11. A dentist causes the bit of a high-speed drill to accelerate from an angular speed of 1.05 x 10^4 rad/s to an angular speed of 3.14 x 10^4 rad/s. In the process, the bit turns through 1.88 x 10^4 rad. Assuming a constant angular acceleration, how long would it take the bit to reach its maximum speed of 7.85 x 10^4 rad/s, starting from rest?

$$\omega_f = \omega_0 + \alpha t$$

Solving for t

$$t = \frac{\omega_f - \omega_0}{\alpha} = \frac{\omega_f}{\alpha}$$

So we need an angular acceleration. We have been given the angle moved through to change between two angular speeds.

$$\omega_B^2 = \omega_A^2 + 2\alpha\theta$$

$$\alpha = \frac{\omega_B^2 - \omega_A^2}{2\theta} = \frac{\left(3.14\ x\ 10^4\ {rad}/{s}\right)^2 - \left(1.05\ x\ 10^4\ {rad}/{s}\right)^2}{2(1.88\ x\ 10^4 rad)}$$

$$\alpha = \frac{\omega_B^2 - \omega_A^2}{2\theta} = \frac{9.860\ x\ 10^8\ {rad^2}/{s^2} - 1.103\ x\ 10^8\ {rad^2}/{s^2}}{3.76\ x\ 10^4 rad} = \frac{8.757\ x\ 10^8\ {rad^2}/{s^2}}{3.76\ x\ 10^4 rad}$$

$$\alpha = \frac{8.757\ x\ 10^8\ {rad^2}/{s^2}}{3.76\ x\ 10^4 rad} = 2.329 x\ 10^4\ {rad}/{s^2}$$

Now we can use this angular acceleration in the equation

$$t = \frac{\omega_f}{\alpha} = \frac{7.85\ x\ 10^4\ {rad}/{s}}{2.329 x\ 10^4\ {rad}/{s^2}} = 3.371\ s$$

$$\boxed{t = 3.37\ s}$$

Please send any comments or questions about this page to ddonovan@nmu.edu

This page last updated on April 7, 2023