ASEN 6008: Interplanetary Mission Design

Description

The class ASEN 6008: Interplanetary Mission Design covers many topics in the field of astrodynamics that are useful when constructing conventional interplanetary mission designs.
The course focuses on simple ballistic mission designs, such as the interplanetary trajectories of Galileo, Cassini, New Horizons, and the various missions to Venus and Mars. Other types of interplanetary missions will also be briefly explored, such as SOHO's libration point trajectory design.

Outline

1. Review
    a. Two Body Problem
    b. N-Body Problem
    c. Patched Conics
    d. Reference Frames
    e. Sphere of Influence
2. Transfer Orbits
    a. Bi-elliptical
    b. Hohmann
    c. Lambert’s Problem
    d. PorkChop Plots (Type I, II, etc solutions)
    e. Minimum energy solutions
    f. Planetary Ephemerides
3. Gravity Assists
    a. Planetary flybys
    b. 2D, 3D evaluations
    c. Multiple Earth/Planet flybys
    d. Resonant Orbits
    e. Tisserand Plots
4. Departure and Arrival B-Planet Targeting
    a. Definition of B-Plane
    b. Applications of B-Plane in mission design
    c. Targeting
5. Three-Body Problem
    a. Overview, Assumptions, Definitions
    b. Libration Points
    c. Periodic Orbits
    d. Applications to Mission Design
6. Special Topics (as time allows)
    a. Integrators
    b. Navigation
    c. Low-Thrust
7. Various Guest Lectures may be given throughout the semester by professions in the astrodynamics industry highlighting specific missions or topics.

Benefits

Students will learn techniques to design interplanetary trajectories theoretically using simplified models and to take these theoretical trajectories and transition them into more robust trajectories in the ephemeris. Students will also gain experience using mission design software.

Objectives

To provide students with the fundamental concepts and mission design tools for interplanetary spaceflight.

Prerequisites

Courses: ASEN 5050 or equivalent, or the instructor's consent.
Material: We expect you to know the following (or to learn about these very quickly): Particle dynamics and orbital mechanics, Keplerian orbital elements, Conic orbits.

Familiarity with computer programming
Matlab, Python, C, Java, whatever

Access to GMAT software. This can be through a lab on campus, or GMAT can be downloaded to personal computers.

Textbooks

There are no required textbooks for this class. However, these are some suggested texts that are good additions to an astrodynamicist's library:

Vallado, *Fundamentals of Astrodynamics and Applications*. We will probably reference this frequently.

Bate, Roger R., D.D. Mueller, and J.E. White, *Fundamentals of Astrodynamics*, New Dover Publications, New York, 1971.

Brown, Charles D., *Spacecraft Mission Design*, AIAA Education Series, Reston, VA, 1998.

Curtis, H., *Orbital Mechanics for Engineering Students*, Elsevier, Butlington, MA., 2005.

Danby, J.M.A., *Fundamentals of Celestial Mechanics*, 2^{nd} Edition, Willmann-Bell, Inc., Richmond, Virginia, 1992.

Gurzadyan, G.A., *Theory of Interplanetary Flights*, CRC Press, London, 1996.

Meuss, J., *Astronomical Algorithms*, Willmann-Bell, Inc., 1991.

Murray, C.D. and S.F. Dermott, *Solar System Dynamics*, Cambridge University Press, 1999.

Prussing, J. and B. Conway, *Orbital Mechanics*, Oxford University Press, 1993.

Szebehely, V., *Theory of Orbits: The Restricted Problem of Three Bodies*, Academic Press, New York, 1967.

Hardware & Software

Coding software of choice (MATLAB, C, Python, etc).
GMAT software.

Grading Policy

Homework: 30%

- There are typically 9 assignments in the class.

Labs: 30%

- There are typically 6 labs and 1 midterm project. The midterm project is weighted as 2 labs.

Final Project: 40%

- There are several separate submissions for the final project. Due dates and point values will be clearly denoted on the assignment. The Final Project will be announced in March.

There are no exams in this class and there are no dropped assignments. If you don't submit an assignment, it is counted as a zero.

Late Policy

- If it's turned in 1-6 days late: 10% off
- After 1 week, 10% deduction per day
- If it's turned in 8 days late: 20% off, etc.

We'll grant exceptions for good reasons of course! Please do your best to notify us IN ADVANCE if you will be turning something in late (Conference, travel, etc)
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Biography

Kate Davis graduated from the University of Colorado at Boulder with a PhD in Aerospace Engineering in 2009. Since 2009, she has been a research associate for the Colorado Center for Astrodynamics Research where she specializes in the design and analysis of trajectories in the three-body problem. In addition to her work at CCAR, she has worked as a consultant for the Sierra Nevada Corporation (formerly MicroSat Systems). She began teaching Interplanetary Mission Design in 2006.

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