## AE554 Applied Orbital Mechanics - Fall 2020

Orbital mechanics constitutes the basis of a space mission. The universal laws that govern the motion of the spacecraft informs us about the options for selecting orbits, maneuvers, and mission profiles that impact the eventual spacecraft design. Once a spacecraft is on orbit, orbital mechanics is the foundation for tracking, orbit determination, and computing orbit corrections.

This course aims to provide the students with an understanding of orbital motion of the spacecraft by covering all the necessary topics such as orbit perturbations, trajectories, orbital maneuvers, orbit determination and the spacecraft dynamics. We will be interested in spacecraft's motion to, in, and from space. All of these topics will be discussed with up-to-date application examples for spacecraft orbital motion and mission design. Application examples will be enriched with coding practices and simulations.

### Tentative Weekly Schedule

1) Introduction: A historical perspective and the preliminaries
2) The two-body problem
3) Orbital position as a function of time **(HW1)**
4) Preliminary orbit determination (Part 1)
5) Preliminary orbit determination (Part 2) + Orbit propagation **(HW2)**
6) Orbit estimation (Part 1)
7) Orbit estimation (Part 2) + Orbital maneuvers (Part 1) **(HW3)**
8) Orbital maneuvers (Part 2) **(Short Exam 1)**
9) Interplanetary trajectories
10) Introduction to orbital perturbations + Midterm
11) Relative motion and spacecraft rendezvous **(HW4)**
12) Rigid body dynamics
13) Spacecraft dynamics and attitude stabilization **(HW5)**
14) Launch and rocket dynamics **(Short Exam 2)**

**HWs:** Each homework has a 2-weeks due date. They will be mostly exercise questions to help understanding what has been introduced during the course hours. They will include coding exercises to apply what has been learnt in-class.

**In-class Exams:** Short exams will be asking conceptual questions to be answered within the given duration. They will be on the mentioned weeks. Yet exact date and time may be decided with consensus.

### Reference Material

*Primary*

1) Howard D. Curtis, Orbital Mechanics for Engineering Students (3rd Ed.), Butterworth-Heinemann, Oxford, UK, 2014

*Supplementary*

1) Gerald R. Hintz, Orbital Mechanics and Astrodynamics: Techniques and Tools for Space Missions, Springer International Publishing, Switzerland, 2015
2) David. A. Vallado, Fundamentals of Astrodynamics and Applications, McGraw-Hill, New York, USA, 1997.
3) Vladimir A. Chobotov (Ed.), Orbital Mechanics (3rd Ed.), AIAA, Reston, Virginia, USA, 2002.
4) Alessandro de Iaco Veris, Practical Astrodynamics, Springer International Publishing, Switzerland, 2018
5) Anton. H.J. De Ruiter, Christopher J. Damaren, James R. Forbes, Spacecraft Dynamics and Control: An Introduction, John Wiley & Sons, West Sussex, UK, 2013.

**Grading**

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| 5 x Homework | 30% |
| Mid-term | 30% |
| 2 x Short Exam | 10% |
| Final (Project) | 30% |

**Make-up Policy:**

There are no make-up homework assignments. In case of late submissions -20 pts/day rule is applied for next two days. Later submissions than that are not accepted.

If you will miss an exam, 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.

**Prerequisite(s):**

None. However, the student is expected to have knowledge on linear algebra, rigid body dynamics, and numerical methods (specifically numerical integration).

**Lecture Hours:**

Thursdays 13:40 – 16:30

**Contact:**

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