Course guide
205330 - 205330 - Applied Subsystem Design

Last modified: 02/04/2024

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

Degree: MASTER'S DEGREE IN AERONAUTICAL ENGINEERING (Syllabus 2014). (Optional subject).
MASTER'S DEGREE IN SPACE AND AERONAUTICAL ENGINEERING (Syllabus 2016). (Optional subject).

Academic year: 2024 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: MANUEL SORIA GUERRERO

Others: JORGE LUIS GUTIERREZ CABELLO
MANEL SORIA GUERRERO

PRIOR SKILLS

The students must be familiar with basic Space Aerospace Engineering concepts and be fluent in at least one computer language (C, Matlab, Python..) in order to follow the subject.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEEESPAC1. MUEA/MASE: Sufficient applied knowledge of the planning of space missions (specific competency for the specialisation in Space).

TEACHING METHODOLOGY

Theoretical lectures and hands-on sessions to solve problems with the help of computers

LEARNING OBJECTIVES OF THE SUBJECT

The main objective of this course is to deepen the design of different subsystems. A combination of theoretical and practical lessons will take the student to an applied knowledge of the design of space vehicles.
The course is divided into two parts, each of them corresponding to a specific subsystem:
1. Attitude determination and control subsystem (ADCS)
2. Power subsystem

STUDY LOAD

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

Total learning time: 125 h

CONTENTS

Module 1.1: Satellite classification

Description:
Satellite classificationx

Full-or-part-time: 14h 30m
Theory classes: 3h
Laboratory classes: 1h 30m
Self study : 10h

Module 1.2: Attitude representation

Description:
-Euler angles
-Director cosine matrices
-Quaternions
-Rodrigues paràmetres

Full-or-part-time: 24h
Theory classes: 6h
Laboratory classes: 3h
Self study : 15h

Module 1.3: Spacecraft dynamics

Description:
-Euler equations
-Environmental torques
-Gravity-gradient stabilisation

Full-or-part-time: 24h
Theory classes: 6h
Laboratory classes: 3h
Self study : 15h

Module 2.1: Introduction to Power subsystem

Description:
The goals and importance of the power subsystem will be illustrated with several examples: JUNO, Sputnik 1 vs. Vanguard 1, Ingenuity helicopter, Voyager I & II

Full-or-part-time: 10h
Theory classes: 4h
Laboratory classes: 1h
Self study : 5h

Module 2.2: Technologies for Power subsystem

Description:
The main technologies used by the power subsystem will be described
-PV cells: physics, MPPT
-Batteries: general aspects, equivalent circuit, charge & discharge models
-RTG: physics, equivalent circuit
-Power electronics, DC/DC converters
-Effects of space environment

Full-or-part-time: 22h
Theory classes: 4h
Laboratory classes: 3h
Self study : 15h

Module 2.3: Hands-on case study. Juno solar power & trajectory (SPICE)

Description:
The power subsystem of the JUNO spacecraft will be described and analysed using its actual trajectory and attitude from NASA kernels. SPICE library will be used to do so. A thermal model of the JUNO solar panels will be developed.
-Introduction to SPICE
-Trajectory representation
-Occultations
-Solar incidence angle
-Panel temperature estimation (thermal model)

Full-or-part-time: 17h
Theory classes: 4h
Laboratory classes: 3h
Self study : 10h

Module 2.4: Power subsystem project

Description:
The students, working in groups, will choose and develop one project. Three illustrative examples are: Solar tracker for Mars (software), Solar tracker for Mars (hardware), Testing Ingenuity Lithium batteries (Lab). Their work on the project will be presented in class.

Full-or-part-time: 13h 30m
Theory classes: 3h
Laboratory classes: 0h 30m
Self study : 10h

GRADING SYSTEM

1st Part (50%): ADCS
Practical exercises: 15%
Individual project: 15%
Exam: 20%

2nd Part (50%): Power subsystem:
Assignment 1: 10%
Assignment 2 (project): 30%
Class exercises: 10%

Students with a grade below 5.0 in one or both of the parts (ADCS and Power subsystems), will be able to take an additional written exam covering all the subject, that will take place in the date fixed in the calendar of final exams. The grade obtained in this exam will range between 0 and 10, and will replace the part or parts below 5.0 only in case it is higher, up to a maximum of 5.0 points.

BIBLIOGRAPHY

Basic:

- Patel, Mukund R. Spacecraft power systems. Boca Raton: CRC Press, cop. 2005. ISBN 0849327865.
- Hughes, Peter C. Spacecraft attitude dynamics. Mineola, New York: Dover Publications, cop. 2004. ISBN 9780486439259.