

Math 53 Chaos!: Homework 7

due Tues Nov 17 ... but best if do relevant questions after each lecture

The only questions not relevant for Midterm 2 are those from Ch. 7 which use Lyapunov *functions*, and the Matlab one.

5.1

- A. Compute the Lyapunov exponents of the baker map $B(x, y) = (x/2, 2y(\text{mod } 1))$ for $y \geq 1/2$ and $((1+x)/2, 2y(\text{mod } 1))$ otherwise, acting on the unit square. In general, assuming constant Jacobean, how does the sum of the exponents relate to $\det Df$? [BONUS: what does this tell you about what this map does to areas?]

T7.2 (ODE review)

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T7.9 (ODE review)

T7.5 (quick; sketch the phase plane too)

7.3

7.10 (x_2 for b is supposed to be a critical point of the cubic type)

T7.11 (use the $P(\mathbf{x})$ for the undriven Duffing oscillator) Please carefully sketch level curves of E for the case $c = 0$, and phase plane flow curves for $c > 0$.

Compu. Expt. 7.3 Forced damped Duffing oscillator. Answer the questions in the book for this experiment. You might want to use Matlab's `ode45` for the formulation as two coupled first-order ODEs. See for instance the end of <http://math.dartmouth.edu/~m46s09/intro46.m>

Go out to at least 200 time units. Please produce a phase plane plot of the three different orbits and state an IC which leads to each: two period- 6π orbits, one period- 2π orbit. Remember to clean up your orbits by not plotting an appropriate amount of early 'settling' time. [Hint: to measure periods you'll need to plot graphs vs t ; you don't need to hand these in].

T7.13 (easy but nice)

T7.17 For c) draw carefully the flow lines emanating from the saddles, and shade in the basin of $(0, 0)$.

7.9 (look at 7.8 first).