

Mathematics 4556 Dynamical Systems Autumn 3 credits

Catalog Description:

Systems of linear, first-order differential equations; existence and uniqueness theorems; numerical methods; qualitative theory (phase plane analysis, linearization, stability, limit cycles); and physical applications.

Prerequisite:

C- or better in 2153, 2162.xx, 2173, 2182H, or 4182H; or credit for 254.xx, 263, 263H, or 264H.

Text:

Nonlinear Dynamics and Chaos, Steven H. Strogatz, published by Westview Press, ISBN 9780738204536

Topics List:

- 1. One-dimensional flows: geometric way of thinking; fixed points and stability; population growth and other applications.
- 2. Bifurcations in one-dimensional flows: saddle-node, transcritical and pitchfork bifurcations; imperfect bifurcations.
- 3. Theory: existence; uniqueness; continuous dependence.
- 4. Phase planes: phase portraits; vector fields; nullclines; fixed points; stability; linearization.
- 5. Linear systems: classification of linear systems; what does the linear system say about the nonlinear system?
- 6. Limit cycles; introduction; Poincare-Bendixson theorem; conservative systems.
- 7. Bifurcations of two-dimensional flows; saddle-node, transcritical, and pitchfork bifurcations; Hopf bifurcation theorem.
- 8. XPPAUT: phase planes; bifurcations; applications.
- 9. Global bifurcations: homoclinic orbits; Poincare map; stability of periodic orbits.
- 10. Singular perturbations: Relaxation oscillator; averaging.
- 11. Applications: (e.g., Neurons).
- 12. One-dimensional maps: Logistic map.
- 13. Smale horseshoe: symbolic dynamics.
- 14. Applications.