Example Problem - Le 15

Ex. The wheel rolls up the incline on its hubs without slipping and is pulled by the 100-N force applied to the cord wrapped around its outer rim. If the wheel start from rest, compute its angular velocity after its center has moved a distance of 3-m up the incline. The wheel has a mass of 40-kg with a center of mass at O and has a centroidal radius of gyration of 150-mm.

*(taken from Engineering Mechanics, 4th Edition by Meriam & Kraige)*

Known:

\[ m = 40 \text{ kg} \quad P = 100 \text{ N} \quad k_G = 0.15 \text{ m} \]

Kinetics:

\[ \Delta E_{sys} = W \]
\[ (E_{K2} + E_{G2}) - (E_{K1} + E_{G1}) = W \]

\[ E_{K1} = 0 \]
\[ E_{K2} = \frac{1}{2}mv_{G,2}^2 + \frac{1}{2}I_G\omega_2^2 \]
\[ E_{G1} = 0 \]
\[ E_{G2} = mgz \]

\[ W = Ps \neq P(3m) \]

Kinematics:

\[ v_{G,2} = \omega_2 r_{G/IC} \]
\[ r_{G/IC} = 0.1 \text{ m} \]
\[ s = 9 \text{ m} \]

Other:

\[ I_G = mk_G^2 = 0.9 \text{ kgm}^2 \]
\[ z = 3 \sin(15^\circ) \text{ m} \]

Solving:

\[ \omega_2 = 30.3 \text{ rad/s} \]