

## ASEN 5090 INTRODUCTION TO GNSS - SYLLABUS

**Lecture MWF 9:40-10:30 AM, AERO 111 + Zoom**

**Instructor:** Professor Penny Axelrad [Penina.Axelrad@colorado.edu](mailto:Penina.Axelrad@colorado.edu) Phone 303-884-1297 (cell)

**Teaching Assistant:** Alex Conrad [Alex.Conrad@colorado.edu](mailto:Alex.Conrad@colorado.edu)

**Office hours:** (to be scheduled)

### Logistics for Fall 2020 Hybrid Course Modalities

This fall, ASEN5090 will be taught using a mix of in-person, remote, and on-line learning. Students registered in the ASEN5090-010 section are expected to attend the scheduled lectures regularly in person or remotely; however, there is no problem making up a few lectures by watching asynchronously online if you are ill or have other personal reasons for missing class. Each student in ASEN5090-010 **who wishes to attend in person** will have an opportunity to sign up for a regular weekly spot in the classroom. In-person attendance is not required. Students attending class in person are required to complete a health questionnaire before coming to campus. Students registered in the 010B section are not required to attend synchronously with the scheduled lecture times.

### Overview

ASEN 5090 *Introduction to GNSS* is a core Aerospace Engineering Sciences (AES) 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. 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 satellite navigation 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*, 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 2<sup>nd</sup> edition available that you might find online. Both are fine. You should **NOT** purchase the 1<sup>st</sup> edition. It is missing a number of sections that we will use.

### Subject Outline

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

### Assignments

There are 10 homework assignments that range from working assigned problems in the book to a series of assignments that build up to programming a GPS position solution. Collaboration is permitted on these assignments. This means 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 found to be copying any portion of an assignment will be reported for violation of honor code and may incur both academic and non-academic sanctions. For most assignments, students will be encouraged to work in teams of two and submit a joint solution, for which they will both receive the same grade.

Each homework assignment will identify what must be turned in and the deadline for submission, which is the same for both on-campus and distance learning students. All assignments are to be submitted via the Canvas website, accessible through the CU Boulder portal. Up to two late assignments per student will be accepted as described on the course schedule.

### Exams

There will be a midterm exam in week 8 and a final exam due on the assigned date and time. Both exams will be administered as 24-hour take-home exams via Canvas. Each student, whether on-campus or distant, is personally responsible to abide by the CU Honor Code and the exam rules specified on the assignment. Any violation of this requirement including collaboration or copying on an exam constitutes cheating and will result in an F for the course. An honor code violation report will also 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, 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, not satisfactory to fulfill graduate degree requirements
- D Poor technical work
- F Unsatisfactory performance

Final grades will be based on the following weighting

Participation	5	<i>Includes in-class and/or online activities and discussions</i>
Midterm Exam	10	
Final Exam	15	
<u>Assignments</u>	<u>70</u>	
Total	100	

### University Policies

**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 Code of Conduct](#).

**Requirements for COVID-19**

As a matter of public health and safety due to the pandemic, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements, and public health orders in place to reduce the risk of spreading infectious disease. Required safety measures at CU Boulder relevant to the classroom setting include:

- maintain 6-foot distancing when possible,
- wear a face covering in public indoor spaces and outdoors while on campus consistent with state and county health orders,
- clean local work area,
- practice hand hygiene,
- follow public health orders, and
- if sick and you live off campus, do not come onto campus (unless instructed by a CU Healthcare professional), or if you live on-campus, please alert [CU Boulder Medical Services](#).

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 policies on [COVID-19 Health and Safety](#) and [classroom behavior](#) and the [Student Code of Conduct](#). If you require accommodation because a disability prevents you from fulfilling these safety measures, please see the “Accommodation for Disabilities” statement on this syllabus.

Before returning to campus, all students must complete the [COVID-19 Student Health and Expectations Course](#). Before coming on to campus each day, all students are required to complete a [Daily Health Form](#). Students who have tested positive for COVID-19, have symptoms of COVID-19, or have had close contact with someone who has tested positive for or had symptoms of COVID-19 must stay home and complete the [Health Questionnaire and Illness Reporting Form](#) remotely. In this class, if you are sick or quarantined please notify the instructor and your lab/homework partner. You are NOT required to provide any specifics about your illness or to provide a doctor’s note.

**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](mailto: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. Violations of the policy may include: 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 at the [Honor Code Office website](#).

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

The University of Colorado Boulder (CU Boulder) is committed to fostering an inclusive and welcoming learning, working, and living environment. CU Boulder 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 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 [cureport@colorado.edu](mailto:cureport@colorado.edu). Information about the OIEC, university policies, [anonymous reporting](#), and the campus resources can be found on the [OIEC website](#).

Please know that faculty and instructors have a responsibility to inform OIEC when 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 options for reporting and support resources.

### **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. For this class, you are expected to review the course schedule and let the instructor know within the first two weeks of the semester of any such conflicts so that we can work out an accommodation plan.

See the [campus policy regarding religious observances](#) for full details.