

10.20. For the rotational system described in Example 9.8, with parameter values $J = 1 \text{ kg-m}^2$, $K = 9 \text{ N-m/rad}$, and $B = 0.6 \text{ N-s/rad}$

- Compute the state transition matrix for the system, based on a time increment of 0.2 s. ✓
- Compute and plot the solution for (i) the flywheel angular velocity Ω_J and (ii) the spring torque T_K as a function of time when the motor speed increases suddenly from 0 to 50 rad/s and then remains constant. ✓
- Compute and plot the response of
 - the flywheel speed
 - the spring torque
 as a function of time when the motor speed increases from 0 to 50 rad/s in a linear ramp over a period of 10 s and then remains constant.
- Compare the two solutions with respect to
 - the maximum torque in the spring
 - the maximum flywheel angular velocity
 - the steady-state angular velocity and torque

Example 9.8

A rotational system consists of an inertial load J mounted in viscous bearings B and driven by an angular velocity source $\Omega_{in}(t)$ through a long light shaft with significant torsional stiffness K , as shown in Fig. 9.16. Derive a pair of second-order differential equations for the variables Ω_J and Ω_K .

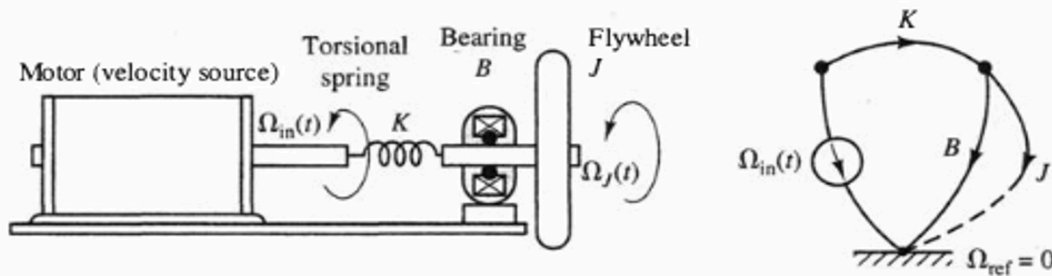


Figure 9.16: Rotational system for Example 9.8.

Solution The state variables are Ω_J and T_K , and the state equations are

$$\begin{bmatrix} \dot{\Omega}_J \\ \dot{T}_K \end{bmatrix} = \begin{bmatrix} -B/J & 1/J \\ -K & 0 \end{bmatrix} \begin{bmatrix} \Omega_J \\ T_K \end{bmatrix} + \begin{bmatrix} 0 \\ K \end{bmatrix} \Omega_{in} \tag{i}$$