Course guide
300091 - SENV - Space Environment

Last modified: 22/05/2023

Unit in charge: Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 748 - FIS - Department of Physics.

Degree: MASTER'S DEGREE IN AEROSPACE SCIENCE AND TECHNOLOGY (Syllabus 2021). (Optional subject).

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: Gutierrez Cabello, Jorge Luis

Others: Gil Pons, Pilar

PRIOR SKILLS

Good knowledge of Physics and Mathematics.

REQUIREMENTS

None

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE1 MAST21. Apply the scientific method to the study of the particular phenomenology of the aerospace environment.
CE3 MAST21. Carry out, present and publicly defend a research work carried out in a group, on a research topic in the aerospace field.

Generical:
CG2 MAST. Identify and apply the fundamental theoretical, experimental and numerical analyzes currently used in aerospace engineering.
CG3 MAST. Identify and consistently manage the different types of aerospace vehicles and the technological, design and implementation aspects of payloads for scientific missions.

Transversal:
CT1b. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding the mechanisms on which scientific research is based, as well as the mechanisms and instruments for transferring results among socio-economic agents involved in research, development and innovation processes.
CT2. SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.

CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

CT5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

CT6. GENDER PERSPECTIVE: An awareness and understanding of sexual and gender inequalities in society in relation to the field of the degree, and the incorporation of different needs and preferences due to sex and gender when designing solutions and solving problems.

Basic:
CB6. Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context.
CB7. Students will be able to apply the acquired knowledge and their ability to solve problems in new or little explored environments in broader (or multidisciplinary) contexts related to their study area.
CB8. Students will be able to integrate knowledge and face the complexity of formulating judgments based on information that, while being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and opinions.
CB9. Students will be able to communicate their conclusions and the knowledge and ultimate reasons that support them to specialized and non-specialized audiences in a clear and unambiguous manner.
CB10. Students will acquire learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.

TEACHING METHODOLOGY

Classical teaching for the theoretical lectures, short analytical exercises, and numerical simulations (using codes developed by the students as well as simulation suites such as Spenvis, DRAMA, and ORDEM, among others).

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the topic, students will identify the relevant effects of the environment on satellites and will be able to design and implement methods to protect and ensure the mission goals. Furthermore, they will also know the most relevant scientific topics relate to space weather, with a particular emphasis on the terrestrial environment.

STUDY LOAD

Type	Hours	Percentage
Self study	80,0	64.00
Guided activities	13,5	10.80
Hours large group	31,5	25.20

Total learning time: 125 h

CONTENTS

Why is the space environment relevant?

Description:
- Effects on the terrestrial surface
- Effects on spacecraft
- Scientific topics

Specific objectives:
Provide a general understanding of the goals and applications of the topic.

Full-or-part-time: 6h
Theory classes: 2h
Self study : 4h

The gravitational field

Description:
- Static geopotential
- Dynamic geopotential
- Astrodynamical effects

Specific objectives:
Understand the details of the terrestrial gravitational field and its consequences on orbit evolution.

Full-or-part-time: 18h
Theory classes: 4h
Practical classes: 2h
Self study : 12h

The magnetosphere

Description:
- Terrestrial magnetic field
- Other magnetospheres in the solar system
- Applications for ADCS

Specific objectives:
Understand the properties of the magnetosphere (mainly, but not exclusively, the terrestrial magnetosphere) and its effects and uses for spacecraft engineering.

Full-or-part-time: 18h
Theory classes: 4h
Practical classes: 2h
Self study : 12h

The neutral environment

Description:
- The thermosphere
- The exosphere
- Atmospheric loss mechanisms
- Drag upon satellites
- Re-entry

Specific objectives:
Provide a detailed knowledge of the high atmosphere from a scientific and practical point of view.

Full-or-part-time: 18h
Theory classes: 4h
Practical classes: 2h
Self study : 12h

The plasma environment

Description:
- Ionization mechanisms
- The ionosphere
- Ionospheric phenomena: scintillation, dephasing
- Electrostatic and electrodynamic effects on spacecraft

Specific objectives:
Understanding the ionised environment and its effects upon spacecraft.

Full-or-part-time: 18h
Theory classes: 4h
Practical classes: 2h
Self study : 12h

Ionizing radiation

Description:
- Classification of ionizing radiation
- Dosimetry
- Van Allen Belts
- Solar phenomena
- Cosmic rays
- Single event effects
- Protection strategies

Specific objectives:
Describe the ionising radiation environment. Analyse the effects on spacecraft.

Full-or-part-time: 18h
Theory classes: 4h
Practical classes: 2h
Self study : 12h

Meteoroids and space debris

Description:
- Meteoroids origin and flux models
- Space debris
- Hypervelocity impacts
- Protection against impacts

Full-or-part-time: 18h
Theory classes: 4h
Practical classes: 2h
Self study : 12h

Planetary surfaces and atmospheres

Description:
- Lunar environment. The regolith.
- Martian regolith and atmosphere
- Venus
- Gaseous planets
- Outer solar system solid bodies

Specific objectives:
Describe solar system environments and the burden imposed on planetary probes by them.

Full-or-part-time: 11h
Theory classes: 3h
Practical classes: 1h
Self study : 7h

GRADING SYSTEM

Individual bibliographical essay: 30%
Exercises handouts: 30%
Final exam: 40%

BIBLIOGRAPHY

Basic:
- Moldwin, Mark. Introduction to space weather. Second edition. Cambridge: Cambridge University Press, 2023. ISBN 9781108791717.
- Khazanov, George V. Space Weather Fundamentals. Boca Raton, FL: CRC Press, 2016. ISBN 9780367875558.
- Pisacane, Vincent L. The Space environment and its effects on space systems. First edition. Reston, Va.: American Institute of Aeronautics and Astronautics, [2008]. ISBN 9781563479267.