COURSE DESCRIPTION
Math 532H – Topics in Ordinary Differential Equations
Mon., Wed., Fri. 10:10 — 11:00.   Hasbrouck 230

Instructor: Bruce Turkington
Office: LGRT 1423K
Office Hours: Monday 11:00 – 12:30, Tuesday 1:30 – 3:00, or by appointment.
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Textbook:

Nonlinear Dynamics and Chaos, with Applications to Physics, Biology, Chemistry, and Engineering, by Steven Strogatz.
Perseus Books Publishing, 1994; paperback edition 2000.
ISBN 0-7382-0453-6

This textbook has been our standard choice for this course for several years. It is a really fun introduction to the modern viewpoint on ordinary differential equation — namely, the qualitative and geometry approach to understanding dynamical systems. The author has a breezy style, and his book is full of fascinating applications from a wide spectrum of science fields.

Other recommended books:

Elementary Differential Equations, by W.E. Boyce and R.C. DiPrima.
John Wiley and Sons, Inc., 8th Ed., 2005.

This is a classic in the field, which is often used for a first course at the undergraduate level. But it also contains more advanced material that overlaps with our course. It offers a more traditional viewpoint on differential equations, which complements Strogatz's book.

A Second Course in Elementary Differential Equations, by P. Whitman
Academic Press, Inc., 1986.

A readable and compact account of the qualitative theory of ODEs at the same level as our course. It takes a more pedestrian approach, with fewer interesting examples than Strogatz's book, but it is useful to fill in details of the mathematical steps that Strogatz sometimes skips over.

Course content:

We will follow the topics as in the textbook. We plan to cover all of Sections 2, 3, 5, 6, 7, and some of Sections 4, 8, 9. But the lectures will supplement the book's exposition by giving more details on the standard mathematical methods that arise throughout the book's development.

Strogatz's book emphasizes a modern perspective on ODEs, which is to treat them qualitatively and to understand the structure of their solutions geometrically. Moreover, the book motivates all of its theory with real examples taken from diverse areas of science. We begin with single, first-order nonlinear ODEs in Sections 2,3,4. Here many of the key ideas are introduced in the simplest possible context. Then we move on to second-order nonlinear ODEs, or equivalently systems of two nonlinear ODEs, in Sections 5,6,7,8. These sections are the core of the course. We will cover all the key ideas, but we will select among the many applications and examples. Finally, the book gets into rather more advanced and contemporary topics in its last part — namely, chaos and fractals. We hope to discuss Section 9 on the chaos and strange attractor using the famous Lorenz equations as an example. Probably there will not be time for more.

Prerequisites:

A first course on ordinary differential equations, equivalent to Math 331 at UMass. Ability to solve first-order (scalar) ODEs that are linear or separable, and linear second-order ODEs. Also, a standard one-semester course on Linear Algebra. Knowledge of linear transformations, matrices, eigenvalues and eigenvectors.

Assignments and Grading:

The total course grade will be assembled from 2 graded problem sets, 2 hour exams (during the term), a final exam (during the scheduled week) and a short paper. The details follow.

Rather than having weekly homework, we will bundle the assigned problems into 2 problem sets. Problem Set 1 will be assigned on Sept. 19 and collected on Oct. 6. Problem Set 2 will be assigned on Oct. 24 and collected on Nov. 10. Each problem set will consist of several problems from the textbook, taken from the sections that have been covered up to that point.

There will be 2 in-class hour exams that will scheduled to alternate with the problem sets. Hour Exam 1 will be on Oct. 10. Hour Exam 2 will be on Nov. 14. Each exam will test the material covered in class up to that point, including the topics on the preceding problem set.

There will be a 2-hour final exam scheduled by the University during the final exam week.

Finally, a short paper will be required by the end of the semester. It will be a 5 to 10 page exposition of a model that uses a differential equation or dynamical system. The specific choice of a topic will be left to each student's creativity and personal interests.

The total grade will be calculated with the following weights: each problem set (15%), each hour exam (15%), final exam (25%), expository paper (15%).