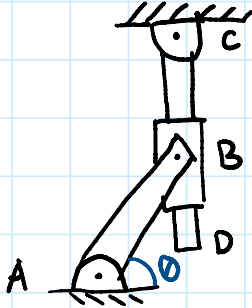


20-R-KM-DK-21

## Beginner Rotating Frame



A linkage system consists of two arms and a collar. Arm AB has a length  $r_{AB} = 0.5 \text{ m}$  and, in the instant shown, is at an angle of  $\theta = 45 \text{ degrees}$  with the horizontal. The collar sits on arm CD and is at a distance  $r_{BC} = 0.8 \text{ m}$  from point C. If the collar slides up arm CD at a relative velocity of  $v_{B/C_{rel}} = 1.1 \text{ m/s}$ , determine the angular velocity and angular acceleration of both arms.

$$\vec{v}_B = \vec{v}_C + \vec{\Omega}_{CD} \times \vec{r}_{B/C} + (v_{B/C_{rel}})_{A'V'Z'}$$

$$\vec{v}_B = \vec{\omega}_{AB} \times \vec{r}_{B/A}$$

$$\vec{r}_{B/C} = (-0.8 \hat{i}) \quad \vec{r}_{B/A} = (0.5 \cos 45 \hat{i} - 0.5 \sin 45 \hat{j})$$

$$\omega_{AB} \hat{k} \times (0.5 \cos 45 \hat{i} - 0.5 \sin 45 \hat{j}) = \Omega_{CD} \hat{k} \times (-0.8 \hat{i}) + (1.1 \hat{j})$$

$$0.5 \omega_{AB} \cos 45 \hat{j} + 0.5 \omega_{AB} \sin 45 \hat{i} = -0.8 \Omega_{CD} \hat{j} + 1.1 \hat{j}$$

$$1.1 = 0.5 \omega_{AB} \sin 45$$

$$\omega_{AB} = \frac{11\sqrt{2}}{5}$$

$$\Omega_{CD} = -\frac{11}{8}$$

$$\begin{aligned} \vec{a}_B &= \vec{\Omega}_{CD} \times \vec{r}_{B/C} + 2 \vec{\Omega}_{CD} \times (v_{B/C_{rel}})_{A'V'Z'} - \Omega_{CD}^2 \vec{r}_{B/C} \\ &= \Omega_{CD} \hat{k} \times (-0.8 \hat{i}) + 2 \left(-\frac{11}{8} \hat{k}\right) \times (1.1 \hat{j}) - \left(-\frac{11}{8}\right)^2 (-0.8 \hat{i}) \\ &= -0.8 \Omega_{CD} \hat{j} - \frac{121}{40} \hat{j} + \frac{121}{80} \hat{i} \end{aligned}$$

$$\begin{aligned} \vec{a}_B &= \alpha_{AB} \hat{k} \times (0.5 \cos 45 \hat{i} - 0.5 \sin 45 \hat{j}) - \left(\frac{11\sqrt{2}}{5}\right)^2 (0.5 \cos 45 \hat{i} - 0.5 \sin 45 \hat{j}) \\ &= 0.5 \alpha_{AB} \cos 45 \hat{j} + 0.5 \alpha_{AB} \sin 45 \hat{i} - \frac{121}{25} (\cos 45 \hat{i} + \frac{11}{25} \sin 45 \hat{j}) \end{aligned}$$

$$\hat{i}: 0.5 \alpha_{AB} \sin 45 - \frac{121}{25} \cos 45 = \frac{121}{80}$$

$$\alpha_{AB} = 13.95799603$$

$$\hat{j}: -0.8 \Omega_{CD} - \frac{121}{40} = 0.5 \alpha_{AB} \cos 45 + \frac{121}{25} \sin 45$$

$$\Omega_{CD} = -14.227667$$