Syllabus:

1. Introduction; Dynamics of Maps
   - a brief tour of nonlinear dynamics
   - an extended example: the logistic map
     - how to plot its behavior
     - initial conditions, transients, and fixed points
     - bifurcations and attractors
     - chaos: sensitive dependence on initial conditions, $\lambda$, and all that
     - pitchforks, Feigenbaum, and universality
     - the connection between chaos and fractals
     - period-3, chaos, and the u-sequence
     - maybe: unstable periodic orbits
   chs 1 & 10 of [50] [32] (in [17]) [22] [23], ch 11 of [50] [31, 34] (latter is in [17]) [2, 25, 49]

2. Dynamics of Flows
   [50], sections 2.0-2.3, 2.8, 5, and 6 (except 6.6 and 6.8)
   - maps vs. flows
     - time: discrete vs. continuous
     - axes: state/phase space [9]
   - an example: the simple harmonic oscillator
     - some math & physics review [8]
     - portraying & visualizing the dynamics [9]
   - trajectories, attractors, basins, and boundaries [9]
   - dissipation and attractors [42]
   - bifurcations
• how sensitive dependence and the Lyapunov exponent manifest in flows
• anatomy of a chaotic attractor:
  – stretching/folding and the un/stable manifolds
  – fractal structure and the fractal dimension
  – unstable periodic orbits
  – shadowing
  – maybe: symbol dynamics

3. Tools

• ODE solvers and their dynamics
• maybe: PDE solvers
• Poincaré sections
• stability, eigenstuff, un/stable manifolds and a bit of control theory
• embedology
• maybe: calculating Lyapunov exponents and fractal dimensions

4. Applications

• prediction
• filtering
• control
• communication
• classical mechanics
• music, dance, and image

References


References [1, 3, 4, 13, 15, 17, 28, 37, 50, 53] are in the CSSS library.

More Resources:

www.cs.colorado.edu/~lizb

amath.colorado.edu/faculty/jdm/faq.html

www.mpipks-dresden.mpg.de/~tisean/Tisean_3.0.1/index.html