ERTH631: Solid, Fluid and Wave Mechanics

Instructor: Dr. Robert Dunn

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office hours: by appointment

Lectures: TTh 13:30-14:45 in POST 702

Principle Text: Introduction to Continuum Mechanics, by Lai, Rubin, & Krempl
Reference Texts: Geodynamics, by Turcotte & Schubert
Elastic Wave Propagation and Generation in Seismology, by Pujol
Seismic Ray Theory, by Cerveny

The solid Earth deforms over a wide range of length and time scales, and in a variety of different 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).

Catalog Description: ERTH631 Geophysics–Solid, Fluid, and Wave Mechanics (3) Continuum mechanics in geophysics, as applied to the deformation of Earth materials (elastic, viscous, viscoelastic, and plastic deformations) and seismic wave propagation (body waves, surface waves, anisotropy, and attenuation). Pre: (with a minimum grade of B-) for PHYS 170, PHYS 272, and MATH 307 or GG 312 (or equivalent).
## Preliminary Schedule:

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<th>Week</th>
<th>Topic</th>
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| 1    | Course Introduction  
      | Vector and Tensor Review |
| 2    | Stress in Solids  
      | The Stress Tensor |
| 3    | Rock Failure  
      | Moment Tensors for Earthquakes |
| 4    | Infinitesimal Strain  
      | Finite Strain and Geological Applications |
| 5    | Elasticity  
      | Elastic Deformation in the Earth |
| 6    | Ductile Rheology  
      | Navier-Stokes Equation |
| 7    | Viscous Flows (Couette & Poiseuille)  
      | Stokes Flow |
| 8    | The Stream Function  
      | Corner Flow / Non-Newtonian Rheology |
| 9    | Wave Mechanics – Equation of Motion  
      | Wave Mechanics – Boundary Conditions |
| 10   | Vector Wave Equation  
      | Vector Wave Equation |
| 11   | NO CLASS (Election Day)  
      | Wavefield Energy |
| 12   | NO CLASS (Veterans Day)  
      | Wavefields at Boundaries and Waveguides |
| 13   | Reflection and Transmission  
      | R&T Coefficients and Zoeppritz Equations |
| 14   | Eikonal Equation  
      | NO CLASS (Thanksgiving) |
| 15   | Ray Tracing Systems  
      | Surface Waves |
| 16   | Surface Wave Eigen-solutions  
      | Seismic Anisotropy / Seismic Attenuation |

**Note:** We will deviate from this schedule as necessary!

## Grading

The relative weightings of homework assignments and class participation are as follows:

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<tbody>
<tr>
<td>Homework</td>
<td>60%</td>
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<tr>
<td>Class Participation</td>
<td>40%</td>
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</tbody>
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Other Reference Sources

Material Properties

Continuum Mechanics

Fluid Dynamics

Math and Mathematical Physics

Solid Earth Geophysics

Learning Objectives
The Department of Earth Sciences has established the following student learning objectives. All of these objectives are relevant targets for the curriculum of ERTH631.

1. Students can explain the relevance of geology and geophysics to human needs, including those appropriate to Hawaii, and be able to discuss issues related to geology and its impact on society and planet Earth.
2. Students can apply technical knowledge of relevant computer applications, laboratory methods, and field methods to solve real-world problems in geology and geophysics.
3. Students use the scientific method to define, critically analyze, and solve a problem in earth science.
4. Students can reconstruct, clearly and ethically, geological knowledge in both oral presentations and written reports.
5. Students can evaluate, interpret, and summarize the basic principles of geology and geophysics, including the fundamental tenets of the sub-disciplines, and their context in relationship to other core sciences, to explain complex phenomena in geology and geophysics.

Disability Access
If you have a disability and related access needs the Department will make every effort to assist and support you. For confidential services students are encouraged to contact the Office for Students with Disabilities (known as “Kokua”) located on the ground floor (Room 013) of the Queen Lili‘uokalani Center for Student Services:

KOKUA Program; 2600 Campus Road; Honolulu, Hawaii 96822
Voice: 956-7511; Email: kokua@hawaii.edu ; URL: www.hawaii.edu/kokua

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](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 Uwono Title IX Coordinator (808) 956-2299 [9uhm@hawaii.edu](mailto:9uhm@hawaii.edu).