21-R-KM-ZA-06 Solution

Question: Links $AB$and CDmove at the same angular velocity magnitude $\omega = 6\,rad/s$ in the directions shown. If $L = 1.5\,m$, find the angular velocity of link CE, and the velocity of link BE.

Solution: As points A and D are fixed, the velocity equation and the angular velocity can be used to find the velocity of points B and C which are on the same links. Link BE is constrained to move only in the x direction, so the velocity in the y direction is 0. The velocity of point E is equal to the velocity of point B as the motion of the link is constrained.

$$v_B = v_A + \omega \times r_{B/A} = 6\hat{k} \times (-2 * 1.5)\,\hat{j} = 18\,\hat{i}\,m/s = v_E$$

$$v_C = v_D + \omega \times r_{C/D} = -6\hat{k} \times 1.5\hat{j} = 9\hat{i}\,m/s$$

As shown by the coordinate system, one unit 'L' is equal to one unit in the coordinate system, so we can deduce that link CE is '3L' units long. Since we know the velocity of points C and E, the velocity equation for the link can be written, and the angular velocity can be isolated. We assume the link rotates in the $-\hat{k}$ direction. The positive value after solving indicates this assumption is correct.

$$v_C = v_E + \omega_{CE} \times r_{C/E} \Rightarrow 9\hat{i} = 18\hat{i} - \omega_{CE}\hat{k} \times -3(1.5)\,\hat{j} \Rightarrow \omega_{CE} = 2\,rad/s$$

$$\omega_{CE}\hat{k} = -2\hat{k}\,rad/s$$