# University of Pavia Doctorate School in Engineering Science Academic year 2008-2009

## INTRODUCTION TO INVERSE PROBLEMS IN ELECTROMAGNETISM

## Instructor

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## Programme

Inverse problems

- 1. History of inverse problems
- 2. Classification of inverse problems
- 3. Insidiousness of inverse problems: one, no, infinite solutions

Solution of an inverse problem by minimising a functional

- 1. Integral formulation (Fredholm's equation of the first kind)
- 2. Minimisation methods
- 3. Deterministic and stochastic algorithms
- 4. Scalar and vector minimisation

Matrices and linear systems of equations

- 1. Quasi-solution of an over-determined (or under-determined) system
- 2. Least squares, singular-value decomposition, regularization

#### Direct problems

- 1. Maxwell's equations of electromagnetic field
- 2. Differential formulation (Laplace-Poisson's equation)
- 3. Field problems and shape design

#### Case studies

- 1. Synthesis of the magnetic field along the axis of a solenoid
- 2. Identification of the material properties of a dielectric motor
- 3. Optimal shape design of an antenna for magnetic induction tomography
- 4. Optimal shape design of a magnetic levitator using high-temperature superconductors

#### **Reference textbooks**

P. Di Barba, A. Savini, S. Wiak: Field Models in Electricity and Magnetism. Springer, 2008.

P. Neittaanmaki, M. Rudnicki, A. Savini: <u>Inverse Problems and Optimal Design in Electricity and</u> <u>Magnetism</u>. Clarendon Press, 1996.

## Examination

Oral presentation and discussion of one of the topics of the course.