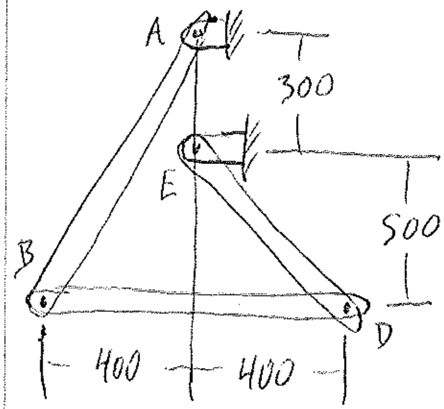
PROB. 15-133



$\omega_{AB} = 4 \frac{RAD}{S}$ ↻, $\alpha_{AB} = 0$

FIND α_{BD}, α_{DE}

VELOCITY

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

$$\vec{v}_B = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & -4 \\ -0.4 & -0.8 & 0 \end{vmatrix}$$

$$\vec{v}_B = [0-(-4)(-0.8)]\hat{i} - [0-(-4)(-0.4)]\hat{j}$$

$$\vec{v}_B = (-3.2)\hat{i} + (1.6)\hat{j}$$

$$\vec{v}_D = \cancel{\vec{v}_E}^{\,0} + \omega_{ED}\hat{k} \times \vec{r}_{D/E}$$

$$\vec{v}_D = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \omega_{ED} \\ 0.4 & -0.5 & 0 \end{vmatrix}$$

$$= [0-(\omega_{ED})(-0.5)]\hat{i} - [0-(\omega_{ED})(0.4)]\hat{j}$$

$$\vec{v}_D = (0.5\omega_{ED})\hat{i} + (0.4\omega_{ED})\hat{j}$$

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

$$\omega_{BD}\hat{k} \times \vec{r}_{D/B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \omega_{BD} \\ 0.8 & 0 & 0 \end{vmatrix} = -[0-(\omega_{BD})(0.8)]\hat{j}$$

$$= (0.8\omega_{BD})\hat{j} \ \frac{m}{s}$$

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$$\vec{v}_D = (-3.2)\hat{i} + (1.6)\hat{j} + (0.8\,\omega_{BD})\hat{j}$$

$$\vec{v}_D = (-3.2)\hat{i} + (1.6 + 0.8\,\omega_{BD})\hat{j}$$

$$(0.5\,\omega_{ED})\hat{i} + (0.4\,\omega_{ED})\hat{j} = (-3.2)\hat{i} + (1.6 + 0.8\,\omega_{BD})\hat{j}$$

X-DIRECTION: $0.5\,\omega_{ED} = -3.2 \Rightarrow \omega_{ED} = -6.4\ \frac{RAD}{s}$ ↻

Y-DIRECTION: $0.4\,\omega_{ED} = 1.6 + 0.8\,\omega_{BD}$

$$\omega_{BD} = \frac{1}{0.8}\left[0.4(-6.4) - 1.6\right] = -5.2\ \frac{RAD}{s}$$ ↻

ACCELERATION

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

$$\vec{a}_B = -(-4)^2\left[(-0.4)\hat{i} + (-0.8)\hat{j}\right]$$

$$\vec{a}_B = (6.4)\hat{i} + (12.8)\hat{j}\ \frac{m}{s^2}$$

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

$$\alpha_{BD}\hat{k} \times \vec{r}_{D/B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \alpha_{BD} \\ 0.8 & 0 & 0 \end{vmatrix} = -\left[0 - (\alpha_{BD})(0.8)\right]\hat{j}$$

$$= (0.8\,\alpha_{BD})\hat{j}\ \frac{m}{s^2}$$

$$-\omega_{BD}^2\,\vec{r}_{D/B} = -(-5.2)^2(0.8)\hat{i} = (-21.63)\hat{i}\ \frac{m}{s^2}$$

$$\vec{a}_D = (6.4)\hat{i} + (12.8)\hat{j} + (0.8\,\alpha_{BD})\hat{j} + (-21.63)\hat{i}$$

$$\vec{a}_D = (-15.23)\hat{i} + (12.8 + 0.8\,\alpha_{BD})\hat{j}$$

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

$$\alpha_{ED}\hat{k} \times \vec{r}_{D/E} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \alpha_{ED} \\ 0.4 & -0.5 & 0 \end{vmatrix}$$

$$= [0 - (\alpha_{ED})(-0.5)]\hat{i} - [0 - (\alpha_{ED})(0.4)]\hat{j}$$

$$= (0.5\alpha_{ED})\hat{i} + (0.4\alpha_{ED})\hat{j} \ \frac{m}{s^2}$$

$$-\omega_{ED}^2 \vec{r}_{D/E} = -(-6.4)^2[(0.4)\hat{i} + (-0.5)\hat{j}]$$

$$= (-16.38)\hat{i} + (20.48)\hat{j} \ \frac{m}{s^2}$$

$$\vec{a}_D = (0.5\alpha_{ED})\hat{i} + (0.4\alpha_{ED})\hat{j} + (-16.38)\hat{i} + (20.48)\hat{j}$$

$$\vec{a}_D = (0.5\alpha_{ED} - 16.38)\hat{i} + (0.4\alpha_{ED} + 20.48)\hat{j}$$

$$(-15.23)\hat{i} + (12.8 + 0.8\alpha_{BD})\hat{j} = (0.5\alpha_{ED} - 16.38)\hat{i} + (0.4\alpha_{ED} + 20.48)\hat{j}$$

X-DIRECTION: $-15.23 = 0.5\alpha_{ED} - 16.38$

$$\boxed{\alpha_{ED} = 2.3 \ \frac{RAD}{s^2} \ \circlearrowleft}$$

Y-DIRECTION: $12.8 + 0.8\alpha_{BD} = 0.4(2.3) + 20.48$

$$\boxed{\alpha_{BD} = 10.75 \ \frac{RAD}{s^2} \ \circlearrowleft}$$