Syllabus:
ASEN 6050 – Space Instrumentation

Instructor: Prof. Zoltan Sternovsky, (303) 819-2783, Zoltan.Sternovsky@colorado.edu
Lecture Time: Tuesday/Thursday 8:30 – 9:45 am (meets remotely via zoom)
Zoom link: TBD
Office Hour: TBD
Webpage: https://canvas.colorado.edu/, & shared google drive

Text Books - none required, reading material will be posted as needed. See class web portal.

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

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

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 or injury, see Temporary Medical Conditions under the Students tab on the Disability Services website and discuss your needs with your professor.

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.

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 fostering a positive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct (including sexual assault, exploitation, harassment, dating or domestic violence, and stalking), discrimination, and 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. 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, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

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); 303-492-5550). Students who are 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.

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 cloth face covering (over nose and mouth), especially when unable to maintain a distance of at least 12 feet,
- 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
    - you live on-campus, please alert CU Boulder Medical Services (https://www.colorado.edu/healthcenter/coronavirus-updates/symptoms-and-what-do-if-you-feel-sick)

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 (https://www.colorado.edu/sccr/). For more information, see the policies on COVID-19 Health and Safety (https://www.colorado.edu/policies/covid-19-health-and-safety-policy) and classroom behavior (https://www.colorado.edu/policies/student-classroom-course-related-behavior) and the Student Code of Conduct (https://www.colorado.edu/sccr/). 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 (https://www.colorado.edu/protect-our-herd/how#anchor1). Before coming on to campus each day, all students are required to complete a Daily Health Form (https://www.colorado.edu/protect-our-herd/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 (https://www.colorado.edu/protect-our-herd/daily-health-form). ***In this class, if you are sick or quarantined, alert the instructor about the anticipated absence.***