












Ordinary Differential Equations

Math 2208




Instructor Info —

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-  Office Hrs: See Blackboard
-  Searles 104
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Course Info —

-  Prereq: Math 2000
-  Mon & Wed
-  1:15p-2:40p
-  Searles 215

Lab Info —

-  Wed
-  1:15p-2:40p
-  Searles 216

Course Goals

Math 2208 Specific Goals: Learn how to use differential equations (DEs) to model real world phenomena. There are three main categories of tools we focus on to analyze such DE models.

1. Know how to solve a variety of DEs (analytical techniques) “by hand”.
2. Know how to analyze and say something about DEs without explicitly solving them (qualitative techniques).
3. Know how to approximate solutions using algorithms implemented on a computer (numerical techniques).

While we will learn several analytical techniques, understanding their limitations should be one of main takeaways of the course. This is why, when compared to more traditional courses on the subject, more emphasis is placed on qualitative and numerical techniques and the use of computer software.

Putting it all together: Given a real world phenomena, learn how to you derive a model, pick the right tool to analyze it (not all tools work on every model), and then interpret that result in the context of the real world phenomena.

Life Long Skills: Your abilities of general problem solving skills, self learning, self evaluation and how to formulate ideas and solutions will be refined throughout the course. This means problems appearing on homework or exam will not “be just like problems” you have seen before. You might be asked to explore new topics in homework before I cover them in class. Finally, how you present your solutions will also be evaluated.

Required Course Materials

Textbook

Differential Equations, 4th edition, by Blanchard, Devaney and Hall

Software

GNU Octave, for your own computer. All computers in Searles 216 have Octave installed.

Others

DFIELD, and *PPLANE*, some Java applets, will be available from Blackboard.

Grading Scheme

Weekly assignments	20%
Projects	15%
Quizzes	20%
Midterm 1	10%
Midterm 2	15%
Final exam	20%

Scores will NOT be curved. However, the cutoff percentage for letter grades will be set at my discretion. The weights are tentative and subject to change on an individual basis.

Important Dates

Quiz # 1	Wednesday, Feb 5
Quiz # 2	Wednesday, Feb 26
Quiz # 3	Wednesday, Apr 8
Quiz # 4	Wednesday, Apr 22
Midterm # 1	due Monday, Mar 2, 1:15PM
Midterm # 2	due Monday, Apr 13, 1:15PM
Final Exam	due Tuesday, May 12, 4:30PM

Both Midterms and the Final exams will be take-home. The quizzes will serve as in-class tests.

FAQs

? Where can I find Octave?

! You can download a free copy for your own use from gnu.org/software/octave.

? I can't run DFIELD or PPLANE.

! You may need [Java Runtime environment](#) to run these on your computer.

? What is the late submission and make-up exam policy?

! In general, late submission (even 15 mins late) of homework assignments will NOT be accepted. You may turn in *up to two* homeworks late, with no questions asked, so long as you notify me before the time the homework is due. Please see me in case of other extenuating circumstances.

You can make up an exam if certain unavoidable reasons prevent you from taking it and if you inform me in advance. Contact me as soon as possible if you are going to miss an exam. Missed exams can only be made up at my discretion, and are subject to a lost fraction of the grade.

? Do I need to attend every class?

! Although attendance is not directly part of your grade, it is very easy in a math class to fall behind after skipping even one class. You cannot be an effective and involved member of the class unless you are present! If you miss multiple classes in a row, you may expect a comment card.

Diversity and Inclusion Statement

I consider this classroom to be a place where you will be treated with respect, and I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability - and other visible and non-visible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class.

No student is required to take an examination or fulfill other scheduled course requirements on recognized **religious holidays**. Please declare your intention to observe these holidays at the beginning of the semester.

Student Accommodations

- If you are a student with learning needs that require special accommodation, please see Lesley Levy in the [Office of Student Accessibility](#) as soon as possible to make an appointment to discuss your special needs and to obtain an accommodations letter. Please email me as soon as possible in order to set up a time to discuss your learning preferences, challenges you may face learning this semester, and how we can create an effective learning experience for you. *In particular, I understand that the quizzes at the beginning of class can present a challenge, and I'm eager to discuss options with you.*
- As a student, you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These **mental health concerns** or stressful events may lead to diminished academic performance or reduced ability to participate in daily activities. Bowdoin College is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. You can learn more about the broad range of confidential mental health services available on campus at: <https://www.bowdoin.edu/counseling/>

Title IX

As a faculty member I am considered a **Responsible Employee**, per the [Student Sexual Misconduct and Gender Based Violence Policy](#). While my goal is for you to be able to share information related to your life experiences through discussion and written work, I want to be make sure you understand that as a Responsible Employee I am required to report disclosures of sexual misconduct, dating violence, stalking, and/or sexual and gender-based harassment to the University's Title IX Coordinator, Benje Douglas. My reporting to Benje does NOT mean that any actions will be taken beyond him reaching out to you and trying to schedule a time to talk to see what assistance you might need to be successful as a student here at Bowdoin.

Academic Integrity

I support and adhere to the principles of [The Bowdoin College Academic Honor Code](#). Your work should never be directly copied from another student and I will expect that *you are not reading solution manuals* for this textbook. In particular, I will assume all members of the class are trustworthy in their dealings with me as well as their fellow classmates. However, should a violation of this trust be discovered, it will be reported to the Judiciary Board. The goal is not vengeance against those who violate the Code but fairness for those who adhere to it. If you have any questions about the appropriateness of a particular situation, please communicate with me.

Components of the Course

- You will need to **read the textbook**. Several homework and suggested review problems will come directly from the book, and possibly quiz or exam problems. Some in class examples will be similar or identical to the book, but many will be different. The overall topic choice and course philosophy will be from the book.
- **Weekly assignments** will contain questions based on the textbook readings and class work. These assignments with their due dates will be regularly posted on Blackboard.
- You are encouraged to work on the weekly assignments with others, but you must write your final solution in your own words and you must complete and attach an **Assignment Cover Sheet** with every submission. This sheet can be downloaded from Blackboard.
- As is typical for ODE courses in the Mathematics Department, homework will generally be corrected by student graders who work under my supervision; this is done to ensure that you regularly receive graded assignments in a timely manner. *Please inform me immediately if you find any mistake in graded homeworks.*
- There will be three longer **projects** built around more challenging questions from the exercises, to showcase interesting applications of the study materials. These will require you to do programming in Octave or use the Java applets.
- You are allowed to work in groups of size **at most 2 (two)** to work on the projects. In your report you should include pictures and graphs of data and of solutions of your models *as appropriate*. Remember that one carefully chosen picture can be worth a thousand words, but a thousand pictures aren't worth anything. Final submissions must include a **Project Report Cover Sheet** (downloadable from Blackboard) on which the signatures of all participants must appear along with *brief but substantive* discussions of any issues confronted at your meetings. If any group member did not participate in an important aspect of the assignment, this must be stated in the Report. *One submission for your entire group will suffice.*
- Homeworks are extremely important, as it is the best way for you to engage with the material on a regular basis. I expect that in case you need extra practice with a certain concept, you will seek *extra, unassigned problems from the textbook to work out*; I am always happy to discuss how to locate good practice problems in your book.
- The point of the homeworks is for you to work out what you do and don't understand. When your graded homework has been handed back to you, you should go through it and see if you understand what has been written on it by the grader. If you don't, you should come to office hours and ask.
- As you are solving problems in this course, remember that getting the "answer" is only one of the steps. Don't think of what you write as just showing your instructor that you have done the homework. Write as if you were explaining what you are doing to one of your classmates who missed that day of class. Think of writing as part of the process of learning. The more carefully and clearly you write your mathematics, the more likely it is to be correct, and the more likely you will be to remember it. *Correct answers without explanation will not reap full credit, but clear explanations with an incorrect answer can certainly earn partial credit.*
- We will semi-regularly go into the **computer lab** during the lecture period for either demonstrations or for you to do your own programming. Homework problems throughout the semester will require you to use Octave/Matlab or other applets.
- **Student participation and collaboration** is an integral part of this class and is highly valued. Everyone is expected to make thoughtful contributions in the form of questions (even if unprompted), statements, and reasoned arguments. You might be also occasionally invited to present something on the board. Whenever possible, there will be opportunities for you to work through practice problems in small groups during our class meetings. Paper copy of **worksheets** will be provided and an electronic copy will be available on Blackboard.
- Additionally, there will be four **quizzes** and **two midterms** given during the semester, as well as a **final examination** at the end of the semester. All tests will emphasize the concepts of the course.

General Policies

- Be courteous when using mobile devices. Make sure your cell phone is turned fully off, or silent. If you must make or receive a call, please go outside the classroom.
- Use of laptops or tablets is permitted for note-taking and labs. Please turn off your Wi-fi and sound.
- For any private communication regarding this course, please email me from your **bowdoin.edu email address**. This is mainly for identity verification purposes.

Class Schedule

The following is a preliminary outline of the topics that we hope to cover. This is an idealized plan, and it *may be adjusted as the semester progresses*. But it should give some indication of the major topics to be covered in this class.

Week No.	Monday	Wednesday
1		22-Jan Syllabus Overview + 1.1 (Modelling via Differential Equations)
2	27-Jan 1.2-1.3 (Separation of Variable, Slope Field) + Using DFIELD	29-Jan Intro to Octave - Basic Plotting + Euler's Method
3	3-Feb 1.5 (Existence and Uniqueness Theorem)	5-Feb 1.6 (Equilibria and Phase Line)
4	10-Feb 1.9 (Integrating Factor)	12-Feb Quiz 1 + ODE45
5	17-Feb 1.7 (Bifurcation)	19-Feb Project 1 (The Spruce Budworm - Hysteresis)
6	24-Feb Bifurcation contd.	26-Feb Quiz 2 + Review
	Midterm 1	
7	2-Mar 2.1 (Predator-Prey Model) + Nullclines and Direction Field	4-Mar 3.1 (Linear Systems) + LA Review
	Spring Break + Bonus Project (Recipe for an All-nighter - Kick-flow systems)	
8	23-Mar 3.2 (Straight line solutions) + using PPLANE	25-Mar 3.3 (Phase Portraits for Real Distinct Eigenvalues)
9	30-Mar 3.4 (Complex Eigenvalues)	1-Apr Trace-Determinant Plane, Defective and Degenerate cases, Bifurcation
10	6-Apr Second Order Linear ODEs, Simple Harmonic Oscillators	8-Apr Quiz 3 + Review
	Midterm 2	
11	13-Apr Project 2 (Linear Systems in Higher Dimensions)	15-Apr Forced Harmonic Oscillation, Method of Undetermined Coefficients, Resonance
12	20-Apr 5.1-5.2 (Equilibrium Point Analysis, Jacobian)	22-Apr Project 3 (SIR model)
13	27-Apr Almost Linear Systems, Consequences of Poincaré-Bendixson theorem	29-Apr Project 4 (Glycolytic Oscillations - Hopf Bifurcation)
14	4-May Lorenz Equations, Example of Chaos	6-May Quiz 4 + Review