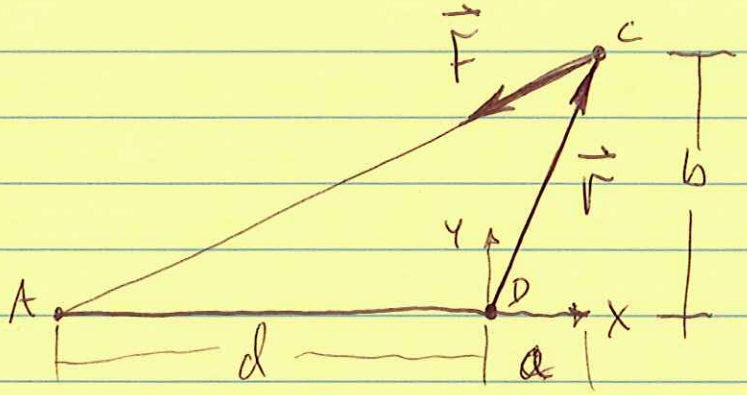
PROB. 3.13



$M_D = 960^{N\cdot m}$

$F = 2400^{N}$

$a = 0.2^{m}$, $b = 0.875^{m}$

FIND d

LOCATE POINTS:

$A(-d, 0)$, $C(a, b)$

$\vec{T}_{AC}$: $dx = X_A - X_C = -d - a = -(d+a) = -c$

$dy = Y_A - Y_C = 0 - b = -b$

$d = \sqrt{c^2 + b^2}$

$$F_x = F\frac{dx}{d} = T_{AC}\cdot\frac{-c}{\sqrt{c^2+b^2}}$$

$$F_y = F\frac{dy}{d} = T_{AC}\cdot\frac{-b}{\sqrt{c^2+b^2}}$$

$\vec{T}_{AC} = (F_x)\hat{i} + (F_y)\hat{j}$

$\vec{r} = (dx)\hat{i} + (dy)\hat{j} = (a)\hat{i} + (b)\hat{j}$

PROB. 3.13 CONT.

$$\vec{M}_D = \vec{r} \times \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ a & b & 0 \\ F_x & F_y & 0 \end{vmatrix}$$

$$\vec{M}_D = (aF_y - bF_x)\hat{k}$$

$$M_D = a \cdot F_y - b \cdot F_x$$

$$M_D = a \cdot T_{AC}\left(\frac{-b}{\sqrt{c^2+b^2}}\right) - b \cdot T_{AC}\left(\frac{-c}{\sqrt{c^2+b^2}}\right)$$

$$\left(\frac{M_D}{T_{AC}}\right)\sqrt{c^2+b^2} = -ab + bc$$

$$\left(\frac{M_D}{T_{AC}}\right)^2 (c^2+b^2) = (-ab+bc)^2$$

$$\left(\frac{M_D}{T_{AC}}\right)^2 c^2 + \left(\frac{M_D}{T_{AC}}\right)^2 b^2 = a^2b^2 - 2ab^2c + b^2c^2$$

$$\left[\left(\frac{M_D}{T_{AC}}\right)^2 - b^2\right]c^2 + 2abc + \left[b^2\left(\frac{M_D}{T_{AC}}\right)^2 - a^2b^2\right] = 0$$

$$\left(\frac{M_D}{T_{AC}}\right)^2 - b^2 = \left(\frac{960^{N.m}}{2400^{N}}\right)^2 - (0.875^{m})^2 = -0.6056^{m^2}$$

PROB. 3.13 CONT.

$$2ab^2 = 2(0.2^m)(0.875^m)^2 = 0.3062^{m^3}$$

$$b^2\left[\left(\frac{M_D}{T_{AC}}\right)^2 - a^2\right] = (0.875^m)^2\left[\left(\frac{960^{N\cdot m}}{2400^N}\right)^2 - (0.2^m)^2\right] = 0.09187^{m^4}$$

$$-0.6056 \cdot c^2 + 0.3062 \cdot c + 0.09187 = 0$$

$$X = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$c = \frac{-0.3062 \pm \sqrt{(0.3062)^2 - 4(-0.6056)(0.09187)}}{2(-0.6056)}$$

$$c = 0.2528 \pm 0.4643 = 0.7171, -0.2115$$

$$c = d + a, \quad d = c - a$$

$$\underline{d = 0.7171 - 0.2 = 0.5171^m} \ \bigstar$$

$$d = -0.2115 - 0.2 = -0.4115^m$$