



GEOL 7333: Seismic Waves and Rays | Fall 2022

Location | Day & Time: **F-213 | Fridays 1-5PM & Saturdays 9:00AM-5:30PM (8/26/2022-9/21/2022)**

Instructor: Leon Thomsen E-mail: LThomsen@UH.edu

TA: TBA E-mail: TBA

Instructor Office Hours (SR1-221B): **By appointment.**

Course description: This short course will cover the principles and methods underlying the application of seismology to petroleum exploration.

Lecture material:

- Lecture slides as pdf files will be provided to students.

References (optional for purchasing):

- Sheriff, R. E., and L. P. Geldart (1995), Exploration Geophysics, 2nd ed., SEG.

Expected learning outcome: Students are expected to achieve the following from the course:

- ✓ Know historical highlights and current context of petroleum exploration
- ✓ Know the fundamental concepts of elasticity
- ✓ Know how to derive the wave equation, in various approximations
- ✓ Understand body-wave solutions to the wave equation: P, S, C
- ✓ Understand surface-wave solutions to the wave equation
- ✓ Understand seismic reflections
- ✓ Know about multiples, diffractions, and resolution;
Beyond the basic topics, these Real-World issues:
- ✓ Understand how poro-elasticity modifies these elementary ideas
- ✓ Understand how attenuation modifies these elementary ideas
- ✓ Understand how anisotropy modifies these elementary ideas

Grading:

Final Exam

100%. The exam will be a new format for you: to be completed in one sitting (unlimited duration), with open books and notes, but no consultation with others. It will be a test of your understanding, not your memory.

Academic integrity: Cheating devalues your degree and is strictly prohibited. All work you turn in must be your own, but you may consult classmates for assistance and collaboration. As a member of the UH community it is your responsibility to protect your educational investment by knowing and following the rules. You are responsible for being familiar with the UH policy for academic honesty (<https://uh.edu/provost/policies-resources/honesty/>).

Tentative schedule:

| Date, Time | Topic/Content | Date, Time | Topic/Content |
|-------------------------|---|-------------------|---|
| Prior to 8/26 PM | 1. Introduction and context | 9/3 PM | 6. Reflections and refractions |
| | <u>Read this yourself,</u> | | • Boundary conditions |
| | prior to the first class meeting. | | • Normal incidence, oblique incidence |
| | Materials available on BB ! | | • Weak elastic contrasts |
| | In class: mathematics review | | • Free-surface, post-critical incidence |
| 8/26 PM | 2. Elasticity | 9/9 PM | • QUIZ (take-home, 25% of grade) |
| | • Math: vectors, matrices, tensors | | 7. Complications |
| | • Hooke's Law, Stress, strain | | • Multiples |
| | • Compliance, stiffness | | • Diffractions |
| | • Anisotropy | | • Rugose interfaces, Fresnel zone |
| 8/27 AM | 3. The wave equation | 9/10 AM | • Resolution |
| | • Scalar wave equation | | 8. Poro-elasticity |
| | • Vector wave equation | | • Inhomogeneous rocks, porosity |
| | • Source term, reciprocity | | • Pore pressure, effective stress |
| | • Solutions | | • Fluids: Biot, Gassmann, Brown&Korringa |
| 8/27 PM | 4. Body waves | 9/10 PM | 9. Attenuation |
| | • Plane waves, radiating waves | | • Attenuative Hooke's Law |
| | • Wavefronts, rays | | • Attenuative plane waves |
| | • Moveout, interference, S-waves | | • Attenuative reflections |
| | • QUIZ (take-home, 25% of grade) | | • Mechanisms of attenuation |
| 9/2 PM | 5. Surface waves | 9/16 PM | 10. Anisotropy |
| | • Rayleigh waves | | • Classes of anisotropic rocks |
| | • Dispersion | | • Polar anisotropy, exact and weak |
| | • Love waves | | • Anisotropy in exploration seismic data |
| | • Tube waves | | • Anisotropic reflections |
| 9/3 AM | We expect to be behind-schedule by this point, and use this time-slot to get back on schedule | 9/21 PM | FINAL EXAM Due (take-home, 50% of grade) |

IMPORTANT INFORMATION AND POLICIES

If you are experiencing any COVID-19 symptoms that are not clearly related to a pre-existing medical condition, do not come to class. Please see [Student Protocols](#) for what to do if you experience symptoms and [Potential Exposure to Coronavirus](#) for what to do if you have potentially been exposed to COVID-19. Consult the (select: [Undergraduate Excused Absence Policy](#) or [Graduate Excused Absence Policy](#)) for information regarding excused absences due to medical reasons.

COVID-19 Information

Students are encouraged to visit the University's [COVID-19](#) website for important information including diagnosis and symptom protocols, on-campus testing, and vaccine information. Please check the website throughout the semester for updates.

Vaccinations

Data suggests that vaccination remains the best intervention for reliable protection against COVID-19. Students are asked to familiarize themselves with pertinent [vaccine information](#) and to consult with their health care provider. The University strongly encourages all students, faculty and staff to be vaccinated.

Reasonable Academic Adjustments/Auxiliary Aids

The University of Houston complies with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990, pertaining to the provision of reasonable academic adjustments/auxiliary aids for disabled students. In accordance with Section 504 and ADA guidelines, UH strives to provide reasonable academic adjustments/auxiliary aids to students who request and require them. If you believe that you have a disability requiring an academic adjustments/auxiliary aid, please contact [the Justin Dart Jr. Student Accessibility Center](#) (formerly the Justin Dart, Jr. Center for Students with DisABILITIES).

Excused Absence Policy

Regular class attendance, participation, and engagement in coursework are important contributors to student success. Absences may be excused as provided in the University of Houston [Undergraduate Excused Absence Policy](#) and [Graduate Excused Absence Policy](#) for reasons including: medical illness of student or close relative, death of a close family member, legal or government proceeding that a student is obligated to attend, recognized professional and educational activities where the student is presenting, and University-sponsored activity or athletic competition. Under these policies, students with excused absences will be provided with an opportunity to make up any quiz, exam or other work that contributes to the course grade or a satisfactory alternative. Please read the full policy for details regarding reasons for excused absences, the approval process, and extended absences. Additional

policies address absences related to [military service](#), [religious holy days](#), [pregnancy and related conditions](#), and [disability](#).

Recording of Class

Students may not record all or part of class, livestream all or part of class, or make/distribute screen captures, without advanced written consent of the instructor. If you have or think you may have a disability such that you need to record class-related activities, please contact the [Justin Dart, Jr. Student Accessibility Center](#). If you have an accommodation to record class-related activities, those recordings may not be shared with any other student, whether in this course or not, or with any other person or on any other platform. Classes may be recorded by the instructor. Students may use instructor's recordings for their own studying and notetaking. Instructor's recordings are not authorized to be shared with *anyone* without the prior written approval of the instructor. Failure to comply with requirements regarding recordings will result in a disciplinary referral to the Dean of Students Office and may result in disciplinary action.

Syllabus Changes

Due to the changing nature of the COVID-19 pandemic, please note that the instructor may need to make modifications to the course syllabus and may do so at any time. Notice of such changes will be announced as quickly as possible through (*specify how students will be notified of changes*).

Academic Honesty Policy

High ethical standards are critical to the integrity of any institution, and bear directly on the ultimate value of conferred degrees. All UH community members are expected to contribute to an atmosphere of the highest possible ethical standards. Maintaining such an atmosphere requires that any instances of academic dishonesty be recognized and addressed. The [UH Academic Honesty Policy](#) is designed to handle those instances with fairness to all parties involved: the students, the instructors, and the University itself. All students and faculty of the University of Houston are responsible for being familiar with this policy.

Title IX/Sexual Misconduct

Per the UHS Sexual Misconduct Policy, your instructor is a "responsible employee" for reporting purposes under Title IX regulations and state law and must report incidents of sexual misconduct (sexual harassment, non-consensual sexual contact, sexual assault, sexual exploitation, sexual intimidation, intimate partner violence, or stalking) about which they become aware to the Title IX office. Please know there are places on campus where you can make a report in confidence. You can find more information about resources on the Title IX website at <https://uh.edu/equal-opportunity/title-ix-sexual-misconduct/resources/>.

Security Escorts and Cougar Ride

UHPD continually works with the University community to make the campus a safe place to learn, work, and live. Our Security escort service is designed for the community members who have safety concerns and would like to have a Security Officer walk with them, for their safety, as they make their way across campus. Based on availability either a UHPD Security Officer or Police Officer will escort students, faculty, and staff to locations beginning and ending on campus. If you feel that you need a Security Officer to walk with you for your safety please call [713-743-3333](tel:713-743-3333). Arrangements may be made for special needs.

Parking and Transportation Services also offers a late-night, on-demand shuttle service called Cougar Ride that provides rides to and from all on-campus shuttle stops, as well as the MD Anderson Library, Cougar Village/Moody Towers and the UH Technology Bridge. Rides can be requested through the UH Go app. Days and hours of operation can be found at <https://uh.edu/af-university-services/parking/cougar-ride/>.

Helpful websites

The Cougar Cupboard provides free groceries for all students, with no requirements: <https://uh.edu/dsa/cougarcupboard/>

Coogs Care: <https://uh.edu/dsa/coogscare/>

Student Health Center: <https://www.uh.edu/healthcenter/>