

## GEOL 5660/6660: Applied Geophysics Syllabus

*Spring 2020*

*Lecture: MWF 8:30–9:20 AM, Geology 310*

*Lab: Tue 3:00–5:45 PM, Geology 310*

**Instructor: Ravi Kanda**

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**Office Hours:** 9:30–10:30 MWF (or by appt)

**TA: Robert McDermott**

Grad Offices – Geology 402

**Office Hours:** By appt;

[rgmcdermott@aggiemail.usu.edu](mailto:rgmcdermott@aggiemail.usu.edu)

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### COURSE DESCRIPTION

Most of what we know about the Earth's interior derives from geophysics. It is the primary tool for exploration in the oil and mining industries, and it is also widely used to characterize the subsurface for environmental, engineering and hydrologic investigations. Regardless of what career path you may choose to follow within the solid Earth sciences, you will almost certainly find yourself somewhere down the line looking at a geophysical image and wondering what exactly it is that you're seeing.

This course introduces the field of geophysics and several of its industrial and academic applications. “Geophysics” actually encompasses an incredibly diverse array of math- and physics-based tools for understanding, modeling and imaging Earth processes and properties, but the objectives for this course focus specifically on (1) cursory knowledge of the most widely-used tools for imaging structure of the Earth's shallow interior, (2) a basic understanding of how we estimate in situ material properties such as mass density, seismic velocity and electrical conductivity, and (3) an understanding of how we infer from these more desirable quantities such as rock lithology and pore fluid content.

The course includes a weekly lab in which we will roll up our sleeves and get our hands dirty with geophysical data, some of which we will collect ourselves. Data for the semester project will be collected over the course of a couple of field-research afternoons (note that on these days we will get an early start and use the entire afternoon of Tuesday lab).

Attendance of the field data collection exercises is required, and costs are included in your course fee. Course fees also enable us to maintain & repair equipment that we use in our fieldwork and purchase consumables.

**Text (Suggested):** *Introduction to Applied Geophysics: Exploring the Shallow Subsurface* – Burger, Sheehan & Jones, 2006.

#### **Grading:**

**COVID-19 UPDATES: Grades will reflect your performance on Quizzes (300 pts), Labs & Homework Sets (500 pts), and Final Exam (200 pts).** ~~Quizzes (150 pts), Labs & Homework Sets (250 pts), Final Exam (200 pts), participation in the field exercises (100 pts), and a Final Project (300 pts).~~ GEO 6660 students will submit an additional Research Report on a related Semester Project (200 pts). This project must use at least one of the geophysical techniques that are the topic of this course, and apply the techniques to real data – and ideally, be related in some manner to the student's thesis topic.

## SCHEDULE & TOPICS (approximate)

### Week #

### JANUARY

- 1 Introduction to geophysics; introduction to elastic waves and the wave equation
- 2 Seismic Methods: Instrumentation, particle motions, body and surface waves; Snell's Law and Huygen's principle (rays and wavefronts)  
**\*\*\* Mon 20 Jan: No Class (MLK Holiday)**
- 3 Mode conversions: Reflection and refraction. Seismic amplitudes. Zoeppritz equations.
- 4 Refraction seismic method. Refraction data processing & interpretation.

### FEBRUARY

- 5 More on refraction. Reflection method.  $x^2-t^2$  and Dix equation.
- 6 More on reflection method. NMO. Practical considerations and data processing.  
**\*\*\* Mon 17 Feb: No Class (Presidents' Day)**
- 7 Seismic reflection interpretation; strengths and weaknesses. Wrap up seismic reflection data processing.
- 8 Ground Penetrating Radar (GPR).

### MARCH

- \*\*\* Mon 02 Mar – Fri 06 Mar: No Class (SPRING BREAK)**
- 9 GPS location. Potential field methods: Gravity theory, instrumentation, corrections.
  - 10 Potential field methods: Gravity processing and interpretation. Magnetism theory and instrumentation.
  - 11 Potential field methods: Magnetism processing and interpretation.
  - 12 Electrical methods: DC resistivity, induced potential.

### APRIL

- 13 Electrical methods: Magnetotellurics, self-potential.
- 14 Wireline logging.
- 15 Preparing the final field report; wrap-up of geophysical methods.

**\*\*\* FINAL EXAM: Mon, Apr 27, 7:30-9:20 AM in Geology 310**

### Final Course Projects:

- Written reports on the shared grad/undergrad course project, using the data we collect on field lab dates, will be due on the final day of class: Tue 21 April, at 5 PM.
- Oral presentation on graduate course projects will be given during the final lab period (Tues 21 Apr).
- Written report on the graduate project will be due on the last day of finals week: Wed 29 April, at 5pm.

*All web materials, including lectures and lab assignments, updated scheduling, course announcements, and data sets will be made available at:*

[https://ravi-vs-kanda.github.io/courses/Geo5560\\_ApplGeoph/index.html](https://ravi-vs-kanda.github.io/courses/Geo5560_ApplGeoph/index.html)

**Late Assignment Policy:**

All assignments are due at the date & time specified; no late assignments will be accepted. If you are not finished, just hand in what you have. I will not accept illness as an excuse for late assignments (except under the very direst of circumstances).

**Other Important Dates and policies**

Please note. The USU catalog, registrar's office, and other related websites have all the relevant information regarding USU policies and procedures. See:

<http://www.usu.edu/registrar/htm/registration/dates>

<http://catalog.usu.edu/index.php>

**Notice to veterans and students with disabilities:** Students with ADA-documented physical, sensory, emotional or medical impairments may be eligible for reasonable accommodations. Veterans may also be eligible for services. All accommodations are coordinated through the Disability Resource Center (DRC) in Room 101 of the University Inn, (435) 797-2444 voice, (435) 797-0740 TTY, or toll free at 1-800-259-2966. Please contact the DRC as early in the semester as possible. Alternate format materials (Braille, large print or digital) may be made available with advance notice.

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