20-R-KM-DK-6

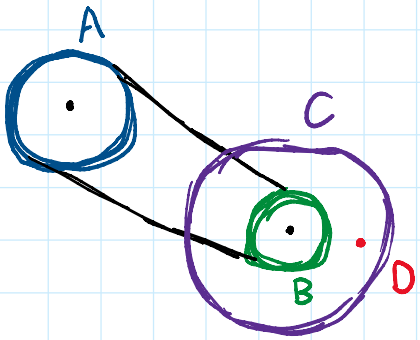
July 31, 2020 11:24 AM

20-R-KM-DK-6 Advanced

Inspiration: 16-9 Hibbeler

Gear Systems

An engineering student is trying to create a new drivetrain system for his bike, consisting of a pulley system. Pulley A is connected to pulley B by a non-slip belt and pulley B is rigidly attached to pulley C. Pulley A rotates at an initial angular velocity of ***omega_A = 3 rad/s*** , and has an angular acceleration of ***alpha_A = 1.1theta rad/s^2***, where ***theta*** is in radians. Use this relationship to determine the magnitude of acceleration at point D when pulley A rotates ***4*** revolutions. The radii of each pulley is given to be ***r_A = 10 cm, r_B = 5 cm,*** and ***r_C = 12 cm***, and point D is a distance ***r_D = 8 cm*** from point B.



$\omega_A = 3$ rad/s $\quad \theta_A = 0$ rad

$\alpha = \frac{d\omega}{dt} \quad \omega = \frac{d\theta}{dt} \quad dt = \frac{d\theta}{\omega}$

$\alpha = \frac{d\omega}{\left(\frac{d\theta}{\omega}\right)} \quad \alpha\, d\theta = \omega\, d\omega$

$\int_0^{\theta_A} 1.1\theta\, d\theta = \int_3^{\omega_A} \omega\, d\omega \Rightarrow \frac{1.1}{2}\theta_A^2 = \frac{\omega_A^2}{2} - \frac{3^2}{2}$

$\omega_A = \sqrt{1.1\theta_A^2 + 3^2} \qquad 4 \text{ revs} \Rightarrow 4(2\pi) = 8\pi \text{ rads}$

$\omega_A = \sqrt{1.1(8\pi)^2 + 3^2} = 26.5296 \text{ rad/s}$

$\alpha_A = 1.1\theta_A = 1.1(8\pi) = \frac{44}{5}\pi$

$\omega_B r_B = \omega_A r_A \qquad \omega_B(5) = (26.5296)(10) \qquad \omega_B = 53.0592178\overline{5}$

$\alpha_B r_B = \alpha_A r_A \qquad \alpha_B(5) = \frac{44}{5}\pi(10) \qquad \alpha_B = \frac{88}{5}\pi$

$a_{Dt} = \alpha_B r_D = \left(\frac{88}{5}\pi\right)(0.08) = 4.42336 \text{ m/s}^2$

$a_{Dn} = \omega_B^2 r_D = (53.0592178\overline{5})^2(0.08) = 225.222 \text{ m/s}^2$

$a_D = \sqrt{225.222^2 + 4.42336^2} = 225.265888 \text{ m/s}^2$