APMA 1941G – SYLLABUS

Welcome to APMA 1941G – an exciting asymptotics 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	Asymptotic Methods in Differential Equations
Term	Spring 2024
Class Times and Location	TuTh 2:30–3:50 pm in BARHOL 158
Instructor Name	Peyam (π–m) Tabrizian
E-mail	drpeyam@brown.edu
Course Website	APMA 1941G Website
YouTube	Dr Peyam
Office	Room 316, 182 George Street
Office Hours	W 1:30-3:30 pm and Th 1-2 pm
UTA	Qile Jiang
UTA E-mail	qile_jiang@brown.edu

2. Logistics

Course Description: This will be an applied differential equations course, covering various sort-of rigorous and actually rigorous methods for nonlinear ODE and PDE in interesting asymptotic limits. We will discuss the following topics:

1. Introduction
2. Laplace's method and stationary phase
3. Multiple scales
4. Matching methods

My second goal is to offer you a glimpse of the beautiful world of differential equations. My field of research is Partial Differential Equations (PDE), which has a really elegant theory, but which isn't very accessible, unless you've taken high-level analysis, especially functional analysis. You can think of this course as a pre-introduction to PDE, which *is* accessible to people who've taken introductory real analysis.

Prerequisites: APMA 0350 and 360 are a must. Some background in Analysis (such as MATH 1010) is preferred.

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

- Formulate questions about real-world problems and create differential equations models to answer them
- Approximate complicated differential equations by simpler one, and draw conclusions from them

- Conversely, perturb differential equations to create new ones
- Evaluate integrals asymptotically
- Draw conclusions about real-world problems from differential equation models
- Support, justify, and communicate your conclusions accurately, clearly, and concisely

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 hours in class each week (lectures). Although specific out-of-class time investments may vary for individual students, a reasonable estimate to support this course's learning outcomes is 135 total out-of class hours, or on average, 9 hours weekly over a 15-week term. Out-of-class preparation will regularly include about 6 hours per week on homework, 5 hours for the mini project, and a total of 40 hours for the exams.

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: John Neu, Singular Perturbations in the Physical Sciences, American Mathematical Society

Online resources you can use:

- Course website: This is the main course website, where you can find the lecture notes, homework, and study guides for the exams
- Canvas: Here is where I'll post announcements
- Gradescope: Here is where you upload your homework 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

Reading Period: There will be no lectures during reading period.

3. Grading

Assignment	Date	Percentage
Homework	Weekly on Fridays	45 %
Mini Project	Friday, May 3	5 %
Midterm (take-home)	March 11-15	20 %
Final Exam (take-home)	May 13-17	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!**

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

Exams: There will be one take-home midterm and one take-home final in the course, open book and open notes

Note: Although the final does not replace the midterm (due to the different modalities), any progress will be taken into account when assigning final grades.

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**

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

Mini-Project: There will be a small fun project due at the end of the semester, details to be announced later. It won't be too time-consuming.

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.

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 10, 11, 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 and you are not allowed to use any outside sources. On the homework,**

you are allowed to collaborate with each other, as long as the work submitted is your own. 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 tentative schedule of the lectures.

#		**Date**	**Lecture Title**
1	Th	Jan 25	What is an Asymptotic Expansion?
2	Tu	Jan 30	Acoustic Approximation in Fluid Mechanics
3	Th	Feb 1	Derivation of the KdV equation
	F	Feb 2	HW 1 due
4	Tu	Feb 6	Theoretical Aspects
5	Th	Feb 8	Laplace's Method (I)
	F	Feb 9	HW 2 due
6	Tu	Feb 13	Laplace's Method (II)
7	Th	Feb 15	Stationary Phase
	F	Feb 16	HW 3 due
	Tu	Feb 12	No class
8	Th	Feb 22	Rapidly Oscillating Coefficients
	F	Feb 23	HW 4 due
9	Tu	Feb 27	An Oscillator with Damping
10	Th	Feb 29	WKB Method
	F	Mar 1	HW 5 due
11	Tu	Mar 5	Nonlinear Oscillator with Damping
12	Th	Mar 7	Nonlinear Wave Equation
	F	Mar 8	HW 6 due
13	Tu	Mar 12	Diffusion-Transport PDE
14	Th	Mar 14	No class (Midterm)

15	Tu	Mar 19	Calculus of Variations
16	Th	Mar 21	Homogenization
	F	Mar 22	HW 7 due
	Tu	Mar 26	Spring Break (no class)
	Th	Mar 28	Spring Break (no class)
17	Tu	Apr 2	Matched Asymptotic Expansions
18	Th	Apr 4	Higher Orders
	F	Apr 5	HW 8 due
19	Tu	Apr 9	Internal Layers
20	Th	Apr 11	Earth-Moon Spacecraft Problem
	F	Apr 12	HW 9 due
21	Tu	Apr 16	Singular Variational Problem
22	Th	Apr 18	Singular Reaction-Diffusion PDE
	F	Apr 19	HW 10 due
23	Tu	Apr 23	Singular Perturbation of Eigenvalues
24	Th	Apr 25	The Crushed Ice Problem
	F	Apr 26	HW 11 due
	F	May 3	Mini Project due
25	F	May 17	Final Exam (take-home)