INTRODUCTION TO LINEAR SYSTEMS : ASSIGNMENT 4

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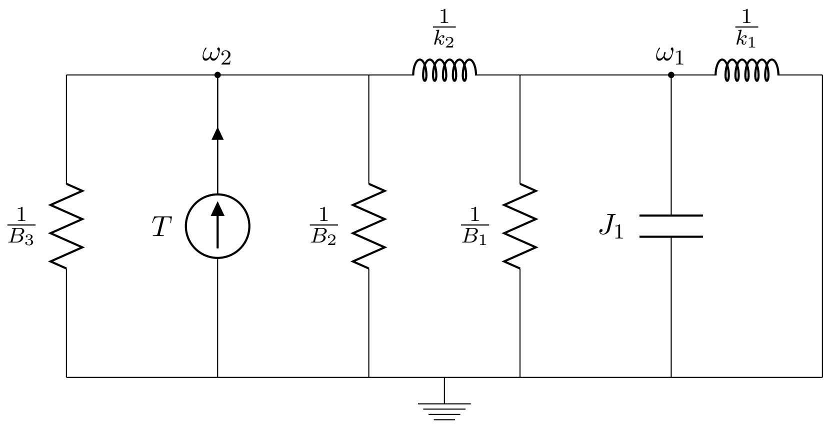
Exercise 1.
Consider the system in the following illustration.

¡++¿ The positive direction is in the direction of the moment τ that operates on the system. The torsional stiffness k_2 operates between B_1 and B_2 only. The segment between B_2 and B_3 is completely stiff.
A torsional damping with damping coefficient B_1 is located next to the moment of inertia J_1.

(1) Draw an equivalent electrical diagram, and mark the angular velocity ω_1 of the moment of inertia J_1, and the angular velocity ω_2 of the stiff axle between B_2 and B_3.
(2) Write the matrix set of equations using Kirchoff's Junction Rule.
(3) Find the transfer function between the angular velocity ω_1 of the moment of inertia J_1 and the moment τ that operates on the system.

Solution 1.
(1)



(2)

$$\begin{pmatrix} \frac{k_1}{s} + \frac{k_2}{s} + B_1 + sJ_1 & \frac{-k_2}{s} \\ -\frac{k_2}{s} & \frac{k_2}{s} + B_2 + B_3 \end{pmatrix} \begin{pmatrix} \omega_1(s) \\ \omega_2(s) \end{pmatrix} = \begin{pmatrix} 0 \\ \tau(s) \end{pmatrix}$$

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(3) By Cramer's Rule,

$$\omega_1(s) = \frac{(0)\left(\frac{k_2}{s} + B_2 + B_3\right) + \tau(s)\left(\frac{k_2}{s}\right)}{\left(\frac{k_1}{s} + \frac{k_2}{s} + B_1 + sJ_1\right)\left(\frac{k_2}{s} + B_2 + B_3\right) - \left(\frac{k_2}{s}\right)^2}$$

$$\therefore \frac{\omega_1(s)}{\tau(s)} = \frac{\frac{k_2}{s}}{\left(\frac{k_1}{s} + \frac{k_2}{s} + B_1 + sJ_1\right)\left(\frac{k_2}{s} + B_2 + B_3\right) - \left(\frac{k_2}{s}\right)^2}$$

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