

ASEN 3700 – Orbital Mechanics/Attitude Dynamics and Control

Syllabus, Fall 2025

Smead Aerospace Engineering
University of Colorado Boulder

Overview

Professor: Vishala Arya (vishala.arya@colorado.edu), AERO 465
Schedule: Monday, Wednesdays, Fridays, 8:30am-9:20am, AERO 120
Credits: 3.0 semester hours
Required Texts: Howard D. Curtis, Orbital Mechanics for Engineering Students, 4th Ed.
Elsevier Aerospace Engineering Series 2021. Electronic edition
available for free through CU Libraries
Final Exam: Monday, 8 December, 7:30pm-10pm, AERO 120 (Optional)
Course Webpage: <http://canvas.colorado.edu>
Prerequisites: ASEN 2703, ASEN 2704, and APPM 2350 or MATH 2400
Office Hours: Mondays, 4-5pm on [Zoom](#) (Meeting ID: [5036019772](#))
Wednesdays, 9:30am-10:30am in AERO 465
Instructional Team: Danny Nguyen (danny.nguyen@colorado.edu)
Office Hours: Fridays, TBA,
Ansh Jha (ansh.jha@colorado.edu)
Office Hours: Mondays, TBA,
Tatsu Kurumiya (tatsuyoshi.kurumiya@colorado.edu)
Office Hours: Wednesdays, TBA,
Study Hall: Tuesdays Thursdays, 5:30pm-7:00pm, AERO 114

Supplementary (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*. Provides useful hardware information
- Vallado, D. A., *Fundamentals of Astrodynamics and Applications*, 4th Ed Microcosm, Hawthorne, CA 2013

General Information

Course Description

Presents the fundamentals of orbital mechanics, 3D rigid body dynamics and satellite attitude dynamics and controls.

Goals and Learning Objectives

Students will learn the basics of spacecraft orbital and attitude motion.

The first component of the course focuses on dynamics and control of the pointing attitude of spacecraft. Nearly all spacecraft must be accurately pointed to accomplish their mission, yet the natural behavior in orbit is typically uncontrolled tumbling. We will develop a fundamental understanding of these natural 3D rigid body kinematics and dynamics, using this to discuss common methods of passive and active attitude control. Attitude sensor and actuator technology will be investigated, as well as common ways of representing and determining attitude. On the topic of rigid body kinematics, the goal is to make the student comfortable with a small subset of attitude representations such as the DCM and the 3-2-1 Euler angles and make them at least aware of other set of coordinates such as other Euler angle sequences and the Euler parameters (quaternions). On the topic of rigid body dynamics, the goal is to expose the students to repeated uses of Euler's equation and the angular momentum vector to develop the system equations of motion. On the topic of control, the goal is to show the students how simple open-loop and closed-loop flow diagrams can be created. This is applied to 1-D constrained rotational motion only.

In the second half of the course, students will study and describe the characteristics of the motion of a particle in space and relative to a single celestial body; this particle could approximate a spacecraft or a celestial object. By the end of this section, students should be able to:

1. Formulate and derive the equations of motion for the two-body problem, approximating the dynamics governing a spacecraft or celestial object in the vicinity of a single celestial body that is modeled with the same gravity field as a point mass.
2. Derive and use the analytical solution to the two-body problem to calculate the state of the object at any location along an orbit that follows a conic section.
3. Derive, numerically solve, and use Kepler's equation to relate the location of the object along its orbit to time.
4. Describe and calculate Keplerian orbital elements that capture the size, shape, and orientation of an orbit in three-dimensional space.
5. Calculate the influence of an impulsive maneuver on the state of a spacecraft and design foundational transfers that connect two distinct orbits.

6. Derive and describe an analytical approximation of the relative motion between two nearby spacecraft with near-circular orbits about a common celestial body.
7. Aspects of Earth orbiting and/or interplanetary mission

Course Format

Class Times. Lecture will be delivered during scheduled course times. Class times are the best and most interactive way to be introduced to the course material. Seeing and hearing new information, processing it, and writing it in your own notes is a great start to learning. Asking questions, solving in-class example problems, and participating in scheduled group discussions are also excellent and diverse learning opportunities.

Recorded Lectures. Recorded lectures are automatically posted by OIT and are available to students. I ***strongly*** recommend students attend in-person as much as possible. Watching a recording in lieu of attending a live lecture is like watching a monochrome recording of a play! If the professor is unable to attend in person, the class may be delivered via recording or on Zoom.

Course Website. There will be a class website on Canvas. All course documents, assignments, schedules, and supplemental documents will be posted to this site throughout the semester. Please check back to see what has been posted. All course announcements outside of the scheduled lecture times will be sent as Canvas announcements.

Study Hall. To improve academic support, provide peer mentorship, and build community for undergraduate students the Aerospace department launched the Undergraduate Study Hall program. During Study Hall course TAs and Engineering Fellows will be available to provide support. These reinforce and are in addition to posted office hours (see Canvas)

Email. We will not respond to questions about homework or example exam problems sent by email. Please post your questions over the class slack in the designated channels. Emails will not be answered over the weekend.

Students should email the instructional team only for logistical, confidential, or emergency purposes. Please include '3700' in the subject line to make sure Prof. Arya's inbox rules correctly file your email for response. Email responses to these types of questions will take approximately 1 business day. Exam regrade requests should follow the procedure identified in that section.

Grading & Assessment

Course grades will be determined using points and the weighting below:

<i>Assessment</i>	<i>Weighting</i>
<i>Homework</i>	25%
<i>Exam 1</i>	25%
<i>Exam 2</i>	25%
<i>Exam 3</i>	25%
<i>Final Exam</i>	Special case

Information on each assessment is given below.

Homework

- Homework problems will be regularly assigned throughout the semester, including both problems from the textbook and more complex problems. These problems are designed to help you learn and practice the concepts covered in class.
- Collaboration is permitted on homework. You may discuss the means and methods for formulating and solving problems and even compare answers, but you 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 outlining the answer with proper units. These problem-solving steps are critical for developing problem formulation skills and communicating your approach. Although you may use mathematical software to aid in computations, code (even when commented) may not be submitted solely as your solution. Full credit for a problem requires both an accurate written presentation of the working and a correct answer.
- Always submit professional and readable work.
- You are not allowed to use artificial intelligence (AI) or machine learning tools (e.g., ChatGPT or Dall-E 2) on any assessment for this course. Each student is expected to complete each assessment without assistance from AI. Use of AI will be treated as a form of academic dishonesty akin to plagiarism or cheating.
- 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.

- No late homework assignments will be accepted. Homework assignments will be due most weeks. All homework assignments will be posted during the first week of the semester. You will be allowed to drop two lowest homework score at the end of the semester.
- Although each homework assignment will have several problems, all problems may not be graded and/or may be weighted differently. However, solutions or answers will be provided to you for all the problems.
- All homework questions must be asked on slack (not private messages to the instructional team) on the general forum under designated channels or discussed in office hours. No homework questions should be emailed to the instructional team - all questions should be asked at office hours or posted to slack. The instructional team will not respond to posts that are posted after 5 PM the day before the homework is due. The instructional team will not answer questions about homework or practice exams outside of business hours.
- If you believe that your homework was graded incorrectly, you have 1 week from when it is returned to request a regrade in Gradescope (except at the end of the semester). This request should include a brief description of the error and the relevant rubric item/s. These requests will be reviewed by a member of the instructional team.

Please note: the Canvas gradebook is a guide to ensure that your 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.

Exams

There will be 4 exams during the semester. Students may use the Final Exam to make up or replace any 2 exams for any reason.

As the Final Exam can be utilized to replace or make up 2 exam grades, there are no make-up Exams or alternative Exam times in this course. Makeup Exams or alternative Exam times will not be granted for any reason. The Final Exam will be used for replacing up to 2 exams grades per the policy stated above. Times for accommodation exams (pre-approved individuals only) will be announced as soon as possible.

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.

Regrade requests must be submitted within 21week of the grade posting to Canvas on Gradescope. This request should include a brief description of the error and the relevant rubric item/s and what you believe the correct score should be.

Final Exam

The final exam is optional: students are not required to take the Final Exam and the Final Exam will not be counted towards your grade on its own. The Final Exam will be used to replace up to 2 Exam grades. If your score on a given Final Exam question is higher than your score for the corresponding Exam, your Exam score will be replaced with your score on that Final Exam question. If your score on a given Final Exam question is lower than your score for that Exam, your Exam score will remain unchanged.

The Final Exam will take place during the university-scheduled final exam time, which is:

Optional Final Exam: Monday, 8 December, 7:30pm-10:00pm, AERO 120 (Optional)

Key Dates

Below is a list of key dates relevant to this course during the semester:

Date	
Sep. 5	Last day to drop without a 'W' and last day to withdraw from the semester
Nov. 24-28	Fall Break
Oct. 28	Last day to drop with a 'W'
Dec. 5	Last day of class
Dec. 8	Final Exam (7:30-10:00pm)

University Policies

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, 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 Infectious Disease

Members of the CU Boulder community and visitors to campus must follow university, department, and building health and safety requirements and all applicable campus policies and public health guidelines to reduce the risk of spreading infectious diseases. If public health conditions require, the university may also invoke related requirements for student conduct and disability accommodation that will apply to this class.

If you feel ill and think you might have COVID-19 or if you have tested positive for COVID-19, please stay home and follow the [guidance of the Centers for Disease Control and Prevention \(CDC\) for isolation and testing](#). If you have been in close contact with someone who has COVID-19 but do not have any symptoms and have not tested positive for COVID-19, you do not need to stay home but should follow the [guidance of the CDC for masking and testing](#).

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 required medical isolation for which you require adjustment, please notify both instructors as soon as possible.

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 (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: 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. Visit [Honor Code](#) for more information on the academic integrity policy.

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 violence (dating or domestic violence), stalking, 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 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](#) 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.

Religious Observances

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, please provide both instructors with a list of these conflicts in the first week of classes.

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

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.