

**ASEN 3404-001,002 AEROSPACE DYNAMICS & CONTROL**

Syllabus, Fall 2026

**Lectures:**     **3404-001:** T & Th 1:00pm-2:15pm, AERO 120  
                  **3404-002:** T & Th 2:30pm-3:45pm, AERO 120

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**Teaching Assistants:**Zakariya Laouar [Zakariya.Laouar@Colorado.edu](mailto:Zakariya.Laouar@Colorado.edu)Karan Muvvala [Karan.Muvvala@Colorado.edu](mailto:Karan.Muvvala@Colorado.edu)**Teaching Facilitators:**Kirin Kawamoto [kika3780@colorado.edu](mailto:kika3780@colorado.edu)Lucas Becker [lube7171@colorado.edu](mailto:lube7171@colorado.edu)Bijan Jourabchi [bijan.jourabchi@colorado.edu](mailto:bijan.jourabchi@colorado.edu)Evan Karen [evka6412@colorado.edu](mailto:evka6412@colorado.edu)**Office hours:**

- Dr. Axelrad / Dr. Scheeres: Tuesday, 4-5, AERO 453 (Bahls Meeting Room)
- TAs/TFs TBD
- Wednesday & Thursday Study Halls, 5:30-7:00, AERO 114

**Final Exam:** Section 001, Tuesday, Dec 8, 4:30-7:00 pm  
                  Section 002, Wednesday, Dec 9, 1:30-4:00 pm

**Course Web Page:** <http://canvas.colorado.edu>

**Required Textbooks:**

- Howard D. Curtis, *Orbital Mechanics for Engineering Students*, 4th Edition, Elsevier Aerospace Engineering Series 2021. Electronic edition available from CU Libraries.
- Rama K. Yedavalli, *Flight Dynamics and Control of Aero and Space Vehicles*, Wiley 2020. Electronic edition available from CU Libraries.

**Supplementary Textbooks:** (not required)

- Bedford and W. Fowler, *Engineering Mechanics: Dynamics*, 5th Edition Pearson Prentice Hall, Upper Saddle River, NJ, 2008. See Chapter 20 and Appendix C.
- H. Schaub and J. L. Junkins, *Analytical Mechanics of Space Systems*, 4th Ed, AIAA Ed Series, Reston, VA, 2014.
- Larson and Wertz, *Space Mission Analysis and Design*.

**Prerequisites:** (ASEN 2403) or (MCEN 2043) or (CVEN 3111); (APPM 2350) or (MATH 2400); (APPM 2360) or (MATH 2130 and Math 3430).

**Overview and Goals:**

In the sophomore ASEN2403 course, students developed an understanding of the motion of particles and rigid bodies in 2D. In ASEN 3404, we break free of the planar motion bounds to explore the full 3D motion of aerospace vehicles and their control.

The first half of the course focuses on the dynamics of aerospace vehicle orientation or attitude. The main emphasis is on spacecraft, but we also develop and study some models of air vehicle motion, namely quadrotors. Nearly all aerospace vehicles must be accurately pointed to accomplish their mission, yet the natural behavior in orbit or flight is typically uncontrolled tumbling. We will develop a fundamental understanding of these natural 3D rigid body kinematics and dynamics, then explore their role in common methods of passive and active attitude control. Attitude sensor and actuator technology will be discussed, as well as common ways of representing and determining attitude. On the topic of rigid body kinematics, the goal is for students to become comfortable working with attitude representations such as the DCM, 3-2-1 and 3-1-3 Euler angles, and quaternions. On the topic of rigid body dynamics, the goal is for students to understand the use of Euler's equations and the angular momentum vector to describe the motion of a rigid body.

The second half of the course is focused on control theory and its applications to aerospace vehicles. The equations of motion developed in the first half of the course are linearized and generalized to second order linear dynamical systems. Concepts of feedback control are introduced and rigorously analyzed. The connection between Laplace Transforms, control theory and block diagrams will be introduced. The performance and design of control systems is investigated. The goal is for students to gain experience working with simple open-loop and closed-loop flow diagrams and see how they can be created, and how to use transfer function methods to develop single-input-single-output linear controls. This is applied to both aerospace vehicle models and general models.

**Class Format:**

The first half of the course is devoted to vehicle attitude dynamics, led by Dr. Axelrad. The second half focuses on controls, led by Dr. Scheeres. Each section has a similar format:

- Lectures are held Tuesday and Thursday. We expect, but do not require, in-person attendance and participation during class.
- Lectures will be recorded via classroom capture and automatically posted to Canvas so that students who are not able to attend a class can access the material they missed. When the instructor cannot teach in person, the class may be delivered via recording or on Zoom.

- Reading and homework assignments are given weekly. Reading assignments are expected to be completed before the class for which they are assigned.

**Exams: 2 midterms + comprehensive final:**

- Three exams will be administered in this course – two in-class midterm exams and one in-person comprehensive final exam. *We will drop the lowest of the three exam scores.*
- Exams are closed-book with students allowed to bring a pre-specified number of note sheets. Additional information on the exams logistics will be provided prior to each.
- Exam dates:
  - Vehicle attitude dynamics midterm: in-class on Tuesday, October 6.
  - Controls midterm: in-class on Thursday, November 19.
  - Final Exam: in-person during finals week (see first page of syllabus or schedule).
  - Note: in the event of an emergency or campus closure, changes to these dates will be communicated promptly to the entire class.
  - Instructors will provide information for timing and logistics of exams to students with accommodations.
- If a student cannot take one of the three exams due to personal reasons, illness, or an emergency occurring on the exam date, it will count as the dropped exam score.
- If a student cannot take an exam in class at the scheduled time due to a planned sanctioned university activity or religious observance, they must notify the instructor as soon as possible, but no later than two weeks prior to the exam date. The instructor will work with the student to arrange for an appropriate accommodation.
- Exams are to be completed independently. **Any type of 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.
- Students should expect to receive accommodations for a timed assessment (e.g., exam) only if their faculty instructor(s) receive the student's accommodations letter at least 5 business days before the assessment, as a departmental policy, in order to facilitate administering the assessment.

**Homework:**

- Homework problems are regularly assigned throughout the semester, including problems from the textbook and other sources. These problems are designed to help students learn and practice the concepts covered in class.
- Collaboration is permitted on homework. Students may discuss the means and methods for formulating and solving problems and even compare answers, but they are not permitted to copy someone's assignment. Copying material from any resource

(including solution manuals) and submitting it as one's own is considered plagiarism and is an Honor Code violation. Honor code violations on homework will result in a grade penalty and a violation report being filed with the honor code office.

- Homework solutions must demonstrate an understanding of the principles involved by including diagrams, using correct mathematical notation and terminology, explaining the approach, showing the key mathematical steps to obtaining the solution, reporting important intermediate values, and presenting the answer with proper units. These problem-solving steps are critical for developing problem formulation skills and communicating your approach. Students may use mathematical software to aid in computations; however, submission of code alone (even when commented) is not considered a complete solution. Full credit for a problem requires both an accurate written presentation of the working and a correct answer.
- Students are expected to submit professional and readable work.
- Homework must be submitted via Gradescope by the listed deadline.
  - Assignment due dates will be indicated on the schedule and the Canvas page.
  - Students are responsible for ensuring that submitted documents are uploaded correctly, readable, and in the correct location. Corrupt files will not be graded.
  - Late homework will generally not be accepted and will be assigned a grade of zero. In the event of extenuating circumstances, students may contact the instructor to request an exception.
- The lowest two homework scores will be dropped in calculating each student's final homework grade.
- Homework assignments will have several problems, each problem will be graded on a scale of 0-5 pts. Solutions will be provided for all the problems.
- Students who find an error or issue in the grading of their homework or exams may submit a regrade request in Gradescope within 1 week after the assignment has been returned. This request should include a brief description of the error and the relevant rubric item/s. Requests will be reviewed by a member of the instructional team.

### **Acceptable Use of AI in This Class**

We expect students to complete all aspects of homework assignments without the use of AI, because the purpose of these assignments is to provide opportunities for students to develop, practice, and deepen their problem-solving skills.

Students who decide to use AI for assistance with homework are required to state that they used AI and to include the queries submitted and AI response summary, in addition to submitting their own problem solutions.

**Grading:** 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-, C+ Demonstrates good understanding of the material, complete technical work
- C, C- Demonstrates sufficient understanding of the material to proceed to the next level; adequate technical work
- D Poor technical work; does not demonstrate sufficient understanding of the material to proceed to the next level
- F Unsatisfactory performance

- Students who find that an error has been made in grading any of their submissions, may submit a regrade request in Gradescope by the listed deadlines. The regrade request must list a precise and clear reason that a specific rubric item should be applied to the grading of a particular problem.
- Please note: the Canvas gradebook is a guide to ensure that student assignments have been graded and that the grade entered is consistent with the score that has been reported to you. The Canvas gradebook does not contain all information related to the final course grade calculation; the final course grade calculation will follow the procedure outlined in this syllabus.

### ***Grading Policy***

Assignments are graded to an absolute standard designed to indicate your level of competency in the course material. Minor adjustments may be made in the assignment of final grades, but there is a limited amount of “curving” in the course. The final grade indicates each student’s readiness to continue to the next level in the curriculum.

The course grade is primarily dependent on individual demonstrated measures of competency. We mainly rely on exam scores to identify whether a student has achieved the basic level of competency of the material. Homework assignments are also important and are designed to enrich the learning experience and to enhance your individual performance.

Course grading:

|                                                           |     |
|-----------------------------------------------------------|-----|
| Exams (dropping lowest 1 out of 3):                       | 70% |
| Homework and in class work (dropping lowest 2 out of 11): | 30% |

## University Policies

### 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. Understanding the course syllabus is a vital part of adhering to the Honor Code.

All incidents of academic misconduct will be reported to Student Conduct & Conflict Resolution: [StudentConduct@colorado.edu](mailto:StudentConduct@colorado.edu). Students found responsible for violating the Honor Code will be assigned resolution outcomes from Student Conduct & Conflict Resolution and will be subject to academic sanctions from the faculty member. Visit [Honor Code](#) for more information on the academic integrity policy.

### 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](mailto: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.

### Accommodation for Religious Obligations

Instructional faculty members must make every reasonable effort to accommodate all students who have conflicts with scheduled exams, assignment deadlines or required attendance due to a religious observance. Whenever possible, students must notify the instructional faculty member at least two weeks in advance of the expected exam, assignment deadline, or attendance conflict to request an accommodation for religious observance. If the start date of the course is less than two weeks before the date of requested accommodation, students must notify the instructional faculty member on the start date of the course. See the [Student Academic Accommodations for Religious Observances Policy](#) for more information.

**Student Names and Pronouns**

CU Boulder recognizes that students' legal information does not always align with how they identify. If you wish to have a name other than your legal name appear on your instructors' class rosters and in Canvas, or if you wish to choose pronouns to appear on your instructors' class rosters and in Canvas, visit the [Registrar's website](#) for instructions on how to change your personal information in university systems.

**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.

**Additional classroom behavior information**

- [Student Classroom and Course-Related Behavior Policy](#).
- [Student Code of Conduct](#).
- [Office of Institutional Equity and Compliance](#).

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

CU Boulder is committed to fostering a productive 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- or off-campus. Denial of an approved accommodation for disability, religious observance, or pregnancy or pregnancy related medical conditions may be discriminatory.

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 [OIEC@colorado.edu](mailto:OIEC@colorado.edu). Information about university policies, [OIEC reporting options](#), and [OIEC support resources](#) including confidential services can be found on the [OIEC website](#).

Faculty and graduate instructors are required to inform OIEC when someone discloses misconduct regardless of when or where it occurred. This is to ensure that those impacted receive outreach from OIEC about resolution options and support resources. To learn more about reporting and support options for a variety of concerns, visit the [Don't Ignore It page](#).

**Mental Health and Wellness**

The University of Colorado Boulder is committed to supporting students' mental health and overall wellbeing. If personal, academic, or emotional challenges are affecting your wellbeing or success, [Counseling and Psychiatric Services \(CAPS\)](#), is here to help. CAPS offers counseling, referrals, psychiatric care, crisis support, and much more. Visit CAPS in the C4C, or call (303) 492-2277, 24/7.