PROB. 4.136

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

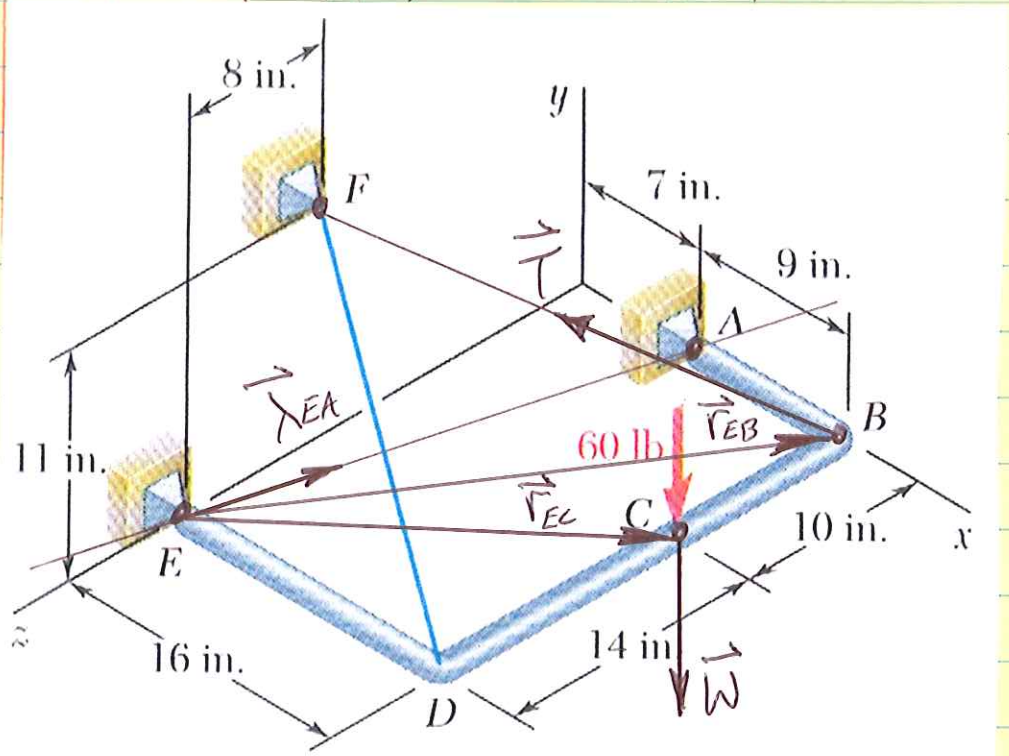

Fig. P4.135

LOCATE POINTS: $A(7,0,0)^{IN}$, $B(16,0,0)^{IN}$,

$C(16,0,10)^{IN}$, $E(0,0,24)^{IN}$, $F(0,11,16)^{IN}$

DEFINE FORCE VECTORS:

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

$\vec{T}$: $d_X = X_F - X_B = 0 - 16 = -16^{IN}$

$d_Y = Y_F - Y_B = 11 - 0 = 11^{IN}$

PROB. 4.136 CONT.

$$d_Z = Z_F - Z_B = 16 - 0 = 16^{IN}$$

$$d = \sqrt{16^2 + 11^2 + 16^2} = 25.16^{IN}$$

$$T_X = T\frac{d_X}{d} = T\left(\frac{-16}{25.16}\right) = -0.636T$$

$$T_Y = T\frac{d_Y}{d} = T\left(\frac{11}{25.16}\right) = 0.437T$$

$$T_Z = T\frac{d_Z}{d} = T\left(\frac{16}{25.16}\right) = 0.636T$$

$$\vec{T} = (-0.636T)\hat{i} + (0.437T)\hat{j} + (0.636T)\hat{k}^{\,lb}$$

POSITION VECTORS:

$\vec{r}_{EC}$: $d_X = X_C - X_E = 16 - 0 = 16^{IN}$, $d_Y = 0$,

$$d_Z = Z_C - Z_E = 10 - 24 = -14^{IN}$$

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

$\vec{r}_{EB}$: $d_X = X_B - X_E = 16 - 0 = 16^{IN}$, $d_Y = 0$,

$$d_Z = Z_B - Z_E = 0 - 24 = -24^{IN}$$

$$\vec{r}_{EB} = (16)\hat{i} + (-24)\hat{k}^{\,IN}$$

PROB. 4.136 CONT.

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

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

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

$$= (-840)\hat{i} + (-960)\hat{k} \text{ IN.LB}$$

$$\vec{r}_{EB} \times \vec{T} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 16 & 0 & -24 \\ -0.636T & 0.437T & 0.636T \end{vmatrix}$$

$$= [0 - (-24)(0.437T)]\hat{i} - [(16)(0.636T) - (-24)(-0.636T)]\hat{j}$$

$$+ [(16)(0.437T) - 0]\hat{k}$$

$$= (10.5T)\hat{i} + (5.09T)\hat{j} + (6.99T)\hat{k} \text{ IN.LB}$$

$$\vec{M}_E = (-840 + 10.5T)\hat{i} + (5.09T)\hat{j}$$

$$+ (-960 + 6.99T)\hat{k}$$

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

PROB. 4.136 CONT.

$$d_y = y_A - y_E = 0$$

$$d_z = z_A - z_E = 0 - 24 = -24^{IN}$$

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

$$\cos\theta_x = \frac{d_x}{d} = \left(\frac{7}{25}\right) = 0.28, \quad \cos\theta_z = \frac{d_z}{d} = \left(\frac{-24}{25}\right) = -0.96$$

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

$$\vec{M}_E \cdot \vec{\lambda}_{EA} = (-840 + 10.5T)(0.28)$$

$$+ (-960 + 6.99T)(-0.96) = 0$$

$$-235.2 + 2.94T + 921.6 - 6.71T = 0$$

$$T = 182^{LB}$$