Control Systems Assignment-1
Problem 17

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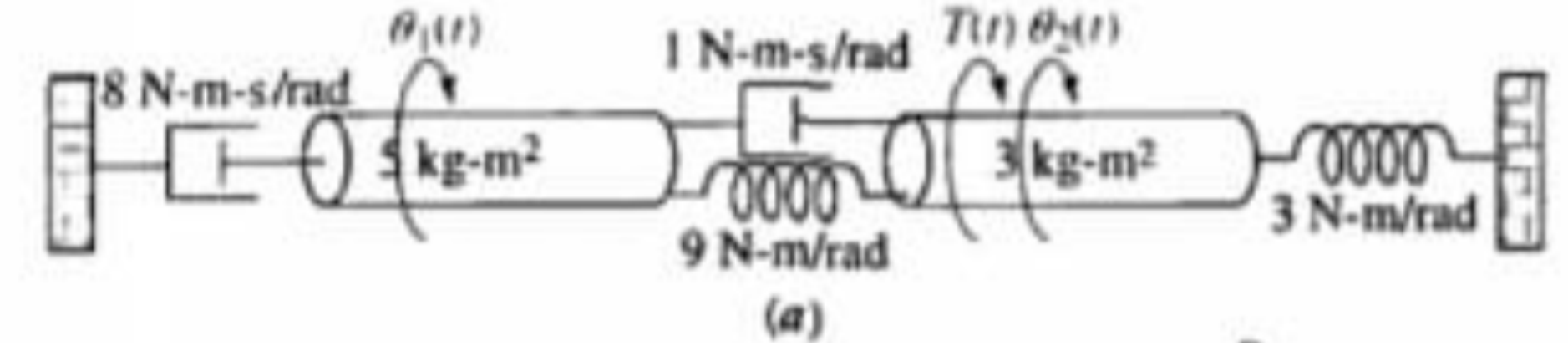
Overview

Problem a

For each of the rotational mechanical system shown in below Figure, write, but do not solve, theequations of motion.



Solution:

[Sum of impedances of $\theta_1]\theta_1(s)-$
(Sum of impedances between $\theta_1 and \theta_2)\theta_2(s) =$
Applied torques at θ_2

$$[D_1 s + I_2 s^2 + D_2 s + K_2]\theta_1(s) - [D_2 s + K_1]\theta_2(s) = 0$$

similarily for θ_2

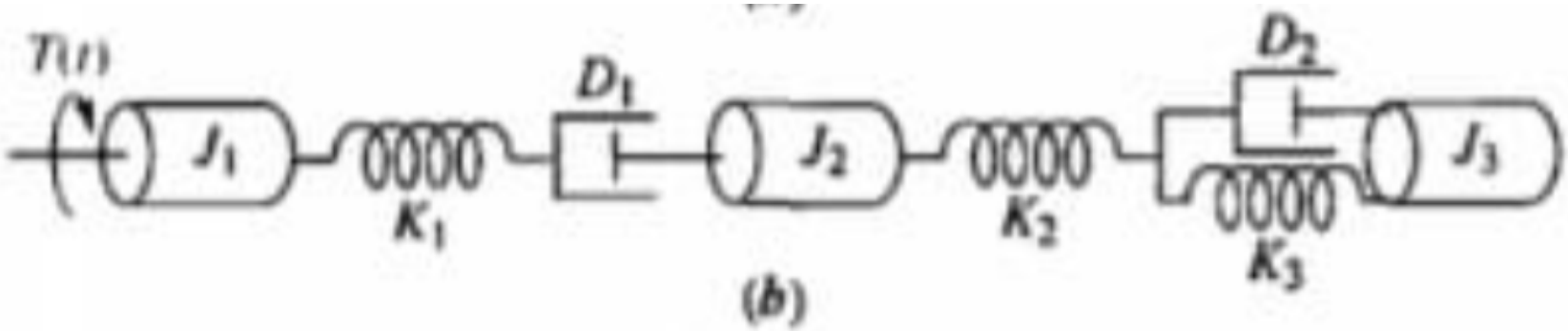
$$[K1 + I_2 s^2 + D_2 s + K_2]\theta_2(s) - [D_2 s + K_1]\theta_1(s) = T(s)$$

Writing the equation of motion:

$$T(s) = \theta_2(s)(3s^2 + s + 12) - \theta_2(s)(s + 9)$$

$$\theta_2(s)(s + 9) = \theta_2(s)(5s^2 + 9s + 9)$$

Problem b



(b)

FIGURE P2.16

Defining

$$\theta_1(s) = \text{rotation of } J_1$$

$$\theta_2(s) = \text{rotation between } K_1 \text{ and } D_1$$

$$\theta_3(s) = \text{rotation of } J_3$$

$$\theta_4(s) = \text{rotation of right-hand side of } K_2$$

The equations of moiton are: [Sum of impedances of θ_1]$\theta_1(s)-$
(Sum of impedances between $\theta_1 and \theta_2)\theta_2(s)-$
(Sum of impedances between $\theta_1 and \theta_3)\theta_3(s) =$
Applied torques at θ_1

$$(J_1 s^2 + K_1)\theta_{1(s)-K_1\theta_2(s)=T(s)}$$

$$-K_1\theta_1(s) + (D_1 s + K_1)\theta_2(s) - D_1 s\theta_3(s) = 0$$

$$-D_1 s\theta_2(s) + (J_2 s^2 + D_1 s + K_2)\theta_3(s) - K_2\theta_4(s) = 0$$

$$-K_2\theta_3(s) + (D_2 s + (K_2 + K_3))\theta_4(s) = 0$$