

Title: Inverse Problems in PDEs: Numerical and Analytical Approaches

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Abstract:

Solving an inverse problem consists in determining unknown parameters or quantities by means of indirect or partial measurements. In various applied settings, this amounts to identifying coefficients or functions governing physical systems -modeled by partial differential equations - from the (often incomplete and noisy) knowledge of one or more solutions. Such problems, whose applications range from medical imaging to geosciences and materials science, are typically ill-posed and, in particular, unstable: small perturbations in the data may induce significant changes in the reconstructions. This poses substantial challenges, both for theoretical analysis and for the formulation of effective solution algorithms.

The course aims to cover foundational aspects of inverse problems for partial differential equations, with particular emphasis on reconstruction algorithms that determine or approximate their solutions. Central topics range from well-posedness analysis to regularization theory, up to more recent approaches based on data integration and machine learning. The course will provide both analytical and numerical perspectives, with a focus on the formulation, analysis, and implementation of iterative algorithms based on (non) convex optimization techniques. The case studies considered will include both practical examples and application-driven problems of significant relevance in biomedical and geophysical contexts.

Lecture hours: 20

Teaching period: January–February 2026

Assessment method: Oral examination on the course content.