# Math 515 – Ordinary Differential Equations and Dynamical Systems

**Course Description from Bulletin:** Basic theory of systems of ordinary differential equations; equilibrium solutions, linearization and stability; phase portraits analysis; stable unstable and center manifolds; periodic orbits, homoclinic and heteroclinic orbits; bifurcations and chaos; nonautonomous dynamics; and numerical simulation of nonlinear dynamics. (3-0-3)

**Enrollment:** Elective for AM and other majors.

**Textbook(s):** L. Perko (2001), Differential Equations and Dynamical Systems, Third edition, Springer. ISBN 0-387-95116-4.
S. Wiggins (1996), Introduction to Applied Nonlinear Dynamical Systems and Chaos, second edition. Springer. ISBN 0- 3540970037 .

**Other required material:** Matlab

**Prerequisites:** MATH 252 or consent of the instructor

**Objectives:**

1. Students will learn basic methods for understanding solutions of systems of ordinary differential equations.
2. Students will learn modern dynamical systems techniques for understanding evolution of systems of ordinary differential equations.
3. Students will improve their problem solving skills in nonlinear dynamical systems.
4. Students will improve their presentation and writing skills.

**Lecture schedule:** 3 50 minutes (or 2 75 minutes) lectures per week

| **Course Outline:** | Hours |
|---|---|
| 1. Basic theory of systems of ordinary differential equations<br>a. Existence and uniqueness<br>b. Dependence on initial conditions<br>c. Solution techniques<br>d. Flow property<br>e. Equilibrium solutions and linearization | 4 |
| 2. Linear systems | 4 |
| 3. Hartman-Grobman theorem | 4 |
| 4. Stability | 4 |
| 5. Poincare-Bendixson theory | 6 |
| 6. Invariant manifold theory | 8 |
| 7. Bifurcation | 5 |
| 8. Strange attractors and chaos | 5 |
| 9. Nonautonomous dynamics | |

| **Assessment**: | | |
|---|---|---|
| | Homework | 10-30% |
| | Computer Programs/Project | 10-20% |
| | Quizzes/Tests | 20-50% |

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| Final Exam | 30-50% |

**Syllabus prepared by**: J. Duan
**Date**: March 22, 2006