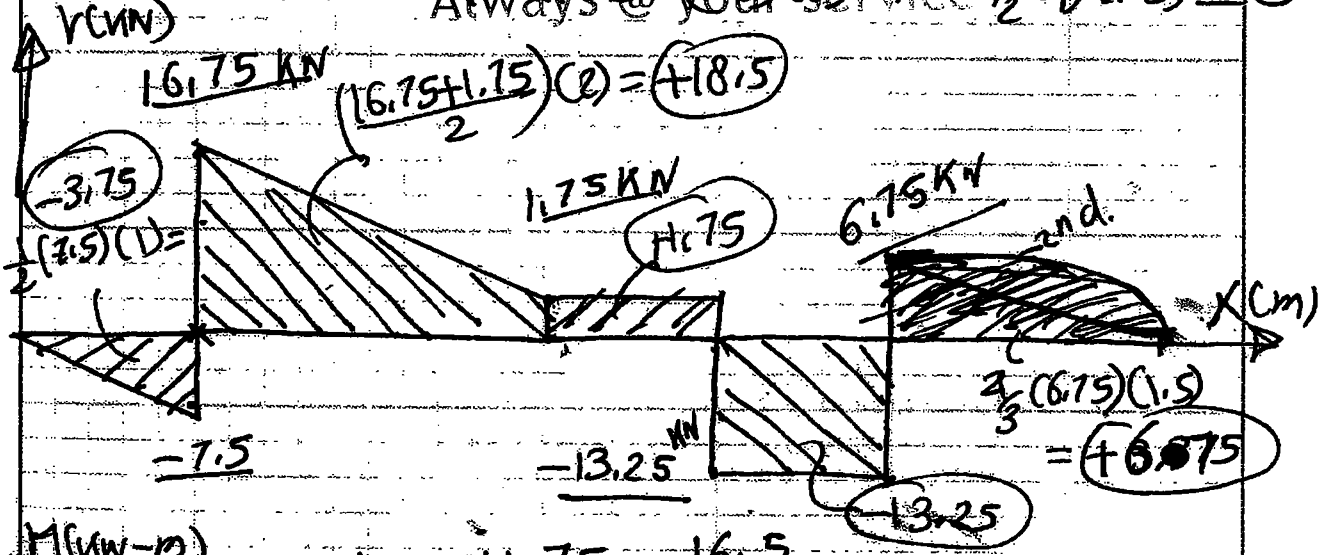
Determine the moment of inertia about the x and y centroidal axes for the Channel beam shown below.

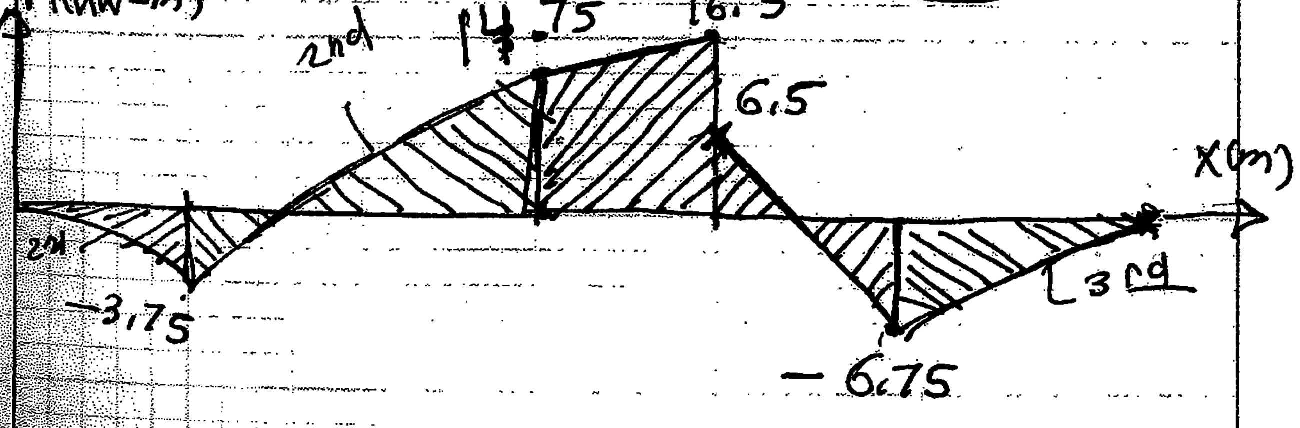




$$\Sigma M_A = 0 = [(3)(7.5)]\left[\left(\tfrac{3}{2}\right)-1\right] + (15)(3) - 10$$
$$+ \left[\tfrac{1}{2}(9)(1.5)\right]\left[4 + \tfrac{2}{3}(1.5)\right] - 4R_B$$
$$\Rightarrow R_B = 20KN$$
$$\Sigma M_B = 0 = 4V_A - [(3)(7.5)]\left[\left(\tfrac{3}{2}\right)+2\right] - (15)(1)$$
$$-10 + \left[\tfrac{1}{2}(9)(1.5)\right]\left[\tfrac{2}{3}(1.5)\right] \Rightarrow V_A = 24.25KN$$

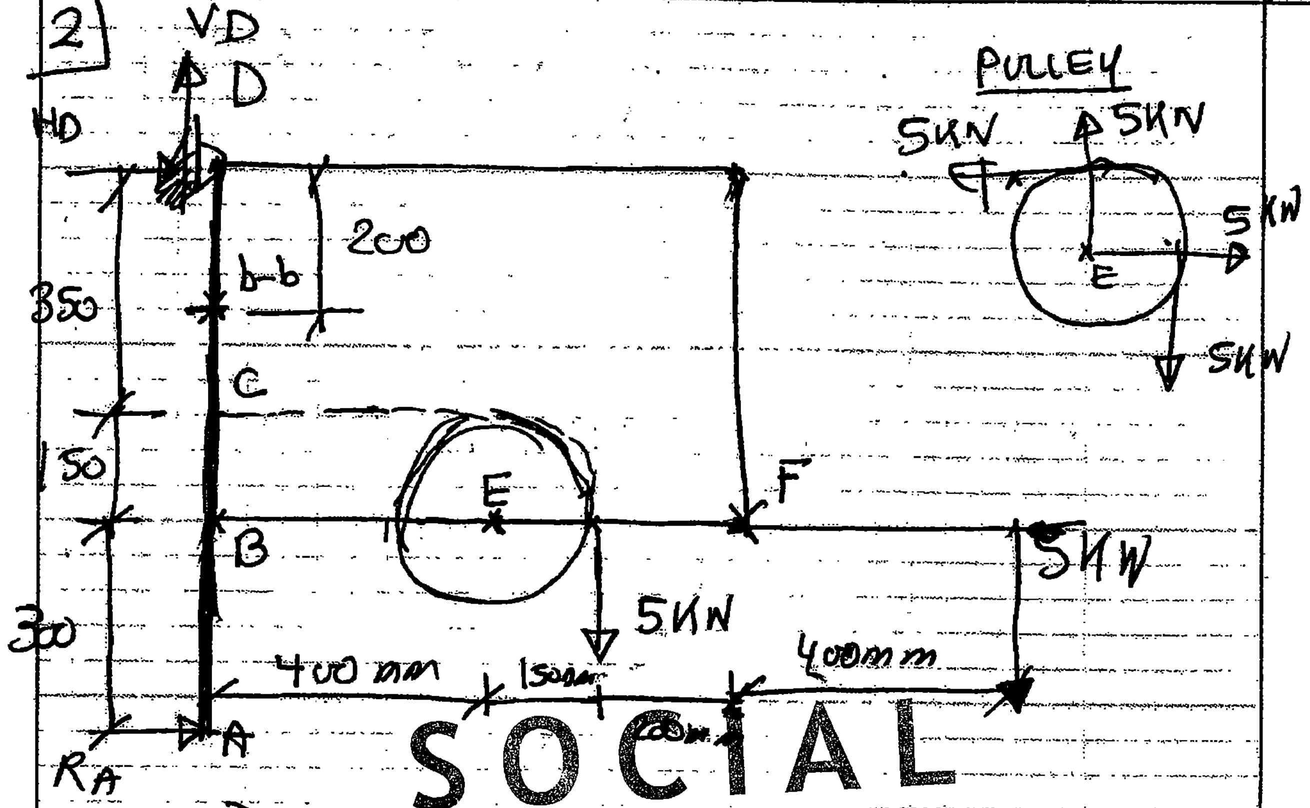
CHECK $\Sigma F\uparrow = 20 + 24.25 - (7.5)(3) - 15 - \tfrac{1}{2}(9)(1.5) \cong 0$





3/20

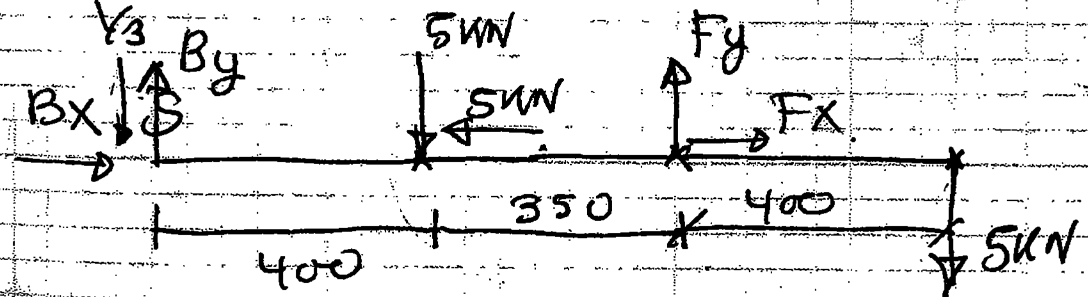
2)



$$\Sigma M_D = 0 = (5)(550) + (5)(1150) - (800)(R_A)$$

$$\Rightarrow R_A = 10.625 \text{ KN}$$

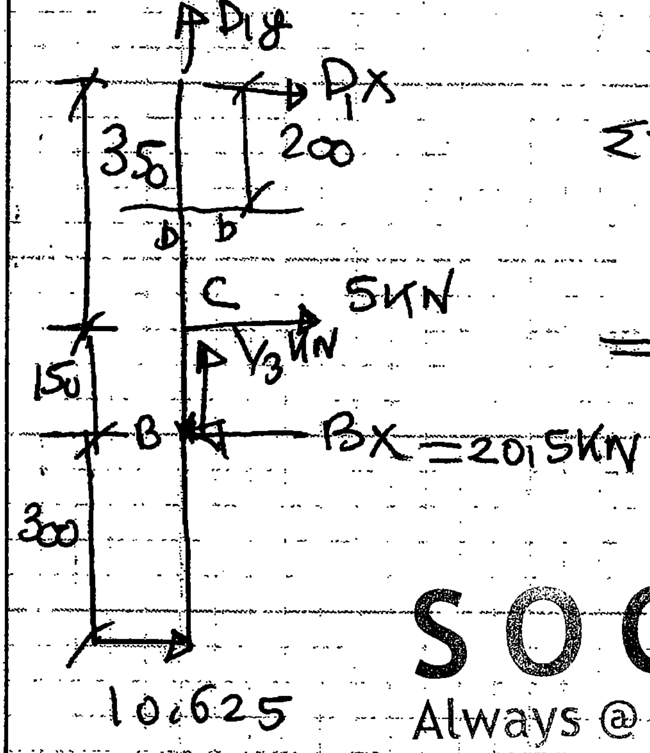
MEMBER BEF



$$\Sigma M_F = 0 = (750)(B_y) - (5)(350) + (5)(400)$$

$$\Rightarrow B_y = \frac{(5)(350) - (5)(400)}{750} = -\tfrac{1}{3} \text{ KN}$$

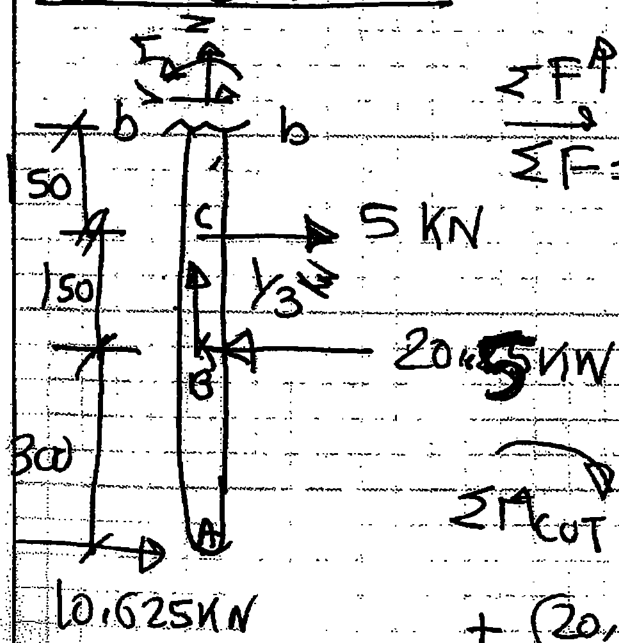
MEMBER ABCD



$$\Sigma M_D = 0 = (10.625)(800) - (500)(B_X) + (350)(5)$$

$$\Rightarrow B_X = 20.5\,KN$$

CUT @ b-b



$$\Sigma F^{\uparrow} = 0 = N_{b-b} + V_3 \Rightarrow \boxed{N_{b-b} = -V_3\,KN}$$

$$\Sigma F_{\rightarrow} = 0 = V + 5 - 20.5 + 10.625$$

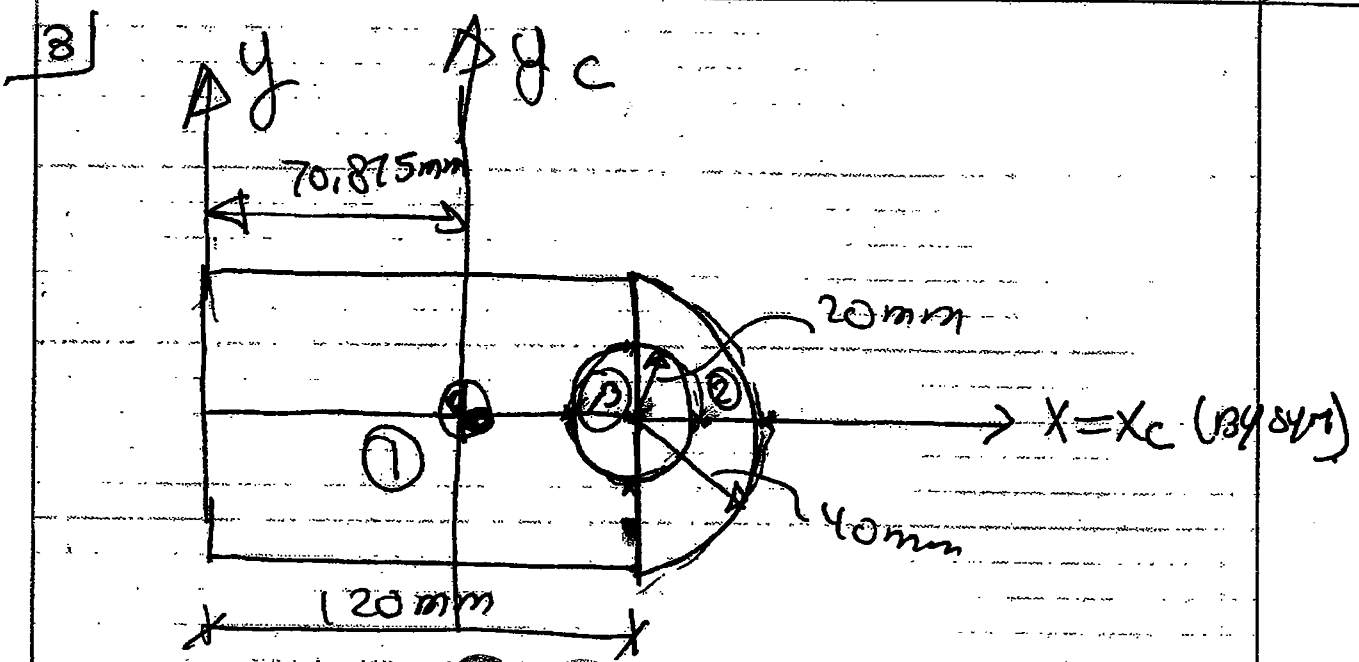
$$\Rightarrow \boxed{V_{b-b} = 4.875\,KN}$$

$$\Sigma M_{CUT} = 0 = -(10.625)(600) + (20.50)(300) - (5)(150) - M_{b-b}$$

$$\Rightarrow \boxed{M_{b-b} = 975\,KN\text{-}mm = \cancel{1.05}\,KN\text{-}m}$$

7/20

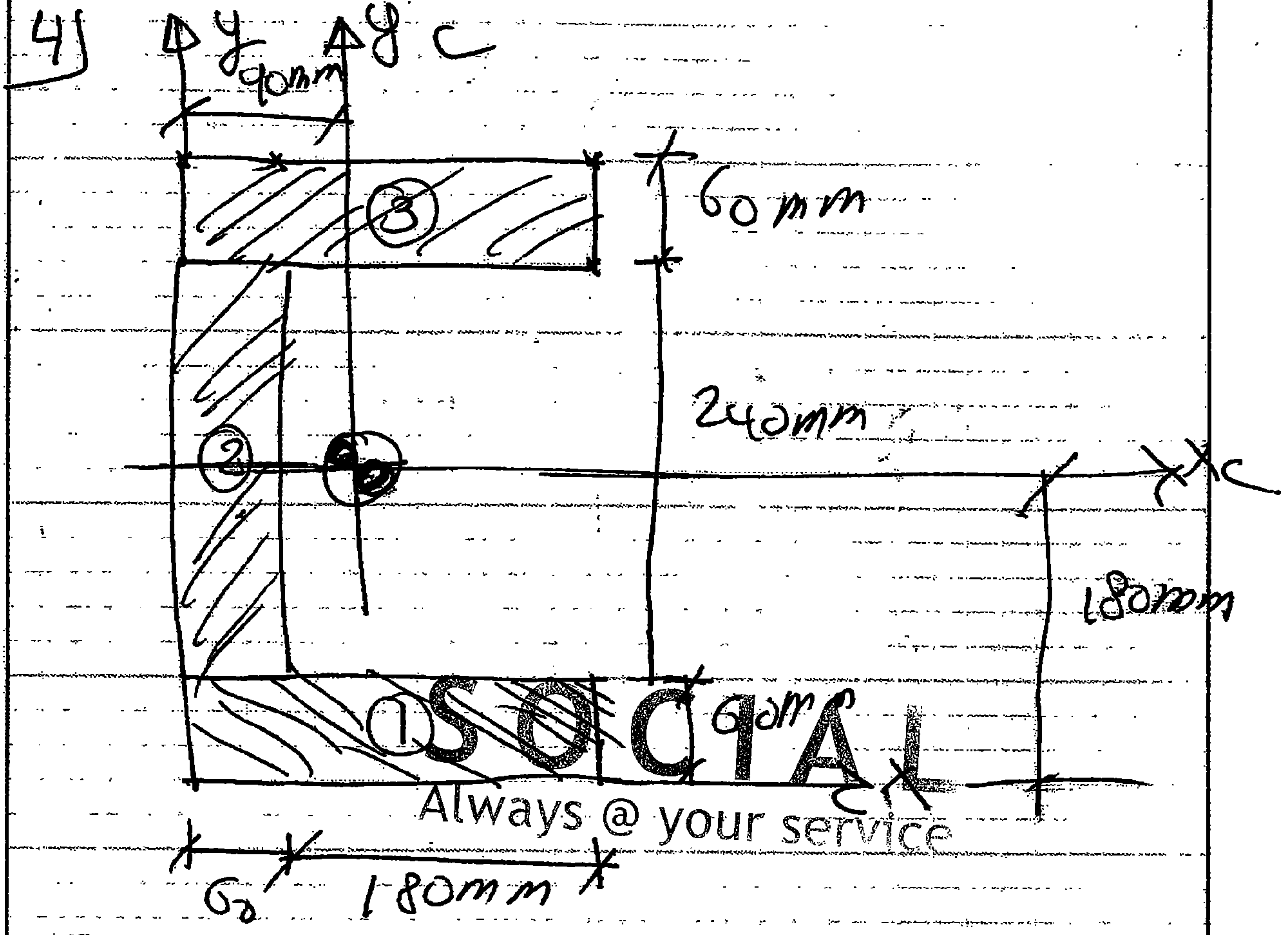
3)



#	X_i	A_i	$X_i A_i$
①	$\frac{120}{2} = 60$	$(120)(80)$	$(60)(120)(80)$
②	$120 + \frac{4(40)}{3\pi}$	$\frac{\pi(40)^2}{2}$	3,44,259.56
− ③	120	$-\pi(20)^2$	$-120(\pi)(20)^2$
Σ		10,856.64	769,463.114

$$\bar{X} = \frac{769,463.114}{10856.63706} = 70.875\ mm$$

4)



#	X_i	Y_i	A_i	X_iA_i	Y_iA_i
1	120	30	14400	1,728,000	432,000
2	30	180	14400	432,000	2592,000
3	120	330	14400	1,728,000	4,752,000
			432,00	3888,000	776,000

$\bar{X} = \frac{\sum X_i A_i}{\sum A_i} = 90mm$, $\bar{y} = \frac{\sum y_i A_i}{\sum A_i} = 180mm$

#	I_{ox_i}	Δy_i	$A_i(\Delta y_i)^2$	I_{oy_i}	Δx_i	$A_i(\Delta x_i)^2$
1	$\frac{1}{12}(240)(60)^3$	150	324×10^6	$\frac{1}{12}(60)(240)^3$	30	1296×10^4
2	$\frac{1}{12}(60)(240)^3$	0	0	$\frac{1}{12}(240)(60)^3$	60	5184×10^4
3	$\frac{1}{12}(240)(60)^3$	150	324×10^6	$\frac{1}{12}(60)(240)^3$	30	1296×10^4
	7776×10^4		648×10^6	14256×10^4		7776×10^4

$\boxed{I_{x_c} = 725.76 \times 10^6 \, mm^4}$ $\boxed{I_{y_c} = 220.32 \times 10^6 \, mm^4}$