Introduction to Geophysics

Geow-B402-V2

Instructor Info

Reinhard Drews

Office Hrs: on demand.

GUZ 3M07/3U03/3F03

Website

reinhard.drews@uni-tuebingen.de

Course Info

Prereq: None

Tues & Thurs

16:15-18.00

Online

Field Exercises

In sub-groups of 6

Three field exercises with individual timing for groups. It will be approximately six hours of field work per exercise.

Outside.

Add. Instructors

Prof. P. Dietrich

Office Hrs: On demand

UFZ, Leipzig

Ershadi/Naumann/Vinson

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Overview

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This course provides a broad overview in applied geophysics with a focus on the most common sub-surface imaging techniques: gravimetry, magnetics, geoelectrics, electromagnetic induction, ground-penetrating radar and seismics. We will discuss applications in industry as well as for general scientific questions in the geo- and environmental sciences.

Everything is subject to change with news University regulations regarding the pandemic, but at this stage I anticipate a large in-person component.

Lecture Format

The lecture is accompanied with three mandatory, hands-on field exercises that will be conducted in small groups. The field measurements take approximately six hours and will be concluded by a joint group report. The lecture format contains frontal lectures on Tuesdays in 3M07, group work on experimental & theoretical exercises on Thursdays in 3U03 and 3F03 and online videos.

Learning Goals

You should get a broad overview for a number of geophysical methods imaging the sub-surface. You should understand the underlying physical principles, which will enable you to go deeper into specific methods that you may encounter later on. Most importantly you should learn to think straightforwardly, to ask the right questions, and to apply quantitative mathematical methods in problem solving.

In-class exercises

Exercises are an important part of the Geophysics lecture. They will treat some aspects of the lecture in more detail, but also cover new ground. We expect that you work on the exercises at home and we will discuss questions and solutions interactively together (typically Thursdays). The joint meetings will start with randomly chosen students presenting their approach. It is ok if the full solution is not available at this stage and there will be no interrogation. However, please don't show up unprepared because this will inevitably be awkward.

Field exercises

We will conduct field exercises for magnetics, geoelectrics and seismics. This is your maybe once-in-a-lifetime chance to work with professional geophysical equipment. The practical part of the exercises will typically take about six hours. Exercises are mandatory and absence is only permissible with a substantiated excuse approved by the instructor before the exercise takes place. The exercise will then need to be repeated another day. Don't miss the submission deadline of your group reports communicated by the instructor. If you fail, you will have a chance to revise the report.

Exercises	Location	Time Frame
Magnetics	Tübingen Morgenstelle	22-28.05 2022
Geoelectrics	Tübingen Kilchberg	08-13.06 2022
Seismics	Tübingen Lauswiesen	05-12.07.2022

Course organisation

Sign-up is required both on ALMA and ILIAS. All communication will be handled via Ilias, including video ressources, sign up for field exercises and a forum for questions pertaining to the exercises sheets. The course is open to a maximum amount of 70 students, preference is given to those for which this course is mandatory.

FAQs

Is this course hard?

Not sure. Rumor has it that the workload is comparatively high. All of you took quite difficult math classes and we will use these, e.g., including differentiation, integration, some linear algebra (e.g. vector fields). We will also brush on computational techniques. Exam relevant content will stick to a BSc level, but hopefully you will also be prepared for higher MSc courses.

How to pass the exam?

Maybe don't google every question during the term. Other than that may the force be with you.

Why do I have to suffer through this?

Even if you don't like geophysics you will learn a mathematical & quantitative approach that people find useful later on. Because we know you don't trust us we made this course mandatory.

Can I call myself a geophysicist after this course ?

This might be a stretch, but on the other hand this is not a protected term. Go for it! (Advises you career-coach).

Material

Books in English

- Luce & Icelle: Introduction to Earth Sciences: A Physics Approach , available online through UB (https://doi.org/10.1142/11631).
- Florsch & Muhlach: *"Everyday Applied Geophysics 1/2"*, (Elsevier).
- Telford: *"Applied Geophysics"*, ca. 750p.
- Sharma: *"Environmental and Engineering Geophysics"*, ca. 470 p. (Cambridge University Press)
- Griffiths, King: *"Applied Geophysics for Geologists & Engineers"*, ca. 220 p. (Pergamon Press)
- Lowrie: *"Fundamentals of Geophysics"*, ca. 340 p. (Cambridge University Press)

Books in German

- Bender: *"Angewandte Geowissenschaften Bd.II: Methoden der Angewandten Geophysik und mathematische Verfahren in d. Geowissenschaften"*, ca. 750p.
- Militzer, Weber: *"Angewandte Geophysik"*, 3 Bände.
- Clauser: *"Einführung in die Geophysik: Globale physikalische Felder und Prozesse in der Erde"*, ca. 420p.
- Clauser: *"Grundlagen der angewandten Geophysik - Seismik, Gravimetrie: Globale physikalische Felder und Prozesse in der Erde"*, ca. 370p.
- Knödel, Krummel, Lange: *"Geophysik. Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) - Handbuch zur Erkundung des Untergrundes von Deponien und Altlasten"*, Band 3.

Some books are available as online resource at UT. Review journal articles will be provided on Ilias.

Expectations for the exam

The written exam will contain a number of basic questions probing your knowledge of the specific topics covered in class. You can answer those typically in a few sentences. This alone is in most cases enough to pass. In order to obtain higher grades, you will need to solve some problems using the level of math that we practiced during the term. For top grades you will need to answer some questions where knowledge needs to be transferred to a problem set that we did not cover in class. Unsurprisingly, the best exam preparation is usually to solve the exercise sheets independently, and to actively participate in the lecture & report writing. My goal is that the large majority of you passes the exam.

Grading Scheme

20%	Average grade of three reports.
80%	Written exam at the end of the term.

Reports will be graded and you have to pass all of them in order to qualify for the exam. If your grade of the exam is better than the average grade from all reports, *only* the exam will count. Grades will follow the standard scale, scaling is at my discretion.

Detailed Class Schedule

Part 1: Introduction & Gravimetry

Grav-01	19.04 (Remote)	Pre-recorded video lecture
Grav-02	21.04 (3U03/3F03)	In-person introduction & exercises
Grav-03	26.04 (3M07)	In-person lecture
Grav-04	28.04 (3U03/3F03)	In-person exercises

Broad Class Schedule

Part 1: Introduction & Gravimetry

Weeks 1-2	• Course Outline • Introduction • Earth's Gravitational Field and Potential • Reduction (Free-Air and Bouger Anomalies) • Applications	In-class exercises

Part 2: Magnetics

Weeks 4-6	• Magnetic Fundamentals • The Earth's Magnetic Field • Magnetic Measurements • Types of magnetism • Examples	In-class exercises Applied exercises Report writing

Part 3: Self-Potential, Geoelectrics and Induced Polarization

Weeks 5-9	• Origin and measurement of self-potential • Vertical & Horizontal electrical sounding • IP (time domain) • Slingram Method	In-class exercises Applied exercises Report writing

Part 4: Seismics

Weeks 10-13	• Seimic waves & raypaths • Refraction seimics • Reflection Seismics • Seismology • Applications	In-class exercises Applied excercises Report writing

Part 5: Electromagnetics

Weeks 14	• Electromagnetics waves & raypaths • Ground-Penetrating Radar • Signal Processing	In-class exercises