

Geophysical Inverse Theory (GEOP 5352/GEOL 6315)  
Fall 2007 MWF 9:30-10:20, Room 302

Instructor: Diane Doser, Geology 307, 747-5851, [doser@utep.edu](mailto:doser@utep.edu)

Office Hours: 10:30-11:30 MWF

Text: "Introductory Geophysical Inverse Theory" by Scales, Smith and Treitel. This book is available for free at either [samizdat.mines.edu](http://samizdat.mines.edu) or I have placed a pdf copy of the book at my ftp site: [www.geo.utep.edu/pub/doser/invtheor.pdf](http://www.geo.utep.edu/pub/doser/invtheor.pdf)

Structure: Lecture material for first part of course is designed around homework assignments and readings from book. The second part of the course will emphasize readings from the literature, class discussion and projects.

Course Outline

Introduction (Chapter 1)

Data, errors, probability concepts, distributions (Chapters 2 and 6)

Overdetermined systems, least squares method, covariance, information density, inverse methods (Chapters 4 and 5)

Vector norms (Chapter 4 + readings)

Underdetermined systems, resolution, mixed systems, use of a priori information (Chapter 5)

Model versus observational uncertainty, weighting (Chapters 7 and 9)

Large problems, solution spaces, non-uniqueness (Chapter 11)

Non-linear problems, Monte Carlo method, genetic inversion, simulated annealing, conjugate gradient (Chapter 11 + supplements + readings)

Experiment design

More on uncertainties (Chapter 12)

Logical inversion, current research topics at UTEP (guest lectures and readings)

Class Projects:

Projects will involve collection, reduction and analysis of a real geophysical data set. Hopefully you can select a project that will help further your thesis/dissertation research. A series of presentations (generally through the use of posters) will be given during the class to insure you are making progress.

Discussion of possible project topics: week of September 17

Short (< 2 pgs) proposal related to project: October 1

Project presentations, Part 1, background, theory, data collection plan: October 10

Actual data collection: October 20?

Project presentations, Part 2, data reduction, data and model uncertainties: November 5

Project presentations, Part 3, final results: November 26

Grading:

Homework, readings, class discussion	30%
Project	20%
Test 1 (October 5)	15%
Test 2 (November 7)	15%
Final exam (Thursday, December 12, 10AM to 12:45 PM)	20%

Doctoral Students:

Doctoral students enrolled in this course will be expected to complete additional work for homework and reading assignments. They will be expected to answer more and/or alternate questions on exams. A higher level of performance will also be expected on the project presentations.

**Useful References for Inverse Theory**

An Introduction to Error Analysis, Second Edition, J. R. Taylor, Univ. Science Books, 1997 QA275.T38 1982 (1982 edition)

Geophysical Inverse Theory, R. L. Parker, Princeton University Press, 1994. QC808.5.P37.1994

Geophysical Data Analysis: Discrete Inverse Theory, W. Menke, Academic Press, 1989 QC802.A1M46.1989 and QC802.A1M46.1984 (1984 edition)

Data Reduction and Error Analysis for the Physical Sciences, P. R. Bevington and D.K. Robinson, McGraw Hill, 2003. QA278.B48.2003

Global Optimization Methods in Geophysical Inversion (Advances in Exploration Geophysics, No. 4), M. Sen and P. Stoffa, Society of Exploration Geophysicists, 1995. QE43.S46 1995

Inverse Problem Theory: Methods for Data Fitting and Model Parameter Estimation, A. Tarantola, Elsevier, 1987 and 2005. (\$85) QA371.T36.1987 (1987 edition) and QA371.T357 2005 (2005 edition)

Inversion of Geophysical Data (edited by L.R. Lines), collected reprints, reprint series no. 9, Society of Exploration Geophysicists, 1988. QE43.I58 1988

Statistics and Data Analysis in Geology, J.C. Davis, 2002. QE48.8D38 1986 (1986 edition)

Parameter Estimation and Inverse Problems, R.C. Aster, B. Borchers, and C.H. Thurber, Elsevier, 2005. QA276.8.A78 2005