

9.5: Exercise Problems

9.1. Generalize the reasoning of Sec. 1 to an arbitrary 1D map $q_{n+1} = f(q_n)$, with a function $f(q)$ differentiable at all points of interest. In particular, derive the condition of stability of an N -point limit cycle $q^{(1)} \rightarrow q^{(2)} \rightarrow \dots \rightarrow q^{(N)} \rightarrow q^{(1)} \dots$

9.2. Use the stability condition, derived in the previous problem, to analyze the possibility of the deterministic chaos in the so-called tent map, with

$$f(q) = \begin{cases} rq, & \text{for } 0 \leq q \leq 1/2, \\ r(1-q), & \text{for } 1/2 \leq q \leq 1, \end{cases} \quad \text{with } 0 \leq r \leq 2 \quad (9.5.1)$$

9.3. A dynamic system is described by the following system of differential equations:

$$\begin{aligned} \dot{q}_1 &= -q_1 + a_1 q_2^3, \\ \dot{q}_2 &= a_2 q_2 - a_3 q_2^3 + a_4 q_2 (1 - q_1^2). \end{aligned}$$

Can it exhibit chaos at some set of constant parameters $a_1 - a_4$?

9.4. A periodic function of time has been added to the right-hand side of the first equation of the system considered in the previous problem. Is deterministic chaos possible now?

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