

# ASEN 5090 Introduction to GNSS

Fall 2017

Class Time: MW 09:30-10:45AM

Location: ECCS 1B28

Instructor:	Professor Y. Jade Morton	Course TA:	Brian Breitsch
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Office hours:	MW 10:45AM-12:15PM		

## Overview:

ASEN 5090 Introduction to GNSS is a core ASEN course for the Astrodynamics and Satellite Navigation Focus Area. It provides an overview of the principles of operation of satellite navigation systems with primary emphasis on the U.S. Global Positioning System (GPS). This course covers the fundamentals of both hardware and algorithms/software aspects of GNSS and is meant for graduate students interested in pursuing further study in GNSS as well as those pursuing specializations in astrodynamics, vehicle systems, remote sensing, communications, and other fields that rely upon GNSS instruments. ASEN 5090 is a prerequisite for advanced ASEN courses including ASEN 6091 GNSS Receivers, ASEN 6090 GNSS Software and Applications, and a new ASEN course on GNSS Remote Sensing, all of which are typically offered in the spring semesters.

## Prerequisites & Eligibility

ASEN 5090 is open to graduate students in Engineering, Physics, Applied Math, Geological Sciences, Geography, and related fields. Advanced undergraduates who are interested in taking the course must get instructor permission. Students are expected to have good problem-solving skills, physics, calculus, vector and matrix math, linear algebra, computer programming, and the ability to write clearly.

## Required Textbook:

Global Positioning System, Signals Measurements, and Performance, **2<sup>nd</sup> Edition** or **revised 2<sup>nd</sup> Edition**, by P. Misra and P. Enge, Ganga-Jamuna Press.

You can order it directly from this website: <http://www.gpstextbook.com/>. There are two different versions of the 2nd edition available that you might find online. Both are fine. You should **NOT** purchase the 1st edition. It is missing a number of sections that we will use.

## Subject Outline

1. GNSS Basics
2. GPS Signals and Receivers
3. Measurements and Errors
4. Position Solutions
5. Applications

## Assignments

There will be 7 homework exercises. The exercises are problems at the end of the textbook chapter and you do **NOT** have to turn them in. Your TA will offer homework solution sessions outside the class time on a regular basis.

There will be 7 project assignments, which will need to be turned in for grading:

1. Pseudorandom code generation
2. Signal acquisition
3. Reference frames conversion
4. GPS satellite orbit calculation using Almanac

5. Ionosphere TEC estimation
6. Troposphere delay modeling
7. Position, velocity, and time solutions

Collaboration is permitted on project assignments. This means that you may discuss the means and methods for solving problems and even compare answers, but you are not free to copy solutions from classmates or from Internet resources. The work that you turn in must be your own--copying is not allowed for any assignments. Students who are caught copying any portion of an assignment will be reported for violation of honor code and may incur both academic and non-academic sanctions.

For each assignment, student will turn in a report and software codes by a marked deadline that is the same for on-campus students and online distance learning students. Late assignments are not accepted except under extenuating circumstances such as a school closure, sudden illness, or unexpected critical work-related deadline. If such an event occurs, you are expected to contact the instructor immediately by phone or email. If you know in advance that you will not be on campus for a due date, you may submit your assignment via D2L or to the TA any time prior to the due date.

### **Final Project**

There will be one final team project. Each team will consist of 4 students. Each team will collect raw GPS receiver measurements and ephemeris over an extended time period; implement navigation processing algorithms to compute receiver position, time, and velocity, apply error correction techniques to generate meter-level accuracy solutions. Each team will submit a report and give a presentation on the project.

### **Exams**

There will be one in-class midterm exam and 4 quizzes. Any type of collaboration or copying on an exam/quizzes constitutes cheating and will result in an F for the course. An honor code violation or accusation report will be filed.

### **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	60%
Final project	15%
Midterm Exam	15%
<u>Quizzes</u>	<u>10%</u>
Total	100%

### **Distance Learning Students**

For distance learning students, the Zoom meeting ID for virtually join this class synchronously is: 375-358-295. You can get connected via three means:

- Join via web browser: <https://cuboulder.zoom.us/j/375358295>
- Join via Zoom app (using meeting ID)
- Join via phone: 1-646-558-8656 or 1-408-638-0968

if you need help with getting Zoom up and running, please visit the following link:

<http://www.colorado.edu/oit/services/conferencing-services/web-conferencing-zoom>

## **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](#).