SYLLABUS
DIFFERENTIAL EQUATIONS
MA 650 FALL 2026

DEPARTMENT OF MATHEMATICS
UNIVERSITY OF ALABAMA AT BIRMINGHAM

Course Instructor: Dr. Milena Stanislavova
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Course Info

Meeting times: MWF 1:25-2:15pm
Meeting location: UH 4002
Prerequisite: MA 642 Minimum Grade of B equivalent.
Credits: 3 semester hours
Textbook: Gerald Teschl, Ordinary Differential Equations and Dynamical Systems, 2012, Graduate Studies in Mathematics, V.140, AMS
Topics to be covered: Chapters 1, 2, 3, 5, 6, 7 and 9
Other suggested books: Ordinary Differential Equations with Applications by Carmen Chicone and Differential Equations and Dynamical Systems by Lawrence Perko

Important Dates

First day of classes: August 24, 2026
Labor Day: September 7, 2026
Thanksgiving break: November 23- 29, 2026
Last Day of class: December 4, 2026
Final Exam: December 11, 2024 10:45am-1:15pm

Course Description

This is a graduate level course in Ordinary Differential Equations. In the first part of the class we will cover the classical results in the theory including existence, uniqueness and regularity of solutions, continuous dependence on initial data and parameters, and extendability of solutions, the fundamental theory for linear systems (global existence theorems, solution by operator exponentiation), the structure of solutions for autonomous linear systems. In the second part we will introduce dynamical systems, linear stability theory for fixed points and Newton's equation in one dimension. For planar dynamical systems, we will focus on examples from ecology and the Poincare-Bendixon theorem. Finally, for nonlinear systems, we will study local behavior near fixed points, invariant manifolds and periodic orbits. We will finish with the Hartman-Grobman theorem.

Learning Outcomes

Upon successful completion of this course students can:

- Develop a mathematical model using differential equations or systems in a variety of problem situations.
- Develop deep understanding of the classical theory of existence, uniqueness and extendability of solutions.
- Critically analyze and evaluate how quantitative information of the mathematical model is derived, reported, and applied.
- Interpret and construct solutions of differential equations in the form of formulas, graphs, tables, and use them to predict the future development/behavior of the system.
- Understand various types of linear and nonlinear dynamical systems and use appropriate methods to study their local stability.
- Understand the global behavior of dynamical systems - periodic orbits, invariant manifolds and orbital stability.
- Communicate mathematical results in a manner appropriate to the audience.

Homework Sets

The homework sets, which will be assigned as we cover the appropriate material, will be a major part of this course. There will be 5 graded assignments for the semester.

Exams:

The midterm exam is tentatively scheduled during regular class time on October 30.
The Final Exam is scheduled on December 11, 2026 from 10:45am to 1:15pm.

Assessment Procedures

There are 1000 total points possible in the course as follows:
Homework - 600 points, Midterm - 150 points, Final Exam - 250 points.

Tentative Topics

(1) Classical Theory: existence, uniqueness and regularity of solutions, continuous dependence on initial data and parameters, and extendability of solutions.
(2) Linear Dynamics: the fundamental theory for linear systems (global existence theorems, solution by operator exponentiation), the structure of solutions for autonomous linear systems, analysis in the constant coeficient (autonomous) case, Jordan normal forms and associated stability conditions, the periodic-coeficient case and Floquet theory.
(3) Boundary value problems and Sturm-Liouville theory.
(4) Dynamical Systems and Stability Theory: definitions, examples, and counterexamples of various notions of stability, the method of Lyapunov functions, and stability via linearization, Poincare map.
(5) Nonlinear Systems: Local Theory - flows and linear approximation, critical points and hyperbolicity, stable and unstable manifold theorems, the Hartman- Grobman theorem, the center manifold theorem and Carr's theorem, normal form theory, and analysis of gradient and Hamiltonian systems.

(6) Nonlinear Systems: Global Theory - important invariant sets (periodic, homoclinic, and heteroclinic orbits, etc.) and their associated invariant manifolds, the Poincare map and the orbital stability of periodic orbits, Poincare-Bendixson theorem for planar systems.

Divisive Concepts

All University faculty, instructors and teaching staff have the academic freedom to explore, discuss, and provide instruction on a wide range of topics in an academic setting. This class may present difficult, objectionable, or controversial topics for consideration, but will do so through an objective, scholarly lens designed to encourage critical thinking. Though students may be asked to share their personal views in the academic setting, no student will ever be required to assent or agree with any concept considered "divisive" under Alabama law, nor penalized for refusing to support or endorse such a concept. All students are strongly encouraged to think independently and analytically about all material presented in class and may express their views in a time, place, and manner, consistent with class organization and structure, and in accordance with the University's commitment to free and open thought, inquiry, and expressions.

Shared Values Statement

Collaboration, integrity, respect, and excellence are core values of our institution and affirm what it means to be a UAB community member. A key foundation of UAB is diversity. At UAB, everybody counts every day. UAB is committed to fostering a respectful, accessible and open campus environment. We value every member of our campus and the richly different perspectives, characteristics and life experiences that contribute to UAB's unique environment. UAB values and cultivates access, engagement and opportunity in our research, learning, clinical, and work environments. Our department aims to create an open and welcoming environment and to support the success of all UAB community members.

DSS Accessibility Statement

Accessible Learning: UAB is committed to providing an accessible learning experience for all students. If you are a student with a disability that qualifies under the Americans with Disabilities Act (ADA) or Section 504 of the Rehabilitation Act, and you require accommodations, contact Disability Support Services for information on accommodations, registration and procedures. Requests for reasonable accommodations involve an interactive process and consist of a collaborative effort among the student, DSS, faculty and staff. If you are registered with Disability Support Services, please contact me to discuss accommodations that may be necessary in this course. If you have a disability but have not contacted DSS, please call (205) 934-4205 or visit the DSS website.

Title IX Statement

The University of Alabama at Birmingham is committed to providing an environment that is free from sexual misconduct, which includes gender-based assault, harassment, exploitation, dating and domestic violence, stalking, as well as discrimination based on sex, sexual orientation, gender identity, and gender expression. If you have experienced any of the aforementioned conduct we encourage you to report the incident. UAB provides several avenues for reporting. For more information about Title IX, policy, reporting, protections, resources and supports, please visit the UAB Title IX webpage for UAB's Title IX Sex Discrimination, Sexual Harassment, and Sexual Violence Policy; UAB's Equal Opportunity and Discriminatory Harassment Policy; and the Duty to Report and Non-Retaliation Policy.