



Course Syllabus: Inverse Problems - ErSE 213

Division	Physical Science and Engineering Division
Course Number	ErSE 213
Course Title	Inverse Problems
Academic Semester	Spring
Academic Year	2018/2019
Semester Start Date	01/27/2019
Semester End Date	05/23/2019
Class Schedule (Days & Time)	10:30 AM - 12:00 PM Tue Thu

Instructor(s)				
Name	Email	Phone	Office Location	Office Hours
Ibrahim Hoteit	ibrahim.Hoteit@kaust.edu.sa	+966128080344		Tuesday 4:00-5:30pm

Teaching Assistant(s)	
Name	Email
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Course Information	
Comprehensive Course Description	Inverse theory refers to the mathematical techniques used to determine the parameters of a model that describes a set of observed data. This course will introduce the principles of the inverse theory with applications to geophysics and other sciences. Both deterministic and statistical viewpoints will be covered. Subjects studied will include topics such as least squares, generalized inverses, regularization, resolution, etc. Techniques for solving nonlinear inverse problems will be covered.
Course Description from Program Guide	This course will introduce the principles of Inverse theory and data assimilation with applications to geophysics and other sciences. Both deterministic and stochastic viewpoints will be covered. Subjects studied will include topics such as least squares, generalized inverses, regularization, Kalman filter, adjoint method, etc. Techniques for solving nonlinear inverse and data assimilation problems will be also covered (200- level for Master students, 300-level for Ph.D. students with more home- and project work).
Goals and Objectives	Be able to formulate and numerically solve an inverse problem.
Required Knowledge	<ul style="list-style-type: none"> - Strong background in linear algebra. - Good understanding of probability theory. - Good skills in multivariate calculus (gradients, Hessians, etc). - Programming skills in Matlab.
Reference Texts	<p>Richard Aster: Parameter Estimation and Inverse Problems. Academic Press, pp. 302, 2005, ISBN: 0-12-065604-3.</p> <p>William Menke: Geophysical Data Analysis: Discrete Inverse Theory. Academic Press, New York, pp. 289, 1989, ISBN-10: 0-12-490921-3.</p>
Method of evaluation	<p>10.00% - Attendance and Participation</p> <p>30.00% - Homework /Assignments</p> <p>20.00% - Research Project</p> <p>40.00% - Midterm exam</p>

Nature of the assignments	Homeworks and Group project.
Course Policies	No late homeworks.
Additional Information	

Tentative Course Schedule

(Time, topic/emphasis & resources)

Week	Lectures	Topic
1	Tue 01/29/2019	Introduction to Inverse Problems
1	Thu 01/31/2019	Introduction to Inverse Problems
2	Tue 02/05/2019	Formulation of Inverse Problems
2	Thu 02/07/2019	Formulation of Inverse Problems
3	Tue 02/12/2019	Solutions of Inverse Problems
3	Thu 02/14/2019	Solutions of Inverse Problems
4	Tue 02/19/2019	Matlab Session
4	Thu 02/21/2019	Matlab Session
5	Tue 02/26/2019	Characterizing and Solving Linear Inverse Problems
5	Thu 02/28/2019	Characterizing and Solving Linear Inverse Problems
6	Tue 03/05/2019	SVD and Rank Deficiency
6	Thu 03/07/2019	SVD and Rank Deficiency
7	Tue 03/12/2019	Matlab Session
7	Thu 03/14/2019	Matlab Session
8	Tue 03/19/2019	Iterative Methods for Solving Linear Inverse Problems
8	Thu 03/21/2019	Iterative Methods for Solving Linear Inverse Problems
9	Tue 03/26/2019	Spring Break
9	Thu 03/28/2019	Spring Break
10	Tue 04/02/2019	Discretizing Continuous Inverse Problems
10	Thu 04/04/2019	Discretizing Continuous Inverse Problems
11	Tue 04/09/2019	Matlab Session
11	Thu 04/11/2019	Matlab Session
12	Tue 04/16/2019	Midterm
12	Thu 04/18/2019	Midterm
13	Tue 04/23/2019	Nonlinear Inverse Problems
13	Thu 04/25/2019	Nonlinear Inverse Problems
14	Tue 04/30/2019	Nonlinear Inverse Problems
14	Thu 05/02/2019	Nonlinear Inverse Problems
15	Tue 05/07/2019	Nonlinear Inverse Problems
15	Thu 05/09/2019	Nonlinear Inverse Problems
16	Tue 05/14/2019	Projects Defense
16	Thu 05/16/2019	Projects Defense
17	Tue 05/21/2019	Final Exam Week
17	Thu 05/23/2019	Final Exam Week

Note

The instructor reserves the right to make changes to this syllabus as necessary.