

# BME801 Inverse Problem in Bioengineering

## (Spring, 2014)

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### 1. Description

Understand engineering problems as forward and inverse problems with their physical backgrounds and mathematical representations. Understand mathematical backgrounds including vector space, Hilbert space, orthogonality, projection, linear algebra, linear system, least square, SVD, regularization, PDE, FEM and others. Solution methods for forward and inverse problem. Electrical impedance tomography (EIT) using boundary measurement and magnetic resonance electrical impedance tomography (MREIT) using internal measurement.

### 2. Prerequisites

Electromagnetics, vector calculus, linear algebra, numerical analysis

### 3. Text and References

Title	Author	Publisher	Year	Remark
Nonlinear Inverse Problem in Imaging	Seo and Woo	Wiley	2013	Main Text
Introduction to Inverse Problems in Imaging	Bertero and Boccacci	IOP	1998	Reference
Discrete Signals and Inverse Problems	Santamarina and Fratta	Wiley	2005	Reference

Electrical Impedance Tomography	Holder (ed)	IOP	2005	Reference
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#### 4. Grading Plan

Midterm	Final	Homework	Four or more absences
45%	45%	10%	F

#### 5. Schedule

Week	Topics
1	Introduction to forward and inverse problems, linear and nonlinear inverse problems
2	Vector space, Hilbert space, orthogonality principle and projection
3	Series expansion and Fourier analysis
4	Vector calculus: gradient, divergence, curl, and coordinate systems
5	Maxwell's equations and bioelectromagnetism
6	Partial differential equations and Green's function
7	Finite element method
8	Linear system of equations, least square, SVD and regularization
9	Impedance imaging problem
10	Forward and inverse problem in EIT
11	Measurement technique in EIT
12	Image reconstruction algorithm in EIT
13	Forward and inverse problem in MREIT
14	Measurement technique in MREIT
15	Image reconstruction algorithm in MREIT
16	Project demonstration using COMSOL and Matlab