APMA 0350 – SYLLABUS

Welcome to APMA 0350 – an exciting dif-fun-rential adventure awaits you! This is the survival manual for this course, where you can find all the administrative info you need to know, such as office hours, grading, and other goodies. Feel free to e-mail me for any other questions.

Disclaimer: Any item on this syllabus is subject to change. Any in-class or online announcement, verbal or written, is considered official addendum to this syllabus.

1. At a glance

Course Name	Applied Ordinary Differential Equations
Term	Spring 2024
Class Times and Location	MWF 12–12:50 pm in 85 Waterman St. 130
Instructor Name	Peyam (π–m) Tabrizian
E-mail	drpeyam@brown.edu
Course Website	APMA 0350 Website
YouTube	Dr Peyam
Office	Room 316, 182 George Street
Office Hours	W 1:30-3:30 pm and Th 1-2 pm

TA	Role	Email
Caleb Evert	GTA	caleb_evert@brown.edu
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2. Logistics

Course Description: This course provides a comprehensive introduction to ordinary differential equations and their applications. We will see how applied mathematicians use ordinary differential equations to solve practical applications, from understanding the underlying problem, creating a differential-equations model, solving the model using analytical, numerical, or qualitative methods, and interpreting the findings in terms of the original problem. While this course is more geared towards the techniques for solving ODE, I will try my best to mention some rigorous theoretical foundations of differential equations. To learn about the theory of ODE, I suggest taking MATH 1110 instead

Prerequisites: Calculus II (MATH 0100) or equivalent; knowledge of matrix-vector operations, determinants, and linear systems.

Recommended: I *highly* recommend taking Linear Algebra (MATH 0520 or MATH 0540) beforehand or concurrently, since the last third

of the course requires it. In addition, about three lectures require Multivariable Calculus knowledge (MATH 0180)

Learning Outcomes: By the end of the course, you will be able to

- Formulate questions about real-world problems and create ordinary differential equations models to answer them
- Determine when an ordinary differential equation has a solution and when the solution is unique
- Analyze and solve ordinary differential equations using qualitative, analytical, and numerical techniques
- Draw conclusions about real-world problems from ordinary differential equations models

Workload: Total time spent in and out of class for this course is estimated at 180 hours. Over the 15 weeks of this course, you will spend 3-4 hours in class each week (3 hours lecture and 1 hour optional recitation section). Although specific out-of-class time investments may vary for individual students, a reasonable estimate to support this course's learning outcomes is 120 total out-of class hours, or on average, 6-8 hours weekly over a 15-week term. Out-of-class preparation will regularly include about 3 hours per week on homework, and a total of 10-20 hours of exam for each exam.

What this course is really about: I highly doubt that you'll forget the techniques you'll learn in this course because they are essential to human survival. That said, as Steve Krantz puts it in his book "How to teach Mathematics," there is another goal of teaching this course. Namely, real purpose of this course is to teach you about mathematical discourse and critical thought. Just like in rhetoric, philosophy or

politics, mathematics has its own language and way of thinking. How do mathematicians deal with an unknown problem? What methods do they use? What do they do when a given method doesn't work? Getting acquainted with all those different types of discourses is what your college education is really about.

Textbook: None. I will post self-contained lecture notes

Recommended:

- Boyce-DiPrima-Meade Elementary Differential Equations, Wiley
- Jiri Lebl Notes on DiffyQ's: Differential Equations for Engineers
- Hirsch, Smale, Devaney, Differential Equations, Dynamical Systems, and an Introduction to Chaos, Elsevier

More Practice Problems: In case you need more practice problems (other than the homework and practice exams), I *highly* recommend you get the Boyce DiPrima book, which has *lots* of practice problems

Online resources you can use:

- Course website: This is the main course website, where you can find the lecture notes, homework, and study material
- Canvas: Here is where I'll post announcements and you can find the lecture recordings
- Gradescope: Here is where you upload your homework, take your exams, and check your grades
- Ed Discussion: A forum-like tool like Canvas Discussions or Piazza, where you can post questions and your classmates can answer them. **Please use Edstem instead of emailing me with questions**

- Dr Peyam: My YouTube channel, where you'll find useful videos related to this course

Recitation Sessions: There will be **optional** recitation sessions led by the Graduate TA. What is covered in those sessions is up to the GTA. In Fall 2022 for example, it was mainly used to go over the homework problems.

Lecture Recordings: The lectures will be recorded, you can find the recordings on Canvas under Media Library > Lecture Captures

Reading Period: There will only be one lecture during reading period, which is an optional review session on Friday, April 26, held via Zoom. In addition, the lecture before spring break is an optional review of linear algebra, and is possibly held during spring break as well.

3. Grading

Assignment	Date	Percentage
Homework	Weekly on Fridays	20 %
Programming Assignments	Three in total	5 %
Mini-Project	Friday, May 3	5 %
Midterm 1	Friday, March 1	20 %
Midterm 2	Friday, April 5	20 %
Final Exam	Monday, May 16	30 %

Range	Grade
$[90, 100]$	A
$[80, 90)$	B
$[65, 80)$	C
$[0, 65)$	NC

Note: The scales above are a *guarantee*. For example, if you get 80, you are guaranteed at least a B. The final grade calculation is up to my discretion. For students taking this course S/NC, a min grade of 65% is required to guarantee a grade of S. **You have to take the final exam in order to pass the class!**

For your information, in Fall 2023 there were 246 students enrolled, and the grade distribution was: 174 A, 44 B, 22 C, and 6 NC. There was no curve, but I rounded up things like 89.9 % to an A.

Calculator Policy: Calculators are **NOT** allowed on the exams. That said, you **ARE** allowed to use them on the Homework and Programming Assignments.

Exams: There will be two midterms and a final in the course. The midterms (not cumulative) are each 50 mins long and the final (cumulative) is 180 mins long Bring your student ID and a pencil to all exams. The exams are closed book and no calculators are allowed.

Note: The final exam replaces your lowest midterm if that's in your favor. For example, if your exam scores are $(70, 80, 90)$ then this will count as $(90, 80, 90)$ but if they are $(90, 80, 70)$ then this will stay as $(90, 80, 70)$. And if they are $(80, 80, 90)$ then we'll count that as

$(90, 80, 90)$.

Cheat Sheets: On the exams, you are allowed to use a standard two-sided 8.5×11 cheat sheet. The cheat sheet can be typed or handwritten, and you are welcome to collaborate with your friend to create the cheat sheet.

Graded Homework: Homework will be due on Fridays by 4 pm and will be posted on the course website. You will upload your assignments on Gradescope. **Make sure to check your submission, we will ABSOLUTELY NOT accept any incomplete or corrupt files.** You are encouraged to work together but all students must independently write up their own solutions. There is no 'make up' homework, but **the lowest 2 assignments are dropped (this does not include the programming assignment or the mini project)**

Uploads: You will get points off if you ask me or the TAs to upload your assignment.

Programming Assignments: There will be three short programming assignments in total, done in Python, and also due on Fridays by 4 pm. The rules are the same as the homework. **The lowest programming assignment gets dropped.** The point of this assignment is to give you a just a little taste of how to solve ODE on a computer.

Mini-Project: There will be a small fun project due at the end of the semester, where you pick your favorite ODE and write a $1-2$ page report describing it. It won't be too time-consuming.

Extra Credit: There is a 1% extra credit opportunity, which will be given to the top 10 posters on Edstem. You can achieve this either by asking questions on Edstem (asker) or answering your peer's questions

(answerer) or by commenting on posts (commenter). The goal of this is to help you be pro-active with the course material.

Late Assignments: We grant two late assignments per student, no later than Sunday 11:59 pm. **Please do NOT email me to ask for an extension, use the google form on the course website instead** You have to use the google form for every late assignment, including the first two. Homework extensions are automatically granted, meaning you won't receive an email confirming the extension. **We** will email you in case any problems arise, such as requesting more than 2 extensions. If a programming assignment is due on the same day as a homework, that only counts as one extension, but you will still need to submit two separate requests on the google form for them.

More Extensions: If you have any extenuating circumstances (like a medical note or dean's note or SAS accommodation or signed up for the class late) and need to submit the assignment after Sunday 11:59 pm, you can hand me in the assignment **after class and in-person**. You can only hand in a max of 3 assignments that way and/or 2 consecutive assignments. I will grade it after finals and only if the assignment bumps you up to a higher letter grade.

Regrades: If there is a mistake in the grading of your assignment or exam (points are added incorrectly, your score was mis-entered into the grade book) please let me know immediately. If you disagree with the grading of your assignment then you may submit a regrade request on Gradescope. **You only have 1 week after your score has been posted to request a regrade, otherwise we won't accept it.** For Homework 9, 10, Programming Assignment 3, the Mini Project, and the Final Exam, you will only have 24h to request a regrade. Please note that it is *extremely* unlikely that one point on the homework will

change your course grade.

Canvas Gradebook: Don't worry if your Gradescope scores and your Canvas scores don't match after a regrade. I will resync all the scores **after finals are over** so that they will match, no need to email me about that beforehand. Please don't trust the Canvas gradebook **too** much, as it sometimes incorrectly displays your average grade. It's always wisest to calculate your average manually to get the correct grade.

Simplification Policy: We reserve the right to take points off for not simplifying answers like $\frac{\sqrt{64}}{8}$ or $2 + \frac{6}{3}$ even if it's not explicitly written in the homework or exam problem.

4. Miscellaneous Information

Statement on Inclusivity: I strive to foster an inclusive, collaborative, and supportive learning environment where everybody is welcome and feels they belong. I also aim to create an atmosphere where everyone is comfortable to add their voices and opinions. Being a member of the LGBT community, I acknowledge that there are many disparities in representation in the mathematical sciences and that we, as a community, need to work much harder and more persistently to become more diverse.

Academic Integrity: Plagiarism and cheating are serious offenses and are more harmful to you, the student, than to the university. Please refer to the Brown University Academic and Student Conduct Codes for details regarding Brown University's policy on academic integrity and penalties for violating the academic code. **On the exams, you are not allowed to collaborate with others on the exams and you are not allowed to use any outside sources other than**

your cheat sheet. On the homework, you are allowed to collaborate with each other, as long as the work submitted is your own. In addition, you are not allowed to use AI tools such as ChatGPT to complete your assignments.

Accessibility and Accommodations Statement: Brown University is committed to full inclusion of all students. Please inform me early in the term (by email, office hours, after class, or by appointment) if you may require accommodations or modification of any of course procedures. If you need accommodations around online learning or in-classroom accommodations, please reach out to Student Accessibility Services (SAS) for their assistance (sas@brown.edu, 401-863-9588). Undergraduate students in need of short-term academic advice or support can contact an academic dean in the College by emailing college@brown.edu. Graduate students may contact one of the deans in the Graduate School by emailing graduate_school@brown.edu.

Books, Supplies, and Materials If your Brown undergraduate financial aid package includes the Book/Course Material Support Pilot Program (BCMS), concerns or questions about the cost of books and course materials for this or any other Brown course (including RISD courses via cross-registration) can be addressed to bcms@brown.edu. For all other concerns related to non-tuition course-related expenses, whether or not your Brown undergraduate financial aid package includes BCMS, please visit the Academic Emergency Fund in E-GAP (within the umbrella of "E-Gap Funds" in UFunds) to determine options for financing these costs, while ensuring your privacy.

Finally: Sit back, relax, and enjoy the show! On the next page, you can find a schedule of the lectures.

#		Date	Lecture Title	
1	W	Jan 24	What is a differential equation?	
2	F	Jan 26	Direction Fields	
3	M	Jan 29	Qualitative Methods	
4	W	Jan 31	Existence and Uniqueness	
5	F	Feb 2	Separable Equations	HW 1 due
6	M	Feb 5	Integrating Factors	
7	W	Feb 7	Applications	
8	F	Feb 9	Exact Equations	HW 2 due
9	M	Feb 12	Euler's Method (I)	
10	W	Feb 14	Euler's Method (II)	
11	F	Feb 16	Second-Order ODE	HW 3 due
	M	Feb 19	No class	
12	W	Feb 21	Complex Roots	
13	F	Feb 23	Boundary-Value Problems	HW 4 due
				Coding 1 due
14	M	Feb 26	Undetermined Coefficients	
15	W	Feb 28	Mechanical and Forced Vibrations	
16	F	Mar 1	Midterm 1	

17	M	Mar 4	Variation of Parameters	
18	W	Mar 6	Laplace Transform	
19	F	Mar 8	Initial-Value Problems	HW 5 due
20	M	Mar 11	Step Functions (I)	
21	W	Mar 13	Step Functions (II)	
22	F	Mar 15	ODE with jumps	HW 6 due
23	M	Mar 18	Dirac Delta	
24	W	Mar 20	Convolution	
25	F	Mar 22	Linear Algebra Review	HW 7 due
				Coding 2 due
	M	Mar 25	Spring Break (no class)	
	W	Mar 27	Spring Break (no class)	
	F	Mar 29	Spring Break (no class)	
26	M	Apr 1	Systems of ODE (I)	
27	W	Apr 3	Midterm 2 – Review	
28	F	Apr 5	Midterm 2	

29	M	Apr 8	System of ODE (II)	
30	W	Apr 10	Complex Eigenvalues	
31	F	Apr 12	Repeated Eigenvalues	HW 8 due
32	M	Apr 15	Undetermined Coefficients	
33	W	Apr 17	Variation of Parameters	
34	F	Apr 19	Nonlinear Systems	HW 9 due
				Coding 3 due
35	M	Apr 22	Ecology: Competing Species	
36	W	Apr 24	Epidemiology: SIR Models	
37	F	Apr 26	Final Exam Review (via Zoom)	HW 10 due
	F	May 3		Mini Project due
38	F	May 16	Final Exam	