Course guides
220137 - 220137 - An Introduction to Space Systems

Last modified: 22/04/2021

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). (Optional subject).
BACHELOR'S DEGREE IN AEROSPACE VEHICLE ENGINEERING (Syllabus 2010). (Optional subject).

Academic year: 2021 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Enrique García-Berro Montilla

Others:

TEACHING METHODOLOGY

The course is essentially taught delivering theoretical classes. However, students will have to do autonomous learning and they will be required to solve a practical case, chosen by the students themselves. Students will be required to deliver a seminar to explain the team development project. Additionally, students will have to solve and deliver two exercises, under strict deadlines.

In the theoretical sessions I will introduce the basic concepts and emphasize on the fundamental issues, leaving the details for self-study. Students will be guided with some examples of real space missions, emphasizing not only the scientific goals, but also the mission concept, and the detailed implementation to fulfill the science requirements. This will ease the process of acquiring the basic concepts and to acquire a critical perspective of the processes involved in the design and implementation of a space mission. Also, students will have the opportunity of learning how to integrate different subsystems, acquiring in this way a wide perspective of the concepts learned in other subjects of the bachelor.

LEARNING OBJECTIVES OF THE SUBJECT

Learn about the different systems of a space mission.

STUDY LOAD

Type	Hours	Percentage
Self study	45,0	60.00
Hours large group	30,0	40.00

Total learning time: 75 h

CONTENTS

An introduction to space

Description:
Introduction to the topic

Specific objectives:
1. A premier on Cosmos.
2. A journey across our Cosmos.
3. The Solar System.
4. The Solar Neighborhood.
5. Our Galaxy.
6. ...and beyond.

Full-or-part-time: 2h
Theory classes: 1h
Self study : 1h

A historical perspective.

Description:
1. The beginnings.
2. The pioneers
3. Subsequent developements.
4. The space race.
5. Main milestones of unmanned flights.
6. Main milestones of manned flights.
7. European efforts.
8. New players.

Full-or-part-time: 2h
Theory classes: 1h
Self study : 1h

Space environment

Description:
1. Generalities
2. Microgravity
3. Absence of atmosphere
4. Effects of the atmospheric upper layers
5. Effects of vacuum
6. Debris and space garbage

Full-or-part-time: 9h
Theory classes: 2h
Self study : 7h

Mission activities, classification, phases, systems and involvement

Description:
1. Activities
2. Classification
3. Phases
4. Systems
5. Level of involvement

Related activities:
Exercise 2

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

Orbital Mechanics

Description:
1. Simple treatment
2. Lagrangian formulation
3. Types of trajectories
4. Kepler's laws
5. Orbital elements
6. Perturbations
7. Osculating elements
8. Regression of the line of nodes.
9. Precession of the line of apses.
10. Lagrangian points.
11. Formation flight.
12. Reference frames.
13. Ground track.
14. Visibility.

Full-or-part-time: 14h
Theory classes: 5h
Self study : 9h

Orbital maneuvers

Description:
1. Definition and classification
2. Coplanar maneuvers of 1 and 2 impulses
3. Hohman transfer
4. Bi-elliptic transfer
5. Changes of orbital plane
6. Interplanetary trajectories
7. Gravitational assists
8. Orbital rendezvous
9. Launch windows

Full-or-part-time: 8h
Theory classes: 3h
Self study : 5h

Attitude and orbit control system

Description:
1. Preliminaries
2. Requirements and generalities
3. Angular moment, principal axes, torques
4. Equations of motion
5. Torque free motion stability
6. Spin stabilization
7. Satellite classification
8. Sensors
9. Actuators

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

Power system

Description:
1. Mission and tasks
2. Power sources: classification
3. Definitions and general considerations
4. Solar panels
5. Batteries
6. Fuel cells
7. Nuclear energy: disintegration and fission

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

Thermal controls system

Description:
1. Generalities
2. Heat transport mechanisms
3. Thermal balance
4. Active and passive technologies

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

Communications system

Description:
1. Terminology.
2. Communications strategy.
3. Links.
4. Design of the communications architecture.
5. Classification of strategies.
6. Functionality.
7. Criteria for the dessign.
8. Digital communications.
9. Link dessign.
10. Modulation.
11. Multiple access.

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

Payload Data Handling System.

Description:
1. Introduction.
2. Generalities.
3. Definitions.
4. On board/on ground processing.
5. Hardware/Software processing.
6. Architecture.
7. Configuration.
8. Examples.
9. Data compression.

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

Ground and User Segment

Description:
1. Generalities.
2. Structure and organization.
3. Mission Control Center.
4. Scientific Operations Planning Committee.
5. User support system.
6. Control Authority Office.
7. Data format.
8. Databases.

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

Life Support System

Description:
1. Mission and tasks.
2. Overview.
3. An example: the ISS.
4. Physiological effects.
5. Psychological effects.
6. Solutions.

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

Mission operations

Description:
1. Mission and tasks.
2. Technical support.
3. Design of Mission Operations Plan.
4. Key responsibilities.
5. Costs.
6. Operational complexity trade-off.

Full-or-part-time: 3h
Theory classes: 2h
Self study : 1h

Logistics

Description:
1. Generalities.
2. An example: the Space Shuttle.

Full-or-part-time: 2h
Theory classes: 1h
Self study : 1h

GRADING SYSTEM

The final grade will be calculated based on the following rules:

a) 50% from a team development project.
b) 20% from the grades obtained from the individual exercises required in modules 1 and 4.
c) 20% will be assigned based on the quality of the presentations delivered at the seminars.
d) 10% will be assigned according to student?s attitude, assistance, and interest on the matter subject.

BIBLIOGRAPHY

Basic:
- Fortescue, P.; Stark, J.; Swinerd, G. Spacecraft systems engineering. 3rd ed. Chichester ; New York: Wiley, cop. 2003. ISBN 9780471619512.
- Wertz, J. R.; Larson, W. J. Space mission analysis and design. 3rd ed. Dordrecht [etc.]: Kluwer Academic, cop. 1999. ISBN 9781881883104.

Complementary:
- Griffin, M. D.; French, J. R. Space vehicle design. 2nd ed. Reston, VA: American Institute of Aeronautics and Astronautics, Inc, 2004. ISBN 1563475391.