ASEN 5010
Spacecraft Dynamics and Control
Spring 2025

Instructor: Vishala Arya, Office: AERO 465,
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Lectures: TR 8:30-9:45am, AERO 111

Office Hours: M 1:00-2:00pm, W 9:30am-10:30am

TA Information: Karina Patricia Rivera Lopez
Office Hours Location: AERO N453
Office Hours Times: TR 3:00-4:30 pm

Text: H. Schaub and J. L. Junkins, *Analytical Mechanics of Space Systems*, AIAA Education Series, 4th Edition, 2018. (The errata sheet is published on Canvas, please download and refer as needed. It is also available on the web page
http://hanspeterschaub.info/books.html
Course notes supplied on the class Canvas web site along with announcements and assignments.

Canvas Course Web Page: https://canvas.colorado.edu

Overview: Studies the rotational motion of spacecraft, including attitude parameters and spacecraft torques. Applies Euler equations to the attitude motions of simple spacecraft and their stability. Pre: ASEN 3200/3700 or equivalent, or permission of instructor. (3H, 3C)

Goal: To introduce students to the spacecraft attitude dynamics, kinematics, as well as control.

Homework Policy: Each homework assignment is due on the specified due date and must be turned in by the beginning of the lecture on that date. Normally, late homework will not be accepted. Some homework will require simple programs to be created. These can be done in Matlab, Mathematica, or Python. Collaboration and team effort on the graded quizzes is not encouraged. If a homework has been graded incorrectly, you need to see me within 2 weeks of having the homework returned to you.

Exams: There will be a mid-term exam and one comprehensive final exam. If you have exam grading issues, you must see me within 2 weeks of having the exam returned to

you. There will also be one course project which will require you to write a technical report. These reports must be type written and composed as a professional technical report.

Class Attendance: You are expected to attend class. If you need to miss a lecture, it is your responsibility to catch up on the material. Don't go to the instructor to catch up on missed material, speak with class mates and get the notes from them. Campus policy regarding religious observances requires that faculty make every effort to reasonably and fairly deal with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. If you cannot attend a regularly scheduled class, it is up to the student to catch up on the missed material. If you cannot take an exam on a particular day, please let the instructor know at the time the exam is being scheduled.

Make-Up Policy: There are no make-up homework assignments. If you miss the assignment, you get a zero for it. If you can't make an exam or a pressing reason, you need to contact the instructor *one week prior* to the exam date to make your case for a make-up exam. If you can't take the exam for some emergency reason, you still need to notify the instructor prior to the exam. Without prior consent, there will be no make-up exams.

Grading Policy: A conventional ten-point system will be used for grading. If I feel it necessary, I will curve the exam scores to reflect the difficulty level of the problems assigned. Thus, your final assigned scores on each set of papers is your true grade and should be interpreted on a 100 point scale (i.e. A(90-100), B(80-89), C(70-79), D(60-69), F(below 60)). The percent worth of exams and class assignments are:
Homework/Quizzes – 10%
Project – 25%
Mid-Term – 30%
Final Exam – 30%
Mystery Points – 5%

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, then you must contact me at least 24h before the due date.

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.

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. For more information, see the policies on classroom behavior and the Student Code of Conduct, and the Office of Institutional Equity and Compliance.

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.

Note, getting caught cheating can result in a course grade of "F" after the first occurrence.

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 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, provide the instructor with a 2-week warning if you are unable to make an exam date due to a religious observance. If regular class lectures are missed, it is up to the student to make up the material. If a homework or project due date falls on a religious observance, then the student must turn in the assignment the day before.

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.

Outline of Topics Covered

Preliminaries Review of vector notation, Vector Differentiation, particle kinematics

Spacecraft attitude coordinates Euler angles, direction cosine matrix, Euler parameters, classical and modified Rodrigues parameters

Spacecraft equations of motion Derive rotational equations of motion from fundamental momentum principles. Use momentum and energy equations to predict torque-free motion of rigid bodies.

Nonlinear attitude control of rigid bodies Learn how to exploit attitude coordinate descriptions to create regulator and tracking feedback control laws.