Geology 451/551 – Applied and Environmental Geophysics
Spring 2009

Instructor:	Igor Beresnev, 164 Science I, 4-7529, beresnev@iastate.edu
Class Time:	Lecture: MW 10 – 10:50 Lab: F 10 – 11:50 (or Lecture 10 – 10:50)
Text:	**Main**: *Introduction to Applied Geophysics*, H. R. Burger, A. F. Sheehan, and C. H. Jones, W. W. Norton & Company, 2006, ISBN 0-393-92637-0 **Additional**: *An Introduction to Geophysical Exploration* (3rd edition), P. Kearey, M. Brooks, and I. Hill, Blackwell Science, 2002, ISBN 0-632-04929-4 *Environmental and Engineering Geophysics*, P. V. Sharma, Cambridge University Press, 1997, ISBN 0-521-57632-6
Prerequisites:	Introductory geology and math
Course Fee:	$10 (materials and field trip)

COURSE DESCRIPTION

Philosophy

I start with the premise that all course material should be given in class. That is why I prefer to explain it during actual lecturing at a comfortable pace; in my view, a live blackboard presentation is the way to follow the logic and see how everything happens. Taking notes is encouraged. I also think it is instructive to derive some of the mathematical expressions used, instead of providing them "cut-and-dried"; this helps understand the inner workings and see the beauty of the geophysical techniques. The math is kept at a simple level; only the knowledge of algebra and trigonometry is strictly required.

Using the textbooks

I try to follow the main text by Burger *et al*. The parts of the course that are not covered by this book are based on Kearey *et al*. (the induced-polarization, self-potential, electromagnetic, and magnetotelluric methods) and Sharma (the ground-penetrating radar). However, the design of the course is such that, if notes are taken, the text is not needed. The lectures are self-sufficient.

Problems and labs (all students)

Problem-set assignments will conclude the presentation of the blocks of material. All students will complete four-five problem sets; in addition, graduate students will prepare two-three article reviews (see below). All assignments are due the same day two weeks after they have been handed out; grades will be lowered at a rate of 5 % per day for late returns.

When working on a problem assignment, please keep these simple rules in mind:

(1) Carefully explain all your work and the steps taken in arriving at the final solution. No problem will be considered complete if only the final answer is provided.

(2) Make the final result clearly seen.

During the labs, we will sample some real-world geophysical-interpretation software. When the weather permits, we will conduct a field survey with the electrical-resistivity and seismic-refraction imaging systems, as well as will see how the ground-penetrating radar is working. The field data will be analyzed during the labs. The survey will take place some time in April. The trip will take 4-5 hours and will not necessarily coincide with the class time; we may have to set aside the time outside of the normal class schedule.

Article critiques (graduate students)

The purpose of journal readings is to learn some typical procedures and case histories in shallow geophysics, refine technical-writing skills, and strengthen the ability to view the work of others critically. There will be two-three reviews, alternating with problem-set assignments. The following rules will apply:

(1) Reviews should represent a synopsis of a journal article describing a particular geophysical method. The write-up should include a quintessence of the method and the results obtained by the authors. Please include your thoughts on the quality of the paper, its strengths and weaknesses, or any issues left unresolved. When reading, picture yourself a reviewer asked by a journal editor to provide an expert opinion.

(2) The critiques will be evaluated according to *comprehension, layout, and style*. The average of three marks will make the assignment grade.

(3) The reviews are to be limited to two double-spaced pages, excluding figures. Try to be concise and write to-the-point. *Important:* sometimes students fill their reviews with excerpts pulled directly from the article. This is unacceptable and will significantly lower the grade. Please write in your own words, reflecting *your* understanding.

(4) Reviews will be due the same day two weeks later. The same grade-reduction rule as for the problem sets will apply to late returns.

Written exams

There will be two mid-term exams and one final exam. The exams will include questions requiring short answers and problems; the problems will be similar to those given as homework and will cover only the lecture material. All exams require calculator and paper.

Final grading

	451	**551**
Exams (average)	60 %	50 %
Problems (average)	40 %	30 %
Article reviews (average)		20 %

Schedule

Date	Topic
Week 1 / January 12-16	Introduction. Goals of exploration geophysics. Elastic properties of rocks. Seismic waves
Week 2 / January 19-23	Seismic-wave propagation in layered media. Energy sources and seismic equipment
Week 3 / January 26-30	Seismic refraction. Refraction methods

	Lab: Preparation of input data for automated refraction interpretation
Week 4 / February 2-6	Refraction interpretation Lab: Refraction travel-time curves. Computer package SIP
Week 5 / February 9-13	Seismic-reflection principles Lab: Refraction interpretation using SIP
Week 6 / February 16-20	Seismic-reflection applications **Exam 1**
Week 7 / February 23-27	Basic electricity. Electric-current flow in the earth. Electrical properties of rock Lab: forward and inverse seismic problems using computer program REFLECT
Week 8 / March 2-6	Resistivity surveys. Resistivity patterns over various subsurface geometries
Week 9 / March 9-13	Interpretation of resistivity curves. Field procedures. Induced- and spontaneous-polarization methods Lab: Inverse problems. Interpretation by curve matching. Resistivity-modeling computer package RINVERT

March 16-20 **Spring Break**

Week 10 / March 23-27	Electromagnetic (EM) principles. EM surveys and interpretation Lab: Field work with portable seismic- and resistivity-imaging systems StrataView and ResiStar
Week 11 / March 30-April 3	Ground penetrating radar (GPR), including work with the radar device **Exam 2**
Week 12 / April 6-10	Gravity field and its measurement Lab: Inversion of collected seismic-refraction and resistivity data using computer programs SIP and RES2DINV. Obtaining a combined subsurface image
Week 13 / April 13-17	Gravity effects of simple geometric shapes. Interpretation of gravity anomalies Lab: forward and inverse gravity problems using computer package GeoModel
Week 14 / April 20-24	Magnetic field and its measurement
Week 15 / April 27-May 1	Magnetic effects of simple geometric shapes. Interpretation of magnetic anomalies

Week of May 4-8	**Final Exam**