Math 8501, 3 Credits, Fall 2009

# Theory of Ordinary Differential Equations

*— Syllabus —*

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## Time & Place

MWF 9:05 – 10:00, VinH 1

## Material Covered

We will study ordinary differential equations from a dynamical systems view point. Motivated by examples from physics, biology, ecology, chemistry, and mechanics, we review basic theory for existence and uniqueness of solutions, as well as basic concepts for linear systems of ODEs. We then study the stability of equilibria and periodic orbits, and analyze bifurcations when stability is lost. Other topics include normal form theory and averaging, invariant manifolds, and singular perturbation theory.

## Text

No textbook is required. The course will cover material from

- Chicone, Carmen. *Ordinary differential equations with applications.* Texts in Applied Mathematics, **34**, Springer-Verlag, New York, 1999.
- Perko, Lawrence. *Differential equations and dynamical systems.* Texts in Applied Mathematics, **7**, Springer-Verlag, New York, 2001.
- Amann, Herbert. *Ordinary differential equations. An introduction to nonlinear analysis.* de Gruyter Studies in Mathematics, **13**, Walter de Gruyter & Co., Berlin, 1990.
- Coddington, Earl A.; Levinson, Norman. *Theory of ordinary differential equations.* McGraw-Hill Book Company, Inc., New York-Toronto-London, 1955.

## Office Hours

MWF 10:10 – 11:00, VinH 251 or by appointment.

## Contact

All material regarding the course, in particular homework assignments, can be found on my homepage http://www.math.umn.edu/∼scheel. Everybody is encouraged to ask questions at any time, best after the lecture at office hours, or by appointment. Best way to reach me is email to scheel@math.umn.edu.

## Projects

Projects will be assigned Friday, October 23, 2009 and are due Monday, December 7, 2009

**Homework**

Homework will be assigned on Fridays and will be due the next Friday before the lecture. Students may work together on the homework. However, they must write their homework individually, in their own words.

**Composition of Grade**

Homeworks 60%, Project 40%.

**Preliminary schedule**

| WEEK | DATES | MATERIAL (preliminary distribution) |
|---|---|---|
| 1. | 09-08 to 09-11 | examples, dynamical systems, vector fields and flows |
| 2. | 09-14 to 09-18 | explicit solutions, first integrals, Banach's fixed point theorem |
| 3. | 09-21 to 09-25 | existence and uniqueness, dependence on parameters, continuation |
| 4. | 09-28 to 10-02 | numerical aspects, phase space and qualitative aspects |
| 5. | 10-05 to 10-09 | linear autonomous equations |
| 6. | 10-12 to 10-16 | Floquet theory and dichotomies |
| 7. | 10-19 to 10-23 | nonlinear stability, stable manifolds |
| 8. | 10-26 to 10-30 | periodic solutions: stability, Poincaré maps, forcing |
| 9. | 11-02 to 11-06 | averaging, nonlinear oscillators |
| 10. | 11-09 to 11-13 | Poincaré-Bendixson theory, winding numbers and degree theory |
| 11. | 11-16 to 11-20 | center manifolds |
| 12. | 11-23 to 11-25 | normal forms |
| 13. | 11-30 to 12-04 | elamentary steady-state and Hopf bifurcations |
| 14. | 12-07 to 12-09 | homoclinic and heteroclinic bifurcations |
| 15. | 12-14 to 12-16 | examples |

The schedule is tentative and subject to change.