

ME 2580 Example #32a: (Rigid Body Kinematics – Relative Velocity)

Given: - coordinates are in inches

$$\omega_{AB} = 10 \text{ (rad/s) (CCW)}$$

Find: ω_{BC} , ω_{CD}

Solution:

Using the relative velocity equation,

$$\boxed{\underline{v}_C = \underline{v}_B + \underline{v}_{C/B}}^*$$

where

$$\underline{v}_C = \underline{v}_{C/D} = \omega_{CD} \underline{k} \times \underline{r}_{C/D} = \omega_{CD} \underline{k} \times (2 \underline{i} + 6 \underline{j}) = \omega_{CD} (-6 \underline{i} + 2 \underline{j})$$

$$\underline{v}_B = \underline{v}_{B/A} = 10 \underline{k} \times \underline{r}_{B/A} = 10 \underline{k} \times (2 \underline{i} + 4 \underline{j}) = -40 \underline{i} + 20 \underline{j}$$

$$\underline{v}_{C/B} = \omega_{BC} \underline{k} \times \underline{r}_{C/B} = \omega_{BC} \underline{k} \times (8 \underline{i} + 2 \underline{j}) = \omega_{BC} (-2 \underline{i} + 8 \underline{j})$$

Substituting into the relative velocity equation (*) gives the following scalar equations:

$$\begin{cases} -6\omega_{CD} = -40 - 2\omega_{BC} \\ 2\omega_{CD} = 20 + 8\omega_{BC} \end{cases} \Rightarrow \begin{cases} 2\omega_{BC} - 6\omega_{CD} = -40 \\ -8\omega_{BC} + 2\omega_{CD} = 20 \end{cases}$$

Solving gives

$$\omega_{BC} = -10 / 11 \approx -0.909 \Rightarrow \boxed{\omega_{BC} \approx -0.909 \underline{k} \text{ (r/s)}}$$

$$\omega_{CD} = 70 / 11 \approx 6.36364 \Rightarrow \boxed{\omega_{CD} \approx 6.36 \underline{k} \text{ (r/s)}}$$

So, in the position shown, link *BC* is rotating **clockwise** at a rate of 0.909 (r/s), and link *CD* is rotating **counterclockwise** at a rate of 6.36 (r/s).

Note: Here again, the **signs** of the variables ω_{BC} and ω_{CD} are found by solving the simultaneous equations. So, the directions of the motions of the two links need not be known prior to solving the equations.

