20-R-KM-DK-29

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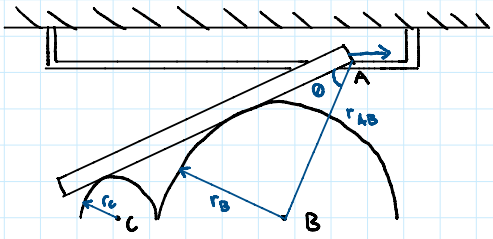
20-R-KM-DK-29 Advanced Time Derivative

Inspiration: 16-39 Hibbeler + Mech Notes



The end A of a bar is constrained by a horizontal slot. At one instant, the bar is moving with a velocity ***v = 0.185 m/s*** and acceleration ***a = 0.1 m/s^2*** to the right. If semicircle C has a radius ***r_C = 0.15 m*** and semicircle B has a radius ***r_B = 0.5 m***, determine the angular velocity and angular acceleration of the bar at this instant. The distance from end A to the center of the semicircle is ***r_AB = 0.8 m***.

Let $s = r_{AB}$, $r = r_B$ $\quad r = s\sin\theta \quad \sin\theta = \frac{r}{s} \quad \cos\theta\cdot\dot\theta = \frac{-r}{s^2}\cdot\dot s$

$\cos\theta = \frac{\sqrt{s^2-r^2}}{s} \Rightarrow \frac{\sqrt{s^2-r^2}}{s}\dot\theta = -\frac{r}{s^2}\cdot\dot s \quad \dot\theta = \frac{-r\dot s}{s\sqrt{s^2-r^2}} = \frac{-0.5\cdot 0.185}{0.4\sqrt{0.8^2-0.5^2}}$

$= -0.185144$ rad/s

$\omega_{Bar} = -0.185144$ rad/s

$r = s\sin\theta \quad \frac{dr}{dt} = \frac{d}{dt}s\sin\theta \Rightarrow 0 = \dot s\sin\theta + s\cos\theta\cdot\dot\theta$

$\frac{d}{dt}(0) = \frac{d}{dt}(\dot s\sin\theta + s\cos\theta\cdot\dot\theta) \Rightarrow 0 = \ddot s\sin\theta + \dot s\cos\theta\cdot\dot\theta + \dot s\cos\theta\cdot\dot\theta - s\sin\theta\dot\theta^2 + s\cos\theta\cdot\ddot\theta$

$0 = (0.1)\left(\frac{0.5}{0.8}\right) + (0.185)\left(\frac{\sqrt{0.8^2-0.5^2}}{0.8}\right)(-0.185144)(2) - (0.8)\left(\frac{0.5}{0.8}\right)(-0.185144)^2 + 0.8\left(\frac{\sqrt{0.8^2-0.5^2}}{0.8}\right)\ddot\theta$

$\ddot\theta = \alpha_{Bar} = -0.012996$ rad/s^2