

Synthetic Aperture Radar (ECEN 5024 / ASEN 5519)

Electrical and Computer Engineering
University of Colorado, Boulder
Course Adapted from Howard Zebker

Fall 2026

Instructor: Prof. Nicole Bienert (pronounced Bye-ner-t)

Email: bienert@colorado.edu

Pronouns: she/ her

Lectures: T/Th9:30am-10:45pm in ECEE 1B32

Instructor Office Hours: Monday 4:15-5:15

Course Website: <https://canvas.colorado.edu/courses/138477>

Midterm Exam: Oct 6, in class

No Class: Mid-semester reading day (Thursday, Oct 8th), Fall Break (Nov 23-27).

Lectures via Zoom: Tuesday Sept. 29th.

MS Teams: We have a Microsoft Teams group and will be using it extensively and can be joined with this link or by searching for the code nc2h52l. All announcements related to the course will be posted here, and you will miss these if you do not join the MS Teams group. The TAs and professor will be available here for questions and concerns and will reply much faster here than by email. When asking a course content-related question, please post in the "Discussions" channel so that other students can see the answer. Please make sure to set up your account using instructions here - teams can be accessed via browser, desktop application, or phone app. I would recommend downloading the phone app and turning on notifications to receive alerts related to weather or illness-related class cancellations.

Class Cancellations: Class will be canceled if the instructor is sick, if campus is closed, or if the weather makes travel unsafe (even if the campus is not closed.) The instructor will notify students of class cancellations on MS Teams no later than 8 am the day of class (except in extenuating circumstances). Campus closure notifications can additionally be found in the CU Boulder Alert system.

Sick Policy: Do not attend class / lab / office hours if you are sick! Except in extreme cases, we will not move deadlines due to illness. This class has a drop policy which is intended for use when you are sick or have other impediments to on-time submissions.

Software: Matlab is the class-supported software, but Python may also be used. Homework solutions will be provided in Matlab. If you are using Python, please submit a zip file containing both your HW PDF and your .py code.

Matlab is available for use by students on computers within the CU ITS Computing Laboratories. The student version of Matlab can be obtained for \$100 through the Mathworks or the CU bookstore, and university licenses to use Matlab are available.

Lecture Recordings/Slides: Slides will also be posted after lecture. If the room is recording-capable, recordings will generally be uploaded to Canvas shortly after lecture, assuming nothing goes wrong. You are still expected to attend class.

Pre/Co-Requisites: Undergraduate level linear systems (ECEN 3300), or other signal and systems class. Familiarity with complex numbers, trigonometry, vector algebra, coordinate systems, Fourier transforms, and calculus is essential. Familiarity with one of MATLAB / Python / MATHCAD / Mathematica or equivalent computational environments is also required. Familiarity with electromagnetics at the level of ECEN 3410, Electromagnetic Waves and Transmission.

Breaks and Scheduled Zoom Classes: Mid-semester reading day (Thursday, Oct 8th), Fall Break (Nov 23-27). .

Course Description: In this course, students will learn how satellite-based radars enable mapping of Earth's surface, and how distributed radars can image internal structures. Through homework problems, students will modularly build up radar processing code that, by the end of the class, can read raw satellite data and produce digital elevation maps and interferograms to see deformation during earthquakes. The first half of the course will be dedicated to radar image formation and signal processing, with topics including viewing geometry, range coding, synthetic aperture processing, correlation, range migration, and range/Doppler algorithms. The second half will focus on information extraction, including digital elevation maps, polarimetric processing, interferometric measurements, and estimation methods. Methods for irregular synthetic arrays, deployed as distributed systems will be discussed, including back projection and tomography. Applications reviewed include monitoring earthquakes, vegetation health, snowpack, and landslides.

The most important rule: *Please take care of yourselves* - do not risk your health or the health of those around you for this class. If *anything in this class* (homework, tests, iClicker, etc.) becomes a problem for you, *get in touch with me*. I will be understanding.

Grading Breakdown:

- Midterm Exam (25%)
- Homework (35%)
- Attendance / Participation (5%)
- Term Project (35%)
 - Project Proposal (1%)
 - Paper Draft (4%)
 - Paper Peer Reviews (3%)
 - Term Paper (15%)
 - Presentation (6%)
 - Presentation Reviews (1%)

Homework: Assignments will be weekly, due at 11:59 PM on Wednesdays. All homeworks are available online, but which part of the homeworks are assigned will be announced on Thursdays in class.

Midterm Exam: The objective of midterm exam is to gauge the ability to use concepts studied in the course. One midterm exam will be scheduled.

Term Project: The objective of the term project is to provide experience in identifying key engineering science issues in environmental signal processing, performing research in the general area of environmental signal processing and related applications, documenting findings, and disseminating them in a professional setting. The project consists of a 7 page (plus references) journal-style paper and seminar where students will deliver conference-style presentations. The term project will be split into multiple assignments:

- Project proposal: The proposal is one paragraph (4-7 sentences) describing the proposed project, what course information will be leveraged, and a plan for the work.
- Paper draft: A 4 page draft. A LaTeX template will be provided.
- Paper peer reviews: Students will review (single-blind) 3 of their peers' drafts.
- Term paper: The term paper is a 6-10 page (plus references) journal-style paper. A LaTeX template will be provided.

- **Presentations:** Students will deliver 15-minute presentations on their work during the last week of class.
- **Presentation Reviews:** Students will review their peers' presentations.

Late Assignments and Resubmissions: The homeworks build upon each other, so homework solutions will be released immediately after homework is due so that you can correct your mistakes and avoid compounding errors. Consequently, late submissions will not be accepted. For prescheduled conflicts, contact the instructor as early as possible. Late presentations will not be accepted.

Regrade Requests: If you believe there has been an error in grading, please contact the professor. Regrades must be requested within one week of the assignment being graded.

Plagiarism: You are expected to do your own work in this class. Simply put, you should own any code or text that you submit to me for a grade.

Acceptable Use of AI in this Class: You may conditionally use AI tools in this course on labs/homework and quizzes, but their use is limited to use as a learning assistant and all final work must be 100% your own. For example, you may ask gen AI for an example of a particular type of C coding problem and break down the solution, or to identify mistakes in your code. You may synthesize what you learned from AI and apply it to your assignments, but you may not use AI to generate any part of your solution. This would constitute a violation of the Honor Code. Additionally, the labs/homework and quizzes are intended to prepare you for the tests, so repeatedly not doing assignments yourself would likely lead to failure on the tests / exams and subsequent failure of the class. If you use gen AI tools for learning assistance on assignments in this class, document your usage with a citation and explanation of how you used AI.

Anonymous Feedback: The ECEE anonymous weblink (<https://www.colorado.edu/ecee/electrical-computer-energy-engineering-feedback>) is for students to provide feedback to the department on this course or any other issue that students would like to bring to the attention of the ECEE department. Student feedback is an important input into the department to improve the course instruction, the degree curriculum, and departmental environment.

Classroom Behavior: Students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote, or online. Failure to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, marital status, political affiliation, or political philosophy. For more information, see the classroom behavior policy (<http://www.colorado.edu/policies/student-classroom-and-course-related-behavior>), the Student Code of Conduct (<https://www.colorado.edu/sccr/media/230>) and the Office of Institutional Equity and Compliance (<https://www.colorado.edu/oiec/>).

Accommodation for Disabilities, Temporary Medical Conditions, and Medical Isolation: If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the Disability Services website (<https://www.colorado.edu/disabilityservices/>). Contact Disability Services at 303-492-8671 or DSinfo@colorado.edu for further assistance. If you have a temporary medical condition, see Temporary Medical Conditions (<https://www.colorado.edu/disabilityservices/students/temporary-medical-conditions>) on the Disability Services website. If you have a temporary illness, injury or required medical isolation for which you require adjustment, please reach out to the instructor.

Preferred Student Names and Pronouns: CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates,

the name that appears on the class roster is the student's legal name.

Honor Code: All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code (<https://www.colorado.edu/sccr/media/229>). Violations of the Honor Code may include but are not limited to: plagiarism (including use of paper writing services or technology [such as essay bots]), cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. Understanding the course's syllabus is a vital part in adhering to the Honor Code.

All incidents of academic misconduct will be reported to Student Conduct & Conflict Resolution: StudentConduct@colorado.edu. Students found responsible for violating the Honor Code (<https://www.colorado.edu/sccr/media/229>) will be assigned resolution outcomes from the Student Conduct & Conflict Resolution as well as be subject to academic sanctions from the faculty member. Visit Honor Code for more information on the academic integrity policy.

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation: CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. University policy prohibits protected-class (<https://www.colorado.edu/oiec/policies/discrimination-harassment-policy/protected-class-definition>) discrimination and harassment, sexual misconduct (harassment, exploitation, and assault), intimate partner abuse (dating or domestic violence), stalking, and related retaliation by or against members of our community on- and off-campus. The Office of Institutional Equity and Compliance (OIEC) addresses these concerns, and individuals who have been subjected to misconduct can contact OIEC at 303-492-2127 or email CUreport@colorado.edu. Information about university policies, reporting options (<https://www.colorado.edu/oiec/reporting-resolutions/making-report>), and support resources (<https://www.colorado.edu/oiec/support-resources>) can be found on the OIEC website (<http://www.colorado.edu/institutionalequity/>).

Please know that faculty and graduate instructors must inform OIEC when they are made aware of incidents related to these policies regardless of when or where something occurred. This is to ensure that individuals impacted receive outreach from OIEC about resolution options and support resources. To learn more about reporting and support for a variety of concerns, visit the Don't Ignore It page (<https://www.colorado.edu/dontignoreit/>).

Religious Holidays: Campus policy requires faculty to provide reasonable accommodations for students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. Please communicate the need for a religious accommodation in a timely manner. In this class, please notify the instructor if you have a conflict as early as possible. See the campus policy regarding religious observances for full details (<http://www.colorado.edu/policies/observance-religious-holidays-and-absences-classes-andor-exams>).

Mental Health and Wellness: The University of Colorado Boulder is committed to the well-being of all students. If you are struggling with personal stressors, mental health or substance use concerns that are impacting academic or daily life, please contact Counseling and Psychiatric Services (CAPS) located in C4C or call (303) 492-2277, 24/7 (<https://www.colorado.edu/counseling/>).

Free and unlimited telehealth is also available through Academic Live Care (<https://www.colorado.edu/health/academiclivecare>). The Academic Live Care site also provides information about additional wellness services on campus that are available to students.