

GEOL-552: Advanced Seismology Fall 2020

Course Description: This advanced seismology course has two parts. The first will be a rapid review of basic seismological theory, beginning with the continuum mechanics of elastic and anelastic media and focusing on the main theoretical models used to describe seismic sources (Volterra representations, moment tensor fields) and the wavefields they produce (ray fields, traveling waves, normal modes). The second part will delve into several topics at the forefront of seismological research. Depending on course pacing and student interest, these topics may include effective-media models of 3D self-affine heterogeneity, apparent dissipation by self-affine elastic scattering, Rytov theory as the basis full-3D tomography, and representation of complex seismic sources by moment-tensor fields.

Prerequisite: GEOL-551 or an equivalent course in basic seismology.

Learning Objectives: Graduate students in geophysics and related fields who take this course will gain theoretical understanding of advanced seismological methods and an improved ability to apply the theory in formulating and solving seismological inverse problems, including the modeling of Earth structure and seismic sources.

Instructor: Prof. Thomas H. Jordan (tjordan@usc.edu, ZHS-267, x1-1237); office hours: Tuesday 07:00-08:30 or by appointment.

Class Time and Location: Class will be taught on-line at 08:30-10:00 on Tuesdays & Thursdays. Zoom meeting links will be posted on Blackboard.

Textbooks: Most written course material will be in the form of lecture notes by T. Jordan, which will be posted on Blackboard in advance of the lectures. On occasion, students will be asked to consult the following references for 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.

Course Design & Format: On-line, 3-unit class with a “flipped” design. Written lecture material will be posted on Blackboard in advance of the class meeting. During the class, the instructor and students will review the pre-assigned materials and engage in discussions of key theoretical concepts. The instructor will lead these discussions about two-thirds of the class time, and the students about one-third.

Class participation: Students are expected to have studied the lecture materials and be knowledgeable enough to participate in class discussions of key theoretical issues. Each student will volunteer to be a discussion leader approximately once per week. Student participation in these class discussions will be the main component of the class participation grade.

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 one with significant theoretical content and of relevance to the student's research. Draft papers are due two weeks before the end of classes (Nov 12). Students will describe their projects orally in 15-minute presentations during the last day of classes (Nov 24). 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%).

Grades: The term grade will be based on class participation (40%), homework (20%), and term project (40%).

Course Topics and Schedule:

Week	Dates	Topics
<i>Part 1: Rapid review of basic seismological theory</i>		
1	Aug 18 & 20	Continuum mechanics and conservation laws
2	Aug 25 & 27	Isotropic and anisotropic elastic media; anelastic media
3	Sept 1 & 3	Equations of motion; boundary conditions; Navier equation
4	Sept 8 & 10	Wave energies and dissipation
5	Sept 15 & 17	SCEC Annual Meeting (no class)
6	Sept 21 & 24	Seismic sources; Green functions; seismic reciprocity; moment tensors
7	Sept 29 & Oct 1	Volterra representation; seismic moment; radiation patterns; stress glut
8	Oct 6 & 8	Asymptotic ray theory
9	Oct 13 & 15	Traveling waves in layered media; ω - k diagrams
10	Oct 20 & 22	Normal mode theory; duality of standing and traveling waves
<i>Part 2: Special topics</i>		
11	Oct 27 & 29	Effective media models of 3D self-affine heterogeneity
12	Nov 3 & 5	Apparent dissipation by self-affine elastic scattering
13	Nov 10 & 12	Rytov approximation and full-3D tomography
14	Nov 17 & 19	Representation of complex seismic sources
15	Nov 24	Student presentations

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. 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

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

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

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

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

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

The Office of Disability Services and Programs. Provides certification for students with disabilities and helps arrange relevant accommodations. 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

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

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

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