SIO103 Introduction to Geophysics - Fall 2023

All class materials will be posted to the SIO103 Canvas Home

Instructor: Dr. Ross Parnell-Turner
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Lectures: Tuesdays/Thursdays 12:00pm–1:20pm
Problem session: Thursdays 1:30pm–2:20pm
Location: Room 4301; top floor, Revelle Building (SIO Campus)

Teaching Assistant: TBA
Email: TBA

Course Description

An introduction to the structure and composition of the solid Earth. Topics include seismology, 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

Drop-in hours

Ross: after lectures and problem sessions on outdoor Revelle patio or Zoom; email for an appointment
TA: after problem sessions and on another day (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 Revelle 4301
Problem help session: One per week, in Revelle 4301
Homework: One problem set per week, answers submitted via Canvas on Tuesdays
Essay: 2000-word review paper, due in final week of class (Tuesday December 5th)
Mid-term: Tuesday October 31st (open book / take-home)
Final: Friday December 15th (open book / take-home)

Course Calendar

Week	Date	Day	L	Theme	Topic	Notes	Problem Sets Out	Help	Due
1	28-Sep	Th	L1	*Intro to Earth*	Overview of class; origin of Earth and Solar System				
2	3-Oct	Tues	L2	*Seismology Theory*	Seismology intro, Linear elasticity, wave equation		1		
	5-Oct	Th	L3		Solutions to wave equation, ray theory intro, $\tau(p)$			1	
3	10-Oct	Tues	L4	*Global Seismology*	Travel time and tau(p) curves	Perception survey	2		1
	12-Oct	Th	L5		Refraction seismology, travel times in complex structures			2	
4	17-Oct	Tues	L6	*Earth's Interior*	Earthquake location, ray nomenclature; Tour of Earth 1	Essay titles due	3		2
	19-Oct	Th	L7		Tour of Earth 2, receiver functions, tomography	Guest seminar: TBC		3	
5	24-Oct	Tues	L8	*Earthquakes*	Earthquake sources and magnitudes, focal mechanisms				3
	26-Oct	Th	L9		InSAR, MidTerm Review				
6	31-Oct	Tues		**MidTerm exam (take home)**			4		
	2-Nov	Th	L10	*Earth's Interior*	Pressure vs. radius, convection			4	
7	7-Nov	Tues	L11	*Heatflow & Gravity*	Heatflow	Essay first drafts due	5		4
	9-Nov	Th	L12		Gravity and the shape of the Earth	Guest Seminar: TBC		5	
8	14-Nov	Tues	L13	*Earth in Motion*	Geoid and gravity anomalies	Essay feedback	6		5
	16-Nov	Th	L14		Moments of inertia, rotational dynamics			6	
9	21-Nov	Tues	L15	*Geomagnetism*	Earth's magnetic field		7		6
	THANKSGIVING				NO CLASS			7	
10	28-Nov	Tues	L16	*Plate Tectonics*	Dynamos, secular variation				7
	30-Nov	Th	L17		Paleomagnetism and plate tectonics				
11	5-Dec	Tues	L18	*Electromagnetism*	Electromagnetic methods	Final essays due			
	7-Dec	Th	L19		Class Review				
F				**Final exam (take home), 8am-4pm Friday December 15th**					

Recommended textbooks

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 exams 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 with the title chosen from the list given in Week 1. The objective is to develop your scientific writing skills, with opportunities for feedback and improvement through the quarter. Essay timeline:

- Titles due: Tuesday October 17
- First drafts due: Tuesday November 7
- First draft feedback: Tuesday November 14
- Final essay due: Tuesday December 5

You may choose your own topic and title (i.e., one other than from the list), but it must be approved by Ross first. Initial drafts will be accepted for comments and suggestions for improvements anytime up until Tuesday November 7), and will be returned to you with suggestions to help write the final version. 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 can be found on Canvas.

Problem sets

Problem sheets will be published online via Canvas each week and answers are due on Tuesdays. 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 help session on Thursdays 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).

Open Book Policy

'Open books/notes' does not mean that you can get other people, whether those people are friends, family or some 'tutor' or 'freelancer' on a website, or artificial intelligence to answer the exam questions for you. Do not use websites and tools (e.g., Chegg, Coursehero, ChatGPT, CoPilot) that will do your work for you. Such actions will undermine honesty and fairness, violate the my trust and that of your peers, and may result in an academic integrity violation and a report to the Academic Integrity Office. Remember, I care about what you know and can do, if you're learning; I don't care what someone else or something knows or can do. If you're not sure about which tools are appropriate for you to use, please ask.