National Taiwan University

Department of Engineering Science and Ocean Engineering

2019 Winter Semester

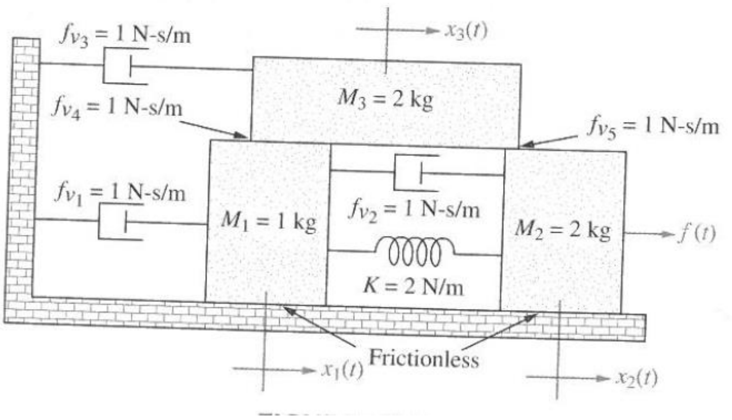
Homework 2

Chap 3 State equation for physical systems

Chap 4 Transient response

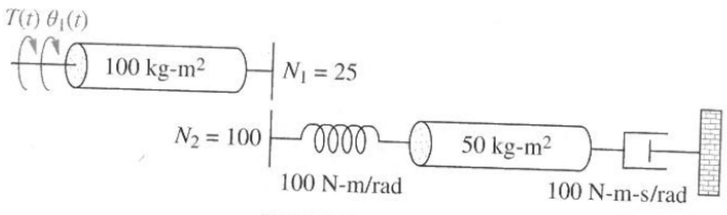
1. **Chap 3 Prob.3**

3. Find a state-space representation for the system in Figure P3.3. Assume the output is $x_1(t)$. [Section: 3.4]



2. **Chap 3 Prob.5**

5. Assuming $\theta_1(t)$ is the output of the rotational system of Figure P3.5, find a state-space representation. [Section: 3.4]



3. **Chap 3 Prob. 13(a)**

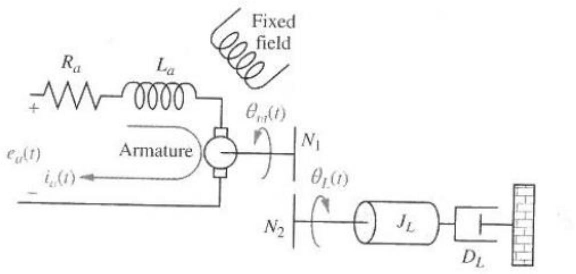
13. For each one of the following systems in state space, find the corresponding transfer function $G(s) = Y(s)/R(s)$. [Section: 3.6]

a. $$\dot{\mathbf{x}} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -3 & -2 \end{bmatrix}\mathbf{x} + \begin{bmatrix} 0 \\ 0 \\ 23 \end{bmatrix} r$$

$$y = [1 \quad 0 \quad 0]\mathbf{x}$$

4. Chap 3 Prob. 17

17. Given the dc servomotor and load shown in Figure P3.10, represent the system in state space, where the state variables are the armature current, i_a, load displacement, θ_L, and load angular velocity, ω_L. Assume that the output is the angular displacement of the armature. Do not neglect armature inductance. [Section: 3.4]



5. Chap 4 Prob.13 (a) / 16(a)

13. For each of the second-order systems that follow, find ζ, ω_n, T_s, T_p, T_r, and $\%OS$. [Section: 4.6]

a. $T(s) = \dfrac{16}{s^2 + 3s + 16}$

16. Find the location of the poles of second-order systems with the following specifications: [Section: 4.6]

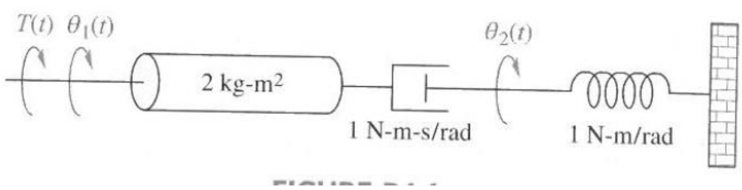
a. $\%OS = 15\%$; $T_s = 0.5$ second

6. Chap 4 Prob. 18

18. For the system shown in Figure P4.6, a step torque is applied at $\theta_1(t)$. Find:

a. The transfer function, $G(s) = \theta_2(s)/T(s)$

b. The percent overshoot, settling time, and peak time for $\theta_2(t)$. [Section: 4.6]



7. Chap 4 Prob. 22

22. Examine each one of the following response functions to see if it is possible to cancel the zero with a pole. If it is, determine the approximate response, percent overshoot, settling time, rise time, and peak time. [Section: 4.8].

a. $C(s) = \dfrac{(s+5)}{s(s+1)(s^2+3s+10)}$

b. $C(s) = \dfrac{(s+5)}{s(s+2)(s^2+4s+15)}$

c. $C(s) = \dfrac{(s+5)}{s(s+4.5)(s^2+2s+20)}$

d. $C(s) = \dfrac{(s+5)}{s(s+4.9)(s^2+5s+20)}$

8. Chap 4 Prob. 26

26. Without solving the state equation, find [Section: 4.10]

a. the characteristic equation and

b. the poles of the system for

$$\dot{\mathbf{x}} = \begin{bmatrix} 3 & 2 & 1 \\ 1 & 1 & 0 \\ 1 & 5 & 0 \end{bmatrix}\mathbf{x} + \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix}u(t)$$

$$y = \begin{bmatrix} 0 & 2 & 3 \end{bmatrix}\mathbf{x}$$

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Textbook:

1. Norman S. Nise, ‘Control Systems Engineering’, 8th ed., Wiley & Sons Ltd., 2019.

Submission place and deadline:

先進流體傳動控制實驗室 AFPCL R139 / 12:00 pm, October 29, 2019