# Control Systems

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# Overview

# Problem Statement

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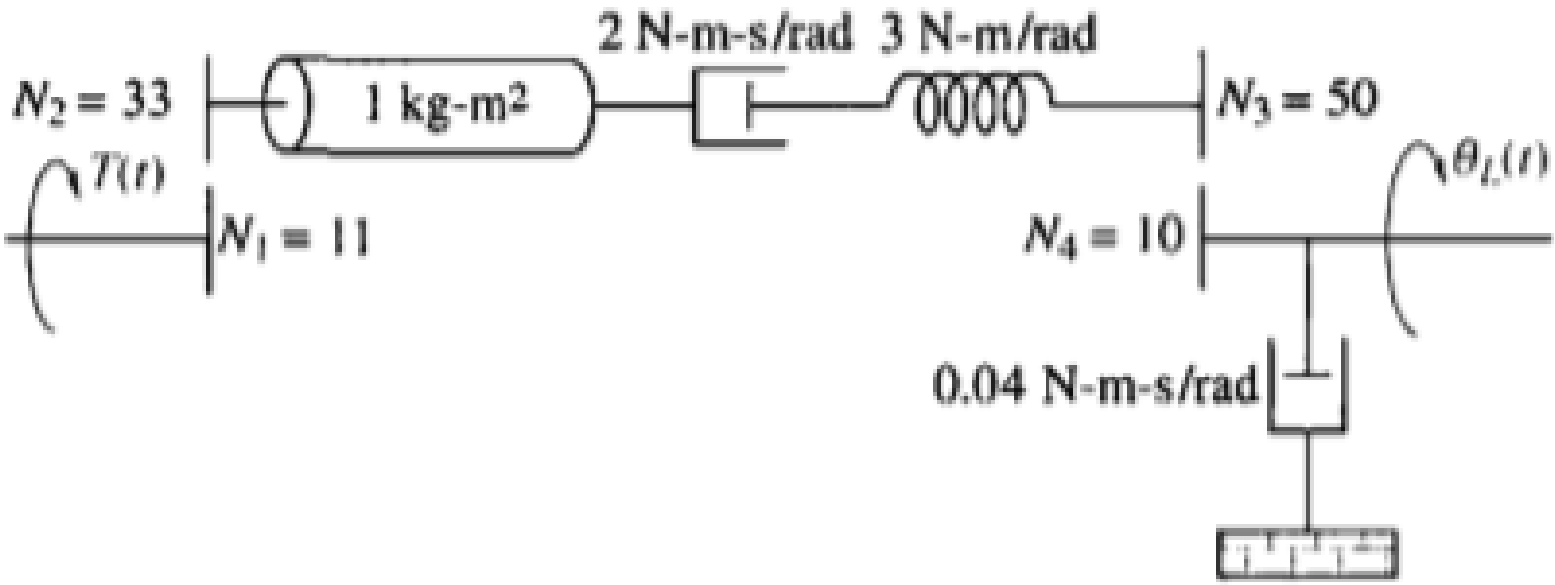
- For the rotational system shown in the figure, find the transfer function

$$G(s) = \theta_L / T(s)$$



# Solution

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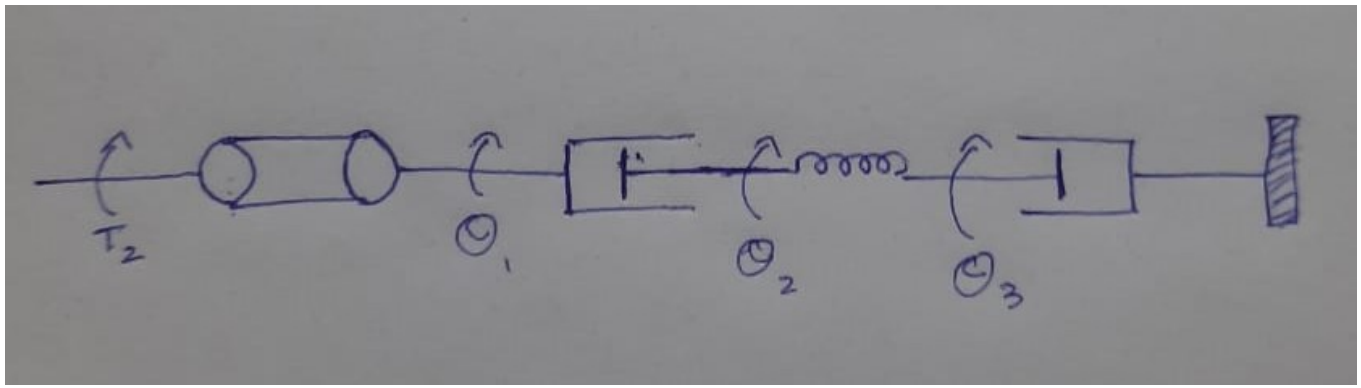
- Torque is applied to the lever of the first gear.
  To take the lever out of the equation, the current scenario is equivalent to applying **3*T*** on the inertial mass because

$$T_1/T_2 = N_1/N_2$$

  N-Teeth on the gear , T-Torque applied

- The system could now be seen as




where $\theta_3 = \theta_L/5$
$\boldsymbol{(\theta_1/\theta_2 = N_1/N_2)}$

- From the figure we can formulate three equations

$$3T = (s^2 + 2s)\theta_1 - 2s\theta_2$$

$$0 = (2s + 3)\theta_2 - 3\theta_3 - 2s\theta_1$$

$$0 = (s + 3)\theta_3 - 3\theta_2$$

- Solving the three, we get

$$\theta_3/T = 18/(2s^3 + 9s^2 + 6s)$$

Substituting $\theta_3 = \theta_L/5$

$$\theta_L/T = 90/(2s^3 + 9s^2 + 6s)$$

**Hence the transfer function,**

$$\boldsymbol{\theta_L/T = 90/(2s^3 + 9s^2 + 6s)}$$