

Elementary Dynamics Example #34: (Rigid Body Kinematics – Instantaneous Centers)

Given: $R = 3$ (in), $L = 6$ (in), $\theta = 30$ (deg)

$$\omega_{OA} = \dot{\theta} = 100 \text{ (rpm) (CCW)}$$

Find: ω_{AB} , $v_B = \dot{s}$

Solution:

To find the instantaneous center (IC) for the connecting link AB construct a line perpendicular to the velocity of A , and construct a second line perpendicular to the velocity of B . The intersection of these two lines is the IC of AB and is shown as point C on the diagram.

Using the triangle OAB , write

$$R \sin(\theta) = L \sin(\phi)$$

$$\Rightarrow \phi = \sin^{-1}\left(\left(\frac{R}{L}\right)\sin(\theta)\right) = 14.4775 \text{ (deg)}$$

and

$$s = R \cos(\theta) + L \cos(\phi) = 8.40755 \text{ (in)}$$

Using the right-triangle OBC , write

$$(R + r_A) \cos(\theta) = s \Rightarrow r_A = \left(\frac{s}{\cos(\theta)}\right) - R = 6.7082 \text{ (in)}$$

$$\frac{r_B}{s} = \tan(\theta) \Rightarrow r_B = s \tan(\theta) = 4.8541 \text{ (in)}$$

Velocity Analysis:

$$\left. \begin{aligned} v_A &= R \omega_{OA} = r_A \omega_{AB} \\ \Rightarrow \omega_{AB} &= \left(\frac{R}{r_A}\right) \omega_{OA} = 4.68321 \approx 4.68 \text{ (r/s) (CW)} \end{aligned} \right\} \Rightarrow \omega_{AB} = -4.68 \hat{k} \text{ (r/s)}$$

$$v_B = r_B \omega_{AB} = 22.7328 \approx 22.7 \text{ (in/s) to the left} \quad v_B \approx -22.7 \hat{i} \text{ (in/s)} \approx -1.89 \hat{i} \text{ (ft/s)}$$

Note:

As noted in the previous example, the analyst must determine the directions (or signs) of the calculated motions.

