Syllabus – Global Seismology

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Prerequisites: Physics II; Calculus III. Along the way, we'll also delve into complex numbers, differential equations, tensor and matrix algebra, Unix/Linux, shell scripting, and MATLAB.

Description: Quantitative introduction to seismology; basics of seismic data analysis; fundamentals of wave propagation; earthquakes; structure of the Earth.

Learning Objectives:

- Understand the basic theory behind elastic wave propagation in the Earth.
- Gain insight into how seismic observations can constrain the structure, composition, and temperature of the Earth.
- Practical experience in manipulating seismic data and basic computational skills.

Textbook:

Stein, S. and M. Wysession (2002), *An Introduction to Seismology, Earthquakes, and Earth Structure*, Blackwell Publishing.

Go here for online information about the text: http://epscx.wustl.edu/seismology/book/

Optional Textbook:

Shearer, P. (2009), *Introduction to Seismology*, 2nd Edition, Cambridge University Press.

Peter Shearer's home page: http://mahi.ucsd.edu/shearer/index.html
Shearer's page for his book: http://mahi.ucsd.edu/shearer/book.html
Shearer's known book typos/mistakes: http://mahi.ucsd.edu/shearer/errata.html

Class presentations: There will be two class presentations:
1) Presentation 1: Pick an earthquake that happened during the year and discuss it. Try and get data from it to show us.
2) Presentation 2: Pick a scientific paper published in a peer-reviewed journal and discuss it.

Lab Final Project: You will divide into two (2) groups, download seismic data, process it, and perform a type of seismic analysis on it.

Grading:

Homework:	25%
Two Presentations (total):	10%
Two midterm tests (total):	20%
Lab Exercises:	20%
Lab Final Project:	10%
Final exam:	15%

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1. General Course Layout, Policies, Goals, Expectations

1.1 General information

This is an upper division course that introduces the main principles of seismology. The course is structured somewhat traditionally: we'll follow a textbook, have regular homework, lectures, a midterm and final exam. In addition, we'll discuss recent research in the field of seismology as well as recent earthquakes that happen throughout the term.

Our lab will be focused on practical teleseismic research. We'll first start with a few exercises devoted to learning your way around in a Linux/Unix environment, then download some data, and move into some basic data processing. Your final lab project will be to take real data and analyze it.

Seismology is a fairly young field, and understanding earthquakes and Earth's interior is still a very active area of research. The Stein and Wysession textbook does a nice job covering the basic principles at a level appropriate for our class (and in some cases, beyond). We'll fill in the gaps with modern ideas and results from the literature (in some cases augmenting from other textbooks). Each lecture will have a PDF associated with it, where I work through the math and explain some of the steps that the book skips. I highly recommend you read this and the book.

This field requires knowledge of some math to be able to work through the concepts. We'll review math principles, as needed, in order to facilitate understanding the concepts. With these basics under our belt, we'll address the pressing questions pursued today, from understanding how to decipher the Earth's internal structure to earthquake prediction, from internal dynamical processes inferred from seismology to monitoring nuclear testing with seismic data, and so on.

1.2 Homework

- We will have fairly regular homework assignments.
- There may be a few different homework themes: problem sets, literature review, earthquakes.
- Work together to make sure you get the homework correct. I don't mind helping you if you run into problems—my goal is for all of you to get 100% on the homework.

1.3 Class presentations

- Presentations will be group projects, with 2-3 people per group. No solo projects allowed without special permission.
- Each presentation will be a 10-15 minute slideshow. No paper is required.
- Presentation 1: Students will present on recent earthquakes that happen during the term.
- Presentation 2: Students will present on a professional peer-reviewed seismology paper related to their interests. Check with me to make sure the paper is suitable.
- Some thoughts on earthquake presentations:
    - What tectonic setting did this earthquake occur in?

  - What stress caused this?
  - Show a map of the fault.
  - Did the earthquake cause any damage?
  - Show a seismogram.
  - Was the earthquake unexpected?
  - What is the intensity recorded?
- Some thoughts on the paper presentations:
  - Understand what the Data, Methods, Results, Discussion sections of a paper mean, and format your presentation in this manner.
  - Explain why the paper is interesting to you.
  - Explain why the paper is important science (or is not important science)—tell us what scientific problem they are trying to solve.
  - Tell us what technique they used to shed light on the aforementioned scientific problem.
  - Tell us what the results are.
  - What do the results mean (the Discussion section of the paper)?
  - Do they solve the problem the project was trying to address? Do they shed light on the problem? What could be done to further resolve the issue?

1.5 Labs

Final Lab Project: Break up into a group of 2-3 and analyze real data using the technique of your choice. Give me a 5 page paper (including figures and figure captions), discussing: 1) why you chose to analyze this area; 2) problems or surprises you encountered; 3) description of your method; 4) results; 5) discussion. <u>Start this project early.</u>