SIO103 Introduction to Geophysics - Fall 2020

This class is online-only: SIO103 Canvas Home

Instructor: Ross Parnell-Turner
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Lectures: Mondays/Wednesdays 12:30–1:50pm (via Zoom)
Problem session: Wednesdays 2:00–2:50pm (via Zoom)

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

SIO103 Zoom room
Ross: after lectures and problem sessions, or 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 **online-only**, with no in-person instruction.
Lectures: Two per week, via Zoom
Problem session: One per week, via Zoom
Homework: One problem set per week, answers submitted via Canvas are due on Mondays
Essay: 2000-word review paper, due in last class (Dec 9)
Mid-term: tentatively Nov 2–4 (open book / take-home)
Final: tentatively Dec 15–17 (open book / take-home)

Course Calendar

Week	Date	Day	L	Theme	Topic	Notes	PsOut	PsHelp	PsDue
1	5-Oct	M	L1	*Earth's Interior*	Overview of class; Origin of Earth and Solar System		**PS1**		
	7-Oct	W	L2		Structure of the core and mantle			PS1	
2	12-Oct	M	L3	*Seismology Theory*	Linear elasticity, wave equation		**PS2**		PS1
	14-Oct	W	L4		Ray theory intro, tau(p)			PS2	
3	19-Oct	M	L5	*Global Seismology*	Refraction, travel times, global phases	Perception survey	**PS3**		PS2
	21-Oct	W	L6		Global body waves, ray nomenclature, normal modes			PS3	
4	26-Oct	M	L7	*Earthquakes*	Earth inner structure, receiver functions, tomography		**PS4**		PS3
	28-Oct	W	L8		Earthquake scaling laws, focal mechanisms, InSAR	Guest: W. Fan		PS4	
5	2-Nov	M	L9	*Midterm*	Midterm Review				PS4
	4-Nov	W			Midterm	Take-home			
6	9-Nov	M	L10	*Heatflow*	Heat Flow, plate cooling	Essay drafts open	**PS5**		
	11-Nov	W	L11		Life Cycle of an Oceanic Plate	Guest: M. Morris		PS5	
7	16-Nov	M	L12	*Gravity*	Gravity and the shape of the Earth		**PS6**		PS5
	18-Nov	W	L13		Gravity and geoid anomalies	Essay drafts close		PS6	
8	23-Nov	M	L14	*Earth in Motion*	Moments of inertia, geoid, rotational dynamics		**PS7**		PS6
	25-Nov	W	L15		Earth's main magnetic field			PS7	
9	30-Nov	M	L16	*Geomagnetism*	Dynamos, secular variation	Guest: C. Constable			PS7
	2-Dec	W	L17		Paleomagnetism and plate tectonics				
10	7-Dec	M	L18	*Class Review*	Electromagnetic Methods				
	9-Dec	W	L19		Class Review and Essays Due	Class Evaluation			Essay
Finals	17-Dec	M			Final	Take-home			

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 will be 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 title, but it must be approved by Ross first. Initial drafts will be accepted for comments and suggestions for improvements anytime in Weeks 6 or 7 (i.e. between Nov 9 and Nov 18), 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 (on Mondays). 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 Wednesdays 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 so we recommend you make an attempt at the problem set before Wednesday.

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 on the Wednesday 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 3D 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.

Working in Groups

You are welcome to work in teams to figure out the solutions, but the goal is to have everyone understand the solutions at an individual level so please ensure that the teamwork doesn't do any of your peers a disservice in this way - because it will hurt them when it comes to exam time. In any case, the homeworks should be written up individually, even if it took help from the entire group to find the solution.