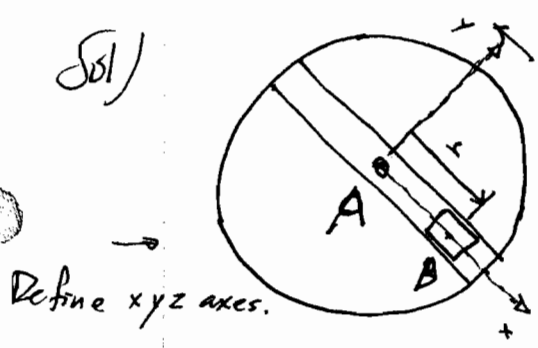
Ex. At the instant shown, the disk with the radial slot is rotating about A with a CCW angular velocity of 4 rad/sec which is decreasing at the rate of 10 rad/sec². The motion of slide B is separated controlled, and at this instant, $r = 6$ in, $\dot{r} = 5$ in/sec and $\ddot{r} = 81$ in/sec². Determine the absolute velocity and acceleration of B for this instant

Sol)



Choose A as the origin of the rotating axis xyz

$$\vec{V}_B = \vec{V}_A + \vec{\Omega} \times \vec{r}_{B/A} + \left(\vec{V}_{B/A}\right)_{xyz}$$

$\vec{V}_A = 0$ no translation

$$\vec{V}_B = 4\vec{k} \times 6\vec{i} + 5\vec{i} = 24\vec{j} + 5\vec{i} \ (\text{in/s})$$

$$V_B = \sqrt{(24)^2 + (5)^2} = 24.5 \ \text{in/s} \quad *.$$

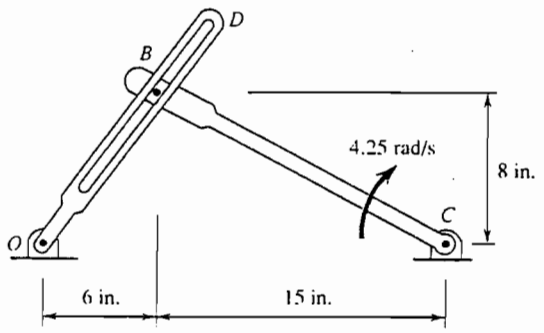
$$\vec{a}_B = \vec{a}_A + \dot{\vec{\Omega}} \times \vec{r}_{B/A} + \vec{\Omega} \times (\vec{\Omega} \times \vec{r}_{B/A}) + 2\vec{\Omega} \times \left(\vec{V}_{B/A}\right)_{xyz} + \left(\vec{a}_{B/A}\right)_{xyz}$$

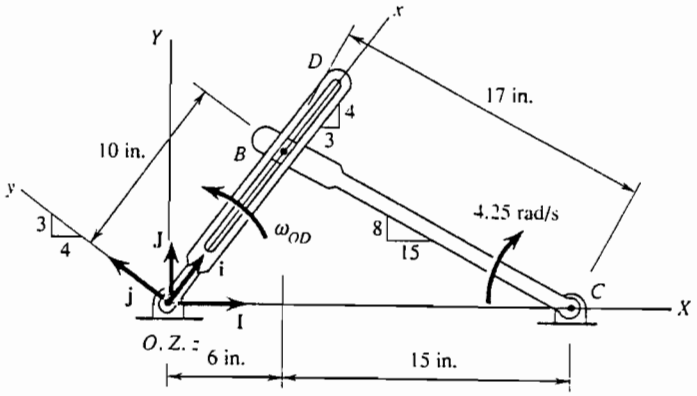
$$= 0 + (-10)\vec{k} \times 6\vec{i} + 4\vec{k} \times (4\vec{k} \times 6\vec{i}) + 2 \times 4\vec{k} \times (5\vec{i}) + 81\vec{i}$$

$$= -15\vec{i} - 20\vec{j} \ (\text{in/s}^2)$$

$$a_B = \sqrt{(15)^2 + (20)^2} = 25 \ \text{in/s}^2 \quad *.$$

Ex In the position, the crank BC rotates with a constant angular velocity of 4.25 rad/s ↻, and its pin at B is confined to move in the slot of the link OD. Determine for this position $\vec{\omega}_{OD}$ of the link OD and the velocity $\vec{V}_{B/OD}$ of the pin at B relative to the link OD.





OXYZ fixed coordinate

oxyz aligned with the link OD as shown. (rotating with OD).

$\vec{\omega}_{BC} = 4.25 \text{ rad/s} \circlearrowright = -4.25\,\vec{K} \text{ rad/s}$

$\vec{V}_C = 0$ fixed pivot point.

$$\vec{V}_B = \vec{V}_C + \vec{V}_{B/C} = \vec{\omega}_{BC} \times \vec{r}_{B/C} = -4.25\,\vec{K} \times (-15\,\vec{I} + 8\,\vec{J})$$

$$= 34\,\vec{I} + 63.75\,\vec{J} \qquad (1)$$

The angular velocity of Oxyz is $\vec{\Omega} = \omega_{OD}\,\vec{K}$

$$\vec{V}_B = \vec{V}_O + \vec{\Omega} \times \vec{r}_{B/O} + \vec{V}_{B/Oxyz}$$

$$= 0 + \omega_{OD}\,\vec{K} \times (10\,\vec{j}) + v_{B/OD}\,\vec{i}$$

$$= v_{B/OD}\,\vec{i} + 10\,\omega_{OD}\,\vec{j}$$

Relates $\vec{i}$ & $\vec{j}$ to $\vec{I}$ & $\vec{J}$

$$\vec{i} = \tfrac{1}{5}(3\vec{I} + 4\vec{J})$$

$$\vec{j} = \tfrac{1}{5}(-4\vec{I} + 3\vec{J})$$

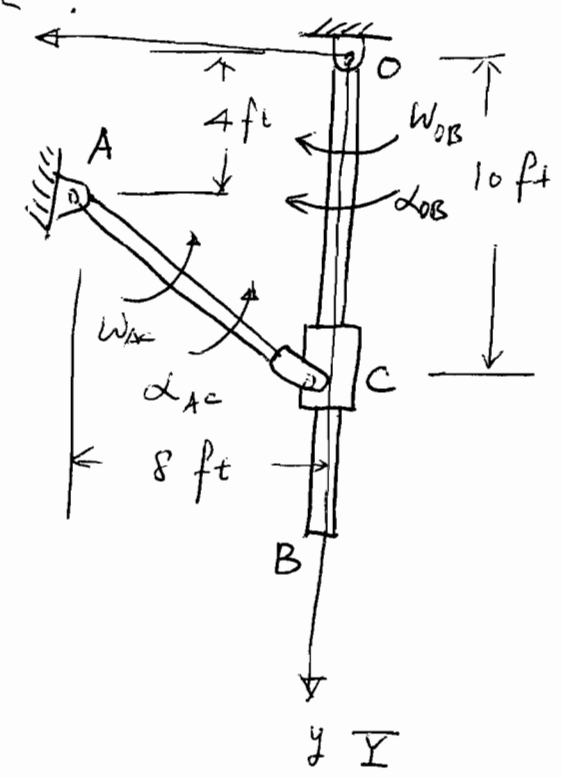
$$\vec{V}_B = \left(\tfrac{3}{5}v_{B/OD} - 8\omega_{OD}\right)\vec{I} + \left(\tfrac{4}{5}v_{B/OD} + 6\omega_{OD}\right)\vec{J} \qquad (2)$$

(1) = (2) $\Rightarrow$ $\omega_{OD} = 1.05$ rad/s ↻

$v_{B/OD} = 71.4$ in/s 53.1° w.r.t the horizontal dir.

X

x



$\omega_{OB} = 2$ rad/s

$\alpha_{OB} = 8$ rad/s^2

Define a moving coordinate xyz → coincide with the fixed coordinate X Y Z.

$$\vec{V}_C = \vec{V}_A + \vec{\omega}_{AC} \times \vec{r}_{C/A}$$

$$= 0 + \omega_{AC}\vec{k} \times (-8\vec{i} + 6\vec{j})$$

$$= -8\omega_{AC}\vec{j} - 6\omega_{AC}\vec{i}$$

$$\vec{V}_C = \vec{V}_O + \vec{\Omega} \times \vec{r}_{C/O} + (\vec{v}_{C/O})_{xyz}$$

$$= 0 + (-2\vec{k}) \times (10\vec{j}) + v_{C/O}\vec{j}$$

$$= 20\vec{i} + v_{C/O}\vec{j}$$

$$= -8\omega_{AC}\vec{i} - 8\omega_{AC}\vec{j}$$

$\omega_{AC} = -3.33$ rad/s. * $v_{C/O} = 26.67$ ft/s *

$$\vec{a}_C = \vec{a}_A + \vec{\alpha}_{AC} \times \vec{r}_{C/A} - \omega_{AC}^2 \vec{r}_{C/A}$$

$$= 0 + \alpha_{AC}\vec{k} \times (-8\vec{i} + 6\vec{j}) - (-3.33)^2(-8\vec{i} + 6\vec{j}$$

$$= (88.7 - 6\alpha_{AC})\vec{i} - (8\alpha_{AC} + 66.5)\vec{j}$$

From the point of view of the rotating coordinate.

$$\vec{a}_c = \vec{a}_o + \dot{\vec{\Omega}} \times \vec{r}_{c/o} + \vec{\Omega} \times (\vec{\Omega} \times \vec{r}_{c/o}) + 2\vec{\Omega} \times (\vec{v}_{c/o})_{xyz} + (\vec{a}_{c/o})_{xyz}.$$

$$= 0 + (-8\vec{k}) \times (10\vec{j}) - (2)^2 (10\vec{j}) + 2(-2\vec{k}) \times (26.67\vec{j}) + [(a_{c/o})\vec{j}]$$

$$= (80 + 106.7)\vec{i} + (-40 + a_{c/o})\vec{j}$$

$$= (188.7 - 6\alpha_{AC})\vec{i} - (8\alpha_{AC} + 66.5)\vec{j}$$

$$\begin{cases} \alpha_{AC} = -16.33 \text{ rad/s}^2 \quad * \\ a_{c/o} = 64.2 \text{ ft/s}^2 \end{cases}$$