SIO103 Introduction to Geophysics - Fall 2021

All class materials will be posted to the SIO103 Canvas Home

Instructor: Dr. Ross Parnell-Turner
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Lectures: Mondays/Wednesdays 11:00am–12:20pm
Problem session: Mondays 12:30pm–1:20pm
Location: Room 303, Munk Lab, 8800 Biological Grade (SIO Campus)

Teaching Assistant: Margaret Morris
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Course Description

An introduction to the structure and composition of the solid Earth. Topics include seismology, the gravity and magnetic fields, high-pressure geophysics, and concepts in geodynamics. Emphasis is on global geophysics, i.e., on the structure and evolution of the planet.

Learning Outcomes

1. Recall the definition of terms associated with geophysical theory, covering topics including seismology, heatflow, gravity, and geomagnetism;
2. Summarize how geophysical methods can be used to investigate the physical properties and processes within Earth;
3. Describe the principles underlying geophysical data collection techniques;
4. Use geophysical theory and governing equations to perform simple analysis and interpretation of example data;
5. Solve quantitative problems relating to geophysical investigation of Earth's interior;
6. Synthesize the results of geophysical research published in the peer-reviewed literature

Student hours

Ross: after lectures and problem sessions on outdoor Munk patio or zoom; email for an appointment
Margaret: after problem sessions and on Fridays (time TBC), or email for an appointment
Please include 'SIO103' in the subject line of emails

Class Format

This class is planned to be in-person, with minimal online instruction.
Lectures: Two per week, in Munk 303
Problem session: One per week, in Munk 303
Homework: One problem set per week, answers submitted via Canvas (see course Calendar)
Essay: 2000-word review paper, due in last class (Wednesday December 1st)
Mid-term: tentatively Monday November 1st (open book / take-home)
Final: tentatively Tuesday December 7th (in person)

Course Calendar

							Problem Sets		
Week	Date	Day	L	Theme	Topic	Notes	Out	Help	Due
1	27-Sep	M	L1	*Intro to Planet Earth*	Overview of class; origin of Earth and Solar System		PS1	PS1	
	29-Sep	W	L2		Earth's deep interior, pressure vs. radius, convection				
2	4-Oct	M	L3	*Seismology Theory*	Seismology intro, Linear elasticity, wave equation		PS2	PS2	PS1
	6-Oct	W	L4		Solutions to wave equation, ray theory intro, tau(p)				
3	11-Oct	M	L5	*Global Seismology*	Travel time and tau(p) curves	Perception survey	PS3	PS3	PS2
	13-Oct	W	L6		Refraction seismology, travel times in complex structures				
4	18-Oct	M	L7	*Earth's Interior*	Earthquake location, ray nomenclature; Tour of Earth 1		PS4	PS4	PS3
	20-Oct	W	L8		Tour of Earth 2, receiver functions, tomography	Guest seminar: Fan			
5	25-Oct	M	L9	*Earthquake Seismology*	Earthquake sources and magnitudes, focal mechanisms			InSAR	PS4
	27-Oct	W	L10		MidTerm Review				
6	1-Nov	M			**MidTerm exam, take-home**				
	3-Nov	W	L11	*Heatflow*	Heatflow	Guest seminar: Morris	PS5		
7	8-Nov	M	L12	*Gravity*	Gravity and the shape of the Earth (Margaret)			PS5	
	10-Nov	W	L13		Geoid and gravity anomalies	Essay drafts due	PS6		PS5
8	15-Nov	M	L14	*Earth in Motion*	Moments of inertia, rotational dynamics			PS6	
	17-Nov	W	L15		Earth's magnetic field	Guest seminar: Morzfeld	PS7		PS6
9	22-Nov	M	L16	*Geomagnetism*	Dynamos, secular variation			PS7	
	24-Nov	W	L17		Paleomagnetism and plate tectonics				PS7
10	29-Nov	M	L18		Electromagnetic methods			Essay	
	1-Dec	W	L19		Class Review	Class Evaluation			Essay
Finals	7-Dec	Tues			**Final exam, 11.30am-2.30pm Tues December 7th**				

Recommended Books

The main reference for this class is the comprehensive collection of notes posted on Canvas. For additional reading see:
Fowler, C. M. R., *The Solid Earth: An Introduction to Global Geophysics*, 2004. Cambridge.
Shearer, P. M., *Introduction to Seismology*, 2009. Cambridge.

Grading

Final exam: 40%
Mid-term exam: 30%
Essay: 20%
Problem sets: 10%

Mid-term and Final exams

Exam questions will broadly follow the same format as those in the problem sheets, and the mid-term will be take home / open-book. There will be reviews before the mid-term and final exams to go over what you need to know, plus we'll provide a 'cheat sheet' which will contain most of the useful equations.

Essay assignment

You will write a review essay to be submitted in the final week of class, with the title chosen from the list given in Week 1. You may choose your own topic and title, but it must be approved by Ross first. Initial drafts will be accepted for comments and suggestions for improvements anytime up until Week 7 (Wednesday November 10th), and will be returned to you to aid your final draft. Essays should be fully referenced, up to 2000 words long (including figure captions, but not including title or references), and include up to four figures. They should be typed in 12-pt size font, with citations using the author-date format, and provided in pdf format. The grading rubric will be provided.

Problem sets

Problem sheets will be published online via Canvas every week and answers are due one week later. Please submit your answers via Canvas. The easiest method is to hand-write your answers and scan them to a pdf using an app on your phone such as GeniusScan. Photos of hand-written notes are not a good option. If you want to type up your answers (and make them look like the question sheets), try using a program such as LaTeX or Overleaf; this option can be rewarding, but also very time consuming.

There is a problem session on Mondays where we will discuss the problem sheets and any other things that crop up, and attendance is highly recommended. Note that *you* will be tackling the problems in the problem session.

You will likely need to spend about 8 hours each week to do a good job on each problem set. The instructors are happy to provide help if needed. A solution sheet will be handed out in the session that follows the homework due date, which means that we can not accept late problem sets.

Tips on doing problem sets

When you first see a problem set, nearly every question may seem difficult. You will eventually adjust and recognize that, for most people, this is a typical starting point. After using whatever resources you have (notes from lectures, course notes, textbooks, etc) you will get some idea of how to do the problem, but sometimes you will get stuck. Some weeks you will get stuck on several problems and this is both totally natural and expected. The key to success is to start early. The earlier you identify which problems you are getting stuck on, the more time you will have to ensure you get the problem set completed.

Note that it is often helpful to draw a picture, particularly if there is a three-dimensional aspect to the problem. You should also write down the relevant governing equations and any other information you will need (like boundary conditions – don't worry we'll explain this). While working through the solution, do things in a general way first using symbols and wait until you have a final algebraic expression before substituting in any numerical values. Lastly, after you have

worked out the solution for each problem, ask yourself, does the answer make sense? Does the answer have the order of magnitude you would have expected? Does it have the right units?

When you write out your final version, make sure to include words and explanation along with the mathematical steps. Leave enough space for the instructors to give you comments and show you where you may have made a mistake. Remember this is not a contest to see who can complete the problem set using the least amount of paper. The final write up for each problem will reinforce your understanding, and the neater presentation will be useful when you go to study for the exams.

Academic Integrity

Academic Integrity is expected of everyone at UC San Diego. This means that you must be honest, fair, responsible, respectful, and trustworthy in all of your actions. Lying, cheating or any other forms of dishonesty will not be tolerated because they undermine learning and the University's ability to certify students' knowledge and abilities. Thus, any attempt to get, or help another get, a grade by cheating, lying or dishonesty will be reported to the Academic Integrity Office and will result sanctions. Sanctions can include an F in this class and suspension or dismissal from the University. So, think carefully before you act by asking yourself: a) is what I'm about to do or submit for credit an honest, fair, respectful, responsible and trustworthy representation of my knowledge and abilities at this time and, b) would my instructor approve of my action? You are ultimately the only person responsible for your behavior. So, if you are unsure, don't ask a friend; ask your instructor, instructional assistant, or the Academic Integrity Office. You can learn more about academic integrity at academicintegrity.ucsd.edu (source: Academic Integrity Office, 2018).

COVID-19 Health Expectations and Best Practices

Public health is a collective effort. Keeping the UC San Diego community healthy takes all of us following campus safety requirements to help prevent infection. You are also expected to follow university public health requirements and pursue personal protection practices to protect yourself and the others around you. These include:

- Participating in the university's daily screening process, by completing the Daily Symptom Screener
- Participating in the university's COVID-19 testing program
- Wear a well-fitting mask that covers your nose and mouth **at all times**.
- Monitor potential exposures and comply with contact tracing efforts.
- Stay home if you're feeling ill.
- Contact us if impacted by COVID-19, we can help you continue to participate in class