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

Instructor:	Maarten V. de Hoop	**Class Time:**	TuTh 9:25-10:40 am
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Office:	Duncan Hall 2035	**Office Hours:**	TBA
Course Website:	`TBA`		and by appointment

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, and real analysis.

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 instructor's website. Hence, regular attendance of the lectures is required.

Exams and Homework

There will be 8-9 homework assignments and no exams.

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 courses. You are not allowed to discuss pledged problems with anyone but your instructor or TA.
- The grade will be determined from your scores on the homework assignments. There will be no exams.
- NO LATE HOMEWORK will be accepted. We will automatically drop your worst two regular assignment scores. Exceptions will only be made for documented illnesses or emergencies.
- Look over the graded homework as soon as it is returned. If you detect mistakes in the grading, notify your instructor immediately. Homework scores will only be changed during the first two weeks after they have been returned.

Absence Policies

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

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 me 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. We will generally cover approximately six pages of the textbook per lecture depending on the topic. In a typically week, I plan to cover one chapter of the book, but this may change due to the complexity of certain chapters.

Course Schedule

Week 1	Intro to Laplace and Poisson equations
Aug 21, Aug 23	Reading: 1, 2.2.1, 2.2.2
Week 2	Harmonic functions, Green's function for the Laplacian
Aug 28, Aug 30	Reading: 2.2.3, 2.2.4
Week 3	Intro to energy methods, intro to heat equation

Sep 4, Sep 6	Reading: 2.2.5, 2.3.1
Week 4	Heat equation
Sep 11, Sep 13	Reading: 2.3
Week 5	Wave equation
Sep 18, Sep 20	Reading: 2.4
Week 6	First-order semilinear and quasilinear equations, method of characteristics
Sep 25, Sep 27	Reading: 3.2
Week 7	Fourier transform, intro to Sobolev spaces
Oct 2, Oct 4	Reading: 4.3.1, 5.1, 5.2, 5.8.5
Week 8	Sobolev approximation
Oct 11	Reading: 5.3
Week 9	Sobolev extensions, trace theorem
Oct 16, Oct 18	Reading: 5.4, 5.5
Week 10	Sobolev inequalities
Oct 23, Oct 25	Reading: 5.6, 5.7
Week 11	General elliptic systems, weak solutions
Oct 30, Nov 1	6.1, 6.2
Week 12	Maximum principles, elliptic eigenproblem
Nov 6, Nov 8	6.4, 6.5
Week 13	Second-order hyperbolic equations
Nov 13, Nov 15	Reading:
Week 14	Hyperbolic equations
Nov 20	Reading:
	Thanksgiving
Week 15	???
Nov 27, Nov 29	Reading: