

Problem 20-26

$$\vec{\omega}_{AC} = 8 \text{ k rad/s constant}$$

$$\vec{\omega}_{BD}?$$

$$\vec{\omega}_{BD} = \omega_{BD} \hat{i}$$

$$\vec{V}_A = \vec{\omega}_{AC} \times \vec{r}_{A/C} = 8(1.5) \hat{j} = 12 \hat{j} \text{ ft/s}$$

$$\vec{V}_B = \vec{\omega}_{BD} \times \vec{r}_{B/D} = V_B \hat{k}$$

$$\vec{V}_B = \vec{V}_A + \vec{\omega}_A \times \vec{r}_{B/A} = 12 \hat{j} + [(\omega_A)_x \hat{i} + (\omega_A)_y \hat{j} + (\omega_A)_z \hat{k}] \times (3\hat{i} + 2\hat{j} - 6\hat{k})$$

$$V_B \hat{k} = 12 \hat{j} + [(-6\omega_y - 2\omega_z) \hat{i} - (6\omega_x - 3\omega_z) \hat{j} + (2\omega_x - 3\omega_y) \hat{k}]$$

$\hat{i}$	$\hat{j}$	$\hat{k}$
ω_x	ω_y	ω_z
3	2	-6

$$\Rightarrow (-6\omega_y - 2\omega_z) = 0 \quad \text{--- (1)}$$

$$12 + 6\omega_x + 3\omega_z = 0 \quad \text{--- (2)}$$

$$-V_B + 2\omega_x - 3\omega_y = 0 \quad \text{--- (3)}$$

3 equations
4 unknowns?

One can assume that $\vec{\omega}$ in the direction of $\vec{r}_{B/A} = 0$

This will not affect $\vec{V}_B$.

$$\Rightarrow \vec{\omega} \cdot \vec{r}_{B/A} = 0$$

$$\Rightarrow 3\omega_x - 2\omega_y - 6\omega_z = 0$$

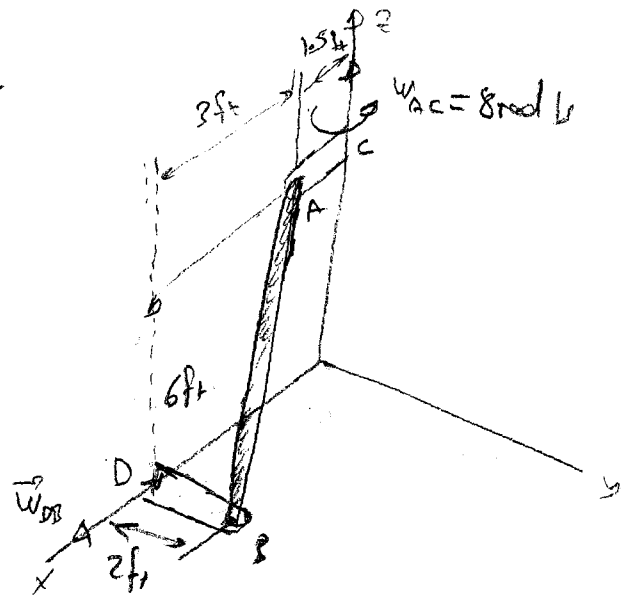
$$3\left(-\frac{12+3\omega_z}{2.6}\right) + 2\left(\frac{-\omega_z}{-3}\right) - 6\omega_z = 0 \Rightarrow \omega_z =$$

$$\omega_z = \frac{6}{-\frac{3}{2} - \frac{2}{3} - 6} = -0.7347$$

$$\Rightarrow \omega_x = \frac{12 + 3(-0.7347)}{-6} = -1.681 \text{ rad/s} \quad \omega_y = -\left(\frac{-0.7347}{3}\right) = +0.184 \text{ rad/s}$$

$$V_B = 2(2.581 - 3(-1.220)) = -1.27 \text{ ft/s}$$

$$\omega_{BD} = \frac{15.42}{2} = 7.71 \text{ rad/s} \quad \vec{\omega}_{BD} = 7.71 \hat{i}$$



Two many calculations

It is possible to make a mistake.

$$\text{from (1)} \Rightarrow \omega_y = -\frac{\omega_z}{2}$$

$$\text{from (2)} \Rightarrow \omega_x = -\frac{\omega_z}{2} - 2$$

$$\text{in (3)} \Rightarrow -V_B + (-\omega_z - 4) + \omega_z = 0$$

$$\Rightarrow V_B = -4 \text{ m/s} \quad \vec{V}_B = -4 \hat{k}$$

$$\omega_{BD} = \frac{4}{2} = 2 \text{ rad/s} \quad \vec{\omega}_{BD} = 2 \hat{i} \text{ rad/s}$$