3.10. For the closed-loop multivariable chemical process of Example 2.29, derive a state-space representation. Transform the state-space representation into:

(a) the Jordan canonical form,

(b) the controller companion form,

(c) the observer canonical form.

3.11. For the aircraft longitudinal dynamics of Example 3.10 derive:

(a) the Jordan canonical form,

(b) the controller companion form,

(c) the observer canonical form.

3.12. For the nonlinear electrical network of Exercise 2.3, derive a state-space representation with input as the voltages, $v_1(t)$ and $v_2(t)$, and the output as the current $i_2(t)$. Linearize the state-space representation about the equilibrium point falling in the *dead-zone*, $-a < v_1(t) < a$. Use $L = 1000$ henry, $R_1 = 100$ ohm, $R_2 = 200$ ohm, $C_1 = 2 \times 10^{-5}$ farad, and $C_2 = 3 \times 10^{-5}$ farad. Is the electrical network stable about the equilibrium point?

3.13. Repeat Exercise 2.29 using a state-space representation for each of the multivariable systems.

3.14. For the multivariable closed-loop system of Exercise 2.30, derive a state-space representation, and convert it into the Jordan canonical form.

References

1. Nise, N.S. *Control Systems Engineering*. Addison-Wesley, 1995.
2. Maciejowski, J.M. *Multivariable Feedback Design*. Addison-Wesley, 1989, pp. 406–407.