

Course guide

220057 - EE - Space Engineering

Last modified: 19/04/2023

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: 2023	ECTS Credits: 6.0	Languages: Spanish, English	

LECTURER

Coordinating lecturer: ADRIÀ ROVIRA GARCIA

Others:

PRIOR SKILLS

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.

REQUIREMENTS

For the correct understanding of the contents of the course, it is mandatory to have coursed Physics I, II, III, Algebra, Calculus I, Thermodynamics, Electrical Circuits, Mechanics. Besides, it is recommended to have coursed Propulsion and Gas Dynamics and Heat and Mass Transfer

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 former, 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 dynamics
- * 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. He/she 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

Module 1

Description:

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

Specific objectives:

Knowledge of following issues:

- * historical, scientific and technological context of the subject of the course,
- * phases of the development of the space vehicles
- * current state of the conquest and use of space
- * future trends in space activities

Related activities:

Ac. 1

Full-or-part-time: 5h

Theory classes: 2h

Self study : 3h

Module 2

Description:

Space environment:

- * Physics of the space environment: Earth's atmosphere (temperature, density and pressure profiles, composition), gravitational field, geomagnetic field, ionosphere, radiation structures, terrestrial magnetosphere and interactions with charged particles of solar and galactic origin, space debris and micrometeoroids.
- * Effects of the space environment on satellites: vacuum conditions (outgassing), effects of UV light, charged particles, thermal radiation, absorption of particle radiation (dose and single events), impacts of micrometeoroids and space debris.

Specific objectives:

Understanding of the physical environment of a satellite in planetocentric and 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

Module 3

Description:

Astrodynamics:

- * 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 maneuvers (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 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

Module 4

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

Module 5

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



Module 6

Description:

Payload: remote sensing detectors and optical systems with applications (astrophysics, Earth observation, service)

Related activities:

Ac. 1, 2, 3, 4

Full-or-part-time: 12h

Theory classes: 2h

Practical classes: 1h

Laboratory classes: 1h

Self study : 8h

ACTIVITIES

ACTIVITY 1 - THEORY LECTURES

Material:

Lecture notes

Full-or-part-time: 118h

Theory classes: 28h

Self study: 90h

ACTIVITY 2 - EXERCISE SESSIONS

Description:

Solution of exercises

Material:

Lecture notes

Full-or-part-time: 21h

Practical classes: 14h

Laboratory classes: 7h

ACTIVITY 3 - TEST EXERCISES

Full-or-part-time: 7h

Laboratory classes: 7h

ACTIVITY 4 - PARTIAL EXAM

Full-or-part-time: 2h

Theory classes: 2h

ACTIVITY 5 - FINAL EXAM

Full-or-part-time: 2h

Theory classes: 2h



GRADING SYSTEM

The mark of the course is assessed on the basis of these evaluation items:

- * Final exam (50%)
- * Test exercises (25%)
- * Deliverables (25%)

Low results can be recovered with an additional written exam. All students can do it. The mark obtained will supersede the previous one. This exam will be done on demand, and it will be conducted upon agreement with the student.
of the mark of the partial exam

EXAMINATION RULES.

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

BIBLIOGRAPHY

Basic:

- Fortescue, P. W.; Swinerd, G.; Stark, J. P. W. (eds.). Spacecraft systems engineering [on line]. 4th ed. Chichester: Wiley, 2011 [Consultation : 03/10/2022]. Available on : <https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=693314>. ISBN 9780470750124.
- Tribble, Alan C. The space environment: implications for spacecraft design. Rev. and expanded ed. Princeton: Princeton University, 2003. ISBN 0691102996.
- 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. 3rd ed. Oxford: Elsevier Butterworth-Heinemann, 2014. ISBN 9780080977478.
- Bate, R.R.; Mueller, D.D.; White, J.E. Fundamentals of astrodynamics. New York: Dover, 1971. ISBN 0486600610.