GEOPHYSICS: SOLID, FLUID, AND WAVE MECHANICS

DEPARTMENT OF EARTH SCIENCES | SOEST | UNIVERSITY OF HAWAIʻI AT MĀNOA

INSTRUCTOR: Helen Janiszewski
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OFFICE: POST 614A

CLASS TIME: TTh 1:30 – 2:45
MEETING ROOM: POST 702
OFFICE HOURS: TBD/By Appointment

COURSE INFORMATION

The solid Earth deforms over a wide range of length scales, locations, and time scales, and in a variety of ways in response to different forcing mechanisms. In this class, we will study continuum mechanics in geophysics, as applied to the deformation of Earth materials (elastic, viscoelastic, and plastic deformations) and seismic wave propagation (body waves, surface waves, anisotropy, and attenuation). Topics to be covered include tensors, stress and strain in solids, rock failure, moment tensors, elasticity, ductile rheology, viscous flow, equations of motion and boundary conditions, the vector wave equation, wave field energy, reflection and transmission of seismic waves, and seismic imaging.

PREREQUISITES

PHYS 170, PHYS 272, MATH 307 or ERTH 312 (or equivalent), with a minimum grade of B-.

TEXTS

Readings for this class will be a mix of sections from texts, journal papers, and other distributed class notes. We will further discuss textbook useage in class, but purchase of a text is not necessary. However, the following are useful references:
Introduction to Seismology; Shearer
Geodynamics; Turcotte and Schubert
Introduction to Seismology, Earthquakes, and Earth Structure; Stein and Wysession

GRADING

Problem Sets (60%)

Weekly(ish) problem sets. *Assignments can be corrected and resubmitted for half credit. Lowest grade problem set will drop at end of semester.*

Class Engagement (20%)

Students are expected to regularly attend lectures, and should actively participate by asking and answering questions, and engage in discussions with classmates.

Journal Paper Reading Assignments (20%)

Assigned readings of relevant sciences papers related to class concepts. You will be expected to write a short (~1 page) summary of the paper, and how it relates to course material.

POLICIES

Class Engagement

All students are expected to be active participants in this class and to promote a supportive environment that is conducive to learning. This means regular attendance, asking and answering questions in class, respecting your classmates, and proactively attending office hours/ emailing me

when you have questions or would like to discuss the material further. Lecture materials will be made available after class, but students should plan to regularly attend in person except in extenuating circumstances. You do not need to notify me about an isolated absense, but if you will miss class for more than one session, please notify me as soon as possible (ideally ahead of time).

Collaboration

Students are encouraged to discuss assignments, but all submitted work must be your own. Evidence of cheating or copying will result in a zero grade for the assingment, and multiple offences will result in university-level action.

Late Work

All assignments must be submitted by midnight on their due date. You must make prior arrangements with me via email if you will be unable to submit your assignment on time (travel, meetings, and other extenuating circumstances). Unexcused late work will be deducted half credit, and will not be accepted more than 5 days late. Exceptions may be granted in case of documented emergency (*e.g.,* medical, family, etc), but should be brought to my attention as soon as possible.

TENTATIVE SCHEDULE

1. Stress and Strain (Weeks 1 – 3)

Vectors and Tensors
The Stress Tensor
Stress in the Earth, Equations of Motion
The Strain Tensor
Elasticity and Rock Rheology

2. Seismic Wave Propogation and Imaging (Weeks 4 – 9)

The Seismic Wave Equation
Plane and Spherical Waves
P- and S-Waves
Ray Theory
Snell's Law
Reflection and Transmission Coefficients
Seismic Phases and Travel Time Curves
Travel Time Tomography
Surface Waves and Dispersion
Anisotropy
Attenuation

3. Faulting and Brittle Failure (Weeks 10 – 13)

Stress, Faulting, and Earthquakes
Focal Mechanisms and Moment Tensors
Seismic Sources, Wave Radiation
Brittle Rock Failure
Mohr's Circle
Anderson Theory of Faulting

4. Rheology and Flow (Weeks 14 – 16)

Ductile Rheology
Fluid Mechanics
Viscous Flows
Stokes Flow
The Stream Function

EARTH LEARNING OBJECTIVES

This course will introduce the following Earth Department Student Learning Objectives (SLOs).
For the M.S. degree: (1) Technical knowledge; (2) Scientific method; (3) Communicate geological knowledge; (4) Employability/contributions post-graduation.
For the Ph.D. degree: (1) Technical knowledge; (2) Expertise in a sub-discipline; (3) Scientific method; (4) Communicate geological knowledge; (5) Employability/contributions post-graduation.

Title IX:
The University of Hawai'i is committed to providing a learning, working and living environment that promotes personal integrity, civility, and mutual respect and is free of all forms of sex discrimination and gender-based violence, including sexual assault, sexual harassment, gender-based harassment, domestic violence, dating violence, and stalking. If you or someone you know is experiencing any of these, the University has staff and resources on your campus to support and assist you. Staff can also direct you to resources that are in the community. Here are some of your options:
As members of the University faculty, your instructors are required to immediately report any incident of potential sex discrimination or gender-based violence to the campus Title IX Coordinator. Although the Title IX Coordinator and your instructors cannot guarantee confidentiality, you will still have options about how your case will be handled. Our goal is to make sure you are aware of the range of options available to you and have access to the resources and support you need.
If you wish to remain ANONYMOUS, speak with someone CONFIDENTIALLY, or would like to receive information and support in a CONFIDENTIAL setting, use the confidential resources available here: http://www.manoa.hawaii.edu/titleix/resources.html#confidential
If you wish to directly REPORT an incident of sex discrimination or gender-based violence including sexual assault, sexual harassment, gender-based harassment, domestic violence, dating violence or stalking as well as receive information and support, contact: Dee UwonoTitle IX Coordinator (808) 956-2299 t9uhm@hawaii.edu.

Student Conduct and Academic Integrity:
University guidelines for acceptable student conduct are very specific and will be strictly followed. Please read the guidelines (http://www.studentaffairs.manoa.hawaii.edu/policies/conduct_code/) and contact me if you have any concerns. Cheating, of any form, will not be tolerated. Blind copying of intellectual material (text) from resources such as books, journals, and the internet is plagiarism and is illegal. You are encouraged to work together on your problem sets, but all work turned in for grading (including computer programs) must be yours, and yours alone. There will be no collaborations during exams.

Counseling & Student Development Center
Counseling and Student Development Center (CSDC) offers an array of services to meet counseling and testing needs among students, staff, and faculty of the UH Mānoa campus. Our multidisciplinary staff includes psychologists, psychiatrists, graduate-level therapists, and counselor trainees. It is our mission to uphold excellence in quality of care that is respectful to the socio-cultural diversity of our clientele. We offer walk-in, individual, and group counseling, as well as career and psychological assessments. When a client's needs could be best addressed by providers outside of the CSDC, we offer appropriate referrals in the community. We also provide outreach events to increase awareness on issues relevant to healthy campus lifestyle. For more information, please visit the Counseling & Student Development Center web site at: http://www.manoa.hawaii.edu/counseling/.

Disability Access:
The Earth Sciences Department will make every effort to assist those with disability and related access needs. For confidential services, please contact the Office for Students with Disabilities (known as "Kokua") located in the Queen Lili'uokalani Center for Student Services (Room 013): KOKUA Program; 2600 Campus Road; Honolulu, Hawaii 96822. Voice: 956-7511; Email: kokua@hawaii.edu; URL: www.hawaii.edu/kokua

Department of Public Safety:

(808)956-6911 (Emergency) / (808)956-8211 (Non-Emergency) http://manoa.hawaii.edu/dps/

Basic Needs:

Basic needs include food and housing, childcare, mental health, financial resources and transportation, among others. Student basic needs security is critical for ensuring strong academic performance, persistence and graduation and overall student well being. If you or someone you know are experiencing basic needs insecurity, please see the following resources: https://www.hawaii.edu/student-basicneeds/.