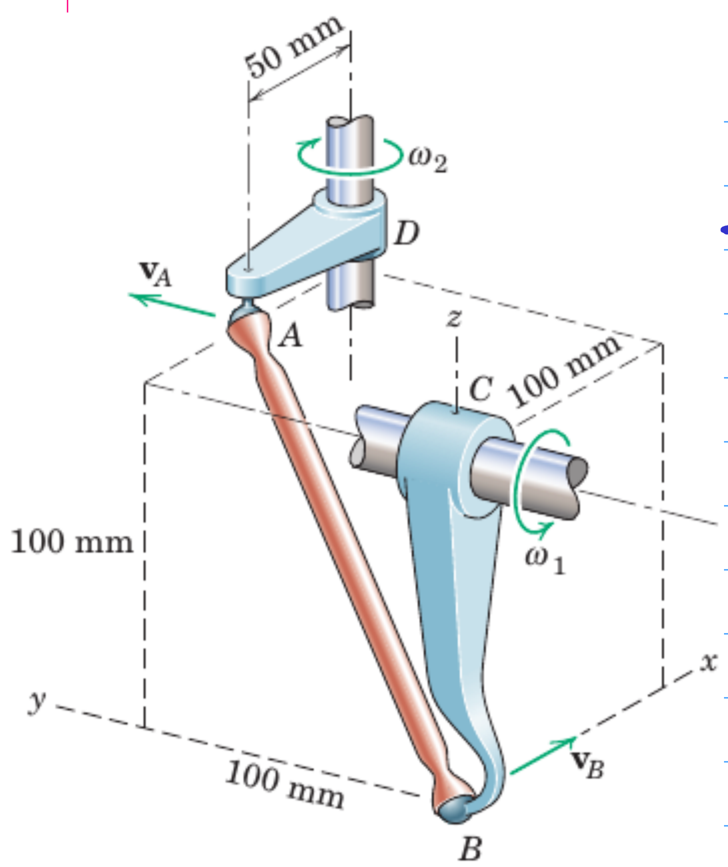
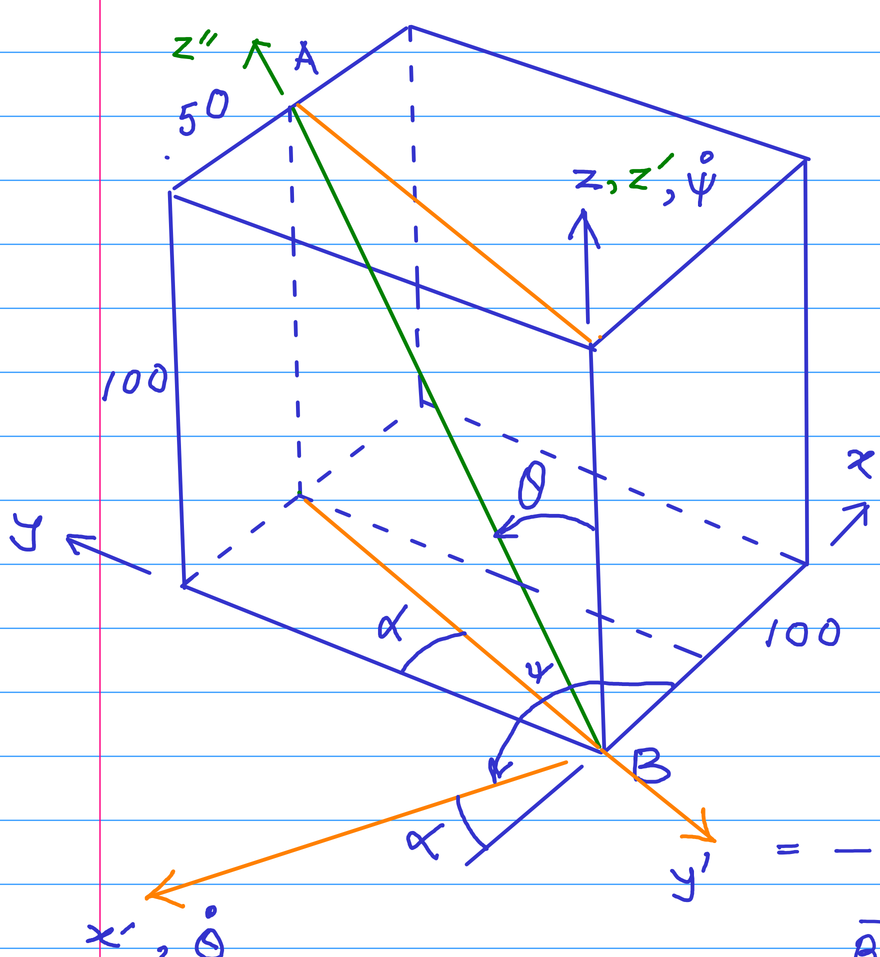


Sample problem 7.3

- $\omega_1 = 6$ rad/s & constant
- Ball & socket jts at B & A
- Ang velocity ω_n of link AB = ?

Method 1



$$\bar{\omega}_n = \dot{\psi}\hat{k} + \dot{\theta}\hat{i}'$$

$$\hat{i}' = -\cos\alpha\,\hat{i} + \sin\alpha\,\hat{j}$$

$$\alpha = \tan^{-1}\frac{50}{100} = 26.565^\circ$$

$$\bar{\omega}_n = \dot{\psi}\hat{k} + \dot{\theta}\left(-c\alpha\,\hat{i} + s\alpha\,\hat{j}\right)$$

$$= -0.894\,\dot{\theta}\,\hat{i} + 0.447\,\dot{\theta}\,\hat{j} + \dot{\psi}\,\hat{k}$$

$$\bar{BA} = 50\hat{i} + 100\hat{j} + 100\hat{k}$$

$$\bar{v}_A = \bar{v}_B + \bar{\omega}_n \times \overline{BA}$$

$$50\,\omega_2\,\hat{j} = 600\,\hat{i} + \left(-0.894\,\dot{\theta}\,\hat{i} + 0.447\,\dot{\theta}\,\hat{j} + \dot{\psi}\,\hat{k}\right) \times \left(50\,\hat{i} + 100\,\hat{j} + 100\,\hat{k}\right)$$

$$-100\,\dot{\psi} + 44.721\,\dot{\theta} + 600 = 0 \quad \text{——} \ (1)$$

$$-50\omega_2 + 50\,\dot{\psi} + 89.443\,\dot{\theta} = 0 \quad \text{——} \ (2)$$

$$-111.8\,\dot{\theta} = 0 \quad \text{——} \ (3)$$

$$\dot{\theta} = 0, \quad \dot{\psi} = \omega_2 = 6 \text{ rad/s}$$

$$\bar{\omega}_n = 6\,\hat{k} \text{ rad/s}, \quad \omega_2 = 6 \text{ rad/s}$$

Method 2

$$\bar{\omega}_n = \omega_{nx}\,\hat{i} + \omega_{ny}\,\hat{j} + \omega_{nz}\,\hat{k}$$

$$\bar{v}_A = \bar{v}_B + \bar{\omega}_n \times \overline{BA}$$

3 scalar eqns

$$50\,\omega_2\,\hat{j} = 300\,\hat{i} + \left(\omega_{nx}\,\hat{i} + \omega_{ny}\,\hat{j} + \omega_{nz}\,\hat{k}\right) \times \left(50\,\hat{i} + 100\,\hat{j} + 100\,\hat{k}\right)$$

1 scalar eqn

$$\leftarrow \bar{\omega}_n \cdot \overline{AB} = 0$$

$$\bar{\omega}_n = \frac{2}{3}\left(-2\,\hat{i} - 4\,\hat{j} + 5\,\hat{k}\right), \quad \omega_2 = 6 \text{ rad/s}$$

Method 1	Method 2
$\overline{\omega}_n = 6\hat{k}$	$\overline{\omega}_n = \frac{2}{3}\left(-2\hat{i} - 4\hat{j} + 5\hat{k}\right)$
$\overline{\omega}_n \times \overline{BA} = 600\hat{i} - 300\hat{j}$	$\overline{\omega}_n \times \overline{BA} = 600\hat{i} - 300\hat{j}$
$\overline{v}_B - \overline{v}_A = \overline{\omega}_n \times \overline{BA}$	$\overline{v}_B - \overline{v}_A = \overline{\omega}_n \times BA$
$\overline{\omega}_n \cdot \overline{BA} \neq 0$, $\dot{\phi} = 0$	$\overline{\omega}_n \cdot \overline{BA} = 0$

Explanation

$$\overline{\omega}_n = (\overline{\omega}_n)_{BA} + (\overline{\omega}_n)_{\perp BA}$$

$$\left\{(\overline{\omega}_n)_{BA} + (\overline{\omega}_n)_{\perp BA}\right\} \times \overline{BA}$$

$$= (\overline{\omega}_n)_{\perp BA} \times \overline{BA}$$

$$(\overline{\omega}_n)_{BA} \times \overline{BA} = \overline{0}$$

$$(\overline{\omega}_n)_{Meth2} = (\overline{\omega}_n)_{Meth1} - \left\{(\overline{\omega}_n)_{Meth1} \cdot \hat{n}_{BA}\right\} \hat{n}_{BA}$$

$$\hat{n}_{BA} = \frac{\overline{BA}}{|\overline{BA}|}$$