

ASEN 5010

Spacecraft Dynamics and Control

Spring 2018

Instructor: Dr. Hanspeter Schaub, Office: ECNT 321, Phone: (303) 492-2767,
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Lectures: TR 8:00-9:15am, ECCS 1B28

Office Hours: M 2:30-4:00pm, W 9:00-10:00am (or by appointment)

TA Information: Mandar Phadnis (Mandar.Phadnis@colorado.edu)
Office Hours Location: George Born Conference Room (ECNT 328)
Office Hours Times: Tuesday (10am–12pm), Thursday (1pm–3pm)

Text: H. Schaub and J. L. Junkins, *Analytical Mechanics of Space Systems*, AIAA Education Series, 3rd Edition, 2014. (please download the errata sheet from the web page <http://hanspeterschaub.info/books.html>)
Course notes supplied on the class blackboard web site.

Course Web Page: <http://learn.colorado.edu>

Zoom Course Video Conference: <https://cuboulder.zoom.us/j/361209956>

Lecture Recording Web Page: Now available through <http://learn.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 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 at the beginning of the lecture. Normally, late homework will not be accepted. Some homework will require simple programs to be created. These can be done in Matlab, Maple, Mathematica, C, or Fortran. See instructor if not sure about the software package being used. 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. 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)). I will assign "+" and "-" grades at my discretion. The exam with your *highest* score will be weighted with an additional 5%. The percent worth of exams and class assignments are:

- Homework/Quizzes – 20%
- Project – 25%
- Mid-Term – 25%
- Final Exam – 25%
- Mystery Points – 5%

Honor Code: All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the [academic integrity policy](#) of the institution. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access, clicker fraud, resubmission, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code Council (honor@colorado.edu; 303-735-2273). Students who are found responsible of violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code Council as well as academic sanctions from the faculty member. Additional information regarding the academic integrity policy can be found at <http://honorcode.colorado.edu>.

As of the fall of 2010, all ASEN students are required to signed an acknowledge form of the honor code which is available at

<http://www.colorado.edu/aerospace/HonorCode.html>

Students with Disabilities If you qualify for accommodations because of a disability, please submit to your professor a letter from Disability Services in a timely manner (for exam accommodations provide your letter at least two weeks prior to the exam) so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities. Contact Disability Services at 303-492-8671 or by e-mail at dsinfo@colorado.edu.

If you have a temporary medical condition or injury, see [Temporary Medical Conditions: Injuries, Surgeries, and Illnesses](#) guidelines under Quick Links at [Disability Services website](#) and discuss your needs with your professor.

Classroom and On-Campus Behavior Students and faculty each have responsibility for maintaining an appropriate learning environment, not only while in class, but *also while working outside of class such as in labs and study areas*. 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 differences of race, color, culture, religion, creed, politics, veterans status, sexual orientation, gender, gender identity and gender expression, age, disability, and nationalities. Class rosters are provided to the instructor with the student's legal name. We will gladly honor your request to address you by an alternate name or gender pronoun. Please advise us of this preference early in the semester so that we may make appropriate changes to our records. For more information, see the [policies on classroom behavior](#) and the [student code](#).

Religious Observances 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 full details at this [web page](#).

Discrimination and Harassment The University of Colorado Boulder (CU-Boulder) is committed to maintaining a positive learning, working, and living environment. CU-Boulder will not tolerate, both in-class and outside of class, acts of sexual misconduct, discrimination, harassment or related retaliation against or by any employee or student. CUs Sexual Misconduct Policy prohibits sexual assault, sexual exploitation, sexual harassment, intimate partner abuse (dating or domestic violence), stalking or related retaliation. CU-Boulders Discrimination and Harassment Policy prohibits discrimination, harassment or related retaliation based on race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. Individuals who

believe they have been subject to misconduct under either policy should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127. Information about the OIEC, the above referenced policies, and the campus resources available to assist individuals regarding sexual misconduct, discrimination, harassment or related retaliation can be found at the [OIEC website](#).

Estimate of Topics Covered

Introduction Review of vector notation, Vector Differentiation, Euler angles

Spacecraft attitude coordinate choices direction cosine matrix, Euler parameters, modified and classical Rodrigues parameters

Spacecraft equations of motion Use momentum and energy equations for rigid bodies

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

Momentum exchange devices Develop equations of motion of satellite with multiple VSCMGs.