

21-R-KM-SS-35

The gear A is spinning with a velocity of $5\hat{\mathbf{k}} \text{ rad/s}$ and is accelerating at $2t\hat{\mathbf{k}} \text{ rad/s}^2$. The gear ratio, $\frac{r}{R} = 15$. Determine the angular acceleration and velocity of gear B after 5 seconds.

Soluton

Since it is a non-constant acceleration, we need to integrate the angular acceleration equation to get angular velocity. Remember to evaluate the constant (+C). The answer box asks for vector solutions. Remember that a gear flips the direction of rotation.

$$\begin{aligned}\alpha_A &= \frac{d\omega_A}{dt} = 2t \\ \omega_A &= \int 2t \, dt \\ &= t^2 + C\end{aligned}$$

At $t = 0$, $\omega = 5$, so:

$$\Rightarrow C = 5$$

After 5s,

$$\omega_A = 30\hat{\mathbf{k}} \quad [\text{rad/s}]$$

$$\alpha_A = 10\hat{\mathbf{k}} \quad [\text{rad/s}]$$

$$\begin{aligned}\text{GR} = 15 &= -\frac{\omega_A}{\omega_B} \\ \Rightarrow \omega_B &= -2\hat{\mathbf{k}} \quad [\text{rad/s}]\end{aligned}$$

$$\begin{aligned}\text{GR} = 15 &= -\frac{\alpha_A}{\alpha_B} \\ \Rightarrow \alpha_B &= -\frac{2}{3}\hat{\mathbf{k}} \quad [\text{rad/s}^2]\end{aligned}$$