EAS 8803/4803: COMPUTATIONAL SEISMOLOGY

FALL 2026

Time and Location: Monday/Wednesday 2:00 pm – 3:15 am, TBD
Instructor: Zhigang Peng, ES&T 2256, 404-510-5995, zpeng@gatech.edu
Office Hour: Monday/Wednesday 3:15 pm – 4:00 pm (immediately after class)

General description: This is an advanced level course designed to involve students into computational seismological research. The topics covered include digital signal processing, seismometers and seismic networks, basic and advanced seismic data processing tools, travel time and synthetic seismogram calculations, earthquake location, surface wave inversions, and microseismic detection, etc. The class also includes an optional field trip to learn how to deploy seismometers in the field.

Prerequisite: Introduction to Geophysics or equivalent

Grading (tentative): 30% homework assignment; 20% midterm exam; 15% paper reading and discussion; 20% term paper project; 5% Field Trip; 10% online quiz.
Final Grade:
Letter grade: A≥ 90% > B ≥ 80% > C ≥ 70% > D ≥ 60% > F
Satisfactory/Unsatisfactory grade: Satisfactory ≥ 70% > Unsatisfactory

Recommended Textbook:
S. Stein and M. Wysession (2003), An Introduction to Seismology, Earthquakes, and Earth Structure, Blackwell Publishing.
Zhou, H.-W. (2015), Practical Seismic Data Analysis, Cambridge University Press.
P. Shearer (2019), Introduction to Seismology, 3rd edition, Cambridge University Press.
Additional material will be either handed out in class or made available on the course website.

Class website: https://gatech.instructure.com/courses/547390

Course Outline:
1. Digital Signal Processing
    a. Fourier analysis
    b. Linear systems
    c. Discrete time series and transforms
2. Seismometers, Seismic Networks, and Data Centers
    a. Historical development and the Earth's background noise
    b. The damped harmonic oscillator
    c. Basic types of seismic sensors and digital recording devices
    d. Global and regional seismic networks and data management centers
    a. Instrument response removal
3. Observational Seismology
    b. Basic data processing tools
    c. Data request and management
    d. Waveform stacking, cross-correlation and deconvolution

    e. Polarization and array analysis
4. Theoretical and Computational Seismology
    a. Ray theory and travel time calculation
    b. Theoretical seismogram calculation
    c. Earthquake location and magnitude
    d. Travel-time tomography/Surface wave inversion
5. Current topics in observational and computational seismology (tentative)
    a. Seismic event detection
    b. Seismic interferometry
    c. Machine-learning in seismology

Homework assignment: There will be six homework problems, which will involve analysis of selected issues, including analytical calculations, computer simulations, or data analysis. The homework is designed for each student to work by him/herself. The homework will count as 30% of your overall course grade, with each counting 6%.
Mid-term exam: The mid-term exam will be a closed-book exam focusing on fundamental basis of the topics covered in the class. It counts 20% of the final grade.
Paper reading and discussion: In the last few weeks we will discuss three topics of modern research in computational seismology. You are required to submit a 2-page summary after each topic. Paper reading and discussion comprises 15% of total grade.

Term paper project: You are required to write a term paper with any topic related to this course. These can be literature reviews, or research projects involving calculations, data analysis, or theoretical results done in consultation with the instructor. The topic needed to be approved by the instructor before the spring break. Your paper should be written up in journal form with length (double space, 12-point fonts, minimum 12 pages), figures and referencing in a format suitable for submission to journals like Geophysical Research Letters (GRL). Preliminary version of the final paper should be shown to the instructor for approval at least two weeks beforehand. You will present your term paper in a 15-minute AGU-style talk; a 12-minute presentation with 3 minutes of questions. The project will count as 20% of your overall course grade, in which 15% will be based on the quality of the project, 5% on written and oral presentation.
Online Quizzes: There will be several online quizzes throughout the semester. The quiz is meant to help students to understand better the material learned recently in the class. More details will be provided later. The quiz will count 10% of the grade.

Optional Field trip: We will organize a field trip to learn how to deploy seismic sensors in the field. The time and location are to be determined but will likely happen in mid-September. We will ask students to give a short presentation on what they have learned from the field trip. You will be evaluated by your participation and presentation, which count as 5%. Those who cannot participate in the field trip can submit a 3-page report on the development of seismic sensor/deployment methods.

Academic honesty: It is expected that all students are aware of their individual responsibilities under the Georgia Tech Academic Honor Code, which will be strictly adhered to in this class. The complete text of the Georgia Tech Academic Honor Code is at http://www.honor.gatech.edu/.