Math 6340
Modern Partial Differential Equations

Place: Monroe B36, **Time:** WF 02:20 - 03:35 PM
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Office Hours: W & F 3:45 - 4:45 PM or by appointment

Textbook: Lawrence C. Evans, *Partial Differential Equations*, Second Edition, Graduate Studies in Mathematics, Vol. 19, AMS, Providence, RI, 2010.

Prerequisites A previous course in partial differential equations (such as Math 6319 (formerly Math 219)) is useful, but not essential. Contact the instructor if you are interested in this course or have questions about your background.

About Math 6340 The modern approach to the study of partial differential equations (PDEs) involves a different point of view regarding the notion of differentiability that leads one to study generalized or weak solutions. The proper settings for this study are certain function spaces that arise in a very natural way from the PDEs of interest. In Math 6340 (formerly Math 221), we will present an overview of many important topics in the theory of partial differential equations. These topics have a wide range of applications to areas of pure and applied mathematics, geometry, engineering, and physics.

Course work will include regular homework assignments and short in-class presentations. In consultation with the instructor, students will select a course project suitable to their own interests. This may involve reading a research article or text and giving a short presentation.

Topics:

- Introduction - Strategies for studying PDEs, classical solutions, weak solutions, regularity.
- Linear PDEs (Transport equation, Laplace's equation, heat equation, wave equation)
- Topics in functional analysis - Hölder, spaces, Hilbert spaces, Sobolev spaces, approximation by smooth functions, compactness.
- Second order elliptic PDEs - Lax-Milgram Theorem, energy estimates, maximum principles, eigenvalues of elliptic operators.
- Nonlinear PDEs - calculus of variations (existence of minimizes, coercively, lower semi-continuity), monotonicity methods, fixed point methods, bifurcation theory.

Learning Objectives

A student who completes this course will:

- Know the concept of a weak derivative, approximation by smooth functions.
- Know the important theorems and properties of Banach spaces and Sobolev spaces that arise in the study of PDEs.
- Know the Lax-Milgram Theorem.
- Know the fundamental theory of direct methods in the calculus of variations (including coercivity, lower semicontinuity, existence of minimizer).
- Know the Liapunov-Schmidt method for the solution of nonlinear PDEs.