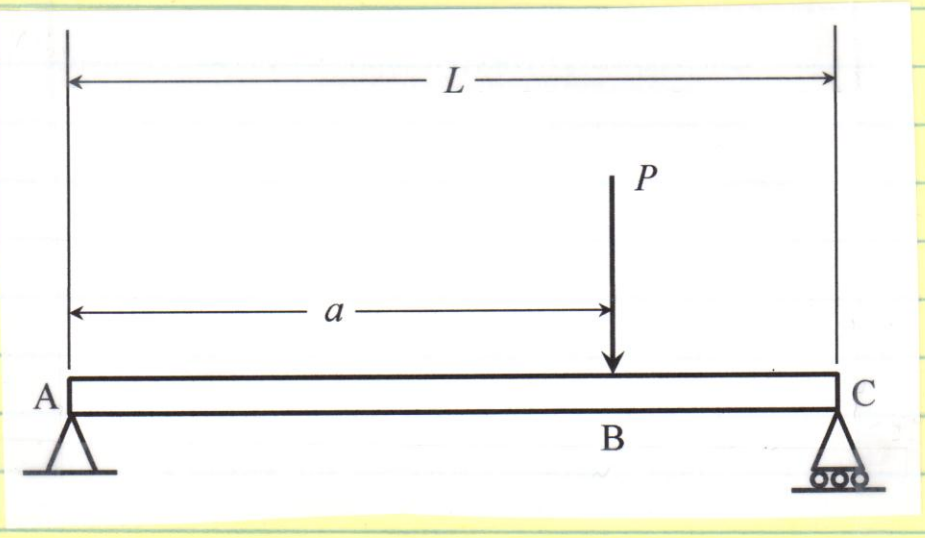
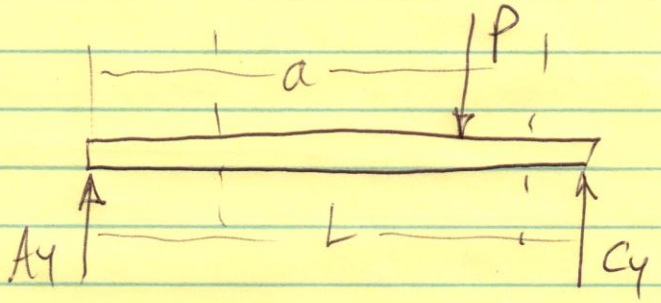
PROB. 1 ME2120: STATICS
FALL 2012



FIND SHEAR, BENDING MOMENT EQUATIONS

FBD:



$\Sigma F_y = 0$: $A_y + C_y - P = 0$

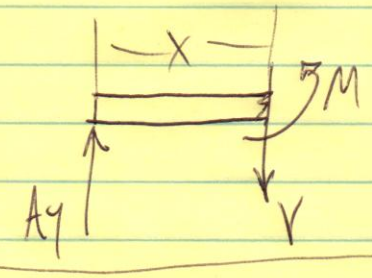
$\Sigma M_A = 0 +\circlearrowleft$: $-aP + LC_y = 0$

$C_y = \left(\frac{a}{L}\right)P$

$A_y = P - C_y = P - \left(\frac{a}{L}\right)P = P\left(1 - \frac{a}{L}\right)$

PROB. 1 CONT.

FBD A TO B:



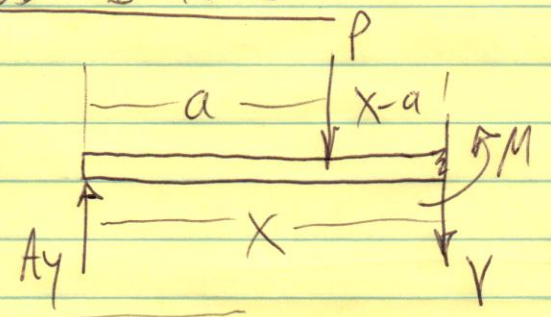
$\Sigma F_y = 0$: $A_y - V = 0$

$$\boxed{V = A_y = P\left(1 - \frac{a}{L}\right)}$$

$\Sigma M = 0$ ↻: $M - A_y \cdot x = 0$

$$\boxed{M = A_y \cdot x = P\left(1 - \frac{a}{L}\right)x}$$

FBD B TO C:



$\Sigma F_y = 0$: $A_y - P - V = 0$

$V = A_y - P$

$V = P\left(1 - \frac{a}{L}\right) - P$

$$\boxed{V = -\left(\frac{a}{L}\right)P}$$

$\Sigma M = 0$ ↻: $M + P(x-a) - A_y \cdot x = 0$

$M + P(x-a) - P\left(1 - \frac{a}{L}\right)x = 0$

$M + Px - Pa - Px + P\left(\frac{a}{L}\right)x = 0$

$M = Pa - P\left(\frac{a}{L}\right)x$

$$\boxed{M = Pa\left(1 - \frac{x}{L}\right)}$$

PROB, 1 CONT.

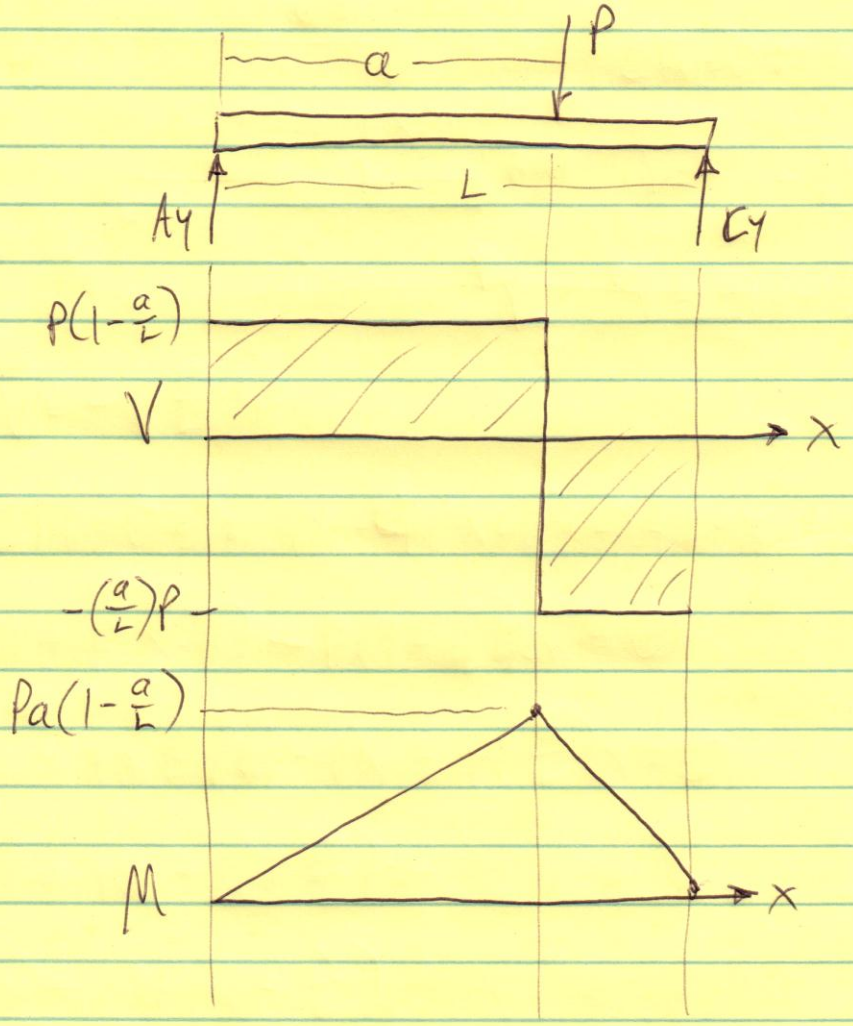
@ $x = 0$, $V = P(1 - \frac{a}{L})$, $M = P(1 - \frac{a}{L}) \cdot 0 = 0$

@ $x = a^-$, $V = P(1 - \frac{a}{L})$,

$M = P(1 - \frac{a}{L})a = Pa(1 - \frac{a}{L})$

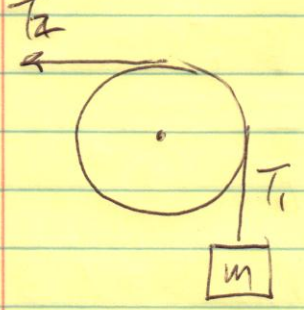
@ $x = a^+$, $V = -(\frac{a}{L})P$, $M = Pa(1 - \frac{a}{L})$

@ $x = L$, $V = -(\frac{a}{L})P$, $M = Pa(1 - \frac{L}{L}) = 0$



PROB. 2

DRUM B:



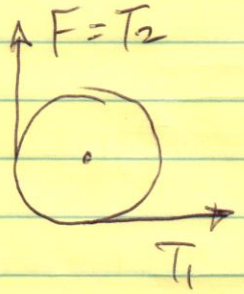
$$\frac{T_2}{T_1} = e^{\mu_k \beta}$$

$$T_2 = mg\, e^{\mu_k \beta}$$

$$T_2 = (20\,kg)\left(9.81\,\frac{m}{s^2}\right) \exp\left[(0.25)\left(\frac{\pi}{2}\right)\right]$$

$$T_2 = 290.6\,N$$

DRUM A:



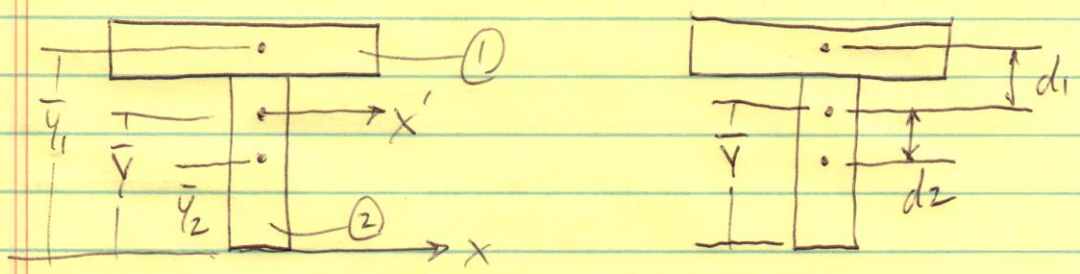
$$\frac{T_2}{T_1} = e^{\mu_k \beta} = \frac{F}{T_1}$$

$$F = T_1 e^{\mu_k \beta}$$

$$F = (290.6\,N) \exp\left[(0.25)\left(\frac{\pi}{2}\right)\right]$$

$$\boxed{F = 430.4\,N}$$

PROB. 3



$$\bar{y} = \frac{\sum y_i A_i}{\sum A_i}$$

AREA 1: $y_1 = 250 + \frac{1}{2}(50) = 275^{mm}$

$A_1 = (50)(300) = 15{,}000^{mm^2}$

AREA 2: $y_2 = \frac{1}{2}(250) = 125^{mm}$

$A_2 = (50)(250) = 12{,}500^{mm^2}$

$$\bar{y} = \frac{(275)(15{,}000) + (125)(12{,}500)^{mm^3}}{(15{,}000) + (12{,}500)^{mm^2}} = 206.8^{mm}$$

$$\bar{I}_x = I_{x,1} + I_{x,2}$$

$$I_{x,1} = \bar{I}_{x,1} + A_1 d_1^2 = \frac{1}{12} b h^3 + b h d_1^2$$

$$I_{x,1} = \frac{1}{12}(300)(50)^3 + (15{,}000)(275 - 206.8)^2 = 7.289 \times 10^{7\ mm^4}$$

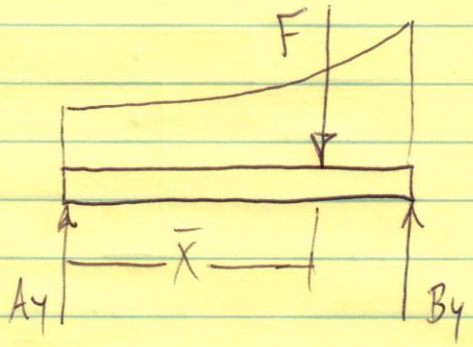
$$I_{x,2} = \bar{I}_{x,2} + A_2 d_2^2 = \frac{1}{12} b h^3 + b h d_2^2$$

$$I_{x,2} = \frac{1}{12}(50)(250)^3 + (12{,}500)(206.8 - 125)^2 = 1.487 \times 10^{8\ mm^4}$$

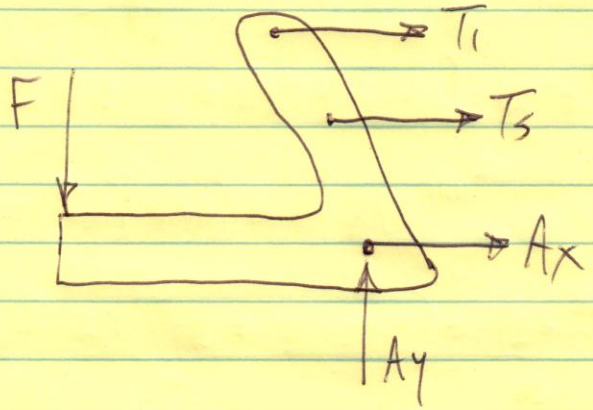
$$I_x = 2.216 \times 10^{8\ mm^4}$$

PROB. 4

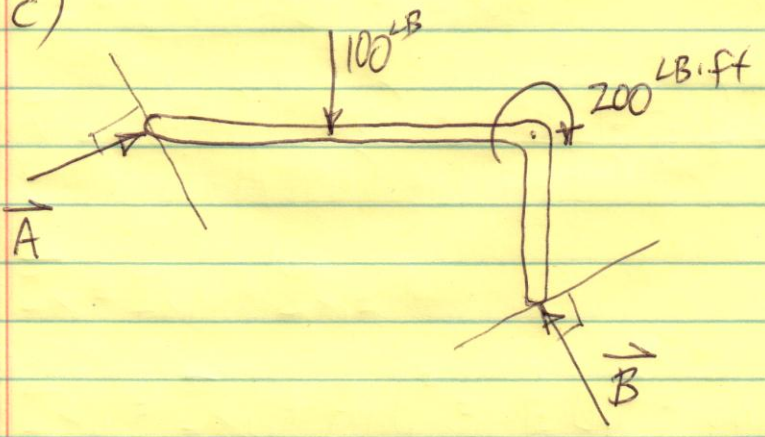
a)



b)

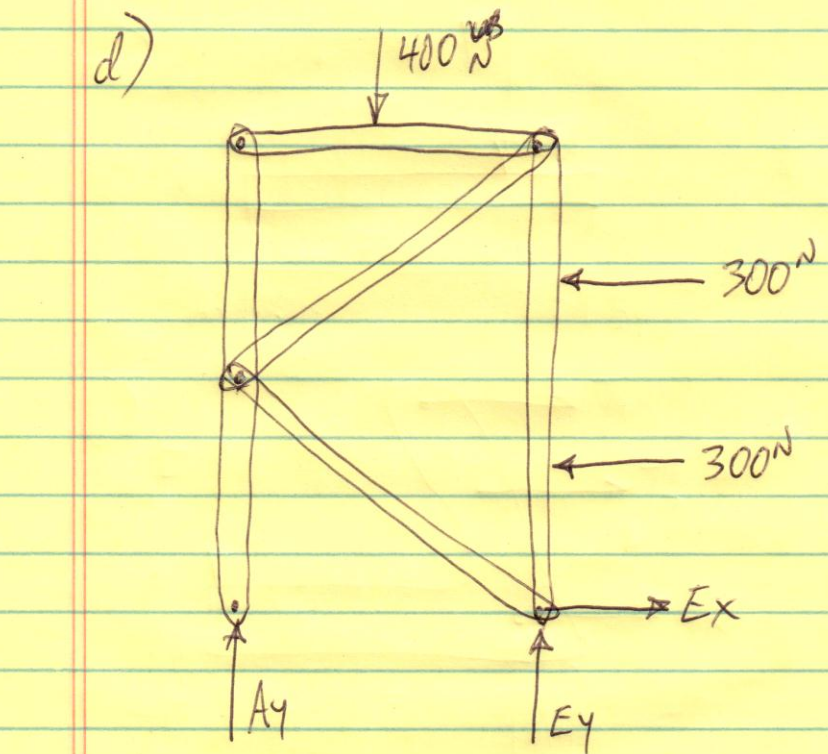


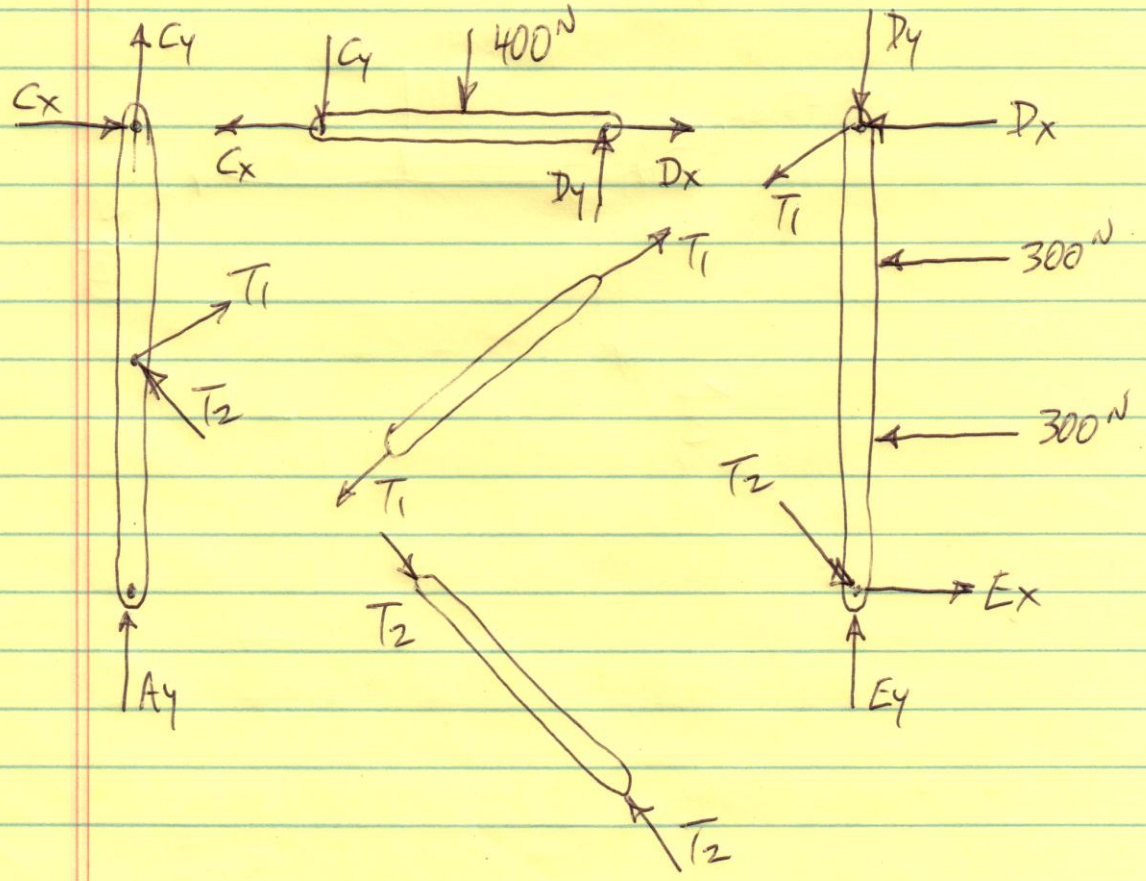
c)



PROB. 4 CONT.

d)


400 N
300 N
300 N
Ex
Ay
Ey


Cy
Cx
Cy
400 N
Cx
Dy
Dx
T1
T2
T1
T1
T2
T2
Dy
Dx
T1
300 N
300 N
T2
Ex
Ay
Ey