Course Title: Ordinary Differential Equations
Course Number: MATH 6410 - 1
Instructor: Andrejs Treibergs
Home Page: http://www.math.utah.edu/~treiberg/M6414.html
Place & Time: M, W, F at 12:55 - 1:45 in LCB 218
Office Hours: 11:45 - 12:35 M, W, F, in JWB 224 (tent.) and by appointment
E-mail: treiberg@math.utah.edu
Prerequisites: Math 5210, its equivalent or consent of instructor.
Main Text: Thomas Sideris, Ordinary DifferentialEquations Atlantic Press 2013. ISBN: 978--94-6239-020-1; 978-94-6239-021-8 (eBook)
Supplementary Notes: Christopher Grant, Theory of Ordinary Differential Equations, pdf, Solutions.
Additional Texts: M6414Supplement.html

In this first semester of a year long graduate course in differential equations, we shall focus on ordinary differential equations and dynamical systems. The second semester, Math 6420 taught by P. Bressloff, will emphasize partial differential equations. In this course, along with the Math 6420, we shall try to cover the syllabus for the qualifying exam in differential equations. Although some mathematical sophistication is required to take the course, and it moves at the blazing speed of a graduate course, I shall provide any background materials needed by the class. If you are unsure about background material, I EXPECT YOU TO ASK ME so I know what needs covering.

Outline
We shall follow Sidlris's text covering the behavior of solutions: existence and uniqueness, continuous dependence on data; and dynamical systems properties: long time existence, stability theory, Floquet theory, invariant manifolds and bifurcation theory. We shall discuss as many applications as we can. Topics include (depending on time):

- Introduction to ODE. Applications. Review of calculus.
- Linear systems and stability.
- Existence, uniqueness and continuity theorems.
- Qualitative theory, Lipunov stability, Limit sets and attractors.
- Applications to physical / biological systems. Charged particle, coupled pendula, planets.
- Invariant manifolds. Hartman-Grobman theorem.
- Planar flows. Poincaré-Bendixon theory.
- Periodic solutions and their stability.
- Sturm-Liouville Theory.
- Bifurcation Theory.
- Chaos.
- Perturbation Methods

## Expected Learning Outcomes

At the end of the course the student is expected to master the theorems, methods and applications of

- Local Theory
  - Proof of the Local Existence and Uniqueness Theorem for ODE's
  - Continuation of solutions
  - Gronwall's Inequality
  - Dependence of the solution on parameters
  - Contraction Mapping Principle
- Linear Equations
  - Linear systems with constant coefficients
  - Jordan Normal Forms
  - Matrix exponential and logarithm, Fundamental Solution
  - Variation of Parameters Formula
  - Floquet Theory for periodic equations
- Stability
  - Liapunov Stability, Assymptotic Stability of solutions
  - Liapunov Functions
  - Proof of the Linearized Stability for Rest Points
  - Grobman - Hartman Theorem
  - Stable and Center Manifold Theorems
- Dynamical Systems
  - Omega limit sets and limit cycles
  - Poincaré-Bendixson Theorem
  - Poincaré Map and stability of periodic orbits
- Bifurcation Theory
  - Persistence of periodic orbits
  - Normal forms for saddle-node, transcritical and pitchfork bifurcations
  - Hopf Bifurcation
- Perturbation Methods

## Grading

The success of the student will be measured by graded daily homework. A student who earns 50% of the homework points will receive an A for the course. In addition, the student's performance will be reported to the Graduate Committee, which decides the continuation of financial support annually. Ultimately, the learning will also be measured by the Differential Equation Qualifying Examination.

Last updated: 8 - 21 - 17