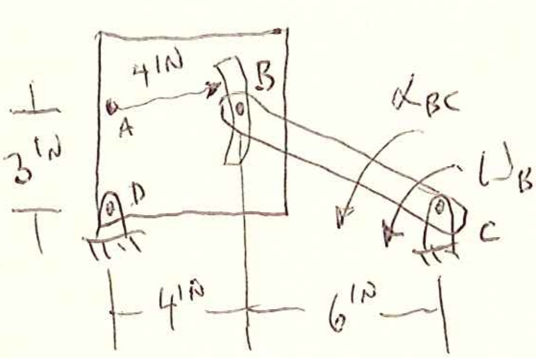
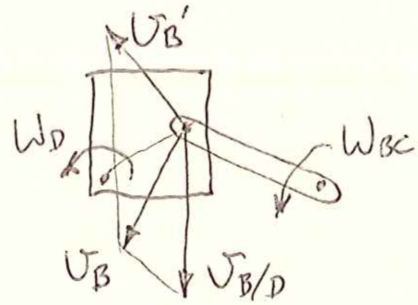
PROB. 15-177



$\omega_{BC} = 3 \frac{RAD}{s}$, $\alpha_{BC} = 2 \frac{RAD}{s^2}$

FIND α_D

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



$$\vec{v}_B = \omega_{BC}\hat{k} \times \vec{r}_{B/C}$$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & 3 \\ -6 & 3 & 0 \end{vmatrix}$$

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

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

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

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

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

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

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

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

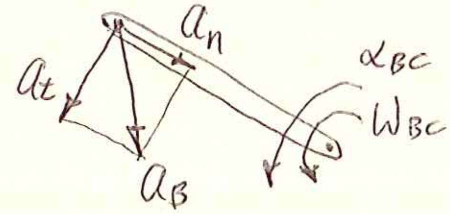
PROB. 15-177 CONT.

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

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

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

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

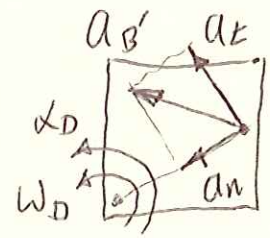


$$\alpha_{BC}\hat{k} \times \vec{r}_{B/C} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & 2 \\ -6 & 3 & 0 \end{vmatrix}$$

$= [0-(2)(3)]\hat{i} - [0-(2)(-6)]\hat{j} = (-6)\hat{i} + (-12)\hat{j} \ \frac{\text{IN}}{\text{S}^2}$

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

$\vec{a}_B = (48)\hat{i} + (-39)\hat{j} \ \frac{\text{IN}}{\text{S}^2}$



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

$\vec{r}_{B'/D} = (4)\hat{i} + (3)\hat{j} \ \text{IN}$

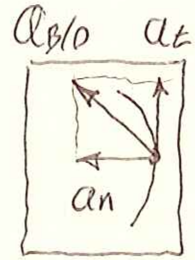
$$\alpha_D\hat{k} \times \vec{r}_{B'/D} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \alpha_D \\ 4 & 3 & 0 \end{vmatrix}$$

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

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

PROB. 15-177 CONT.

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

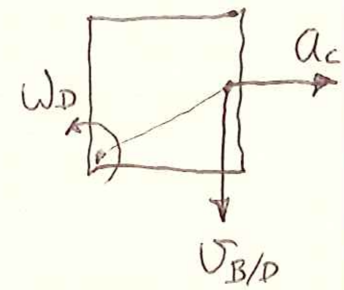


$$\vec{a}_{B/D} = \frac{dv}{dt}\hat{e}_t + \frac{v^2}{\rho}\hat{e}_n \quad \text{EQN. (11.39)}$$

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

$$\vec{a}_{B/D} = (-225)\hat{i} + (a_{BD})\hat{j} \ \frac{\text{IN}}{s^2}$$

$$\vec{a}_C = 2\omega_D\hat{k} \times \vec{v}_{B/D} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & 6 \\ 0 & -30 & 0 \end{vmatrix}$$



$$\vec{a}_C = [0 - (6)(-30)]\hat{i} = (180)\hat{i} \ \frac{\text{IN}}{s^2}$$

$$(48)\hat{i} + (-39)\hat{j} = (-3\alpha_D - 36)\hat{i} + (4\alpha_D - 27)\hat{j}$$

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

X-DIRECTION: $48 = -3\alpha_D - 36 - 225 + 180$

$$\boxed{\alpha_D = -43 \ \frac{\text{RAD}}{s^2}}$$

Y-DIRECTION: $-39 = 4(-43) - 27 + a_{BD}$

$$a_{BD} = (160) \ \frac{\text{IN}}{s^2}$$