EE-584

Spacecraft design and system engineering

David Emmanuelle, Feusier Gilles

Cursus	Sem.	Type
Electrical and Electronical Engineering	MA1, MA3	Opt.
Space Technologies minor	H	Opt.
Systems Engineering minor	H	Opt.

Language of teaching	English
Credits	5
Session	Winter
Semester	Fall
Exam	During the semester
Workload	150h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
TP	2 weekly
Number of positions	

Summary

The objective of the course is to provide tools and notions for spacecraft design and systems engineering. The course will start with an introduction on systems engineering, then the different subsystems of a spacecraft will be explored. External teachers from industry will bring their expertise.

Content

Introduction

- Highlights of space mission organization and engineering.
- Mission objectives, science objectives, mission architectures.

Systems Engineering

- Introduction to systems engineering: foundation, v-model, reviews, stakeholder analysis, requirements, verification & validation, functional analysis, block diagrams, design trade-offs, design budgets, interface management, tradable parameters.

Conception and Design of Spacecraft

- General description of the space environment and survivability, and spacecraft subsystems including science and instruments.
- Telecommunications, power management and distribution, command and data handling, thermal control, propulsion, structures and mechanisms, configuration, end-to-end information system, flight software.

Introduction to Project Engineering

- Other project considerations for a system engineer: requirement, definition and tracking, spacecraft integration and test, mission operations, reliability and quality assurance, cost and risk management.

Project groups (3-5) of a Space Mission with deliverables and a final report including:

- Mission statement and definition, Project organization, Mission design, System Engineering, Science & instruments.
- Subsystems design and definition: Telecom, Electrical power, Structure and Configuration, C&DH, ADCS, Propulsion, Thermal.
- An executive summary and conference abstract.
- Powerpoint files for oral presentations at various stages.

Practical experience

- Based on the availabilities of the labs, there will some exercise to assemble a cubesat, perform test with the Space

center infrastructure and visit of an operation center...

Keywords

spacecraft, space system, systems engineering, trade-off, space sustainability, space environment, launch operations and space exploration.

Learning Prerequisites

Important concepts to start the course

Orbital mechanics knowledge
Bachelor level in engineering (e.g. electrical, material, mechanical, physics, computer and communication, ...)

Learning Outcomes

By the end of the course, the student must be able to:

- Identify key spacecraft systems and sub-systems
- Structure the main steps of the spacecraft systems engineering process
- Apply systems engineering methods and tools to practical examples
- Formulate the tasks and responsibilities of the system engineer
- Dimension the overall spacecraft system and its sub-systems
- Elaborate a coherent and consistent system design
- Design a space mission
- Integrate constraints due to the space environment

Transversal skills

- Evaluate one's own performance in the team, receive and respond appropriately to feedback.
- Demonstrate a capacity for creativity.
- Use a work methodology appropriate to the task.

Teaching methods

- Interactive lectures
- Collaborative learning
- Project-based learning

Expected student activities

Design work every week, interactive presentations, intermediate report, final report, and final oral presentation.
Exercise in the lab

Assessment methods

Mid-term exam (individual), final report, and oral presentation.
participation in the class and group work

Supervision

Office hours	No

Forum	Yes

Resources

Bibliography

"Space Mission analysis and Design", by W. Larson and J. Wertz
"Space Systems Engineering", by P. Fortescue, G. Swinerd, J. Stark
"NASA Systems Engineering Handbook", NASA SP-2016-6105 Rev2.

Ressources en bibliothèque

- Find the references at the Library

Websites

- https://space.epfl.ch/education/epfl-minor-in-space-technologies/

Moodle Link

- https://go.epfl.ch/EE-584

Prerequisite for

ENG-411 Concurrent Engineering