Earthquake seismology

COURSE INFORMATION

Instructor: Dr. Dylan Mikesell
Email: dylanmikesell@boisestate.edu
Phone: (208) 426-1404
Office Hours: by appt. (ERB 3153)

Course Website: http://blackboard.boisestate.edu
Course Dates: Lecture – TuTh
Lecture Time and Location:
TuTh: 10:30 - 11:45PM (ERB 2104)

RESOURCES

Course Github: https://github.com/dylanmikesell/GEOPH677
Book: I will provide most material, but there are a number of references that are worthwhile for any seismologist. (1) An introduction to seismology, earthquakes, and earth structure, (2) Modern global seismology, (3) Theoretical global seismology, (4) Seismic waves and sources, (5) Principles of seismology, (6) Introduction to seismology, (7) Quantitative seismology

COURSE DESCRIPTION

This course will introduce students to key aspects of global and regional seismology. We will cover the physics of the earthquake source, with special emphasis on tectonic earthquakes, volcano-tectonic earthquakes, long-period earthquakes and volcanic tremor. We will introduce seismometry, paleoseismology and seismic hazards. Students will learn about existing software resources for earthquake location, fault-plane solutions and earthquake source mechanism inversion. Students will gain knowledge about how to interpret seismograms and estimate earthquake magnitudes. We will cover the basics of Earth structure, mainshock-aftershock sequences, earthquake swarms and b-values. Because this is an upper-level graduate course students will be expected to use existing software and develop their own tools to process data related to the above topics, as well as perform waveform modeling. Students should have some knowledge of MATLAB or a similar computing language (e.g. Fortran, R, etc.).

LEARNING is the act of seeking new knowledge, or modifying, improving or reinforcing existing knowledge. Learning is active it requires the learner to construct, personalize and pursue knowledge in a way that works best for them. You are entering a learning-centered environment, where both the learner and the instructor have important responsibilities:

Student Responsibilities	**Instructor Responsibilities**
Take control of your learning	Provide opportunities for active learning
Participate in collaborative learning	Effectively manage class time
Spend time learning outside of the classroom	Provide structure, but with flexibility
Learn new how-to-learn strategies	Make sure the course is relevant to the learners
Engage in reflection exercises (early and often)	Assess and evaluate learning
Participate in class	Facilitate shared decision making
Solve problems using (and developing) critical thinking skills	Interact with learners inside and outside of the classroom
Evaluate your peers writing and your own writing	Provide prompt and useful feedback
Provide constructive and thorough peer review for your classmates	Clearly communicate expectations and respect learners
Complete required reading and assignments	Provide tools and opportunities for critical thinking
Provide critical feedback to the instructor on the methods that facilitate your learning throughout the course	Provide feedback and direction to facilitate learning, but largely allow learners to be responsible for their own learning

Adapted from Doyle, T. (2008). Helping Students Learn in a Learner-Centered Environment. Sterling, VA, Stylus Publishing, LLC. p. 15.

INTENDED LEARNING OUTCOMES

GEOPH677: Earthquake Seismology is designed to teach students the basic physics of earthquakes and place earthquakes in the context of global seismology. This course achieves this goal by focusing on the following course learning outcomes. After successful completion of this course, you will be able to:

- Process raw seismograms in order to determine ground displacement in a physical unit
- Use computational ray-tracing tools and software to locate earthquakes
- Locate earthquakes using P and S wave arrival times
- Determine the earthquake focal mechanisms and relate this to regional stress
- Explain the different types of seismic sources (single force, double couple, etc.)
- Explain how to estimate the source time function
- Determine the source spectra of a seismic source
- Compute earthquake magnitudes
- Explain the seismic cycle

HOMEWORK SETS

You will receive a homework problem set every one to two weeks; there will be approximately 8 homework sets. An *electronic write-up* is due, along with the code created to solve the given homework problems. If using MATLAB, the code should be published to HTML using the MATLAB *publish* tool. If you are using some other language, please find a way to make a human-readable pdf or html of your code. Homework is due at 5:00pm on the following Fridays; you will have at least on week to complete homework sets. You are allowed to discuss with your colleagues, but I ask that you list the name of any individuals you discussed a particular homework problem with in the electronic submission.

Homework #1:	Due: 01/20/17	Instrument deconvolution
Homework #2:	Due: 02/03/17	Ray-tracing
Homework #3:	Due: 02/17/17	Event location and seismogram component rotation
Homework #4:	Due: 03/03/17	Global and regional seismicity
Homework #5:	Due: 03/17/17	Mathematics of seismic sources
Homework #6:	Due: 03/31/17	Source parameters and magnitudes
Homework #7:	Due: 04/14/17	Source spectra and focal mechanisms
Homework #8:	Due: 04/28/17	The earthquake cycle

NOTE: THE CONTENTS OF THIS HOMEWORK SCHEDULE MAY CHANGE.

FINAL PROJECTS

Using the tools and techniques covered in this class, your term project will involve processing and analyzing an earthquake source of your choice. You must give detailed descriptions of the data and steps involved in the processing. You will write a short report (max 7 pages single-spaced text) that contains relevant figures and tables showing results. Possibilities include problems related to an extension of a problem from class or another seismic source of interest (e.g shallow seismicity (surface rupturing events), deep earthquakes, volcanic seismicity, glacial seismicity, slow earthquakes, tectonic tremor, repeating earthquakes, fluid-related seismicity (geysers/hydrofracture/volcanoes), earthquake swarms, megathrust earthquakes, earthquake scaling, seismometry). If you need help finding/choosing a project, please make an appointment to discuss possibilities with me. The final project will also involve a 20 to 25 minute **LECTURE** at the end of the semester on your source topic.

COURSE ORGANIZATION AND GRADING CRITERIA

Assessment Category	Percent of Grade
Participation	10%
Homework (8 homework assignments)	70%
Final Project (report (7-page max) and 20-25 minute presentation)	20%

Your final grade will be based on points that you have earned through course participation, homework, and the final project. The weight of each of these assessments in your final grade is as follows:

A	92 - 100%	B	82 - 87%	C	72 - 77%	D	62 - 67%
A-	90 - 91%	B-	80 - 81%	C-	70 - 71%	D-	60 - 61%
B+	88 - 89%	C+	78 - 79%	D+	68 - 69%	F	$< 60\%$

At the end of the semester, your final letter grade will be determined based on the total percentage you have earned on the assessments above as follows:

Your grade is determined based on how you perform on the assessments in the course, not how you perform relative to your peers. **There will be no extra-credit opportunities, so please do not ask.**

Tentative Schedule: NOTE THE CONTENTS OF THIS SCHEDULE MAY CHANGE.

TUESDAY	THURSDAY
Jan 10th **1** Seismometers	12th **2** Instrument response & deconvolution
17th **3** Elastic waves in Earth & Normal modes	19th **4** Ray theory & global phases
24th **5** Earthquake detection/phase identification	26th **6** Earthquake location
31st **7** Single-station analysis (instantaneous polarization)	Feb 2nd **8** Array-based analysis (beamforming, backprojection)
7th **9** Travel time perturbations	9th **10** Tomography
14th **11** Theory of seismic sources	16th **12** Theory of seismic sources
21st **13** Theory of seismic sources	23rd **14** Theory of seismic sources
28th **15** Seismic source parameters	Mar 2nd **16** Seismic source parameters
7th **17** Global seismicity	9th **18** Magnitude-frequency relationship
14th **19** Earthquake magnitudes	16th **20** Earthquake magnitudes
21st Spring Break	23rd Spring Break
28th **21** Source-time functions	30th **22** Source spectra
Apr 4th **23** Focal mechanisms & radiation	6th **24** First motions and beachballs (perhaps paleo from Lee L.)
11th **25** Earthquake Cycle	13th **26** Earthquake Cycle
18th **27** Volcanic tremor	20th **28** Volcano-tectonic sources
25th **29** Final presentations	27th **30** Final presentations

COURSE POLICIES

1. **Academic Dishonesty:** Academic integrity is essential to a positive teaching and learning environment, and scholastic dishonesty is considered unacceptable in any form in this course. All students enrolled in University courses are expected to complete coursework responsibilities with fairness and honesty. Failure to do so by seeking unfair advantage over others or misrepresenting someone elses work as your own, can result in disciplinary action. As described in Article 4, Section 1 of Boise State Universitys Student Code of Conduct:
   A violation may include cheating, plagiarism, or other forms of academic dishonesty. All assignments submitted by a student must represent her/his own ideas, concepts, and current understanding or must cite the original source. Academic dishonesty includes assisting a student to cheat, plagiarize, or commit any act of academic dishonesty. Attempts to violate academic integrity do not have to be successful to be considered academic dishonesty. Academic dishonesty includes turning in substantial portions of the same academic work to more than one course without the prior permission of the faculty members.

Infraction	**Sanction**
Copying part or all of another student's homework	**First offense:** Student(s) receive zero credit for the homework **Second offense:** All students involved fail the course
Any and all of the above	**Instructor files Academic Dishonesty Report Form with the Office of the Dean of Students**

2. **Behavioral Expectations:** All students have the right to a respectful learning environment and as such, each student is tasked with taking individual responsibility in conducting him or herself in a mature manner. Students will be held accountable for their behavior and may be asked to leave the classroom in the event of inappropriate or disrespectful behavior.

3. **Attendance:** Class attendance is essential. In the vast majority of circumstances, late work is not accepted and class homeworks cannot be made up. Much of the class is based on activities and discussions, which require full attention and participation. Please be prompt and ready to begin at the start times for your lecture section.

4. **Accommodation:** If you have any physical or learning needs that might impact your learning and evaluation in this course, please discuss these needs with your instructor at the beginning of the term. The University has a multitude of resources so dont hesitate to let your instructor help you. To request academic accommodations for a disability, contact the Disability Resource Center, Admin 114, (208) 4261583. Students are required to provide documentation of their disability and meet with a Disability Specialist prior to receiving accommodations. Information about a disability or health condition will be regarded as confidential.

5. **Communication:** If you have something important to tell your instructor (i.e. you'll be late, absent, etc.), send an email reminder. Telling your instructor after class and hoping he/she will remember is not a good option. You must notify your instructor(s) well in advance of any travel plans for university-sponsored events (athletics or other activities) that will interfere with the scheduled course activities. When communicating with your instructor, please include your full name, and the course you are enrolled in. Complete sentences and proper grammar are appreciated.

6. **Electronic devices:** Please show respect for your instructor and fellow students by turning off all phones, personal music players, etc., before coming to class. If your phone rings during class your instructor will answer it for you. This is no joke, but it will be funny.

7. **Course Workload:** You should expect to spend a total of 4 hours per week working to earn 1 credit in this class. This includes lecture, which accounts for 1 of those 4 hours. The remainder should be spent studying your notes, and/or coming to office hours, and homework. I will do my best to make the course content as clear and accessible as possible; you should do your part by reviewing your notes day to day.