

# ASEN 6519 GNSS For Remote Sensing

Spring 2019

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Class Time: Tu Th 12:30-1:45PM  
Lecture Location: ECCR 131  
Office hours: Tu Th 11AM-12:30PM

## Overview:

This special topics course covers technologies that rely on GNSS signals for remote sensing applications. Fundamentals of 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, to retrieve and work with data from processing centers, and 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 a semi-inverted classroom style with conventional lectures followed by inverted-classroom discussion sessions. The course contents will be built around five hands-on research projects.

## Prerequisites & Eligibility

ASEN 5090 Introduction to GNSS is a prerequisite for this course.

## Required Textbook:

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

## Subject Outline

1. Fundamentals of GNSS Signals and Receiver Tracking Loops
2. Ionosphere Effects: TEC and scintillation, ground-based, and radio occultation
3. Troposphere Effects: Radio occultation
4. GNSS Reflections: Ocean surface and land cover

## Assignments

Project topics: There will be 5 project assignments for this course. The topics are:

1. GNSS receiver tracking of simulated and real signals
2. GNSS TEC estimations and ionospheric scintillation observations from ground monitoring stations and RINEX files
3. GPS TEC and ionosphere electron density profiles from radio occultation data
4. Atmospheric profiles retrieval from GPS radio occultation data
5. DDM and Earth surface parameters retrieval from GPS reflection measurements

Project team:

1. Each team should have 3 persons.
2. Team members should vary from one project to next.

Project report: Each team should upload a report for each project to Google drive by the designated deadline. The report should include:

- **Title page:** Project title, team member names and email addresses, date submitted.
- **Project description:** a short summary of the purpose of the project. Should be no more than half of a page.
- **Data sources:** List the source of data used in the project. Describe the data (date collected, duration, location, size, sampling rate, etc.).
- **Software used/developed:** Processing software can be found online, downloaded from data center, or written by team members. If the software is obtained from other sources, list the

source and version. If the software is developed by the team, draw block diagrams in the report. Also upload source codes to designated shared folders.

- **Results.** Include findings and plots. Plots should have illustrative captions.
- **References.** If there are critical information that helped you to complete the project, please include references on where you obtain the information.
- **Peer evaluations.** A summary of each team member's contribution and a quantitative evaluation of the percentage of each team member's share of the project should be provided.

Project grading: The project report will be graded by me and by your peers.

- My grades will count for 50% of the overall grades.
- Each student will sign up to grade another team report. We have 15 students divided into 5 teams in the class. Each team report will be graded by 3 students by a specified due date. These 3 students average grade counts for the other 50% of the overall grades. A rubric will be provided to you for grading.
- The overall grade will be distributed among team members based on the peer evaluations.

### **Final Project Presentation**

Students can select one of the five projects they worked on as their final project presentation. Each team will be given 15 minutes to present their projects during the last class session which is on May 2<sup>nd</sup>.

### **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:

Project assignments (15% for each project)	75%
Final presentation	15%
Class participation	10%
Total	100%

## **Class and University Policies**

Students are required to be familiar with the university policies, which are highlighted below.

**Disabilities:** If you qualify for accommodations because of a disability, please submit to your professor a letter from Disability Services in a timely manner (for exam accommodations provide your letter at least one week prior to the exam) so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities. Contact Disability Services at 303-492-8671 or by e-mail at [dsinfo@colorado.edu](mailto:dsinfo@colorado.edu). If you have a temporary medical condition or injury, see [Temporary Medical Conditions](#) under the Students tab on the Disability Services website and discuss your needs with your professor. This course requires the use of the Zoom conferencing tool which is currently not accessible to users using assistive technology. If you use assistive technology to access the course material, please contact your faculty member immediately to discuss.

**Religious Obligations:** 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. Please review the assignment calendar for this class and notify the instructor by email within the first 2 weeks of class if you have such a conflict. See full details at [http://www.colorado.edu/policies/fac\\_relig.html](http://www.colorado.edu/policies/fac_relig.html).

**Classroom Behavior:** Students and faculty each have responsibility for maintaining an appropriate learning environment. 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. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. For more information, see the policies on [classroom behavior](#) and the [Student Code of Conduct](#).

**Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation:** The University of Colorado Boulder (CU Boulder) is committed to maintaining a positive learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct, discrimination, harassment or related retaliation against or by any employee or student. CU's Sexual Misconduct Policy prohibits sexual assault, sexual exploitation, sexual harassment, intimate partner abuse (dating or domestic violence), stalking or related retaliation. CU Boulder's Discrimination and Harassment Policy prohibits discrimination, harassment or related retaliation based on race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. Individuals who believe they have been subject to misconduct under either policy should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127. Information about the OIEC, the above referenced policies, and the campus resources available to assist individuals regarding sexual misconduct, discrimination, harassment or related retaliation can be found at the [OIEC website](#).

**Honor Code:** All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to [the academic integrity policy](#). Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, resubmission, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code Council ([honor@colorado.edu](mailto:honor@colorado.edu); 303-735-2273). Students who are found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code Council as well as academic sanctions from the faculty member. Additional information regarding the academic integrity policy can be found at the [Honor Code Office website](#).