

Course outline - APPM 3010 - Fall 2004

1. Introduction

- Continuous vs. discrete
- Order vs. dimension
- Autonomous vs. nonautonomous
- Linear vs. nonlinear
- Analytical vs. geometric methods

2. Fundamentals

- Integral formulation
- Local well posedness (existence and uniqueness)
- Blow up in finite time and global well posedness
- Continuity in initial conditions and parameters
- Applications to modeling with differential and difference equations

3. One dimensional flows

- Existence and stability of equilibria on the line
- Absence of periodic solutions
- Flows on the circle
- Applications to population dynamics, chemical reaction kinetics, circuits, biological entrainment

4. Bifurcations in one dimensional flows with applications

- Saddle-node bifurcations
- Transcritical bifurcations
- Pitchfork bifurcations

5. One dimensional maps

- Equilibria and stability
- Graphical techniques and simulation
- Introduction to chaos

6. Two dimensional flows

- Phase portraits and stability for linear systems
- Phase portraits and stability of equilibria for nonlinear systems
- Invariant manifolds, heteroclinic, and homoclinic orbits
- Centers and limit cycles
- Existence and stability of periodic orbits (Poincare-Bendixson theorem, Poincare map)
- Special systems (Hamiltonian systems, reversible systems, gradient systems)
- Applications to linear and nonlinear springs, the pendulum, competing species, chemical oscillators

7. Bifurcations in two dimensions with applications

- 2-D saddle-node bifurcations
- 2-D transcritical bifurcations
- 2-D pitchfork bifurcations
- Hopf bifurcation

8. Three dimensional flows and chaos

- Lorenz equations
- The forced Duffing equation