

GEOL/PHYS 6670 Geophysical Inverse Theory

Fall 2021, 2 credits

Tues 3-4:50 p.m., Benson Rm 455

Professor: Anne Sheehan, Anne.Sheehan@colorado.edu

Office: Benson Rm. 440A, Office phone: (303)492-4597

Office hours: Monday 3-4, Tuesday 11-12. Feel free to email me anytime.

Class web page: on Canvas

Course Objectives: This course will cover the principles of geophysical inverse theory as applied to problems in the Earth Sciences, including both theory and applications. Inverse theory is a set of mathematical techniques used to obtain inferences about the Earth from physical measurements. Examples include tomography, earthquake hypocentral determination, and inversion of geodetic data for models of crustal deformation. The focus of this class will be on formulating and solving inverse problems as well as understanding the nonuniqueness and resolution associated with inversions.

Computing: Most of the assignments will require writing short computer codes. The book comes with Matlab scripts and examples, but you are free to use any programming language for your homeworks (such as Python, Fortran, C, etc.). CU has a full license for Matlab for students, faculty, and staff. Check out <https://oit.colorado.edu/software-hardware/software-catalog/matlab> to get started.

Required Text: *Geophysical Data Analysis: Discrete Inverse Theory, 4th Edition*, William Menke, Academic Press (available in CU bookstore, electronic version available through CU library).

Errata sheet <https://www.ldeo.columbia.edu/users/menke/gdadit4/errata/errata.pdf>

Matlab scripts: <https://www.ldeo.columbia.edu/users/menke/gdadit4/gda/index.htm>

Additional Sources:

Parameter Estimation and Inverse Problems, Aster, Borchers, & Thurber (electronic version available through CU library)

Inverse Problem Theory, A. Tarantola

<http://www.ipgp.jussieu.fr/~tarantola/Files/Professional/Books/InverseProblemTheory.pdf>

Grading:

Homeworks	60%
Term Paper	20%
Term Paper presentation	10%
Peer reviews, in-class presentations	10%

Late Policy: Homework assignments are due on the date specified on the assignment. If you have exceptional circumstances, contact me prior to the due date.

Academic Honesty: Working together is allowed and encouraged, but work turned in for credit must be your own and not copied. List any collaborators and acknowledge help received. Using the internet to find examples and teach yourself material is fine, but copying solutions from anywhere is forbidden.

Tentative Lecture Schedule: GEOL/PHYS 6670, Fall 2021

Week	Textbook Chapter	Topics
1. Aug 24	I, 1	Introduction, linear algebra
2. Aug 31	2	Probability
3. Sep 7	3	Least Squares
4. Sep 14	4	Generalized Inverse
5. Sep 21	6	Nonuniqueness, generalized averages
6. Sep 28	7	Singular value decomposition
7. Oct 5	Handouts	Genetic Algorithms
8. Oct 12	Handouts	Data assimilation
9. Oct 19	9	Nonlinear inverse problems
10. Oct 26	9	Nonlinear inverse problems
11. Nov 2	10	Factor analysis
12. Nov 9	12	Example inverse problems
13. Nov 16		TBA
14. Nov 23 No class	Fall Break	
15. Nov 30		Student presentations
16. Dec 7 (last class)		Student presentations
AGU Dec 13-17		

CU SYLLABUS STATEMENTS

CLASSROOM BEHAVIOR

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on [classroom behavior](#) and the [Student Conduct & Conflict Resolution policies](#).

REQUIREMENTS FOR COVID-19

As a matter of public health and safety due to the pandemic, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements and all public health orders in place to reduce the risk of spreading infectious disease. Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to [Student Conduct and Conflict Resolution](#). For more information, see the policy on [classroom behavior](#) and the [Student Code of Conduct](#). If you require accommodation because a disability prevents you from fulfilling these safety measures, please follow the steps in the “Accommodation for Disabilities” statement on this syllabus.

As of Aug. 13, 2021, CU Boulder has returned to requiring masks in classrooms and laboratories regardless of vaccination status. This requirement is a temporary precaution during the delta surge to supplement CU Boulder’s COVID-19 vaccine requirement. Exemptions include individuals who cannot medically tolerate a face covering, as well as those who are hearing-impaired or otherwise disabled or who are communicating with someone who is hearing-impaired or otherwise disabled and where the ability to see the mouth is essential to communication. If you qualify for a mask-related accommodation, please follow the steps in the “Accommodation for Disabilities” statement on this syllabus. In addition, vaccinated instructional faculty who are engaged in an indoor instructional activity and are separated by at least 6 feet from the nearest person are exempt from wearing masks if they so choose.

Students who have tested positive for COVID-19, have symptoms of COVID-19, or have had close contact with someone who has tested positive for or had symptoms of COVID-19 must stay home. In this class, if you are sick or quarantined, please let me know and I will work with you to make up any material missed. You can attend class remotely if you are sick – just let me know and I’ll provide a Zoom link. Please please stay home if you are sick.

ACCOMMODATION FOR DISABILITIES

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the [Disability Services website](#). Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, see [Temporary Medical Conditions](#) on the Disability Services website.

PREFERRED STUDENT NAMES AND PRONOUNS

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

HONOR CODE

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code academic integrity policy. Violations of the Honor Code may include, but are not limited to: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic

materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu); 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found on the [Honor Code website](#).

SEXUAL MISCONDUCT, DISCRIMINATION, HARASSMENT AND/OR RELATED RETALIATION

The University of Colorado Boulder (CU Boulder) is committed to fostering an inclusive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by or against members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or email cureport@colorado.edu. Information about OIEC, university policies, [reporting options](#), and the campus resources can be found on the [OIEC website](#).

Please know that faculty and graduate instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about their rights, support resources, and reporting options.

RELIGIOUS HOLIDAYS

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, please inform me of any absences or conflicts related to religious observances, and I will work with you to allow you to make up anything missed. See the [campus policy regarding religious observances](#) for full details.