ASEN 5052-001, 5052-001B Analytical Astrodynamics

TTh, 10:05-11:20, AERO 111

Instructor: Daniel Scheeres, scheeres@colorado.edu
AERO 454
Office Hours TBD

Introduction to astrodynamics with an emphasis on analytical approaches — alternative to ASEN 5050. General solution of the 2-body problem. Orbital trajectories, transfers, targeting, and time of flight. Orbit perturbations and averaging analysis. Restricted 3-body problem.

Pre-requisite: Undergraduate orbital mechanics course (equivalent to ASEN 3200) or permission of the instructor.

Coursepack:

Selected excerpts from “Orbital Motion in Strongly Perturbed Environments" will be distributed, selected papers will be distributed.

Textbooks:

A.E. Roy, Orbital Motion 4th edition, Institute of Physics Publishing, 2005.

Additional Reference Books:

D.J. Scheeres. “Orbital Motion in Strongly Perturbed Environments: Applications to Asteroid, Comet and Planetary Satellite Orbiters,” Springer-Praxis Books in Astronautical Engineering. 2012. ISBN 978-3-642-03255-4, e-ISBN 978-3-642-03256-1, DOI 10.1007/978-3-642-03256-1

J.E. Prussing and B.A. Conway, Orbital Mechanics, 2nd Ed., Oxford University Press, 2012.

J.M.A. Danby, Fundamentals of Celestial Mechanics, 2nd Ed., Willmann-Bell, 1992.

V.I. Arnold, V.V. Kozlov, A.I. Neishtadt, Mathematical Aspects of Classical and

Grading:

HW problems:	25%
Computational problems:	25%
Mid-term exam:	25%
Final exam:	25%

Topics:

- Principles of orbital mechanics.
- Orbital trajectories, transfers, time of flight.
- Trajectory propagation and targeting.
- Orbit perturbation formulation and analysis.
- Restricted 3-body problem with applications.

Syllabus (Scheeres):

Orbital mechanics

- Formulation of two-body, three-body and n-body problems
- The two-body problem solution
- Elliptical and circular orbits
- Parabolic and hyperbolic trajectories
- 3-D trajectories and orbit elements
- Time of flight and orbit propagation

Orbital transfers

- Impulsive maneuvers
- Lambert's theorem
- 3-D Targeting
- Fuel optimal considerations

Orbit perturbation formulations

- Variation of constants
- Lagrange's Equations
- Gauss' Equations
- Mean elements and averaging

Orbit perturbation analysis

- Effect of non-spherical gravity fields
- Low-thrust trajectories
- Atmospheric drag
- Tidal and third body effects

Restricted 3-body problem with applications

- Derivation of equations of motion

In-Class vs Remote course access:

The following items detail my plans for delivering lectures and office hours, accommodating the restrictions that have arisen from the current pandemic crisis. If the campus transitions to a more restrictive stage, the course has been designed to be able to be run completely remotely. In this case, I will still deliver the lectures at the scheduled time, in general, and keep a Zoom channel open during the lectures. The lectures will also be recorded and available on the Canvas website.

The following guidelines apply to the 001 section. The 001B section is, by design, completely remote. Basically, the 001 students can access the 001B remote section functionality. The 001B students will also be able to dial into the Zoom broadcast if interested.

- Lectures will be delivered, except as noted, in AERO 111.
- All lectures will be recorded and available on the CANVAS website shortly after the lecture.
- I will stream a live Zoom session from my laptop during the lecture, allowing for questions from remote students over the Chat feature.
- Live participation in the course is not required, as all lectures will be available on Canvas. Thus attendance during course lectures is **not** required to successfully participate in the course.
- There is a limit of 21 students allowed in the AERO 111 classroom. We will likely have more than 21 people enrolled in the 001 Section of the course, thus there will need to be some class members that will access the course remotely.
- I will run an anonymous poll of the 001 students to see if anyone wishes to only do the class remotely. Following this, if there are more than 21 students who plan to be “live” in the classroom, I will institute a revolving schedule of live vs remote attendance.
    - Based on the poll information, we do not need to institute a revolving attendance schedule, although this may be revised at a later date.
- When in the classroom, all CU guidelines will be strictly enforced.

Required Syllabus Statements:

Syllabus Statements

Classroom Behavior

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity

(OIEC) at 303-492-2127 or cureport@colorado.edu. Information about the OIEC, university policies, anonymous reporting, and the campus resources can be found on the OIEC website.

Please know that faculty and instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

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