

# ASEN 6519 GNSS For Remote Sensing

Spring 2022

Instructors: Jade Morton in Collaboration with Brian Breitsch, Yang Wang, Lei Liu

Office: Aero N403  
Tel: (303) 492-8630  
Email: [Jade.Morton@Colorado.Edu](mailto:Jade.Morton@Colorado.Edu)

Class Time: Tu Th 8:30-9:45PM  
Lecture Location: Aero N240  
Office hours: Tu Th 10-11AM

## Overview:

This course covers technologies that rely on GNSS signals for remote sensing applications. GNSS receiver signal processing techniques and GNSS signal propagation effects due to interactions with ionosphere, atmospheric, and Earth surface are addressed. Students will learn techniques to process GNSS measurements and to infer ionosphere, atmosphere, and Earth surface properties from real GNSS measurements collected at ground monitoring stations and on LEO satellites. The course will be taught in an inverted classroom style.

## Prerequisites & Eligibility

ASEN 5090 Introduction to GNSS or instructor permission.

## Required Textbook:

There is no required textbook for this course. Reading materials will be provided during the semester.

## Subject Outline

1. Review of GNSS signals, measurement models, error sources, receiver basics (2 week)
2. GNSS receiver carrier tracking: close loop (2 weeks)
3. GNSS receiver carrier tracking: open loop (2 weeks)
4. Tropospheric effects, models, and measurements (2 week)
5. Ionospheric effects, models, and measurements (2 weeks)
6. GNSS radio occultation (1.5 week)
7. GNSS interferometric reflectometry (1.5 week)
8. GNSS reflectometry (2 weeks)

## Assignments

There will be 8 assignments, each is associated with one of the above topics. Students can form 2-person teams. All of the 8 assignments involve software/algorithm development. Deliverables are well-documented and well-organized reports. The software can be developed in Matlab or Python but do not turn them in. The report should include information on data sources, flow charts, and plots showing sample results.

## Final Exam

There will be a final exam testing students understanding of basic concepts covered in the class.

## Grading Policy

Grades on individual assignments and for the overall course are set based on the following criteria:

- A/A-: Demonstrates superior understanding of the material beyond the course requirements, excellent technical work
- B+/B: Demonstrates comprehensive understanding of the material, strong technical work.
- B-: Demonstrates adequate understanding of the material, complete technical work.
- C: Demonstrates barely adequate understanding of the material and minimally sufficient technical work
- D: Poor technical work
- F: Unsatisfactory performance

Grades are allocated as the following:

Assignments (10% for each assignment)	80%
Final exam	20%
Total	100%

### **Classroom Behavior**

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail 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, political affiliation or political philosophy. For more information, see the policies on [classroom behavior](#) and the [Student Conduct & Conflict Resolution policies](#).

### **Requirements for COVID-19**

As a matter of public health and safety, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements and all public health orders in place to reduce the risk of spreading infectious disease. Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to [Student Conduct and Conflict Resolution](#). For more information, see the policy on [classroom behavior](#) and the [Student Code of Conduct](#). If you require accommodation because a disability prevents you from fulfilling these safety measures, please follow the steps in the “Accommodation for Disabilities” statement on this syllabus.

CU Boulder currently requires masks in classrooms and laboratories regardless of vaccination status. This requirement is a precaution to supplement CU Boulder’s COVID-19 vaccine requirement. Exemptions include individuals who cannot medically tolerate a face covering, as well as those who are hearing-impaired or otherwise disabled or who are communicating with someone who is hearing-impaired or otherwise disabled and where the ability to see the mouth is essential to communication. If you qualify for a mask-related accommodation, please follow the steps in the “Accommodation for Disabilities” statement on this syllabus. In addition, vaccinated instructional faculty who are engaged in an indoor instructional activity and are separated by at least 6 feet from the nearest person are exempt from wearing masks if they so choose.

If you feel ill and think you might have COVID-19, if you have tested positive for COVID-19, or if you are unvaccinated or partially vaccinated and have been in close contact with someone who has COVID-19, you should stay home and follow the further guidance of the [Public Health Office](#) (contacttracing@colorado.edu). If you are fully vaccinated and have been in close contact with someone who has COVID-19, you do not need to stay home; rather, you should self-monitor for symptoms and follow the further guidance of the [Public Health Office](#) (contacttracing@colorado.edu).

### **Accommodation for Disabilities**

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](#). 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](#) on the Disability Services website.

### **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 academic integrity policy. Violations of the Honor Code may include, but are not limited to: plagiarism, 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. All incidents of academic misconduct will be reported to the Honor Code ([honor@colorado.edu](mailto:honor@colorado.edu); 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found on the [Honor Code website](#).

### **Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation**

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. The university will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by or against members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or email [cureport@colorado.edu](mailto:cureport@colorado.edu). Information about university policies, [reporting options](#), and the support resources can be found on the [OIEC website](#).

Please know that faculty and graduate instructors have a responsibility to inform OIEC when they are made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about their rights, support resources, and reporting options. To learn more about reporting and support options for a variety of concerns, visit [Don't Ignore It](#).

### **Religious Holidays**

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, you must let the instructors know of any such conflicts within the first two weeks of the semester so that we can work with you to make reasonable arrangements. See the [campus policy regarding religious observances](#) for full details.