

3-D

$$\sum F_x = 0$$

$$\sum F_y = 0$$

$$\sum F_z = 0$$

$$\sum M_x = 0$$

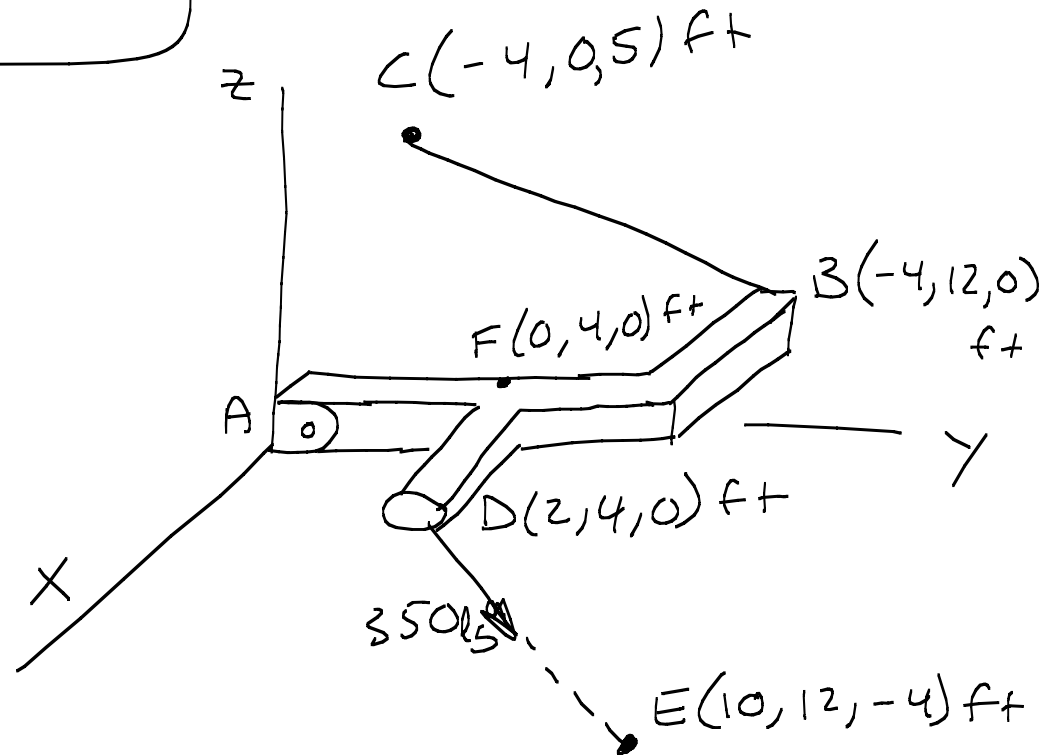
$$\sum M_y = 0$$

$$\sum M_z = 0$$

Example

Determine

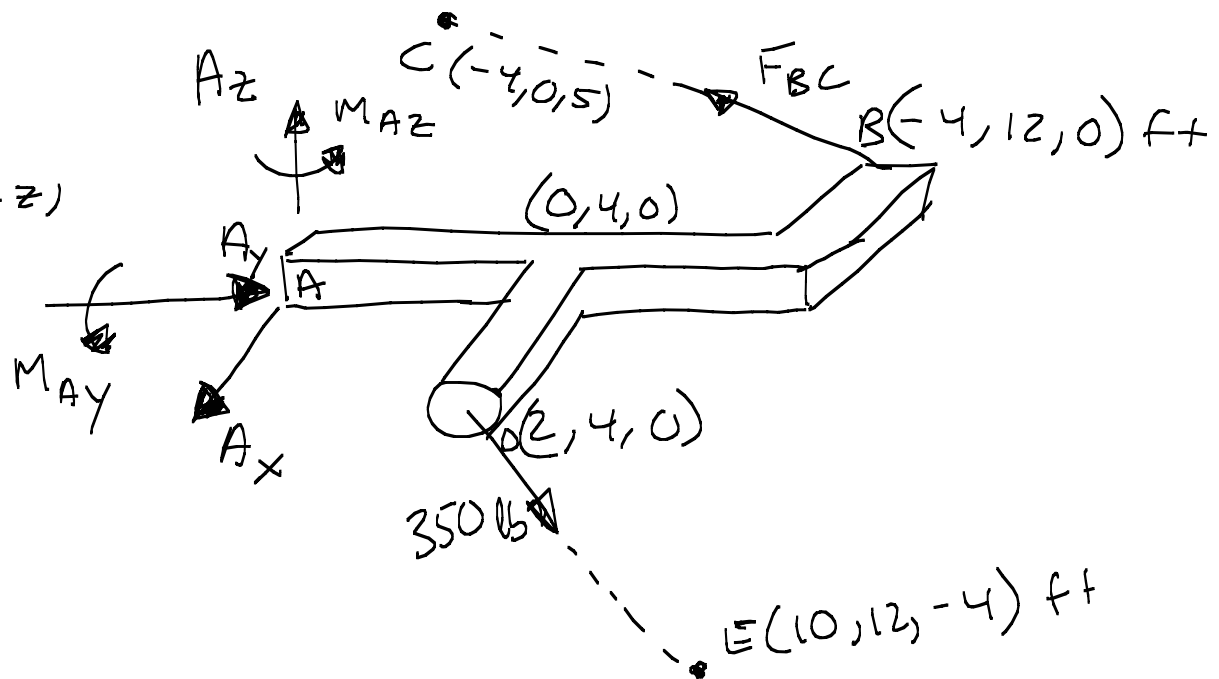
The support reactions



Unknowns

$A_x, A_y, A_z, M_{Ay}, M_{Az}$

F_{BC}



$$\sum \vec{F} = 0$$

$$\vec{r}_{DE} = \{ 8\hat{i} + 8\hat{j} - 4\hat{k} \} \text{ ft}$$

$$r_{DE} = 12 \text{ ft}$$

$$\vec{F} = (350 \text{ lb}) \left(\frac{8\hat{i} + 8\hat{j} - 4\hat{k}}{12} \right) = \{ 233.3\hat{i} + 233.3\hat{j} - 116.7\hat{k} \} \text{ lb}$$

$$\vec{r}_{BC} = \{ 0\hat{i} - 12\hat{j} + 5\hat{k} \} \text{ ft}$$

$$r_{BC} = 13 \text{ ft}$$

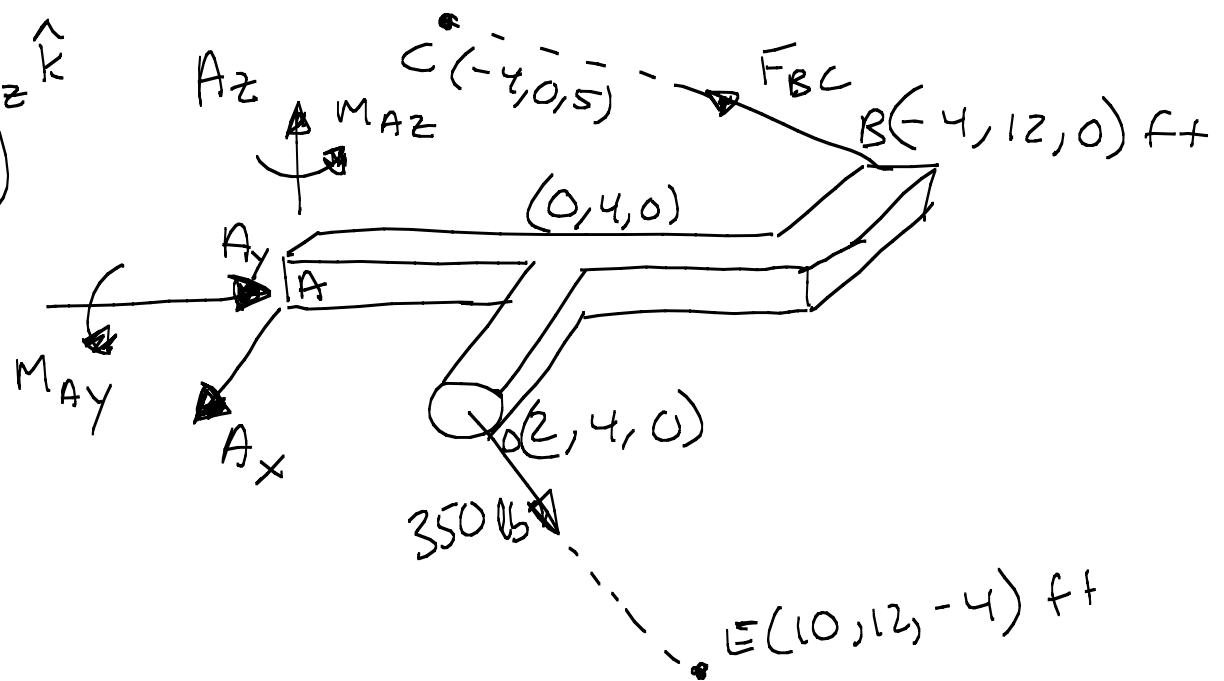
$$\vec{F}_{BC} = F_{BC} \left(\frac{0\hat{i} - 12\hat{j} + 5\hat{k}}{13} \right) = \left\{ -0.9231 F_{BC} \hat{j} + 0.3846 F_{BC} \hat{k} \right\}$$

$$\sum F_x = 0 \Rightarrow A_x + 233.3 \text{ lb} = 0 \quad \boxed{A_x = -233.3 \text{ lb}}$$

$$\sum F_y = 0 \Rightarrow A_y + 233.3 \text{ lb} - 0.9231 F_{BC} = 0$$

$$\sum F_z = 0 \Rightarrow A_z - 116.7 \text{ lb} + 0.3846 F_{BC} = 0$$

$$\sum \vec{M}_A = 0 = M_{Ay} \hat{j} + M_{Az} \hat{k} + (\vec{r}_{AB} \times \vec{F}_{BC}) + (\vec{r}_{AD} \times \vec{F})$$



$$\vec{r}_{AB} \times \vec{F}_{BC} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -4 & 12 & 0 \\ 0 & -0.9231F_{BC} & 0.3846F_{BC} \end{vmatrix}$$

$$= [(12)(0.3846F_{BC}) - 0]\hat{i} - [(-4)(0.3846F_{BC}) - 0]\hat{j}$$

$$+ [(-4)(-0.9231F_{BC}) - 0]\hat{k}$$

$$= \{4.615F_{BC}\hat{i} + 1.538F_{BC}\hat{j} + 3.692F_{BC}\hat{k}\}$$

$$\vec{r}_{AD} \times \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 4 & 0 \\ 233.3 & 233.3 & -116.7 \end{vmatrix} = [(4)(-116.7) - 0]\hat{i} - [(2)(-116.7) - 0]\hat{j}$$

$$+ [(2)(233.3) - (4)(233.3)]\hat{k}$$

$$= \{-466.8\hat{i} + 233.4\hat{j} - 466.6\hat{k}\} \text{ lb}\cdot\text{ft}$$

$$(\sum M_A)_x = 0 \Rightarrow 4.615 F_{BC} - 466.8 = 0 \quad \boxed{F_{BC} = 101.1 \text{ lb}}$$

$$\sum F_y = 0 \Rightarrow \boxed{A_y = -140 \text{ lb}}$$

$$\sum F_z = 0 \Rightarrow \boxed{A_z = 77.8 \text{ lb}}$$

$$(\sum M_A)_y = 0 \Rightarrow M_{Ay} + 1.538(101.1 \text{ lb}) + 233.4 = 0$$

$$\boxed{M_{Ay} = -389 \text{ lb}\cdot\text{ft}}$$

$$(\sum M_A)_z = 0 \Rightarrow M_{Az} + 3.692(101.1) - 466.6 = 0$$

$$\boxed{M_{Az} = 93.3 \text{ lb}\cdot\text{ft}}$$