Inverse Problems and Image Reconstruction

Academic Year: (2019 / 2020) **Review date: 22-04-2020**

Department assigned to the subject: Mathematics Department

Coordinating teacher: TERRAGNI , FILIPPO

Type: Electives ECTS Credits : 6.0

Year : 1 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Partial Differential Equations.
Numerical Analysis.

OBJECTIVES

COMPETENCES and SKILLS

- Acquiring theoretical knowledge that allows the student to develop original ideas, in a research context, knowing how to translate industrial needs into I+D+i projects in the Industrial Mathematics field.

- Being able to explain the results, along with the acquired knowledge, to experts and non-experts.

- Being able to get deeper into a subject in an autonomous way, which will be very useful to obtain a Ph.D.

- Being able to get quantitative and qualitative information from experimental data using numerical techniques.

- Knowing how to select the appropriate techniques to solve a specific problem.

DESCRIPTION OF CONTENTS: PROGRAMME

Introduction and Basic Notions
- Direct and inverse problems
- Well and ill-posed problems
- Existence and uniqueness of the solution
- Stability

Least squares
- Motivation and general idea
- Applications

Regularization
- Motivation and general idea
- Tikhonov, Lardy and Landweber algorithms
- Morozov's discrepancy principle

Singular Value Decomposition
- Theoretical background, meaning and properties
- Noise filtering and data reconstruction
- Linear systems and regularization
- Extensions

Computed Axial Tomography
- Radon transform and sinogram
- Methods: back projection and algebraic reconstruction

Topological Derivative
- Theoretical background
- Defects detection

- Methods: multifrequency and iterative
- Applications

LEARNING ACTIVITIES AND METHODOLOGY

Methodology:
- In-person classes.
- Homeworks and presentations.

Tutorials:
The students can ask questions via e-mail or during classes.

ASSESSMENT SYSTEM

Criteria for both the 1st and 2nd assessment opportunity:
We will follow a continuous evaluation system that will include the student's participation in class, homeworks, and an exposition of practical problems related to the subject.

% end-of-term-examination:	0
% of continuous assessment (assigments, laboratory, practicals…):	100

BASIC BIBLIOGRAPHY

- A. Kirsch An Introduction to the Mathematical Theory of Inverse Problems, Springer-Verlag New York, 2011

- Frank Natterer, Frank Wübbeling Mathematical Methods in Image Reconstruction, SIAM, 2001

- J. Mueller, S. Siltanen Linear and Nonlinear Inverse Problems with Practical Applications, SIAM Computational Science and Engineering, 2012

- M. Bertero, P. Boccacci Introduction to Inverse Problems in Imaging, CRC Press, 1998