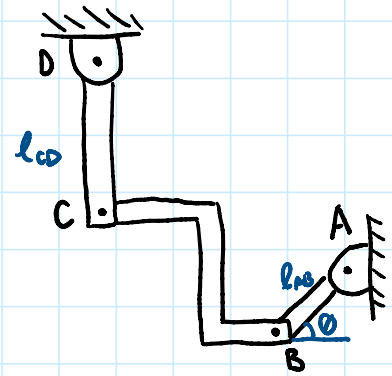
20-R-KM-DK-15

July 31, 2020 11:26 AM

20-R-KM-DK-15 Intermediate ICZV

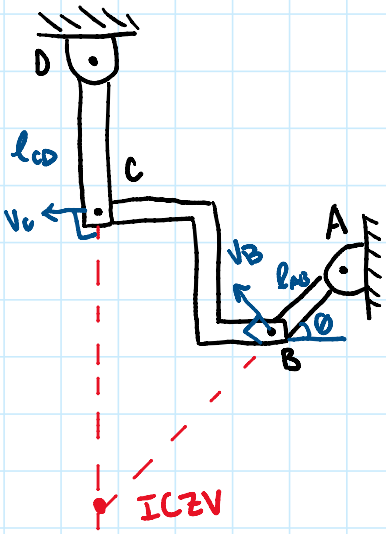
Inspiration: 16-112 Hibbeler

Several arms are linked to form the system shown. Link AB has a length of ***l_AB = 0.5 m***, link CD has a length of ***l_CD = 0.5 m***, and the distance from B to C is ***r_C/B = -1 i + 1 j m***. If the angle between link AB is ***theta = 45 degrees***, determine the angular velocity of link CD. Locate the ICZV. The angular velocities of the links are given as ***omega_AB = -3 rad/s*** and ***omega_BC = (3sqrt2)/4 rad/s***.



$$\vec{r}_{B/A} = (-0.5\cos45\,\hat{i} - 0.5\sin45\,\hat{j})$$
$$\vec{r}_{C/B} = (-1\,\hat{i} + 1\hat{j})$$
$$\vec{r}_{D/C} = (0.5\,\hat{j})$$

$$\vec{v}_B = -3\hat{k} \times (-0.5\cos45\,\hat{i} - 0.5\sin45\,\hat{j}) = 1.5\cos45\,\hat{j} - 1.5\sin45\,\hat{i}$$
$$\vec{v}_C = \omega_{CD}\,\hat{k} \times (-0.5\,\hat{j}) = 0.5\,\omega_{CD}\,\hat{i}$$



unknown, but know direction

$$\vec{v}_C = \vec{\omega}_{BC} \times \vec{r}_{C/IC}$$
$$0.5\,\omega_{CD}\,\hat{i} = \frac{3\sqrt{2}}{4}\,\hat{k} \times \vec{r}_{4IC}$$

unknown, but know direction

$$\vec{v}_B = \vec{\omega}_{BC} \times \vec{r}_{B/IC}$$
$$1.5\cos45\,\hat{j} - 1.5\sin45\,\hat{i} = \frac{3\sqrt{2}}{4}\,\hat{k} \times (r_{B/IC}\cos45\,\hat{i} + r_{B/IC}\sin45\,\hat{j})$$
$$1.5\cos45\,\hat{j} - 1.5\sin45\,\hat{i} = \frac{3\sqrt{2}}{4}\,r_{B/IC}\cos45\,\hat{j} - \frac{3\sqrt{2}}{4}\,r_{B/IC}\sin45\,\hat{i}$$
$$\hat{i}: \quad -1.5\sin45 = -\frac{3\sqrt{2}}{4}\,r_{B/IC}\sin45$$
$$\hat{j}: \quad 1.5\cos45 = \frac{3\sqrt{2}}{4}\,r_{B/IC}\cos45 \qquad r_{B/IC} = \sqrt{2}$$
$$\vec{r}_{B/IC} = \sqrt{2}\cos45\,\hat{i} + \sqrt{2}\sin45\,\hat{j}$$

$$\vec{IC} = \vec{r}_{I/B} + \vec{r}_{B/A} = -\vec{r}_{B/IC} + \vec{r}_{B/A} = -\left(\frac{4+\sqrt{2}}{4}\right)\hat{i} - \left(\frac{4+\sqrt{2}}{4}\right)\hat{j}$$

$$\hat{j}: \quad r_{C/IC} = r_{B/IC}\sin45 + 1 = \sqrt{2}\sin45 + 1$$
$$\vec{r}_{4IC} = 1 + \sqrt{2}\sin45\,\hat{j}$$

$$0.5\,\omega_{CD} = \frac{3\sqrt{2}}{4}\,\hat{k} \times (1 + \sqrt{2}\sin45\,\hat{j})$$

$$\boxed{\omega_{CD} = -3\sqrt{2}\,\hat{k}}$$