Module 08:
§3.1–5 and §6.5

§3.1–4

1. Write a state-space representation for the system in Figure 1 with the acceleration of the mass on the right as the output.

2. Write a state-space representation of the two-tank system shown in Figure 2 with the difference between the two tank heights as the output.

3. Write a state-space representation for the system in Figure 3 with the torque on the wall from the damper as the output.

§3.5

1. Find the state-space representation in phase-variable form for

$$G(s) = \frac{100}{s^4 + 20s^3 + 10s^2 + 7s + 100}$$

2. Find the state-space representation in phase-variable form for

$$G(s) = \frac{30}{s^5 + 8s^4 + 9s^3 + 6s^2 + s + 30}$$

3. Starting with the transfer function $G(s) = \Theta_m/E_a$, write a state-space representation of a DC motor, where e_a is the input and the angular velocity, ω_m, is the output.

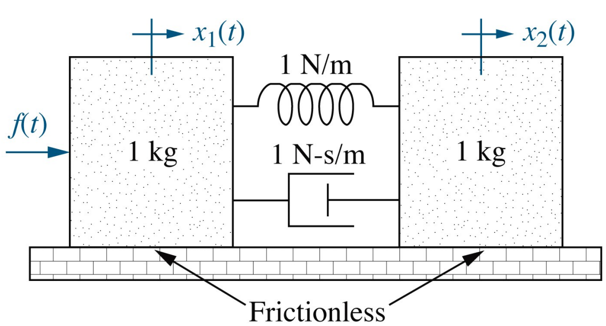
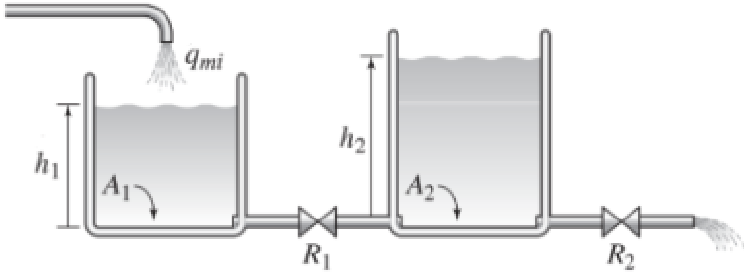


Figure P2.10

Figure 1: Two-block system



$$\rho A_1 \dot{h}_1 + \frac{\rho g}{R_1}(h_1 - h_2) = q_{mi}$$

$$\rho A_2 \dot{h}_2 - \frac{\rho g}{R_1}(h_1 - h_2) + \frac{\rho g}{R_2} h_2 = 0$$

Figure 2: Two-tank system with governing equations

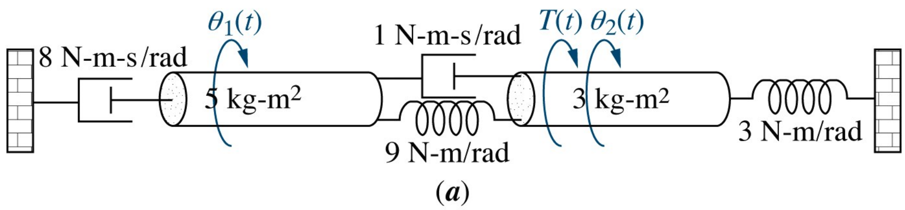


Figure P2.16a

Figure 3: Rotational system

4. Find the state-space representation in phase-variable form for

$$G(s) = \frac{8s + 10}{s^4 + 5s^3 + s^2 + 5s + 13}$$

5. Find the state-space representation in phase-variable form for

$$G(s) = \frac{s^4 + 2s^3 + 12s^2 + 7s + 6}{s^5 + 9s^4 + 13s^3 + 8s^2}$$

§6.5

1. For the following system, determine how many eigenvalues are in the right-half plane, in the left-half plane, and on the $j\omega$-axis.

$$\dot{\bar{x}} = \begin{bmatrix} 0 & 1 & 3 \\ 2 & 2 & -4 \\ 1 & -4 & 3 \end{bmatrix} \bar{x} + \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 1 & 0 \end{bmatrix} \bar{x}$$

2. Use MATLAB to find the eigenvalues of the following system

$$\dot{\bar{x}} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 1 & -4 \\ -1 & 1 & 8 \end{bmatrix} \bar{x} + \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} u$$

$$y = \begin{bmatrix} 0 & 0 & 1 \end{bmatrix} \bar{x}$$

3. Determine whether or not the following system is stable.

$$\dot{\bar{x}} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 1 & 3 \\ -3 & -4 & -5 \end{bmatrix} \bar{x} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 0 & 1 & 1 \end{bmatrix} \bar{x}$$