**GEOL593: Seismology and Earth Structure**

**Instructor**: Dr. Ross Maguire ([rossrm@illinois.edu](mailto:rossrm@illinois.edu))

**Credits**: 4

**Textbook**: Foundations of Modern Global Seismology (Ammon et al., 2020; available as an eBook through the UIUC library)

**Meeting time and location**: In Person, T & Th: 9:30 am – 10:50 am, Room G17 Foreign Languages Building

**Office hours**: M & W 10:00 am – 11:00 am, or by appointment; 3014 NHB or virtually on Zoom

**Course Description**:

In this course, we will cover a variety of methods that seismologists use to probe the structure and dynamics of the interior of Earth and other planetary bodies. A wide range of topics will be explored including the fundamentals of seismic wave propagation, seismic imaging, and earthquake source properties. The course will consist of lectures and computer-based assignments aimed at giving practical experience with seismic analysis methods used in modern research. As a final project, students will read a research paper aligning with one of the topics covered in the course and present a 15-minute talk summarizing the work.

This class is intended for graduate students or advanced undergraduates who are interested in learning about the interior of the Earth and other planets and moons. While we will be examining planetary interiors and dynamics through the lens of seismology, the broad range of material covered will be relevant to students interested in a variety of geoscience disciplines, including geodynamics, mineral physics, volcanology, tectonics, geochemistry and more. Additionally, students will learn technical skills such as data analysis, signal processing, and machine learning, which are relevant in geoscience and beyond. While no pre-requisites are strictly required, prior experience in computer programming, differential equations, statistics, and linear algebra are beneficial.

**Student Learning Outcomes:**

At the end of this class, students will have acquired the following skills:

• Basic competency in python programming and data analysis

• Creating “publication quality” figures, including maps of geospatial data

• Fundamental understanding of how Earth models are constrained from seismic data

• Understand machine learning applications in seismology with practical experience using models capable of earthquake detection

• Identifying important areas of future seismological research and how it relates to other fields

• Communicating research in the form of a short “AGU-style” talk

**Course Credit:**

80%: Computer lab assignments

20%: Research paper presentation

**Grading Scale:**

*A+* (97 – 100%); *A* (93 – 96%); *A-* (90 – 92%)

*B+* (87 – 89%); *B* (83 – 86%); *B-* (80 – 82%)

*C+* (77 – 79%); *C* (73 – 76%); *C-* (70 – 72%)

D (60 – 69%); F (less than 60%)

**Due Dates and Late Assignments**:

All lab assignments are due one week after they are assigned (i.e., before class meets the following week). Late work is not accepted unless prior arrangements have been made.

**Academic Integrity:**

Students in this class are expected to strictly follow the University of Illinois guidelines on academic integrity, as described in the Student Code (<https://studentcode.illinois.edu/article1/part4/1-401/>). Infractions that can lead to disciplinary actions include plagiarism, cheating, data fabrication, and facilitating others in committing academic integrity violations (e.g., allowing others to copy your work). Please take time to familiarize yourself with the University Academic Integrity policy and ask the course instructor if any questions arise.

**Disability Accommodation:**

If you require disability-related accommodations, please let me know as soon as you can either by email or by visiting office hours. This will help ensure that your requirements are met from the beginning of the course. Additional resources related to disability accommodation can be found on the University of Illinois Disability Resources and Educations Services website (<https://www.disability.illinois.edu/>).

**Mental Health Statement:**

Significant stress, mood changes, excessive worry, substance/alcohol misuse or interferences in eating or sleep can have an impact on academic performance, social development, and emotional wellbeing. The University of Illinois offers a variety of confidential services including individual and group counseling, crisis intervention, psychiatric services, and specialized screenings which are covered through the Student Health Fee. If you or someone you know experiences any of the above mental health concerns above, it is strongly encouraged to contact or visit any of the University’s resources provided below. Getting help is a smart and courageous thing to do – for yourself and for those who care about you.

• Counseling Center (217) 333-3704

• McKinley Health Center (217) 333-2700

• National Suicide Prevention Lifeline (800) 273-8255

• Rosecrance Crisis Line (217) 359-4141 (available 24/7, 365 days a year)

• If you are in immediate danger, call 911

**Community of Care:**

As members of the Illinois community, we each have a responsibility to express care and concern for one another. If you come across a classmate whose behavior concerns you, whether in regards to their well-being or yours, we encourage you to refer this behavior to the Student Assistance Center (333-0050) or online at odos.illinois.edu/community-of-care/referral/. Based upon your report, staff in the Student Assistance Center reaches out to students to make sure they have the support they need to be healthy and safe.

Further, as a Community of Care, we want to support you in your overall wellness. We know that students sometimes face challenges that can impact academic performance (examples include mental health concerns, food insecurity, homelessness, personal emergencies). Should you find that you are managing such a challenge and that it is interfering with your coursework, you are encouraged to contact the Student Assistance Center (SAC) in the Office of the Dean of Students for support and referrals to campus and/or community resources.

**Sexual Misconduct Policy and Reporting:**

The University of Illinois is committed to combating sexual misconduct. Faculty and

staff members are required to report any instances of sexual misconduct to the

University’s Title IX and Disability Office. In turn, an individual with the Title IX

and Disability Office will provide information about rights and options, including

accommodations, support services, the campus disciplinary process, and law

enforcement options. A list of the designated University employees who, as

counselors, confidential advisors, and medical professionals, do not have this

reporting responsibility and can maintain confidentiality, can be found here:

[wecare.illinois.edu/resources/students/#confidential](http://wecare.illinois.edu/resources/students/#confidential). Other information about

resources and reporting is available here: [wecare.illinois.edu](http://wecare.illinois.edu/).

**Schedule:**

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|  | Dates | Topic | Lab assignment |
| Week 1: | Jan 17, Jan 19 | Course overview/ Seismic waves | Lab 1: Python crash course |
| Week 2: | Jan 24, Jan 26 | Seismic signal processing | Lab 2: Introduction to Obspy |
| Week 3: | Jan 31, Feb 2 | Moment Tensors/ Inverse methods | Lab 3: Moment tensor inversion |
| Week 4: | Feb 7, Feb 9 | Seismic wave propagation 1 | Lab 4: Reference Earth models: The “1D” Earth |
| Week 5: | Feb 14, Feb 16 | Seismic wave propagation 2 | Lab 5: Seismic tomography |
| Week 6: | Feb 21, Feb 23 | Normal modes: Free oscillations of Earth | Lab 6: Surface waves and normal modes |
| Week 7: | Feb 28, Mar 2 | Imaging Earth Structure 1:  Seismic tomography | Lab 7: Receiver functions |
| Week 8: | Mar 7, Mar 9 | Imaging Earth Structure 2:  Seismic discontinuities | Research paper discussion |
| Week 9: | Mar 14, Mar 16 | Spring break |  |
| Week 10: | Mar 21, Mar 23 | Anisotropy and anelasticity | Lab 8. Shear wave splitting |
| Week 11: | Mar 28, Mar 30 | Planetary seismology 1 | Lab 9: InSight- Seismology on Mars |
| Week 12: | Apr 4, Apr 6 | Planetary seismology 2 | Finish Lab 9 |
| Week 13: | Apr 11, Apr 13 | Machine learning in seismology 1 | Lab 10: Earthquake detection with machine learning |
| Week 14: | Apr 18, Apr 20 | Machine learning in seismology 2 | Finish Lab 10 |
| Week 15: | Apr 25, Apr 27 | Frontiers of seismology: What’s next? | Work on presentations |
| Week 16: | May 2, May 4 | Research paper presentations |  |