Course guide
205128 - 205128 - Interplanetary Trajectory Design and Optimisation

Last modified: 16/01/2025

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 748 - FIS - Department of Physics.

Degree: MASTER'S DEGREE IN AERONAUTICAL ENGINEERING (Syllabus 2014). (Optional subject).
MASTER'S DEGREE IN SPACE AND AERONAUTICAL ENGINEERING (Syllabus 2016). (Optional subject).

Academic year: 2024 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: De La Torre Sangrà, David

Others: De La Torre Sangrà, David

PRIOR SKILLS

The students must be familiar with basic Astrodynamics concepts and be fluent in at least one computer language (C, Matlab, Python..) in order to follow the subject.

TEACHING METHODOLOGY

Theoretical lectures and hands-on sessions to solve problems with the help of computers.

LEARNING OBJECTIVES OF THE SUBJECT

The main objective of this course is to delve deeper into the subject of design and optimization of the trajectory and orbits of artificial satellites.
It is the natural extension of the Astrodynamics course (specifically Module 3); providing more in-depth tools and methodologies to deal with the orbital design of interplanetary spacecraft trajectories. The course has a more practical approach, allowing the students to apply all the theory seen in Astrodynamics course into realistic mission scenarios.
The course will consist mainly on applied projects, where the students will need to build the tools required to design an optimal trajectory profile for a mission scenario proposed by the lecturer. The focus of the projects will be on interplanetary mission designs, although geocentric orbital designs may also be introduced.
A combination of theoretical and practical lessons will take the student to an applied knowledge of advanced design of interplanetary trajectories.

STUDY LOAD

Type	Hours	Percentage
Hours large group	27,0	36.00
Self study	48,0	64.00

Total learning time: 75 h

CONTENTS

Module 1: Introduction

Description:
Recap of basic concepts in Astrodynamics.
Mission requirements identification.

Related activities:
Problem I: Solar System Now

Full-or-part-time: 15h
Theory classes: 5h
Self study : 10h

Module 2: Mission Design

Description:
The pork-chop plot map.
Gravitational fly-by.
The Patched-Conics method.
Selection of mission objectives.

Related activities:
Problem II: Swinging by!

Full-or-part-time: 28h
Theory classes: 10h
Self study : 18h

Module 3: Mission Optimisation

Description:
Techniques for interplanetary trajectory optimisation.
Heuristic-based optimisation methods.
Optimisation of multi-gravity assist interplanetary trajectories.
Single-objective vs. multi-objective cases.

Related activities:
Course Project

Full-or-part-time: 32h
Theory classes: 12h
Self study : 20h

GRADING SYSTEM

Problem I (25%)
Problem II (25%)
Project (40%)
Exam (10%)

BIBLIOGRAPHY

Basic:
- Yang, Xin-she. Nature-Inspired Optimization Algorithms. 2014. ISBN 978-0-12-416743-8.
- Vallado, David A; McClain, Wayne D. Fundamentals of astrodynamics and applications. 4a ed. Hawthorne: Microcosm Press, cop. 2013. ISBN 9781881883180.
- Kemble, Stephen. Interplanetary mission analysis and design [on line]. Berlin: Springer, 2006 [Consultation: 30/01/2025]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/3-540-37645-3. ISBN 9786610620562.
- Conway, Bruce A. Spacecraft Trajectory Optimization. Cambridge Aerospace Series, 2010. ISBN 9780511778025.
- Biesbroek, Robin. Lunar and interplanetary trajectories [on line]. Cham: Springer, 2016 [Consultation: 30/01/2025]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-3-319-26983-2. ISBN 9783319269818.

Complementary:
- Szebehely, Victor G. Adventures in Celestial Mechanics. Wiley, 2004.
- Sergeyevsky, A.; Snyder, G. C.; Cunniff, R. A. Interplanetary mission design handbook. Volume 1, part 2: Earth to Mars ballistic mission opportunities, 1990-2005 [on line]. NASA, 1983 [Consultation: 30/01/2025]. Available on: https://ntrs.nasa.gov/api/citations/19840010158/downloads/19840010158.pdf. ISBN 19840010158.
- George, L. E.; Kos, L. D. Interplanetary mission design handbook: Earth-to-Mars mission opportunities and Mars-to-Earth return opportunities 2009-2024 [on line]. NASA, 1998 [Consultation: 30/01/2025]. Available on: https://ntrs.nasa.gov/api/citations/19980210557/downloads/19980210557.pdf.