

## GEOL-551: Introduction to Seismology Fall 2019

**Learning Objective:** To equip graduate students in geophysics and related fields with a theoretical understanding of basic seismology. Emphasis is on the application of global seismology to the study of earthquakes and Earth structure.

**Instructor:** Prof. Thomas H. Jordan ([tjordan@usc.edu](mailto:tjordan@usc.edu), ZHS-267, x1-1237); office hours: Tuesday 07:00-09:00 or by appointment.

**Class Time and Location:** 09:00-10:30 on Tuesdays & Thursdays in ZHS118.

**Textbooks:** Principal textbook:

- P. Shearer (2019). *An Introduction to Seismology*, 3rd Edition, Cambridge, 442 pp., ISBN: 978-1107184473. Available for purchase at the USC Bookstore: <https://www.bkstr.com/usctextstore/course-materials-results?shopBy=course&divisionDisplayName=&departmentDisplayName=GEOL&courseDisplayName=551&sectionDisplayName=25015&programId=3710&termId=100057487>.

Students will be asked to consult the following references for occasional reading assignments:

- K. Aki & P. G. Richards (2002). *Quantitative Seismology*, 2nd edition, University Science Books, 700 pp.
- F. A. Dahlen & J. Tromp (1998). *Theoretical Global Seismology*, Princeton, 1025 pp.
- S. Stein & M. Wysession (2003). *An Introduction to Seismology, Earthquakes, and Earth Structure*, Blackwell, 498 pp.

**Format:** 3-unit class with a mix of formal lectures (70%) and student presentations on assigned readings and term projects (30%), 2 meetings per week, 1.5 hours per meeting.

**Grades:** Based on class participation (50%), homework (20%), and term project (30%).

**Class participation:** Students are expected to be active participants in questioning the instructor and in the weekly reviews of the course readings. Each student will be assigned as the discussion leader for specific readings on a rotating basis.

**Homework:** Students are expected to spend approximately 6 hours per week on reading the assigned material, answering study questions, and working on their term projects.

**Term project:** Each student will prepare a 10-page paper on a seismological topic approved by the instructor, ideally of relevance to their own research. Draft papers are due two weeks before the end of classes. Students will describe their projects orally in 15-

minute presentations during the last week of classes. Final drafts of the term papers will be due on the last day of classes. Term-project grades will be based on the written paper (70%) and oral presentation (30%).

**Topics and Schedule:** The course will be organized around discussions of the following topics:

1. Seismometers (Aug 27, 29)
  - Damped harmonic oscillator; response of modern seismometers
2. Elasticity (Sept 5, 12)
  - Stress and strain tensors; stiffness and compliance tensors; isotropy and anisotropy
3. Seismic wave equation (Sept 17, 19)
  - Plane and spherical waves in isotropic, homogeneous, elastic media
4. Plane waves in isotropic, layered, elastic media (Sept 24, 26)
  - Snell's law; reflection and transmission coefficients; propagator matrices
5. Seismic sources (Oct 1, 3)
  - Moment-tensor representations; Green functions; far-field approximations
6. Ray theory for 1-D Earth models (Oct 8, 10)
  - Ray tracing;  $T(\Delta)$  and  $\tau(p)$  curves; caustic phase shifts; 1-D Earth structure
7. Attenuation (Oct 15, 17\*)
  - Energy densities; anelastic Earth models; physical dispersion
8. Surface waves and free oscillations (Oct 22, 24)
  - Phase and group velocities; dispersion curves; eigenfrequencies
9. Seismic tomography (Nov 5, 7)
  - Tomographic approximations; full 3-D tomography; 3-D Earth structure
10. Anisotropy (Nov 12, 14)
  - Christoffel equation; transversely isotropic Earth models; shear-wave splitting
11. Earthquakes (Nov 19, 21)
  - Friction and faulting; rupture energetics; scaling relations
12. Seismic hazard analysis (Nov 26)
  - Earthquake rupture forecasts, ground-motion prediction models; hazard maps
13. Student presentations of term projects (Dec 5, 7)

## **Academic Conduct:**

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Part B, Section 11, “Behavior Violating University Standards” [policy.usc.edu/scampus-part-b](http://policy.usc.edu/scampus-part-b). Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct>.

## **Support Systems:**

*Student Counseling Services (SCS)* – (213) 740-7711 – 24/7 on call. Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. [engemannshc.usc.edu/counseling](http://engemannshc.usc.edu/counseling)

*National Suicide Prevention Lifeline* – 1 (800) 273-8255. Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. [www.suicidepreventionlifeline.org](http://www.suicidepreventionlifeline.org)

*Relationship and Sexual Violence Prevention Services (RSVP)* – (213) 740-4900 – 24/7 on call. Free and confidential therapy services, workshops, and training for situations related to gender-based harm. [engemannshc.usc.edu/rsvp](http://engemannshc.usc.edu/rsvp)

*Sexual Assault Resource Center*. For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: [sarc.usc.edu](http://sarc.usc.edu)

*Office of Equity and Diversity (OED)/Title IX Compliance* – (213) 740-5086. Works with faculty, staff, visitors, applicants, and students around issues of protected class. [equity.usc.edu](http://equity.usc.edu)

*Bias Assessment Response and Support*. Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. [studentaffairs.usc.edu/bias-assessment-response-support](http://studentaffairs.usc.edu/bias-assessment-response-support)

*The Office of Disability Services and Programs*. Provides certification for students with disabilities and helps arrange relevant accommodations. [dsp.usc.edu](http://dsp.usc.edu)

*Student Support and Advocacy* – (213) 821-4710. Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. [studentaffairs.usc.edu/ssa](http://studentaffairs.usc.edu/ssa)

*Diversity at USC*. Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. [diversity.usc.edu](http://diversity.usc.edu)

*USC Emergency Information*. Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible. [emergency.usc.edu](http://emergency.usc.edu)

*USC Department of Public Safety – UPC: (213) 740-4321 – HSC: (323) 442-1000 – 24-hour emergency or to report a crime*. Provides overall safety to USC community. [dps.usc.edu](http://dps.usc.edu)