Course Title: *Discrete Inverse Problems in Imaging: Insight and Algorithms*

Program:

1. Fundamentals of Image Processing: Image Formation, Sampling, and Resolution.
2. Acquisition Methods for medical images: X-Rays, Computer Tomography, MRI (or NMR), PET / SPECT (Positron Emission Tomography, Single Photon Emission Computerized Tomography), Ultrasound.
3. Discretization of Linear Inverse Problems: The Singular Value Decomposition.
4. Image Restoration: The Problem and Basic Approaches.
5. Computational Aspects: Regularization Methods (Truncated SVD, Tikhonov Regularization, Choosing the Regularization Parameter).
6. Towards Real-World Problems: Large-Scale Methods (Iterative Methods, Total Variation and general models).

(Prof. F. Sgallari, 8 hours)

7. Total Variation in Imaging
8. Numerical algorithms: Chambolle's algorithm, primal-dual approaches, ADMM, etc..
9. Enhancing sparsity beyond convexity: applications to the restoration of barcode images and segmentation of medical images.

(Dr.A. Lanza, 10 hours)

10. Principles and Analysis of Krylov Subspace Methods

(Prof. V. Simoncini, 4 hours)

11. Fourier and Wavelets Analysis for Image Enhancement and Reconstruction

12. ***Course project*** *– The main idea of the project is to reproduce (with an oral/written report on selected topics, eventually with laboratory experiments)image processing algorithms which have been recently reported in scientific publications, such as journal papers or conference proceedings. By means of reproducing such algorithms, the students will have a chance to see how the material of the course is used in practical applications as well as to learn some new methodologies in the area of their interests. The project teams will consists of either one or two students.*

(Dr. D. Lazzaro, 8 hours)