AUTUMN, 2010

Math 511
Ordinary Differential Equations I

Instructor: Timothy Reluga, treluga@psu.edu

Course Description:

Ordinary differential equations are a core topic in mathematics, and are applied in every field of science and engineering to describe dynamics and geometry of systems. Math 511 provides beginning graduate students a survey of ordinary differential equations by reviewing undergraduate coursework and introducing more sophisticated solution techniques and analysis for the study of smooth dynamic systems. Applications will include classical mechanics, electrical circuits, chemistry, biology, and econmics.

Location: 113 Osmond

Class Schedule: Monday, Wednesday, and Friday, 1:25 -2:15 pm.

Topics:

- General theory: vector fields, semigroups, Lie groups, linear operators, existence and uniqueness of solutions under various boundary conditions.
- Linear equations: series, special functions, Green functions, fundamental solutions.
- Nonlinear equations: stability, local and global analysis, bifurcation theory, periodic solutions, chaotic attractors, asymptotic approximations.
- Generalizations: non-smooth vector fields, differential inclusions, delay equations.

Prerequisite: MATH 411 or MATH 412 (calculus, linear algebra, elementary differential equations, proof concepts)

Textbook: Differential Dynamical Systems by James D. Meiss (ISBN-13: 978-0898716351)

Grading: Grades will be awarded based on weekly assignments (100 points total) and a nal exam (100 points). The nal grade will be calculated out of 200 points.

Rough Week-by-Week Course Outline:

1. Introduction, elementary methods
2. Linear operators and linear algebra review
3. Linear Second Order Equations
4. Autonomous Linear systems
5. Introduction to the phase plane
6. Local analysis in the phase plane
7. Integrable systems
8. Other methods in the phase plane
9. Oscillatory systems in the phase plane
10. Bifurcations
11. Perturbation methods
12. A menagerie of ODE systems
13. Mass action systems
14. Existence and Uniqueness
15. Extensions of ODE theory