# COMPUTATIONAL METHODS AND ALGORITHMS IN IMAGING
## ECSE 4962 and ECSE 6964
## Fall 2009

Time: TF: 10:00am -11:20am
Place: JEC 4107
Instructor: Prof. Yazici

Description – This is a new course that I will introduce in Fall 2009. The course will introduce the field of imaging, its physical principles, methods and applications within a unifying framework that integrates diverse topics which are presented separately in different science, mathematics and engineering courses. The course will emphasize on physics of wave-based imaging, adopt a linear systems based approach to describe wave propagation in a medium and interaction with a target; and in solving the resulting image formation problem. Statistical and matrix inversion techniques, as well as analytic inversion techniques will be covered. The course will prepare undergraduates as well as graduate students in computational techniques in imaging in broad domains of environmental, medical, biological, defense, civil engineering, geophysics imaging applications.

# Tentative Outline

## 1 OVERVIEW
1.1 Scope and Applications

## 2 PHYSICAL MODELS OF IMAGING AND IMAGING MODALITIES
2.1 Waves: Electromagnetic and Acoustic
2.2 Wave Interactions in Media
2.3 Radiation Transport Model
2.4 Linear Imaging Problems
2.5 Non-Linear Imaging Problems

## 3 ANALYTIC METHODS FOR IMAGE RECONSTRUCTION
3.1 Ray Tomography
3.2 Weighted Ray Tomography
3.3 Diffraction Tomography

## 4 ALGEBRAIC METHODS FOR IMAGE RECONSTRUCTION - Deterministic Methods for Image Reconstruction
4.1 Discrete and Matrix Models
4.2 Pseudo-Inverse
4.3 Truncated SVD
4.4 Tikhonov Regularization
4.5 Truncated Iterative Optimization Techniques

## 5 ALGEBRAIC METHODS FOR IMAGE RECONSTRUCTION - Statistical Methods for Image Reconstruction
5.1 Bayesian Approach
5.2 Markov Random Field Models
5.3 Computational Methods for Optimization and Integration
5.4 Non-Stationary Problems – Bayesian Filtering

## 6 NUMERICAL TECHNIQUES FOR PDE BASED IMAGE RECONSTRUCTION PROBLEMS (time permits)

## 7 MODEL PROBLEMS AND CASE STUDIES (time permits)