ME 270

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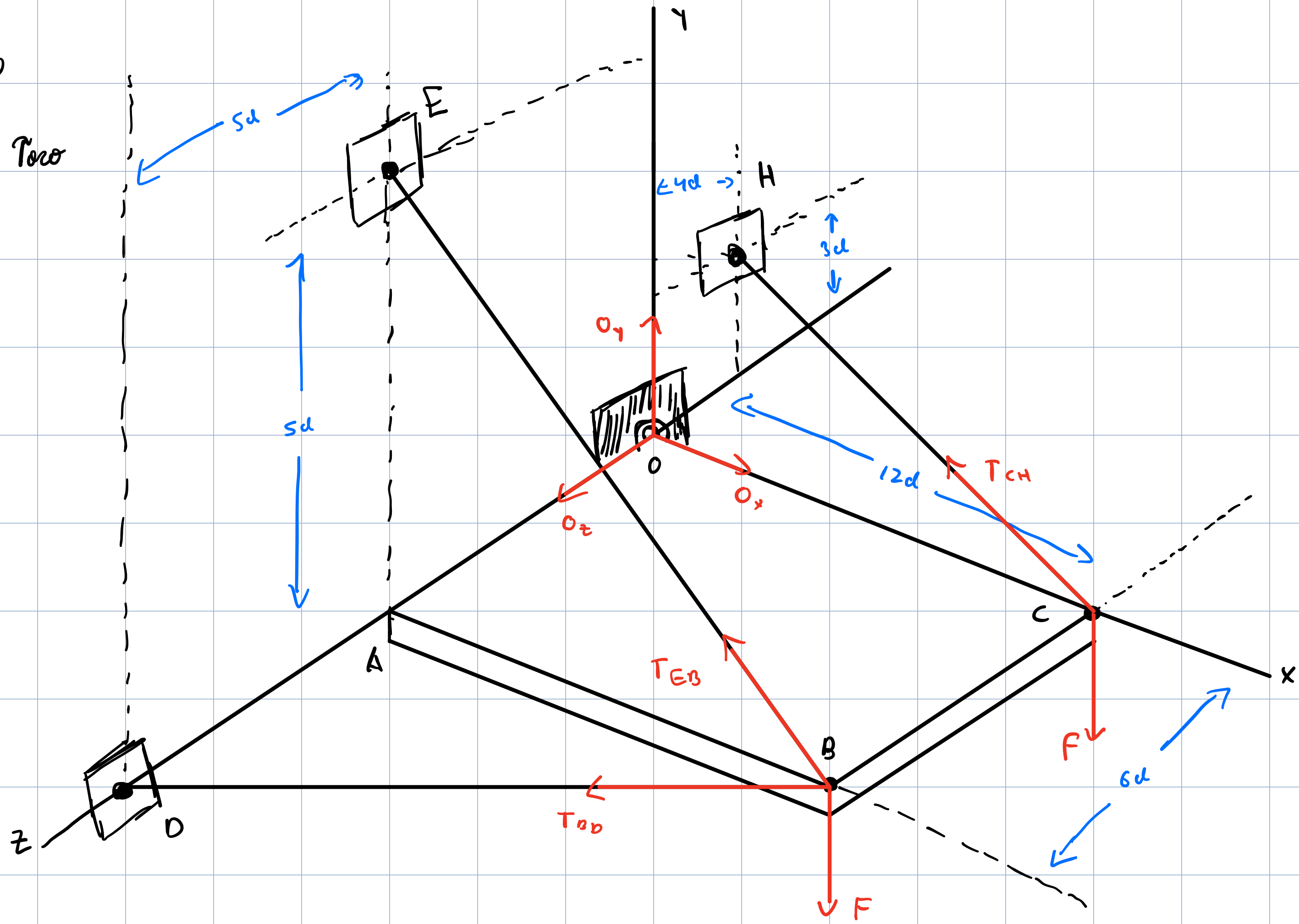
HW - 11



Tension Forces

$$\overline{T_{BD}} = T_{BD}\left(\frac{-12d\,\vec{i} + 5d\,\vec{k}}{\sqrt{(12d)^2 + (-5d)^2}}\right) = T_{BD}\left(-\frac{12}{13}\,\vec{i} + \frac{5}{13}\,\hat{k}\right)$$

$$\overline{T_{BE}} = T_{BE}\left(\frac{-12d\,\vec{i} + 5d\,\vec{j}}{\sqrt{(-12d)^2 + (5d)^2}}\right) = T_{BE}\left(\frac{-12}{13}\,\vec{i} + \frac{5}{13}\,\vec{j}\right)$$

$$\overline{T_{CH}} = T_{CH}\left(\frac{-12d\,\vec{i} + 3d\,\vec{j} - 4d\,\vec{k}}{\sqrt{(-12d)^2 + (3d)^2 + (-4d)^2}}\right) = T_{CH}\left(-\frac{12}{13}\,\vec{i} + \frac{3}{13}\,\vec{j} - \frac{4}{13}\,\vec{k}\right)$$

Moment Equilibrium About Point O

$$\sum \bar{M}_O = 0 = [\bar{r}_{OC} \times \bar{T}_{CH}] + [\vec{r}_{CB} + \bar{T}_{BE}] + [\bar{r}_{OB} \times \bar{T}_{BD}] + [\bar{r}_{OC} \times \bar{F}_C] + [\bar{r}_{OB} \times \bar{F}_B]$$

$\rightarrow$

$$\bar{r}_{OC} \times \bar{T}_{CH} = \begin{vmatrix} 12d & 0 & 0 \\ \frac{-12}{13} & \frac{3}{13} & \frac{-4}{13} \end{vmatrix} = \frac{48}{13} d\,\hat{j} + \frac{36}{13} d\,\hat{k} \cdot T_{CH}$$

$$\bar{r}_{CB} \times \bar{T}_{BE} = \begin{vmatrix} 12d & 0 & 6d \\ \frac{-12}{13} & \frac{5}{13} & 0 \end{vmatrix} = -\frac{30}{13} d\,\hat{i} - \frac{72}{13} d\,\hat{j} + \frac{60}{13} d\,\hat{k} \cdot T_{BE}$$

$$\bar{r}_{OB} \times \bar{T}_{BD} = \begin{vmatrix} 12d & 0 & 6d \\ \frac{-12}{13} & 0 & \frac{5}{13} \end{vmatrix} = -\left(\frac{60d}{13} - \left(\frac{-72}{13} d\right)\right)\hat{j} = \frac{-132}{13} d\,\hat{j} \cdot T_{BD}$$

$$\bar{r}_{OC} \times \bar{F}_C = \begin{vmatrix} 12d & 0 & 0 \\ 0 & -F & 0 \end{vmatrix} = -12dF\,\hat{k}$$

$$\bar{r}_{OB} \times \bar{F}_B = \begin{vmatrix} 12d & 0 & 6d \\ 0 & -F & 0 \end{vmatrix} = 6Fd\,\hat{i} - 12Fd\,\hat{k}$$

$\rightarrow$

$$\sum \bar{M}_O = 0 = T_{CH} \frac{42}{13} d\,\hat{j} + T_{CH} \frac{36}{13} d\,\hat{k} - T_{BE} \frac{30}{13} d\,\hat{i} - T_{BE} \frac{72}{13} d\,\hat{j} + T_{BE} \frac{66}{13} d\,\hat{k}$$

$$- T_{BD} \frac{132}{13} d\,\hat{j} - 12Fd\,\hat{k} + 6Fd\,\hat{i} - 12Fd\,\hat{k}$$

Sum of moments in components

$$\sum M_x = 0 = -T_{BE}\frac{30}{13}d + 6Fd$$

$$\rightarrow \quad T_{BE} = 6Fd\left(\frac{13}{30d}\right)$$

$$T_{BE} = \frac{13}{5}F \quad \text{or} \quad 2.6\,F$$

$$\sum M_z = 0 = T_{CH}\frac{36}{13}d + T_{BE}\frac{60}{13}d - 12Fd - 12Fd$$

$$0 = T_{CH}\frac{36}{13}d + \left(\frac{13}{5}F\right)\frac{60}{13}d - 12Fd - 12Fd$$

$$0 = T_{CH}\frac{36}{13}d + 12Fd - 12Fd - 12Fd$$

$$T_{CH}\frac{36}{13}d = 12Fd$$

$$\rightarrow \quad T_{CH} = 12Fd\left(\frac{13}{36d}\right)$$

$$T_{CH} = \frac{13}{3}F \quad \text{or} \quad 4.33\,F$$

$$\sum M_y = 0 = T_{CH}\frac{48}{13}d - T_{BE}\frac{72}{13}d - T_{BD}\frac{132}{13}d$$

$$0 = \left(\frac{13}{3}F\right)\frac{48}{13}d - \left(\frac{13}{5}F\right)\frac{72}{13}d - T_{BD}\frac{132}{13}d$$

$$0 = 16Fd - \frac{72}{5}Fd - T_{BD}\frac{132}{13}d$$

$$T_{BD}\frac{132}{13}d = \frac{8}{5}Fd$$

$$\rightarrow \quad T_{BD} = \frac{8}{5}Fd\left(\frac{13}{132d}\right)$$

$$T_{BD} = \frac{26}{125}F \quad \text{or} \quad 0.158\,F$$