Problem 1. Exercises 1.19, 1.20(a), 1.21(a) from the textbook.[1]

Problem 2. 2.1(1), 2.1(5), 2.1(6).

Problem 3. 2.15.

Problem 4. 2.17(2).

Problem 5. 2.20(3), 2.20(4), 2.20(5).

Problem 6. Consider the system

$$\begin{aligned} \dot{x}_1 &= ax_1 - x_1x_2 \\ \dot{x}_2 &= bx_1^2 - cx_2 \end{aligned}$$

where $c > a > 0$. Let $D = \{x \in \mathbb{R}^2 : x_2 \geq 0\}$.

(a) Let $b > 0$. Show that every trajectory starting in D stays in D for all future time.

(b) Let $b > 0$. Show that there is no periodic orbit through any $x \in D$. *Hint: Use Lemma 2.2.*

(c) Still letting $b > 0$, show that there can be no periodic orbits (in $\mathbb{R}^2$).

(d) This time let $b \leq 0$. Show that there can be no periodic orbits for this case, either.

Problem 7. 2.24.

[1] H.K. Khalil. *Nonlinear Systems (Third Edition).* Prentice Hall, 2002.