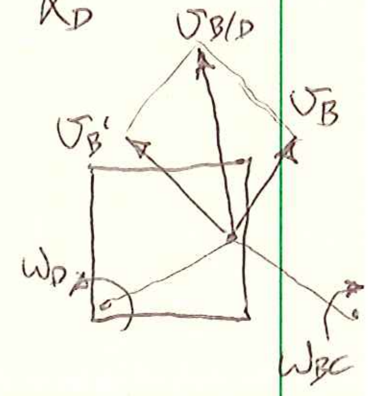
<u>PROB. 15-178</u>

$\omega_{BC} = 3 \ \frac{RAD}{s} \circlearrowright, \quad \alpha_{BC} = 2 \ \frac{RAD}{s^2} \circlearrowright, \quad$ FIND α_D



$$\vec{v}_B = \vec{v}_{B'} + \vec{v}_{B/D}$$

$$\vec{v}_B = \omega_{BC}\hat{k} \times \vec{r}_{B/C} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & -3 \\ -6 & 3 & 0 \end{vmatrix}$$

$$= [0-(-3)(3)]\hat{i} - [0-(-3)(-6)]\hat{j}$$

$$\vec{v}_B = (9)\hat{i} + (18)\hat{j} \ \frac{IN}{s}$$

$$\vec{v}_{B'} = \omega_D\hat{k} \times \vec{r}_{B'/D} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \omega_D \\ 4 & 3 & 0 \end{vmatrix}$$

$$= [0-(\omega_D)(3)]\hat{i} - [0-(\omega_D)(4)]\hat{j}$$

$$\vec{v}_{B'} = (-3\omega_D)\hat{i} + (4\omega_D)\hat{j} \ \frac{IN}{s}$$

$$\vec{v}_{B/D} = (v_{BD})\hat{j}$$

$$(9)\hat{i} + (18)\hat{j} = (-3\omega_D)\hat{i} + (4\omega_D)\hat{j} + (v_{BD})\hat{j}$$

X-DIRECTION: $9 = -3\omega_D \Rightarrow \omega_D = -3 \ \frac{RAD}{s} \circlearrowright$

Y-DIRECTION: $18 = 4(-3) + v_{BD} \Rightarrow v_{BD} = 30 \ \frac{IN}{s}$

$$\vec{v}_{B/D} = (30)\hat{j} \ \frac{IN}{s}$$

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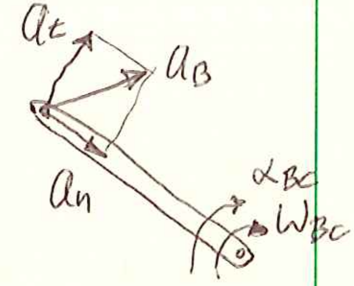


$$\vec{a}_B = \vec{a}_{B'} + \vec{a}_{B/D} + \vec{a}_c$$

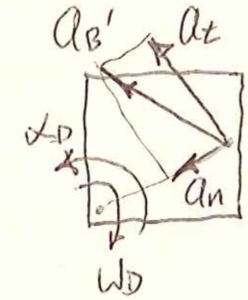
$$\vec{a}_B = \alpha_{BC}\hat{k} \times \vec{r}_{B/C} - \omega_{BC}^2 \vec{r}_{B/C}$$

$$\alpha_{BC}\hat{k} \times \vec{r}_{B/C} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & -2 \\ -6 & 3 & 0 \end{vmatrix} = [0-(-2)(3)]\hat{i} - [0-(-2)(-6)]\hat{j}$$

$$= (6)\hat{i} + (12)\hat{j} \ \frac{in}{s^2}$$

$$-\omega_{BC}^2 \vec{r}_{B/C} = -(-3)^2[(-6)\hat{i} + (3)\hat{j}] = (54)\hat{i} + (-27)\hat{j} \ \frac{in}{s^2}$$

$$\vec{a}_B = (60)\hat{i} + (-15)\hat{j} \ \frac{in}{s^2}$$



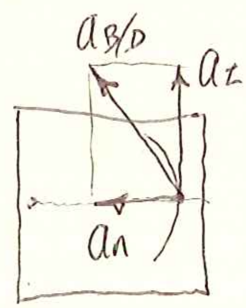
$$\vec{a}_{B'} = \alpha_D\hat{k} \times \vec{r}_{B'/D} - \omega_D^2 \vec{r}_{B'/D}$$

$$\alpha_D\hat{k} \times \vec{r}_{B'/D} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \alpha_D \\ 4 & 3 & 0 \end{vmatrix}$$

$$= [0-(\alpha_D)(3)]\hat{i} - [0-(\alpha_D)(4)]\hat{j} = (-3\alpha_D)\hat{i} + (4\alpha_D)\hat{j} \ \frac{in}{s^2}$$

$$-\omega_D^2 \vec{r}_{B'/D} = -(-3)^2[(4)\hat{i} + (3)\hat{j}] = (-36)\hat{i} + (-27)\hat{j} \ \frac{in}{s^2}$$

$$\vec{a}_{B'} = (-3\alpha_D - 36)\hat{i} + (4\alpha_D - 27)\hat{j} \ \frac{in}{s^2}$$



$$\vec{a}_{B/D} = (a_{BD})\hat{e}_t + \left(\frac{v^2}{\rho}\right)\hat{e}_n$$

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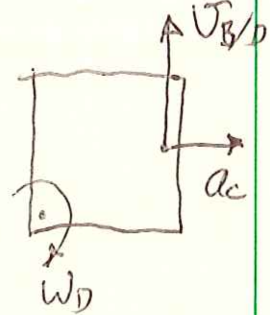
$$\vec{a}_{B/D} = (a_{BD})\hat{j} + \left[-\frac{(v_{B/D})^2}{\rho}\right]\hat{i}$$

$$\vec{a}_{B/D} = \left[-\frac{(30)^2}{4}\right]\hat{i} + (a_{BD})\hat{j} = (-225)\hat{i} + (a_{BD})\hat{j}$$

$$\vec{a}_C = 2\omega_D\hat{k} \times \vec{v}_{B/D} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & 2(-3) \\ 0 & 30 & 0 \end{vmatrix}$$



$$\vec{a}_C = (180)\hat{i} \ \frac{\text{IN}}{s^2}$$

$$(60)\hat{i} + (-15)\hat{j} = (-3\alpha_D - 36)\hat{i} + (4\alpha_D - 27)\hat{j}$$

$$+ (-225)\hat{i} + (a_{BD})\hat{j} + (180)\hat{i}$$

X-DIRECTION: $60 = -3\alpha_D - 36 - 225 + 180$

$$\boxed{\alpha_D = -47 \ \frac{\text{RAD}}{s^2} \circlearrowright}$$