Math 6397 - Applied inverse problems

Syllabus

Instructor – Daniel Onofrei, Office: 632PGH

Class time: T, Th: 1pm - 2:30 pm in C108

Office hours: T, Th 2:30pm - 4pm or by appointment and e-mail.

Class description:

The class will focus on the mathematical understanding of various applied inverse problems such as:

- **Medical imaging techniques:** Computerized tomography (CT), Acoustic tomography, Electric Impedance tomography (EIT), Photoacoustic Tomography (PAT) and its generalizations.
- **Inverse problems in geophysics:** Inverse gravimetry, Molodensky problem (finding the shape of an object from the gravitational potential measured at its surface), Inverse seismic problem, oil recovery and exploration
- **Inverse scattering**
- **Inverse spectral problems**
- **Radar and Sonar**: Detection mechanisms and Cloaking
- **Inverse source problems**
- **Internet tomography**

After the physical principle behind each application, we will try to understand the current state of the art in its development both from the analytical as well as from the implementation perspective. For the mathematical analysis we will introduce the concept of ill-posed problems and discuss the idea behind regularization techniques. We will try to understand each applied problem by discussing its mathematical challenges. Existence and, were possible, uniqueness results will be presented for the application being discussed together with various current implementation approaches and challenges.

The purpose of the class is to introduce the students to a wide array of very important applied inverse problems. The class is designed to help the students understand:

1. the basic principles and the main motivation behind each applied problem studied.
2. the mathematical challenges and their solutions for each applied question.

Grading will be based on Homework, assigned weekly on the class website, (1-2 problem per week will be graded and 4 -6 more will be suggested), attendance to several relevant PDE seminars on the class subject were the students will be required to write a 1-2 page discussion of what was presented, and a final project for each student to be presented in the final exam day.