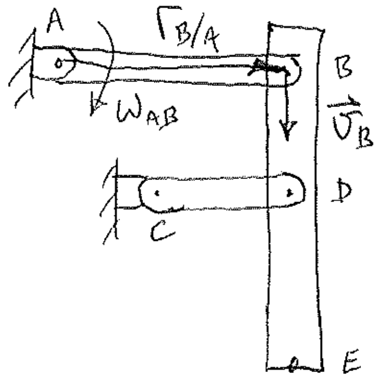
PROB. 15-109



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

a) FIND $\vec{a}_D$

VELOCITY

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

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

$$\vec{v}_B = (-0.72)\hat{j} \ \frac{m}{s}$$

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

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

$$= (0.15\,\omega_{BD})\hat{i} \ \frac{m}{s^2}$$

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

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

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

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$$\omega_{CD}\hat{k} \times \vec{r}_{D/C} = (0.18\,\omega_{CD})\hat{j}$$

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

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

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

ACCELERATION:

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

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

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

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

$$= (0.15\,\alpha_{BD})\hat{i}\ \frac{m}{s^2}$$

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

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

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

$$= (0.18\,\alpha_{CD})\hat{j}\ \frac{m}{s^2}$$

$$-\omega_{CD}^2\,\vec{r}_{D/C} = -\left(-4.0\ \frac{RAD}{S}\right)^2 (0.18)\hat{i} = (-2.88)\hat{i}\ \frac{m}{s^2}$$

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$$\vec{a}_D = (0.18\,\alpha_{CD})\hat{j} + (-2.88)\hat{i} \quad \frac{m}{s^2}$$

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

X-DIRECTION: $0.15\,\alpha_{BD} - 2.16 = -2.88 \Rightarrow \alpha_{BD} = -4.8 \ \frac{RAD}{s^2}$

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

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

b) FIND $\vec{a}_E$

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

$$\alpha_{BD}\hat{k} \times \vec{r}_{E/D} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & -4.8 \\ 0 & -0.15 & 0 \end{vmatrix} = [0 - (-4.8)(-0.15)]\hat{i}$$

$$= (-0.72)\hat{i} \quad \frac{m}{s^2}$$

$$\vec{a}_E = (-2.88)\hat{i} + (-0.72)\hat{i} \boxed{= (-3.6)\hat{i} \quad \frac{m}{s^2}}$$