CAAM 423/523, MATH 423/513: PARTIAL DIFFERENTIAL EQUATIONS

Instructor:	Maarten V. de Hoop	**Class Time:**	MWF 1:00-1:50 pm
Email:	mdehoop@rice.edu	**Classroom:**	the course is online
Office:	Duncan Hall 2035	**Office Hours:**	TBA
Course Website:	Canvas		http://maartendehoop.rice.edu/caam-423523-math-423513/

Course Objectives and Learning Outcomes

This course is an introduction to the theory partial differential equations (PDE) and their wide-ranging applications. PDEs can be used to describe a wide variety of phenomena such as sound, heat, electrostatics, electrodynamics, fluid flow, elasticity, or quantum mechanics. Rather than study specific equations, this course will emphasize phenomena that are general among PDEs, and provide tools to not only solve PDEs, but to understand qualitative properties of their solutions. These qualitative tools must also be emphasized even in numerical solutions of PDE, since without this qualitative understanding one may use numerical methods that result in extremely inaccurate (or completely wrong) solutions even if one decreases the step size mesh size.

On completion of this course, the student should be able to:

- solve first-order linear/nonlinear PDEs and understand their local existence theory
- understand weak derivatives, Sobolev spaces and their application to solving PDEs
- understand properties of certain linear second-order PDEs such as regularity, energy estimates, maximum principles, and propagation
- solve and understand PDEs on domains with boundaries
- use Duhamel's principle to solve certain inhomogeneous PDEs
- understand PDE existence theory via duality
- understand the connection between PDE solutions and minimization problems of certain energy functionals

Prerequisites. Students should have proficiency in multivariable calculus, linear algebra, Ordinary Differential Equations (ODEs), metric topology, and real analysis. The theory of real analysis will be needed in the second half of the course and the students are encouraged to study/recall independently the basics of measure theory and L^p spaces. See for instance the textbook *Real and Complex Analysis*, 3rd ed., by W. Rudin.

Required Texts and Materials

We will use the textbook *Partial Differential Equations*, 2nd ed., by L.C. Evans. The material covered in this book will be supplemented with additional topics covered in class and provided by additional notes, made available on the course website. Alas all the details are not covered in the lectures and reading of the text book is a crucial part of this class.

For supplemental material the textbook *Introduction to Partial differential equations*, 2nd ed., by G.B. Folland is warmly recommended.

Exams and Homework

There will be approximately 8 homework assignments; *there will be a take-home mid-term and final exam.*

Grade Policies

- Homework will typically consist of 3 regular problems and one pledged problem. Unless noted otherwise, you may discuss the regular problems with fellow classmates and this is encouraged. However, you are expected to individually write up your solutions. You may not consult solution sheets from past CAAM/MATH courses. You are not allowed to discuss pledged problems with anyone but your instructor or TA.
- *At this moment, this course does not have a TA or a grader – the CAAM and MATH Department Chairs are aware of this – and, hence, the homeworks will NOT be graded. The grade will be entirely determined by the two take-home exams.*

Absence Policies

Students are strongly encouraged to contribute to our class community by attending and participating in the lectures on zoom.

Rice Honor Code

In this course, all students will be held to the standards of the Rice Honor Code, a code that you pledged to honor when you matriculated at this institution. If you are unfamiliar with the details of this code and how it is administered, you should consult the Honor System Handbook at `http://honor.rice.edu/honor-system-handbook/`. This handbook outlines the University's expectations for the integrity of your academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process.

Disability Support Services

If you have a documented disability or other condition that may affect academic performance you should: 1) make sure this documentation is on file with Disability Support Services (Allen Center, Room 111 / `adarice@rice.edu` / x5841) to determine the accommodations you need; and 2) talk with the instructor to discuss your accommodation needs.

Syllabus Change Policy

This syllabus is only a guide for the course and is subject to change with advance notice. In a typical week, I plan to cover one section of the book, but this may change due to the complexity of certain topics.

Course Schedule

We start with recalling the existence, uniqueness and regularity results for ODE systems, and then cover some topics in Chapter 1, *Introduction to Partial differential equations*, 2nd ed., by G.B. Folland (Chapter 3 in *Partial Differential Equations*, 2nd ed., by L.C. Evans).

We cover Chapters 2, 5 and 6 from *Partial Differential Equations*, 2nd ed., by L.C. Evans. We will proceed mostly chronologically. The notes from, and list of topics covered each week will be published on the course web site. To access the material, you will receive a password.