MATH 226: Differential Equations

Course Description

Spring Term 2025

***Generic Catalog Description*:** This course provides an introduction into ordinary differential equations (ODEs) with an emphasis on linear and nonlinear systems using analytical, qualitative, and numerical techniques. Topics will include separation of variables, integrating factors, eigenvalue method, linearization, bifurcation theory, and numerous applications. . In this course, we will introduce MATLAB programming skills and develop them through the semester. (MATH 0200 or by waiver) 3 hrs. lect./disc. **DED**

***More Specific Description for Spring 2025*:** This course provides a modern introduction to ordinary differential equations. We will emphasize analytic, geometric and numerical approaches to solving differential equations. We will also consider how differential equations can be used as powerful tools in modeling real world phenomena.

There will be an initial focus on *linear* differential equations. We will use extensively the tools of linear algebra to study such equations. After discussing first order equations and systems of first order equations, we will see how higher order equations can be analyzed.

We will then turn our attention to *nonlinear* differential equations, with an examination of autonomous systems and questions of stability. This unit will conclude with an introduction to the exciting new area of *chaos theory*. We will finish the course, as time permits, with an examination of some numerical methods to approximate the solutions of differential equations.

We will explore applications throughout by examples, problems, and projects.

Learning Goals: Students will learn aspects of

• ***Methods of analysis and theory*** for solving differential equations analytically, as well as how to describe properties of solutions using theoretical concepts.

• ***Numerical and quantitative analysis***. Students will be able to identify when and how to implement numerical methods to solve differential equations using *Maple* or MATLAB.

• ***Graphical and qualitative analysis/representation*** of differential equations and solutions. Students will learn to create and interpret (by hand and by computer) direction fields, phase lines, phase planes, and plots of analytical and numerical solutions.

• ***Effective communication in mathematics*** by receiving regular feedback for written solutions, participating in group activities, and completing projects**.**

***Instructor*:** Michael Olinick, Office: Warner 202, Phone: 443-5559. Home telephone: 388-4290; email: *molinick@middlebury.edu*. My usual office hours will be Monday, Wednesday and Friday from 10:40 AM to 1 PM. I would be happy to make an appointment to see you at other mutually convenient times.

Meeting Times: Monday, Wednesday and Friday, 9:45 AM - 10:35 PM in Warner 010.

Course Website: http:// s25.middlebury.edu/MATH0226A or follow the link from my personal webpage http://www.middlebury.edu/~molinick.

***Computer Algebra System**:* Mathematically oriented software such as *MATLAB*, , and *Mathematica* give you an opportunity to investigate the ideas of multivariable calculus in ways not available to previous generations of students. Relatively simple commands can direct a computer to carry out complex calculations rapidly and without error. More importantly, you can create and carry out experiments to develop and test your own conjectures. The very powerful graphics capabilities of these applications provide you with strong tools to deepen your understanding of multivariable calculus through visualization of curves and surfaces. *MATLAB* is an especially powerful computational and visualization tool which is used extensively in scientific research and engineering applications. Intermediate and advanced required and elective courses in. Middlebury's Applied Mathematics Track adopt *MATLAB* as the de facto programming tool. There will be a required introductory *MATLAB* workshop late in the first week of the term; you will be able to choose either a Thursday evening or Friday afternoon session. .

***Prerequisites*:** MATH 200 (Linear Algebra)

***Textbook*:** James R. Brannan and William E. Boyce, *Elementary Differential Equations: An Introduction to Modern Methods and Applications*, Third Edition, Wiley: 2015. The text is available in several different formats: hardcover, loose leaf, or eTextbook. You can purchase new or used hardcover versions through the College Store; other versions are available from Amazon or other online vendors. A copy is also on reserve at Davis Family Library.

Your daily assignments will include a few pages of reading in the text. Be certain to read the book carefully (with pencil and paper, or occasionally *MATLAB* or *Maple*, close by!) Complete the relevant reading before coming to class and before tackling the exercises.

***Requirements*:** There will be two midterm examinations and a final examination in addition to required homework assignments. The midterm examinations will be given in the evening to eliminate time pressure. Tentative dates for these teschts are:

Wednesday, March 12
Wednesday, April 16

The College's Scheduling Officer has set 9 AM – Noon on Friday, May 16 as the time and date for the final exam for our course.

***Homework**:* Mathematics is not a spectator sport! You must be a participant. The only effective way to learn mathematics is to do mathematics. We may occasionally assign some challenging problems which everyone may not be able to solve. You should, however, make an honest attempt at every problem.

You may use your notes, textbooks, calculators, and any computer software you have available (including *MATLAB*) to assist with the homework. Bear in mind, however, that none of these will be permitted during examinations.

I encourage you to talk to each other about the *Practice Exercises* and *Feedback Problems*. **The final write up must be done alone**. You should not have access to the assignment of a colleague while writing up your own. Warning: The College deals quite severely with cases of plagiarism, cheating, or other forms of academic dishonesty. Review Middlebury's policy on academic honesty at
http://www.middlebury.edu/about/handbook/student_policies/Academic_Disciplinary_Policies

Homework must be done neatly and legibly. Shoddy work will not be accepted for grading. Staple your assignments! There will not be a great deal of partial credit given for obviously incorrect answers. You should check your results where possible or at least examine them to see whether they are plausible.

Practice Problems: These problems are designed to hone the skills we will learn in this course. You can complete most problems with pencil and paper, while some require software. We expect you to complete all these problems but not all are graded or collected.

Feedback Problems: These are subsets of the practice problem sets that will be collected and graded for feedback.

Work Together, Write Alone: We strongly encouraged you to work together in pairs or small groups. However, all final drafts of feedback problems should be completed separately and in your own words.

Take Pride In Your Work. Feedback problems are expected to be neat, organized, legible, and stapled. Poorly written or messy work is not acceptable.

Submit All Work On Time. No late work will be accepted. Because we will distribute solution sheets to assigned work on the day it is due, we can not accept late papers. You should start the assignments early and work on them every day.

Important Thought: One of the essential characteristics of college life that distinguishes it from secondary school is the increased responsibility placed on you for your own education. Most of what you will learn will not be told to you by a teacher inside a classroom. Even if our model of you were an empty vessel waiting passively to be filled with information and wisdom, there would not be time enough in our daily meetings to present and explain it all.

We see you, more appropriately, as an *active* learner ready to confront aggressively the often times subtle and difficult ideas our mathematics courses contain. You will need to listen and to read carefully, to master concepts by wrestling with numerous examples and problems and individual/team projects, and frequently to ask thoughtful questions or make suggestions/conjectures about the course material .

Grades: Grades in the course will be based on the two midterm examinations, feedback problems, small group projects and the comprehensive final exam. The relative weights of the various components of the course are roughly as follows:

Examination 1:	25%
Examination 2:	25%
Three Projects:	20%
Final Examination:	30%

Policy on Generative AI: Please see our Policy on AI Usage Any use of generative AI tools will be treated as a violation of Middlebury's Honor Code.

Help: Please see me immediately if you have any difficulties with this course. Do not hesitate to utilize office hours. I welcome questions of any sort, including questions on assignments not yet handed in. In addition, I always appreciate your opinions, comments and suggestions concerning the course.

Students may also obtain many different forms of assistance from the Center for Teaching, Learning and Research (http://www.middlebury.edu/academics/resources/ctlr) in the Davis Family Library, the Q-Center (Armstrong Quantitative Center) in BiHall, and the Disability Resources Center (http://www.middlebury.edu/office/disability-resource-center) . I encourage you to investigate the services they offer.

Accommodations: Students who have Letters of Accommodation in this class are encouraged to contact me as early in the semester as possible to ensure that such accommodations are implemented in a timely fashion. For those without Letters of Accommodation, assistance is available to eligible students through Student Accessibility Services. Please contact Jodi Litchfield or Peter Ploegman through the Disability Resource Center for more information: All discussions will remain confidential.

Expectations

• ***Be There:*** Attend all lectures, arriving on time, and staying for the duration of the class period.
• ***Be Prepared:*** We expect students to complete assigned readings prior to the class. Reading a mathematics text requires a pencil and paper. Do not stress about understanding every detail you read, but focus on getting a general picture of the topics discussed, and understanding most of the examples. Completing these readings will enhance the lecture experience for all of us.
• ***Be Present:*** Plan to participate in lectures by both asking and answering questions, as well as by taking part in discussions and group activities.
• ***Be Proactive*** in your understanding. Complete assignments regularly. Ask questions as they come to you. Attend office hours for clarification the moment you run into trouble.
• ***Be Respectful*** of yourself, your classmates, your instructor, and our classroom. This is our

shared experience, and we are all partially responsible for ensuring a successful semester as a productive, welcoming, and stimulating class environment.

• ***Be Honorable:*** Students are expected to follow the Honor Code for all activities in this course. Expectations for feedback assignments, exams, and projects will be discussed explicitly in advance during class and students will be required to write/sign the honor pledge on larger assignments.

A Final Word: **There is a lot of exciting mathematical material in this course. Have fun with it!**