SD2910 Spacecraft Dynamics 9.0 credits

Rymdfarkosters dynamik

This is a translation of the Swedish, legally binding, course syllabus.

Establishment

Course syllabus for SD2910 valid from Autumn 2019

Grading scale

A, B, C, D, E, FX, F

Education cycle

Second cycle

Main field of study

Mechanical Engineering

Specific prerequisites

Completed degree project on Bachelor level.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

After completing course the student should be able to:

1. Demonstrate broad knowledge and understanding for the scientific basis and proven experience in attitude control of spacecraft, as well as insight into current research and development work.
2. Demonstrate basic methodology and understanding of attitude control of spacecraft, including three-dimensional rotational kinematics, rigid body dynamics and non-linear regulation.
3. Demonstrate the ability to critically and systematically integrate knowledge from previous courses to analyse, assess and deal with complex phenomena, problems and situations within attitude control of spacecraft, even with limited information.
4. Demonstrate the ability to model, simulate, predict and evaluate the rotational motion and stability of spacecraft as well as their passive and active attitude control, even with limited information.
5. Demonstrate ability to clearly present and discuss engineering conclusions and the knowledge and arguments behind them, in dialogue with different groups, orally and in writing, in international contexts.

For the higher grades, the student should also be able to

6. Demonstrate in-depth methodology and understanding of attitude control of spacecraft, including three-dimensional kinematics, rigid body dynamics and non-linear regulation.

Course contents

Part 1: Rigid body kinematics parameterizations in three dimensions: Direction cosine matrix, Euler angles, principal rotation vector, Euler parameters (quaternions), classical and modified Rodrigues parameters.

Part 2: Rigid body dynamics: angular momentum, kinetic energy and moment of inertia in three dimensions, Euler's rotational equations of motion, torque-free rigid body rotation, dual-spin spacecraft, momentum exchange devices and gravity gradient stabilization.

Part 3: Nonlinear spacecraft stability and control: stability definitions, Lyapunov stability, Lyapunov functions, nonlinear feedback control laws, Lyapunov optimal control laws and linear closed-loop dynamics.

Disposition

The lectures briefly introduce the topics and methods used to solve the problems on the problem sheets. The workshops are tutored and the students are strongly encouraged to work in groups. The problem sheets cannot be finished during scheduled hours, so work on problem sheets during non-scheduled hours is required to meet the deadlines.

Course literature

Schaub, H. & Junkins, J. L. Analytical Mechanics of Space Systems, 2nd edition, AIAA Education Series, 2009.

Supplementary material in the form of research articles will be provided.

Equipment

The software Matlab is used throughout the course. Students are expected to use their own computers to solve the problems on the homeworks.

Examination

- PRO1 - Assignments with Oral Presentation, 4.0 credits, grading scale: A, B, C, D, E, FX, F
- TEN1 - Oral Examination, 5.0 credits, grading scale: A, B, C, D, E, FX, F

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

If the course is discontinued, students may request to be examined during the following two academic years.

Other requirements for final grade

The participants are required to complete the following:

- Four problem sheets, related to the four parts of the course. The problem sheets are released at given dates and have to be submitted for correction before given deadlines.
- Oral presentation of selected problem sheet problems in front of class. The presenting students are randomly selected.
- Oral examination on all four parts of the course.

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.