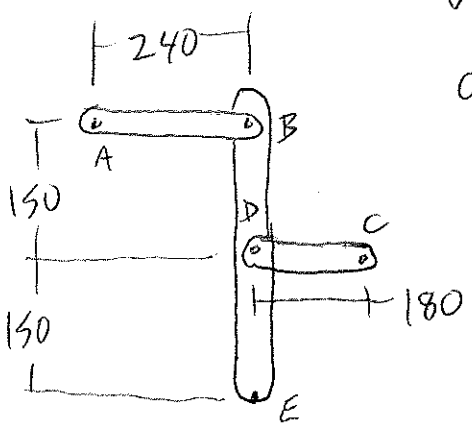
PROB. 15-110



$\alpha_{AB} = 0, \quad \omega_{AB} = 3 \frac{RAD}{s}$ CW

a) FIND $\vec{a}_D$

VELOCITY

$\vec{v}_B = \cancel{\vec{v}_A}^{\,0} + \omega_{AB}\hat{k} \times \vec{r}_{B/A}$

$$\omega_{AB}\hat{k} \times \vec{r}_{B/A} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & -3 \\ 0.24 & 0 & 0 \end{vmatrix}$$

$= -[0-(-3)(0.24)]\hat{j} = (-0.72)\hat{j} \frac{m}{s^2} = \vec{v}_B$

$\vec{v}_D = \vec{v}_B + \omega_{BD}\hat{k} \times \vec{r}_{D/B}$

$$\omega_{BD}\hat{k} \times \vec{r}_{D/B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \omega_{BD} \\ 0 & -0.15 & 0 \end{vmatrix} = [0-(\omega_{BD})(-0.15)]\hat{i}$$

$= (0.15\,\omega_{BD})\hat{i}$

$\vec{v}_D = (-0.72)\hat{j} + (0.15\,\omega_{BD})\hat{i} \frac{m}{s}$

$\vec{v}_D = \cancel{\vec{v}_C}^{\,0} + \omega_{CD}\hat{k} \times \vec{r}_{D/C}$

$$\# = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \omega_{CD} \\ -0.18 & 0 & 0 \end{vmatrix} = -[0-(\omega_{CD})(-0.18)]\hat{j}$$

$\vec{v}_D = (-0.18\,\omega_{CD})\hat{j}$

$(-0.72)\hat{j} + (0.15\,\omega_{BD})\hat{i} = (-0.18\,\omega_{CD})\hat{j}$

PROB. 15-110 CONT.

X-DIRECTION: $\omega_{BD} = 0$

Y-DIRECTION: $-0.72 = -0.18\,\omega_{CD} \Rightarrow \omega_{CD} = 4.0 \frac{RAD}{s}$ ↻

ACCELERATION

$$\vec{a}_B = \vec{a}_A^{\,0} + \alpha_{AB}^{\,0}\,\hat{k} \times \vec{r}_{B/A} - \omega_{AB}^2\,\vec{r}_{B/A}$$

$$\vec{a}_B = -\left(-3 \tfrac{RAD}{s}\right)^2 \cdot (0.24)\,\hat{i} = (-2.16)\,\hat{i} \ \tfrac{m}{s^2}$$

$$\vec{a}_D = \vec{a}_B + \alpha_{BD}\,\hat{k} \times \vec{r}_{D/B} - \omega_{BD}^{2\,0}\,\vec{r}_{D/B}$$

$$\alpha_{BD}\,\hat{k} \times \vec{r}_{D/B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \alpha_{BD} \\ 0 & -0.15 & 0 \end{vmatrix} = [0 - (\alpha_{BD})(-0.15)]\,\hat{i}$$

$$= (0.15\,\alpha_{BD})\,\hat{i}$$

$$\vec{a}_D = (-2.16)\,\hat{i} + (0.15\,\alpha_{BD})\,\hat{i} = (0.15\,\alpha_{BD} - 2.16)\,\hat{i} \ \tfrac{m}{s^2}$$

$$\vec{a}_D = \vec{a}_C + \alpha_{CD}\,\hat{k} \times \vec{r}_{D/C} - \omega_{CD}^2\,\vec{r}_{D/C}$$

$$\alpha_{CD}\,\hat{k} \times \vec{r}_{D/C} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \alpha_{CD} \\ -0.18 & 0 & 0 \end{vmatrix} = -[0 - (\alpha_{CD})(-0.18)]\,\hat{j}$$

$$= (-0.18\,\alpha_{CD})\,\hat{j}$$

$$\vec{a}_D = (-0.18\,\alpha_{CD})\,\hat{j} - (4.0)^2 \cdot (-0.18)\,\hat{i}$$

$$\vec{a}_D = (-0.18\,\alpha_{CD})\,\hat{j} + (2.88)\,\hat{i}$$

$$(0.15\,\alpha_{BD} - 2.16)\,\hat{i} = (-0.18\,\alpha_{CD})\,\hat{j} + (2.88)\,\hat{i}$$

PROB. 15-110 CONT.

X-DIRECTION: $0.15\alpha_{BD} - 2.16 = 2.88 \Rightarrow \alpha_{BD} = 33.6 \frac{RAD}{s^2}$ ↺

Y-DIRECTION: $\alpha_{CD} = 0$

$$\vec{a}_D = (2.88)\hat{i} \ \frac{m}{s^2}$$

b) FIND $\vec{a}_E$

$$\vec{a}_E = \vec{a}_D + \alpha_{BD}\hat{k} \times \vec{r}_{E/D} - \omega_{BD}^{2\,9^0}\vec{r}_{E/D}$$

$$\alpha_{BD}\hat{k} \times \vec{r}_{E/D} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & 33.6 \\ 0 & -0.15 & 0 \end{vmatrix} = [0 - (33.6)(-0.15)]\hat{i}$$

$$= (5.04)\hat{i} \ \frac{m}{s^2}$$

$$\vec{a}_E = (2.88)\hat{i} + (5.04)\hat{i} = (7.92)\hat{i} \ \frac{m}{s^2}$$