

Course guide

205366 - 205366 - Introduction to Space Propulsion

Last modified: 25/09/2026

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

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

Academic year: 2026 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: Josep Oriol Lizandra Dalmases

Others: Josep Oriol Lizandra Dalmases

PRIOR SKILLS

Previous concepts include a great variety of subjects and disciplines given in any bachelor's degree in mechanical/aerospace engineering, especially thermodynamics and compressible fluid mechanics.

Taking these basic concepts, the course on Space Propulsion develops most of the scientific formulations necessary for the correct understanding of the thrusters, including some concepts of theory of plasmas. Thus, this field doesn't constitute a previous requirement.

REQUIREMENTS

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TEACHING METHODOLOGY

The course is developed through lectures including theoretical sessions imparted with the aid of PowerPoint presentations and more applicative and more visual sessions with videos and simulations.

LEARNING OBJECTIVES OF THE SUBJECT

This subject aims to provide the student with an overview of the different aspects inherent in the propulsion of spacecraft, especially (but not exclusively) of satellites orbiting the Earth.

Once the course has been completed and passed the student should:

1. Be aware of the needs for, and be able to carry out, a mission optimization focused on impulsive manoeuvres, the computation of velocity increments for several typical missions, accounting for the limited available power of most thrusters, affecting the acceleration attainable by the spacecraft.
2. Know the physics, design and performance of conventional thermal thrusters, based on expansion of (hot) gases, including not only heat sources arising from a chemical reaction, but also others where the primary source is electrical, solar, nuclear, etc.
3. Have a basic knowledge of plasma physics, on which the operating principles of some types of low thrust, high specific impulse propulsion systems are based



STUDY LOAD

Type	Hours	Percentage
Self study	80,0	64.00
Hours large group	30,0	24.00
Hours small group	15,0	12.00

Total learning time: 125 h

CONTENTS

Module 1: Mission Analysis

Description:

General definitions.

Analysis of trajectories based on impulsive manoeuvres.

Determination of optimal trajectories.

Introduction to continuous low-thrust missions.

Specific objectives:

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Related activities:

Exam and/or assignment

Full-or-part-time: 36h

Theory classes: 8h

Laboratory classes: 4h

Self study : 24h

Module 2: Generalities on Thermal Thrusters

Description:

Review of Ideal Compressible Fluid Dynamics in ducts of smooth cross section variation.

Parameters of general use in Rocketry.

Cold Gas Thrusters.

Specific objectives:

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Related activities:

Exam and/or assignment

Full-or-part-time: 18h

Theory classes: 4h

Laboratory classes: 2h

Self study : 12h

Module 3: Chemical Thrusters

Description:

Monopropellant hydrazine thrusters. Properties of hydrazine. General design. Performance as a function of the degree of decomposition of ammonia. Feeding subsystem, valves, tanks, heaters, etc
Bipropellant thrusters

Specific objectives:

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Related activities:

Exam and/or assignment

Full-or-part-time: 36h

Theory classes: 8h

Laboratory classes: 4h

Self study : 24h

Module 4: Introduction to Low Thrust Missions

Description:

Computation of the optimum specific impulse as a function of the required manoeuvre time and the specific mass of the power System

Analytical approaches for the computation of the velocity increment for a low-thrust spiral climb, including a change of plane.
Other missions.

Specific objectives:

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Related activities:

Exam and/or assignment

Full-or-part-time: 14h

Theory classes: 4h

Laboratory classes: 2h

Self study : 8h

Module 5: Introduction to Electric Propulsion Systems

Description:

Generalities on plasma physics.

Introduction to ion engines.

Introduction to Hall Effect Thrusters

Specific objectives:

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Related activities:

Exam and/or assignment

Full-or-part-time: 21h

Theory classes: 6h

Laboratory classes: 3h

Self study : 12h



GRADING SYSTEM

Any academic fraud, plagiarism or use or possession of unauthorised means in an assessment activity leads to a mark of zero (0) for the affected test or assignment. Furthermore, in accordance with the University's regulations, if disciplinary proceedings are initiated the subject is recorded as "Pending Assessment" until a decision is reached. These incidents are managed in accordance with the [Action Framework for Academic Integrity in Assessment at the UPC](#).

Two teamwork assignments, each one with a weight of 40%.

A final exam, with a weight of 20%.

Students with a grade below 5.0 in any of the assignments will be able to take an additional exam on the same day as the final exam in order to compensate for the poor results. The new grade will replace the original only if it is higher. The maximum grade that can be obtained with this additional exam is 5.0.

EXAMINATION RULES.

Instructions provided on Atenea (digital Campus) will specify auxiliary written material (tables, formula sheet, etc)

BIBLIOGRAPHY

Basic:

- Sutton, George P.; Biblarz, Oscar. Rocket propulsion elements. 9th ed. Hoboken, New Jersey: Wiley, 2017. ISBN 9781118753651.
- Goebel, Dan M.; Katz, Ira. Fundamentals of electric propulsion: ion and hall thrusters. Hoboken: Wiley, 2008. ISBN 9780470429273.

RESOURCES

Other resources:

Presentations and exercises available on Atenea.

Manuel Martínez-Sánchez, Notes on Propulsion,

Manuel Martínez-Sánchez, Notes on Space Propulsion,

MIT Open Courseware