

## **Syllabus:**

### **ASEN 6050 – Space Instrumentation**

**Instructor:** Prof. Zoltan Sternovsky, (303) 819-2783, [Zoltan.Sternovsky@colorado.edu](mailto:Zoltan.Sternovsky@colorado.edu)

**Lecture Time:** Tuesday/Thursday 11:30 – 12:45 am

**Location:** AERO N240 for Section 6050-001, Lecture capture for Section 6050-001B

**Office Hour:** TBD

**Webpage:** Canvas: <https://canvas.colorado.edu/>

**Text Books** - none required, reading material will be posted as needed.

#### **Overview**

Developing scientific instruments for space applications requires a team of scientists and engineers working closely together, starting from identifying an outstanding science question, then deriving the measurement requirements, and finally designing and building a unique piece of hardware that will collect the data needed to answer the original science question. One of the challenges in the design process is evaluating the effects of the space environment on the operation and longevity of the instrument. In addition, there is a complex frame of constraints on the hardware, including the cost, mass, and power and data rate limitations, as well as the constraints posed by the mission design and operations. This class is an introductory overview of space instrumentation from the point of view of an 'instrument scientist', who will link the science goals to measurement requirements, select the method of measurement, and define the key characteristic of the of the instrument. There are three common elements to building space instruments: (1) understanding the space environment and how it affects the design and performance of the instrument, (2) knowledge of basic detectors, their principle of operation, capabilities and limitations, and (3) familiarity with measurement techniques and the capabilities of existing instruments. This course reviews the basic and common instruments used on a range of space missions.

#### **Course Outline**

##### **Space environment**

- Vacuum (very low pressure)
- Thermal environment and thermal design
- Solar spectrum and effects on measurements/instruments
- Other sources of radiation
- Galactic rays
- Radiation environment and its effect on measurements/instruments
- Plasma and charged particle environment
- Meteoroid environment

**Review of relevant physical processes:** secondary electron emission (SEE), ion-surface interactions, photoemission, ionization, particle and photon scattering.

**Materials for space instruments:** CTE, outgassing, mass loss, radiation damage, various properties and limitations

**Detectors:**

- Photon detectors
- Particle detectors

**Electronics:** Basics of front-end electronics. Voltage, current and charge measurements, frequency characteristics.

**Space Instruments\***

- Dust detectors and analyzers
- Magnetometers
- UV spectrometers
- IR instruments (thermal imaging, spectrometers)
- Imaging/cameras
- Neutral/ion mass spectrometers
- Plasma instruments (Faraday cups, solar wind analyzers, energetic particle detectors)
- Neutral particles (high and low energy)

\*For each instrument type, we will review the relevant science questions it can answer, the physical principle of the measurement, the basic parameters used to describe performance, and review the design of past instruments and those currently in development.

**Prerequisites**

ASEN 5335 Space Environment.

**Class Format and Assessment/Exams**

Lectures per assigned schedule. There will be weekly or biweekly homework assignments. The final grade will be based on the submitted homework (40%), a mid-term project (20%), and the final *oral* exam (40%). The oral exam will be no longer than 60 minutes and the students will need to demonstrate the conceptual understanding of the material covered.

**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 [classroom behavior](#) policy, the [Student Code of Conduct](#), and the [Office of Institutional Equity and Compliance](#).

### **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. CU Boulder currently requires COVID-19 vaccination and boosters for all faculty, staff and students. Students, faculty and staff must upload proof of vaccination and boosters or file for an exemption based on medical, ethical or moral grounds through the MyCUHealth portal.

The CU Boulder campus is currently mask-optional. However, if public health conditions change and masks are again required in classrooms, students who fail to adhere to masking 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.

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](mailto: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](mailto:contacttracing@colorado.edu)). {Faculty: insert your procedure here for students to alert you about absence due to illness or quarantine. Because of FERPA student privacy laws, do not require students to state the nature of their illness when alerting you. Do not require "doctor's notes" for classes missed due to illness; campus health services no longer provide "doctor's notes" or appointment verifications.}

### **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 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 Student Conduct & Conflict Resolution (honor@colorado.edu); 303-492-5550). Students found responsible for violating the [Honor Code](#) will be assigned resolution outcomes from the Student Conduct & Conflict Resolution as well as be subject to 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. University policy prohibits sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, protected-class discrimination and harassment, and related retaliation by or against members of our community on- and off-campus. These behaviors harm individuals and our community. The Office of Institutional Equity and Compliance (OIEC) addresses these policies, and individuals who believe they have been subjected to misconduct can contact OIEC at 303-492-2127 or email [cureport@colorado.edu](mailto:cureport@colorado.edu). Information about university policies, [reporting options](#), and 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 any issues related to these policies regardless of when or where they occurred to ensure that individuals impacted receive information about their rights, support resources, and resolution 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 case of missed lectures, the students are referred to the recordings via canvas. Final exams will be distributed over a period of a few days using a signup sheet. See the [campus policy regarding religious observances](#) for full details.