UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

Course guide
220057 - EE - Space Engineering

Last modified: 04/09/2025

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 220 - ETSEIAT - Terrassa School of Industrial and Aeronautical Engineering.

Degree: BACHELOR'S DEGREE IN AEROSPACE TECHNOLOGY ENGINEERING (Syllabus 2010). (Compulsory subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: ADRIÀ ROVIRA GARCIA

Others:

PRIOR SKILLS

For the correct understanding of the contents of the course, the student must have a solid base in algebra, trigonometry, geometry, fundamental physics (point dynamics, rigid body dynamics, electromagnetism), heat transfer by conduction and radiation.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE24-GRETA. Adequate and applied knowledge in the engineering of: design and project calculation methods in aeronautics; the use of aerodynamic experimentation and the most significant parameters in theoretical application; handling of experimental techniques, equipment, and measurement instruments specific to the discipline; simulation, design, analysis, and interpretation of experimentation and flight operations; aircraft maintenance and certification systems. (Specific technology module)

Transversal:
2. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 3. Taking social, economic and environmental factors into account in the application of solutions. Undertaking projects that tie in with human development and sustainability.

TEACHING METHODOLOGY

The teaching method consists in:
* classroom lectures
* Classroom sessions of practical work (exercises and problems).
In the classroom lecturers, the teacher shall introduce and explain concepts, contents, methods and results, also with the support of examples, images and videos.
In the practical sessions, the teacher shall guide the students in the application of the theoretical concepts to the solution of problems, and shall do so by stimulating critical reasoning.

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course the student shall be able to analyse and design a space system based on simplified models. The aspects on which the course is focussed are the following:
* Space environment
* Orbital mechanics
* Launch and space propulsion
* Satellite subsystems
* Payload
The course aims at preparing the student for understanding, analysing and designing models of each of the above aspects. The student shall develop and consolidate basic capabilities in the design of a space system.

STUDY LOAD

Type	Hours	Percentage
Hours large group	32,0	21.33
Hours medium group	14,0	9.33
Hours small group	14,0	9.33
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

Introduction

Description:
Introduction to the course: what is space? Past, present and future of the space activities

Specific objectives:
Knowledge of the historical, scientific, and technological context of the subject matter, the stages of spacecraft development, the current status of the conquest and use of space, and future trends.

Related activities:
Ac. 1

Full-or-part-time: 5h
Theory classes: 2h
Self study : 3h

Space environment

Description:
Space environment - Physics of the space environment: Earth's atmosphere (temperature profile, density, pressure, composition), gravitational field, geomagnetic field, ionosphere, radiation structures, Earth's magnetosphere and its interactions with the interplanetary magnetic field and with particles of solar and galactic origin, space debris and micrometeor environment. Environmental effects on satellites: vacuum effects (outgassing), ultraviolet radiation effects, charged particles, the thermal radiative environment, particle radiation absorption (doses and single events), impacts with micrometeors and space debris.

Specific objectives:
Understanding of the physical environment of a satellite in planetocentric or interplanetary orbit, insight into the unfavourable effects that the space environment has on the components and functions of a space vehicle.

Related activities:
Ac. 1, 2, 3, 4

Full-or-part-time: 20h
Theory classes: 4h
Practical classes: 2h
Laboratory classes: 2h
Self study : 12h

Payloads

Description:
*Space economy, market
*Space program, missions, vehicles
*Space systems engineering
*Payloads definition, types
*Space applications

Related activities:
Ac. 1, 2, 3, 4

Full-or-part-time: 12h
Theory classes: 2h
Practical classes: 1h
Laboratory classes: 1h
Self study : 8h

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Orbital mechanics

Description:
Space and time reference systems (time scales and geocentric, heliocentric and satellite-based reference frames). Keplerian orbits and their perturbations (Kepler laws, trajectory equation, energy and angular momentum conservation, orbital elements and relations with position and velocity as functions of time, orbit types, perturbations produced by the Earth's mass distribution, radiation pressure, third body and atmospheric drag. Impulsive orbital meneuvers (rocket equation, in-plane and out-of-plane, one-impulse maneuvers, Hohmann transfers). Interplanetary trajectories (patched conics and gravity assist)

Specific objectives:
Good knowledge of basic orbital dynamics (keplerian and princpal perturbations) and the most common impulsive maneuvers. Knowledge of the patched conics technique for the design of an interplanetary trajectory

Related activities:
Ac. 1, 2, 3, 4

Full-or-part-time: 41h
Theory classes: 8h
Practical classes: 4h
Laboratory classes: 4h
Self study : 25h

Launchers

Description:
Space transportation: launch dynamics (ascent phases, principles and advantages of staging, launch sites and vehicles used by the several space agencies and private industries, launch windows, allowed launch azimuth intervals), space propulsion (types of engines, performance and use), approaches to a planet (B-plane and orbital parameters), atmospheric entry, descent and landing in different planets and atmospheres.

Specific objectives:
Understanding of the dynamics, kinematics and geometry of launch, knowledge of the several types of engines for space propulsion (electrical, chemical, etc.), understanding of the different strategies and way of approaching a planet

Related activities:
Ac. 1, 2, 3, 4

Full-or-part-time: 24h
Theory classes: 6h
Practical classes: 2h
Laboratory classes: 2h
Self study : 14h

Subsystems

Description:
Subsystems of a space vehicle: introduction (anatomy of the space vehicle), electrical power subsystem, thermal control, structure and mechanisms, attitude determination and control, communications subsystem, life support subsystem

Specific objectives:
Understanding of the physics and technology of the several subsystems that make up a space vehicle. Knowledge of their interactions with the space environment.
Capability to evaluate, choose and design the basic elements of the fundamental subsystems of a satellite.

Related activities:
Ac. 1, 2, 3, 4

Full-or-part-time: 48h
Theory classes: 10h
Practical classes: 5h
Laboratory classes: 5h
Self study : 28h

ACTIVITIES

ACTIVITY 1 - THEORY LECTURES

Material:
Lecture notes

Full-or-part-time: 58h
Self study: 30h
Theory classes: 28h

ACTIVITY 2 - ASSIGNMENTS

Full-or-part-time: 44h
Self study: 30h
Practical classes: 14h

ACTIVITY 3 - SUBJECT PROJECT

Description:
Conceptual preliminary design of a space mission.

Full-or-part-time: 44h
Self study: 30h
Laboratory classes: 14h

ACTIVITY 4 - PRESENTATION OF THE SUBJECT PROJECT

Full-or-part-time: 2h
Theory classes: 2h

ACTIVITY 5 - FINAL EXAM

Full-or-part-time: 2h
Theory classes: 2h

GRADING SYSTEM

The overall grade for the course is based on the following assessment measures:
* Final exam (40%)
* Deliverables with assessable practical exercises on the course syllabus (25%)
* Project related to the course (25%)
* Oral presentation of the project (10%)

EXAMINATION RULES.

The test exercises shall be carried out in small groups and in written form.

BIBLIOGRAPHY

Basic:

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- Griffin, Michael D.; French, James R. Space vehicle design. 2nd ed. Reston: American Institute of Aeronautics and Astronautics, 2004. ISBN 1563475391.
- Kaplan, M.H. Modern spacecraft dynamics & control. New York: John Wiley & Sons, 1976. ISBN 0417457035.
- Pisacane, V.L. Fundamentals of space systems. 2nd ed. Oxford: Oxford University Press, 2005. ISBN 0195162056.
- Curtis, Howard D. Orbital mechanics for engineering students. 4th ed. Oxford: Elsevier Butterworth-Heinemann, 2021. ISBN 9780128240250.
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