

PROB. 4.135

FIND \vec{T} BY SETTING $\vec{M}_E \cdot \vec{\lambda}_{EA} = 0$

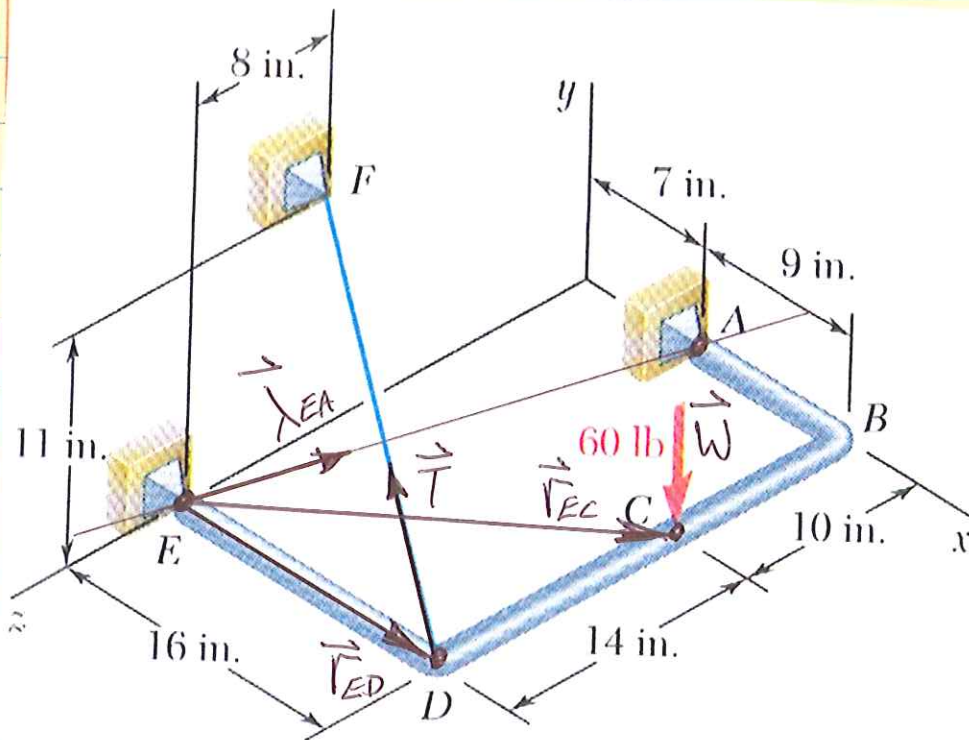


Fig. P4.135

LOCATE POINTS: $A(7,0,0)^{in}$, $C(16,0,10)^{in}$

$D(16,0,24)^{in}$, $E(0,0,24)^{in}$, $F(0,11,16)^{in}$

DEFINE FORCE VECTORS:

$\vec{W} = (-60)\hat{j}^{lb}$

PROB. 4.135 CONT.

(2)

$$\vec{T}: dx = x_F - x_D = 0 - 16 = -16^{\text{IN}}$$

$$dy = y_F - y_D = 11 - 0 = 11^{\text{IN}}$$

$$dz = z_F - z_D = 16 - 24 = -8^{\text{IN}}$$

$$d = \sqrt{16^2 + 11^2 + 8^2} = 21^{\text{IN}}$$

$$T_x = T \frac{dx}{d} = T \left(\frac{-16}{21} \right) = -0.762 T$$

$$T_y = T \frac{dy}{d} = T \left(\frac{11}{21} \right) = 0.524 T$$

$$T_z = T \frac{dz}{d} = T \left(\frac{-8}{21} \right) = -0.381 T$$

$$\vec{T} = (-0.762 T) \hat{i} + (0.524 T) \hat{j} + (-0.381 T) \hat{k} \text{ LB}$$

POSITION VECTORS:

$$\vec{r}_{EC}: dx = x_C - x_E = 16 - 0 = 16^{\text{IN}}, dy = 0$$

$$dz = z_C - z_E = 10 - 24 = -14^{\text{IN}}$$

$$\vec{r}_{EC} = (16) \hat{i} + (-14) \hat{k}^{\text{IN}}$$

$$\vec{r}_{ED}: dx = x_D - x_E = 16 - 0 = 16^{\text{IN}}, dy = 0, dz = 0$$

PROB. 4.135 CONT.

(3)

$$\vec{r}_{ED} = (16)\hat{i} \text{ m}$$

$$\vec{M}_E = \vec{r}_{EC} \times \vec{W} + \vec{r}_{ED} \times \vec{T}$$

$$\vec{r}_{EC} \times \vec{W} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 16 & 0 & -14 \\ 0 & -60 & 0 \end{vmatrix}$$

$$= [0 - (-14)(-60)]\hat{i} - [0]\hat{j} + [(16)(-60) - 0]\hat{k}$$

$$= (-840)\hat{i} + (-960)\hat{k} \text{ N}\cdot\text{m}$$

$$\vec{r}_{ED} \times \vec{T} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 16 & 0 & 0 \\ -0.762\text{T} & 0.524\text{T} & -0.381\text{T} \end{vmatrix}$$

$$= [0]\hat{i} - [(16)(-0.381\text{T}) - 0]\hat{j} + [(16)(0.524\text{T}) - 0]\hat{k}$$

$$= (6.1\text{T})\hat{j} + (8.38\text{T})\hat{k} \text{ N}\cdot\text{m}$$

$$\vec{M}_E = (-840)\hat{i} + (6.1\text{T})\hat{j} + (-960 + 8.38\text{T})\hat{k} \text{ N}\cdot\text{m}$$

$$\vec{\lambda}_{EA} : dx = x_A - x_E = 7 - 0 = 7 \text{ m}$$

$$dy = 0, dz = z_A - z_E = 0 - 24 = -24 \text{ m}$$

PROB. 4.135 CONT.

(4)

$$d = \sqrt{7^2 + 24^2} = 25 \text{ IN}$$

$$\frac{dx}{d} = \left(\frac{7}{25}\right) = 0.28, \quad \frac{dz}{d} = \left(\frac{-24}{25}\right) = -0.96$$

$$\vec{\lambda}_{EA} = (0.28)\hat{i} + (-0.96)\hat{k}$$

$$\vec{M}_E \cdot \vec{\lambda}_{EA} = (-840)(0.28) + (-960 + 8.38T)(-0.96) = 0$$

$$-235.2 + 921.6 - 8.045T = 0$$

$$T = 85.3 \text{ LB}$$