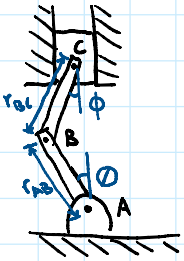
20-R-KM-DK-26

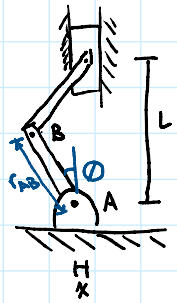
July 31, 2020 11:28 AM

20-R-KM-DK-26 Intermediate Time Derivative

Inspiration: 16-49 Hibbeler



Students are attempting to create a lift to raise their model car. The lift is assembled with two linkages, link AB and link BC, as seen in the picture shown. If the links have length ***l_AB = 0.2 m*** and ***l_BC = 0.4 m***, determine the velocity and acceleration of the lift at the instant where the angular velocity of AB is ***omega_AB = -5 rad/s*** and the angular acceleration of AB is ***alpha_AB = -7 rad/s^2***. Take the angles to be ***theta = 30 degrees*** and ***phi = 20 degrees***.



$$L = 0.2\cos\theta + 0.4\cos\phi$$

$$\frac{dL}{dt} = v_L = -0.2\sin\theta\cdot\dot{\theta} - 0.4\sin\phi\cdot\dot{\phi}$$

$$\frac{d^2L}{dt^2} = a_L = -0.2\cos\theta\cdot\dot{\theta}^2 - 0.2\sin\theta\cdot\ddot{\theta} - 0.4\cos\phi\cdot\dot{\phi}^2 - 0.4\sin\phi\cdot\ddot{\phi}$$

$$X = 0.4\sin\phi - 0.2\sin\theta$$

$$v_X = 0.4\cos\phi\cdot\dot{\phi} - 0.2\cos\theta\cdot\dot{\theta} \qquad v_X = 0 \Rightarrow 0.2\cos\theta\cdot\dot{\theta} = 0.4\cos\phi\cdot\dot{\phi}$$

$$\dot{\phi} = \frac{0.2\cos\theta\cdot\dot{\theta}}{0.4\cos\phi} = -2.304012463$$

$$v_L = -0.2\sin 30\,(-5) - 0.4\sin 20\left(\frac{0.2\cos 30\,(-5)}{0.4\cos 20}\right) = \boxed{0.4152074 69}$$

$$a_X = -0.4\sin\phi\cdot\dot{\phi}^2 + 0.4\cos\phi\cdot\ddot{\phi} + 0.2\sin\theta\cdot\dot{\theta}^2 - 0.2\cos\theta\cdot\ddot{\theta}$$

$$a_X = 0 \Rightarrow \ddot{\phi} = \frac{0.4\sin(20)\cdot(-2.304012463)^2 - 0.2\sin(30)\cdot(-5)^2 + 0.2\cos(30)\cdot(-7)}{0.4\cos(20)}$$

$$= -7.9446$$

$$a_L = -0.2\cos 30\cdot(-5)^2 - 0.2\sin 30\,(-7) - 0.4\cos 20\,(-2.304012463)^2 - 0.4\sin 20\,(-7.9446)$$

$$\boxed{a_C = -4.53855\ m/s^2}$$