APMA 0350: Applied Ordinary Differential Equations (Summer 2018)

Lectures:	MTWR, 9-11 AM, 170 Hope Street Room 108
Course webpage:	Canvas
Instructor:	Melissa R. McGuirl, melissa_mcguirl@brown.edu
Office:	170 Hope Street, Room 209
Office Hours:	Mondays 11am-12pm and Tuesdays 3-5pm in Room 217 (170 Hope Street), or by appointment

Course Description

This course gives a comprehensive introduction to ordinary differential equations (ODEs), which are equations giving a relation between an unknown function and its derivatives. Students in this course are expected to have taken calculus. We will cover both the qualitative and quantitative theory ODEs, as well as their applications. Specific topics covered in this course include integrating factors and separable equations, techniques for solving linear systems of differential equations, numerical approaches to solving differential equations, phase-plane analysis of planar nonlinear systems, and rigorous theoretical foundations of differential equations. We will look at applications of ODEs in biology, chemistry, economics, and physics. By the end of this course students will be able to apply analytical, qualitative, numerical, and theoretical machinery to solving and/or analyzing ODEs.

This course will cover fundamental topics in mathematics as it introduces students to a range of important techniques (such as analytical, numerical, and qualitative theory for ordinary differential equations), and it has applications across many disciplines. Consequently, in this class students will acquire a diverse toolbox to help them solve or analyze real-world systems. As math is best learned by doing, students will practice solving problems through homework assignments, group problem sessions, coding exercises (no experience necessary), and exams.

Course Learning Goals

The overall learning goals for this course are to solve and analyze ordinary differential equations (ODEs) for practical problems using qualitative, quantitative, analytical, and numerical methods. The following skills will help students achieve this overall course learning goal:

1. Students should be able to classify differential equations, and determine if a solution to a differential equation exists and if it is unique.
2. Students should be able to analyze differential equations through a qualitative analysis of equilibria and stability.
3. Students should be able to solve separable equations, and linear first order equations with integrating factors.
4. Students should demonstrate proficiency in using MATLAB or other computer languages to solve differential equations numerically. Specifically, students should understand Euler methods, Runge-Kutta methods, and order of a scheme, and be able to apply these skills to real world problems.
5. Students should be able to solve and analyze systems of ODEs. This includes identifying the existence and uniqueness of solutions to systems of ODEs, solving linear constant coefficient equations, understanding and applying the linear superposition principle, finding fundamental matrix solutions for general linear systems, and solving inhomogeneous linear systems.
6. Students should be able to conduct a complete phase plane analysis for non-linear systems, Moreover, they should be able to provide qualitative interpretations for how the mathematical analyses relate back to the physical phenomena from the model.

Tentative Course Agenda

Dates	Chapter	Topics
Week 1	Chapter 1: Introduction	Definition and classification of differential equations
Weeks 1-2	Chapter 2: First order scalar ODEs	Qualitative approach, existence and uniqueness, separable equations, linearity principle, integrating factors, applications
Weeks 2-3	Chapter 3: Numerical Methods	Euler methods, Runge-Kutta methods, order of a scheme
Weeks 3-5	Chapter 4: Systems of ODEs	Existence and uniqueness, geometry of systems, linear constant coefficient systems, linear algebra, complex eigenvalues, constant coefficient systems, general linear systems, fundamental matrix solutions, inhomogeneous systems
Weeks 5-6	Chapter 5: Nonlinear systems and applications	Phase-plane analysis, infectious disease model

Prerequisites

- Intermediate Calculus: MATH 0100/0170/0180/0190/0200/0350
- Linear Algebra: MATH 0520/0540 (recommended but not required)

Textbook

There is no required textbook. Course notes and homework will be posted on the Canvas page. Optional complimentary resources include:

- Differential Equations, P. Blanchard, R.L. Devaney, G.R. Hall, Published by Brooks Cole, 2011.
- Elementary Differential Equations and Boundary Value Problems, W.E. Boyce and R.C. DiPrima, published by John Wiley & Sons Inc, 2012.

Time Expectations

Class time (8 hours/week)	48	hours
Reviewing Class (8 hours/week)	48	hours
Homework (10 hours/week)	60	hours
Midterms Preparation (8 hours/midterm)	16	hours
Final Exam Preparation	8	hours
Total	**180**	**hours**

Course Format

This course will consist of both lectures and group work problem sessions (recitation sessions). The recitation sessions will be held on Thursdays from 10am-noon, where the second hour is optional but highly recommended. Students are expected to complete weekly homework assignments, 2 midterm exams, and 1 final exam.

Assessment

Homework	30%
Midterm Exam 1	20%
Midterm Exam 2	20%
Final Exam	30%

Anticipated Grading Scale

A	90-100%
B	80-89%
C	70-79%

Grading scale is subject to change. However, the minimum grade cutoffs will not be raised.

Homework
Assignments will be available on Canvas every Wednesday, and are due the following Wednesday at the *beginning* of class (9 AM). Grades will usually be posted on Canvas within a week.

Exams
There will be 2 midterm exams in this course. The midterm exams will be given in class, using the full 2 hour time slot. I will announce the midterm dates during the first week of class. The final exam will be cumulative and held during the time scheduled by the registrar.

Course Policies and Expectation of Students

- **Class Attendance and Participation:**
  - I highly urge you to attend all classes. Class time will include lectures and active learning problem-based sessions. The problem-based sessions will enhance conceptual understanding of the material, and promote effective communication skills.
- **Homework:**
  - Late assignments will not be accepted without a legitimate excuse and prior approval.
  - Students are encouraged to collaborate on homework assignments, but assignments must be written up separately and individually.
  - Homework assignments must take the form of a single, *stapled* packet with your name and neatly written (or typed) solutions labeled with problem numbers. Solutions should show all work. I may deduct points if these requirements are not met.
- **Exams:**
  - Midterms will not be given any time other than their scheduled times, except in cases of illness or emergency. If a serious conflict arises, contact me as soon as possible prior to the midterm.
  - You must see a Dean in the Dean of the College's office for final exam excuses.

Support for Students
If you need accommodations for classes, assignments, or exams, please contact me and Student and Employee Accessibility Services. Website: `https://www.brown.edu/campus-life/support/accessibility-services/`.

Academic Citizenship
I strive to create a learning environment that supports diverse thoughts, perspectives, and experiences, and honors your identities. To help accomplish this:

- Please respect the diverse perspectives and backgrounds of your classmates.
- If you have a name and/or set of pronouns that differ from those that appear in your official Brown records, please let me know!
- If you are an English Language Learner and need additional resources for this course, please let me know!
- If you feel your performance in the course is being impacted by your experiences inside or outside of class, please come talk with me.

Thank you for joining in me in these efforts. I am here to facilitate your learning. Please let me know if you have any questions! I can always be reached by e-mail, and can schedule additional office hours.

Academic Integrity
Students are expected to comply with the Brown University Academic Code. Please review it here: `https://www.brown.edu/academics/college/degree/policies/academic-code`