ASEN 2501, Introduction to Astronautics: Syllabus

Location and Time:

Lecture: AERO 120, M/W 10:40 – 11:30 pm
Lab: AERO 141, T/Th 8:30 – 10:20 or 10:35 – 12:25

Instructors:

Marcus Holzinger: marcus.holzinger@colorado.edu, AERO 459
Jay McMahon: jay.mcmahon@colorado.edu, AERO XX
Katya Arquilla: katya.arquilla@colorado.edu, AERO 315
Robert Marshall: robert.marshall@colorado.edu, AERO 419

Office hours: (will be posted on Canvas)

Teaching Facilitators:

Ashwin Balaji: ashwin.balaji@colorado.edu
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TF Office hours: (will be posted on Canvas)

Some Important Dates: (Full List)
Sept. 5, 2025: Last Day to Drop a Class Without a W Grade
Sept. 19, 2025: Last Day to Withdraw from the Semester with 40% Tuition Assessment & W Grades
October 3, 2025: Last Day for Class Withdrawal (100% tuition, W Grade Posted 11:59 p.m.)

1 Overview

Introduction to Astronautics provides students with a comprehensive foundation across four critical areas of human space activity: systems engineering, astrodynamics, human spaceflight, and space communications/remote sensing. The course begins with systems engineering principles, teaching students how to approach complex space missions through structured design processes, from initial mission objectives through trade studies to final system integration. Students explore diverse mission examples including the Mars Sample Return campaign (systems engineering), orbital mechanics through missions like GPS constellation design (astrodynamics), the International Space Station and Artemis lunar program (human spaceflight), and Earth observation missions such as Landsat and weather satellites (remote sensing).

The curriculum emphasizes the interdisciplinary nature of space missions by demonstrating how astrodynamics fundamentals enable mission design across all domains. Students learn orbital mechanics, launch vehicle requirements, and trajectory design through examples ranging from interplanetary missions like Voyager and New Horizons to human spaceflight missions requiring precise rendezvous and docking capabilities. The human spaceflight module addresses the unique challenges of supporting crew in the space environment, covering physiological effects, life support systems, and risk management through case studies of Mercury, Gemini, Apollo, Space Shuttle, and current commercial crew programs. Space communications and remote sensing topics integrate antenna design, link budget analysis, and sensor systems through missions like the Hubble Space Telescope, Mars rovers, and Earth observation satellites.

Technical depth spans the space environment's impact on design decisions, spacecraft subsystem integration, and mission operations across all four domains. Students gain hands-on experience through laboratory exercises that reinforce theoretical concepts while emphasizing how systems engineering approaches unite diverse technical disciplines. The course prepares students to understand how vacuum, radiation, microgravity, and thermal environments constrain designs for robotic missions like Cassini and Perseverance, crewed missions like Apollo and ISS, and Earth-observing missions like GOES weather satellites and GPS navigation systems. This integrated approach ensures students appreciate both the technical challenges and the systematic methodologies essential for successful space missions.

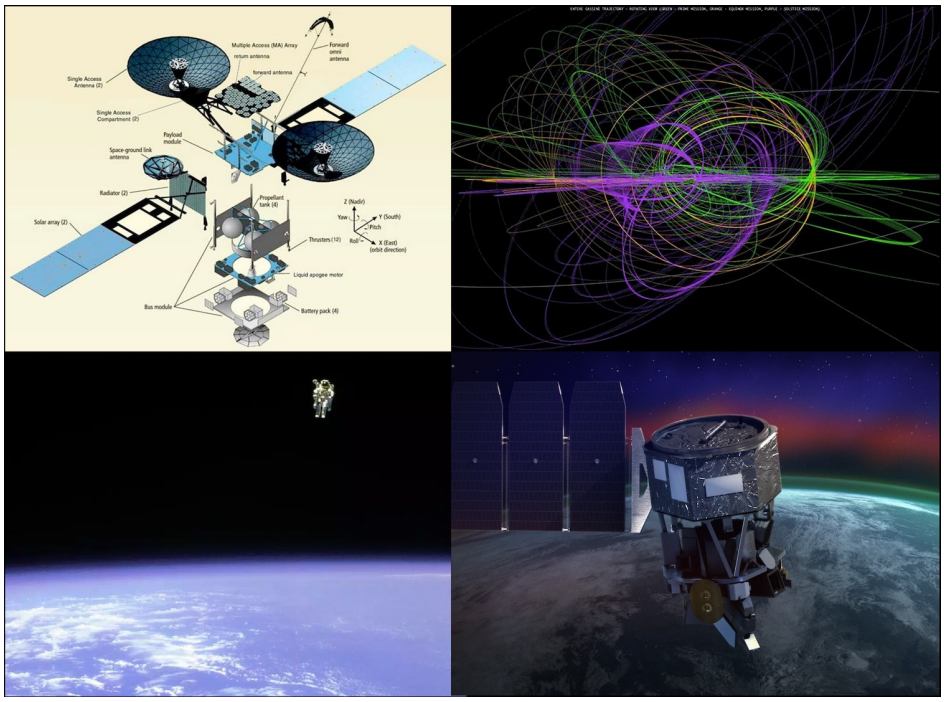

Figure 1: Introduction to Astronautics. i) Anatomy of a spacecraft; ii) orbits around Saturn for the Cassini mission; iii) Bruce McCandless operating the EMV; iv) the ICON mission observing airglow in the ionosphere.

2 Prerequisites & Eligibility

Because ASEN 2501 is a required course for students pursuing BS degrees in Aerospace Engineering Sciences, all seats in this class are initially reserved for ASEN undergraduates and IUT on-track students who have the necessary prerequisites. The course opens to general enrollment after 08/20/2025.

Students are required to have the requisite background in computer science (programming), math, and physics, with minimum grades of C- in each of these courses:

- **Computer Science**: Either ASEN 1030, ASEN 1320, CSCI 1300, CHEN 1310, or ECEN 1310.
- **Math:** Either APPM 1360 or MATH 2300.
- **Physics:** PHYS 1110

3 Reading Materials

Required reading materials for this course are:

- *Understanding Space: An Introduction to Astronautics*, 4th edition, by Jerry Jon Sellers (2015).

You can purchase an ebook through the bookstore here.
Alternatively, you can purchase a hard copy from Space Technology Series (STS) here.

The instructors will assign other reading material throughout the semester and necessary documents will be posted to Canvas.

4 Subject Outline

1. **Module 1:** Systems Engineering and Mission Design
    - Mission objectives and requirements flowdown
    - Mission concepts and architecture development
    - Systems engineering V-model and design reviews
    - Technology readiness levels and risk management
    - Trade studies and design optimization
    - System integration and mission operations
2. **Module 2:** Astrodynamics and Orbital Mechanics
    - Keplerian orbital elements and two-body dynamics
    - Launch mechanics and the rocket equation
    - Common orbit regimes and mission applications
    - Orbital transfers and Hohmann maneuvers
    - Interplanetary trajectories and gravity assists
    - Entry, descent, and landing mechanics
3. **Module 3:** Human Spaceflight and Bioastronautics
    - Physiological effects of the space environment
    - Life support systems and environmental control
    - Crew psychology and behavioral health
    - Human factors in spacecraft design
    - Risk assessment and crew safety systems
    - Exercise countermeasures and medical monitoring
4. **Module 4:** Space Communications and Remote Sensing
    - Space environment effects on communications
    - RF communication systems and antenna design
    - Link budget analysis and system performance
    - Earth observation sensors and remote sensing
    - Space-based telescopes and scientific instruments
    - Ground systems and data processing networks

5 Logistics

1. **Office Hours**: Extensive! Posted on Canvas
2. **Homework Assignments**: Posted on Canvas
3. **Labs**: Thursdays, 8:35am-10:25am (Section 11) or 10:35am-12:25pm (Section 12)
4. **Collaboration**: You will be expected to work with assigned teams on laboratory assignments. Homework, practice exam, and exam questions and solutions may be discussed in the appropriate Canvas discussion board.
5. **Communications**: Please 1) use Canvas for course-related non-private questions, 2) bring your questions to TAs, and/or 3) for questions / issues of a personal nature, please reach out directly to the instructor(s).

6 Grading

Grading will be based on the following course components:

Element	Fraction
Homework Assignments	25%
Lab Assignments	25%
Module Exams	50%

Homework Assignments: There will be 3 homework assignments associated with each module (12 total), each weighted equally.

Lab Assignments: There will be 1 lab assignment in each module, weighted equally. Submission methods and grading rubrics are subject to change - please check the *Announcements* page!

Module Exams: Each module will have 1 exam at the end of the module. During the final exam period, students will have the opportunity to re-take one of module exams of their choice to replace the grade of the initial module exam.

7 University Policies

7.1 Classroom Behavior

Students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote, or online. Failure 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, marital 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.

7.2 Accommodation for Disabilities, Temporary Medical Conditions, and Medical Isolation

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, see Temporary Medical Conditions on the Disability Services website.

If you have a temporary illness, injury or required medical isolation for which you require adjustment, please notify the instructor as soon as possible so that appropriate accommodations can be made. If you are sick or require isolation please notify the instructor of your absence from in-person activities and continue in a completely remote mode, as you are able, until you are allowed or able to return to campus. Please note that for health privacy reasons you are not required to disclose to the instructor the nature of your illness or condition, however you are welcome to share information you feel necessary to protect the health and safety of others within the course.

7.3 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.

7.4 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 (including use of paper writing services or technology [such as essay bots]), 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: studentconduct@colorado.edu. 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. Visit Honor Codefor more information on the academic integrity policy.

7.5 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 protected-class discrimination and harassment, sexual misconduct (harassment, exploitation, and assault), intimate partner abuse (dating or domestic violence), stalking, and related retaliation by or against members of our community on- and off-campus. The Office of Institutional Equity and Compliance (OIEC) addresses these concerns, and individuals who have been subjected to misconduct can contact OIEC at 303-492-2127 or email CUreport@colorado.edu. Information about university policies, reporting options, and support resources including confidential services can be found on the OIEC website.

Please know that faculty and graduate instructors must inform OIEC when they are made aware of incidents related to these policies regardless of when or where something occurred. This is to ensure that individuals impacted receive outreach from OIEC about resolution options and support resources. To learn more about reporting and support for a variety of concerns, visit the Don't Ignore It page.

7.6 Religious Accommodations

Campus policy requires faculty to provide reasonable accommodations for students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. Please communicate the need for a religious accommodation in a timely manner. In this class, students are expected to notify the instructor at least two weeks in advance of the conflict to request special accommodation. If possible, the due dates for homework will be adjusted, and quizzes or exams rescheduled to an alternate date. Students should be prepared for due dates or quiz / exam dates to fall on an *earlier* date than the scheduled date, if that turns out to be the most practical solution.

See the campus policy regarding religious observances for full details.

7.7 Mental Health and Wellness

The University of Colorado Boulder is committed to the well-being of all students. If you are struggling with personal stressors, mental health or substance use concerns that are impacting academic or daily life, please contact Counseling and Psychiatric Services (CAPS) located in C4C or call (303) 492-2277, 24/7.

Free and unlimited telehealth is also available through Academic Live Care. The Academic Live Care site also provides information about additional wellness services on campus that are available to students.

7.8 CU Community of Care

CU Boulder is committed to a community of care in which students are supported by faculty and staff throughout their college journey. You don't have to face academic challenges alone – CU and the college are here to help you learn and succeed in your coursework and campus life. Part of this community of care is your connection to faculty and staff across campus. Our college promotes and hopes you will connect with faculty or staff who may reach out during your educational journey at CU.

7.9 Course Alerts

This course participates in the CU Course Alert process to help connect you with support resources and identify your barriers to success (colorado.edu/engineering-advising/coursealerts). If you receive a course alert for this class, please reach out to schedule a meeting with the instructor to discuss resources and plans to help get you on track.