ASEN 6020-001 Optimal Trajectories

Library course
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Final date: TBD

Optimal Trajectories

An introduction to the theory and practice of trajectory optimization. The general theory behind optimization and optimal control will be introduced with an emphasis on the properties of optimal trajectories. The main application will be to space trajectories, but other applications will also be considered.

Pre-requisites are familiarity with basic orbit mechanics and linear systems theory.

Recommended Texts:

Optimal Control with Aerospace Applications, J.M. Longuski, J.J. Guzman and J.E. Prussing, Springer 2014.
ISBN 978-1-4614-8945-0

Analytical Methods of Optimization, D.F. Lawden, Dover 2006.
ISBN 0-486-45034-1

Course Topics:

I. Optimal Orbit Transfers

Basic results for optimal 2 and 3 body transfers involving 2 body orbit mechanics. This will also serve as an introduction to some the basic methods by which parametric trajectory optimization is carried out.

II. Parametric Optimization

General theory for parametric optimization. General derivation of the necessary and sufficient conditions for constrained optimization problems.

III. Optimal Control

Introduction to the variational calculus and its application to the continuous optimal control problem. Derivation of the necessary and sufficient conditions for trajectory optimization and optimal control/guidance of a spacecraft trajectory. This will cover the mathematical background of the optimal control and guidance problem and will be motivated by examples from spaceflight.

IV. Solution Methodologies

Solution methodologies for trajectory optimization, optimal control and guidance problems. This will review some of the methods used to solve these problems, motivating the algorithms by direct appeal to the necessary and sufficiency conditions. The class will be introduced to a few "practical" methodologies for computing optimal trajectories via HW problems and projects.

V. Applications of Optimality

Applications of optimal control to specific problems. Interrelations between dynamics and optimal trajectories.

Homework and Grading:

Select HW reports will be assigned throughout the term, with answers recorded in a HW binder and graded occasionally. (30%)

One “mid-term” exam will be held in November/December, covering the basic theory and principles presented in the course and their applications to simple dynamics problems. (30%)

A single term project will be assigned to each student, to be completed by the end of the semester. Each student will be required to choose, define and solve a particular problem of interest, applying a computational method of interest. The written project report must provide a detailed analysis of the problem, discuss the solution methodology of the problem, and present detailed results for this problem. The student may be required to make a short presentation on their problem in front of the class during the final exam time slot on December 17. (40%)