Tutorial 3

Problem 1

2. Represent the electrical network shown in Figure P3.2 in state space, where $i_R(t)$ is the output. [Section: 3.4]

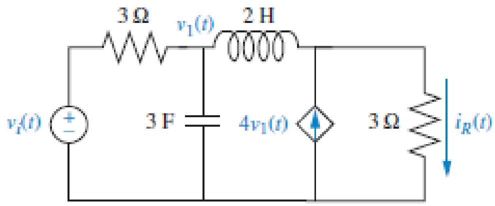

FIGURE P3.2

Problem 2

17. A missile in flight, as shown in Figure P3.10, is subject to four forces: thrust, lift, drag, and gravity. The missile flies at an angle of attack, α, from its longitudinal axis, creating lift. For steering, the body angle from vertical, ϕ, is controlled by rotating the engine at the tail. The transfer function relating the body angle, ϕ, to the angular displacement, δ, of the engine is of the form

$$\frac{\Phi(s)}{\delta(s)} = \frac{K_a s + K_b}{K_3 s^3 + K_2 s^2 + K_1 s + K_0}$$

Represent the missile steering control in state space. [Section: 3.5]

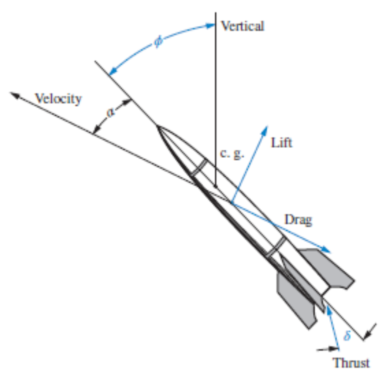

FIGURE P3.10 Missile

Problem 3

22. In the past, Type-1 diabetes patients had to inject themselves with insulin three to four times a day. New delayed-action insulin analogues such as insulin Glargine require a single daily dose. A similar procedure to the one described in the Pharmaceutical Drug Absorption case study of this chapter is used to find a model for the concentration-time evolution of plasma for insulin Glargine. For a specific patient, state-space model matrices are given by (*Tarín, 2007*)

$$\mathbf{A} = \begin{bmatrix} -0.435 & 0.209 & 0.02 \\ 0.268 & -0.394 & 0 \\ 0.227 & 0 & -0.02 \end{bmatrix}; \quad \mathbf{B} = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix};$$

$$\mathbf{C} = \begin{bmatrix} 0.0003 & 0 & 0 \end{bmatrix}; \quad \mathbf{D} = 0$$

where the state vector is given by

$$\mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}.$$

The state variables are

x_1 = insulin amount in plasma compartment
x_2 = insulin amount in liver compartment
x_3 = insulin amount in interstitial (in body tissue) compartment

The system's input is u = external insulin flow. The system's output is y = plasma insulin concentration.

a. Find the system's transfer function.

b. Verify your result using MATLAB.

MATLAB ML