UNIVERSIDAD PONTIFICIA ICAI ICADE COMILLAS MADRID

COURSE SYLLABUS
2022-2023

GENERAL INFORMATION

Course information	
Name	Aerospace Electronics
Code	DEA-OPT-438
Degree	IEM
Year	4th
Semester	Spring
ECTS credits	3 ECTS
Type	Elective
Department	Electronics, Control Engineering and Communications
Area	Electronics
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DETAILED INFORMATION

Contextualization of the course

Contribution to the professional profile of the degree

The aim of this course is two folded. On the one hand, the student will understand the space market, its constraints, the main actors and the main products: the spacecraft and science obtained. On the second hand, the student will go through the complete development process of a space electronics product, an equipment typically.
The technologies, tools, methods for designing an electronic equipment will be covered and exercised. This course provides an overview of the electronic systems and equipment found in spacecraft developments such as power, data handling, and instrumentation. The course also intends as well to provide an overview on cost impacts derived from design and development activities. A visit to SENER facilities (2 or 3 sessions), is included. The visit is intended to provide an overview of the development facilities (assembly and testing) but as well to have a working day on a true environment with dedicated engineering support from experts in the area.

Prerequisites

Fundamentals of Electronics (analogue and digital circuits)
Curiosity on space market and products

CONTENTS

Contents

SECTION 1: Introduction to Space Market

This section aims to understand the specific constraints, needs and context of space market

Chapter 1: Introduction to space market

1.1 Overview of S/C types
1.2 Main actors and normative in space product development: constraints and context of space products.

Chapter 2: Constraints and context of space products

2.1 Which are the main factors constraining the development of an electronic component in a space application.
2.2 Comparison between on-ground equipment and on-board equipment. Figures and size of space electronic in comparison to an on-ground equipment

SECTION 2: Introduction to main electrical S/C subsystems and equipment

This section introduces with the power and data handling subsystems. An overview of typical units both on platform and payload (optical instruments) will be provided.

Chapter 3: Power subsystem

3.1 Power subsystem architecture: main elements
3.2 Power subsystem elements sizing: solar panel, batteries, power distribution

Chapter 4: Data handling subsystem and equipment

4.1 Data handling subsystem architecture: main elements (antennas, processor…)
4.2 Typical space application equipment

SECTION 3: Designing electronic equipment for space applications

This section deals with the process, methods and tools to design electronic equipment for space application.

Chapter 5: Specification preparation

5.1 How to prepare a specification – contents – requirements flow down (trace and applicability)
5.2 Requirement classification
5.3 Sizing requirements vs. non-sizing requirements

Chapter 6: Parts selection

6.1 EEE engineering
6.2 EEE parts – how are these selected?

Chapter 7: Design and dependability analysis: introduction

This section deals with the analysis to be carried out to assess a design and its performance

7.1 Worst Case Analysis: concepts and purpose
7.2 Parts Stress Analysis: concept and purpose

SECTION 4: Introduction to electronics equipment development

This section introduces the phases, the methods and tools and the product generated when designing electronic equipment for space applications.

Chapter 8: Development process

8.1 Development vs. design
8.2 Phases and life-cycles. Reviews
8.3 Main elements for the development of an equipment
8.4 Design documentation

Chapter 9: Visit to SENER facilities or equivalent activity (Gaming Activity): Space Electronics Design & Development

Competences and learning outcomes

Competences[1]

General competences

CG2 The ability to manage activities of engineering project described in CG1 competence.

CG3 The capability of adapting to new theories, methods and changing engineering situations based on a sound technical training.

CG4 The capability of solving problems with personal initiative, efficient decision making, critical reasoning and transmitting technical information in the engineering world.

CG5 The capability of understanding (and potentially providing) coarse assessment, trade offs and sizing

CG10 The ability to work in a multilingual and multidisciplinary environment.

Learning outcomes

By the end of the course students should be able to:

RA1. Understand the space environment, market and context.

RA2. Understand the concept and the use of the electronics in the aerospace electronic field: main systems and equipment.

RA3. Provide an overview of the development process of aerospace electronic equipment.

RA4. Understand the main processes and tools used both for requirement engineering and designing.

RA5. Select the main electronics parts for a space qualified electronic design.

RA6. Design a basic electronic circuitry (flightable design).

RA7. Produce a basic functional specification (user side) and the backbone of a complete specification.

RA8. Describe the main analyses to be carried out in order to guarantee the final product.

[1] Competences in English are a free translation of the Spanish version reproduced from the degree's Official Verification Report.

TEACHING METHODOLOGY

General methodological aspects	
The course will promote the student's own activity and involvement as the key factors to achieve the intended skills.	
In-class activities	**Competences**
▪ **Lectures (21,5 hours)**: theory and in-class discussion about problems previously solved at home.	CG5, CG3
▪ **Team project (5 hours):** application of system analysis and research based on acquired knowledge to a specific use case or application	CG4, CG2, CG10
▪ **Mid-term exam (1,5 hour): to** promote continuous work and permit continuous assessment.	–
Out-of-class activities	**Competences**
▪ Review of the material presented in the lectures (12 hours)	CG5, CG3
▪ Personal work on homework assignments (12 hours)	CG5, CG3
▪ Team working on a common project (5 hours)	CG4, CG2, CG10
▪ Visit to plant. Lecture from several senior experts in the field on different areas, such as space missions, costs, guidance and navigation... Visit to the SENER facilities for space equipment development (assembly, manufacturing and testing). Understanding the Space Engineering development environment	

ASSESSMENT AND GRADING CRITERIA

Assessment activities	Grading criteria	Weight
Mid-term exam	▪ Understanding of the theoretical concepts. ▪ Application of these concepts to problem-solving. ▪ Critical analysis of numerical exercises' results.	30%
Continuous evaluation of individual learning evolution	▪ Understanding theoretical aspects and its pragmatic application based on self-study ▪ Preparation of classes ▪ Class participation based on individual contributions	10%
Individual Project report or research paper	▪ Understanding theoretical aspects and application of theory to a design case ▪ Analysis and interpretation of results from problem solving. ▪ Research and autonomy capabilities ▪ Decision making capabilities (line of argument, trade-offs...) ▪ Understanding how to produce the output information	30%
Team Project presentation	▪ Teamwork capacity. ▪ Understanding the development process and the expected outputs ▪ Understanding how to produce the output information ▪ Workload distribution to allow continuous and gradual advance ▪ 15 mins in-class presentation.	30%

GRADING AND COURSE RULES

Grading

Regular assessment

- **The assessment will take into account:**
  - Mid-term: Mid-term exam - (ME)
  - Individual contribution in class based on individual homework (material for this shall be advanced by the lecturer) – (IC)
  - Individual Project report or research paper – (IP)
  - Teamwork project presentation. 2 students project with a 15 mins. In-class presentation – (TP)
- **Grading:**
  - Final grade = ME (30%) + IC (10%) + IP (30%) + TP (30%)

The mark of the final exam must be greater or equal to 3,5 out of 10 points and the mark of the final project must be at least 5 out of 10 points. Otherwise, the final grade will be the lower of the two marks.

Retakes

Lab practice (team work project) mark will be preserved, as well as that of the individual project if they show a passing grade. Otherwise a new project will have to be developed and handed in. In addition, the student will take a final exam. The resulting grade will be computed as follows:

- Final exam: 40%
- Lab practices (teamwork project presentation): 30%
- Final project (individual paper): 30%

As in the regular assessment period, in order to pass the course, the mark of the final exam must be greater or equal to 4 out of 10 points and the mark of the final project must be at least 5 out of 10 points. Otherwise, the final grade will be the lower of the two marks.

Course rules

- Class attendance is mandatory according to Article 93 of the General Regulations (Reglamento General) of Comillas Pontifical University and Article 6 of the Academic Rules (Normas Académicas) of the ICAI School of Engineering. Not complying with this requirement may have the following consequences:
  - Students who fail to attend more than 15% of the lectures may be denied the right to take the final exam during the regular assessment period.
  - Regarding laboratory, absence to more than 15% of the sessions can result in losing the right to take the final exam of the regular assessment period and the retake. Missed sessions must be made up for credit.
- Students who commit an irregularity in any graded activity will receive a mark of zero in the activity and disciplinary procedure will follow (cf. Article 168 of the General Regulations (Reglamento General) of Comillas Pontifical University).

WORK PLAN AND SCHEDULE[2]

In and out-of-class activities	Date/Periodicity	Deadline
Reviewing and self-study using textbooks	After each in-class session	
Problem-solving assignments (quizzes)	After specific sections of the course	
Mid-term exam preparation		TBD
Team work presentation		Week 15
Visit to SENER facilities.		TBD

STUDENT WORK-TIME SUMMARY			
IN-CLASS HOURS			
Lectures	Problem solving and team project presentation	Visit to plant	Assessment
18	5	6	1
OUT-OF-CLASS HOURS			
Student work on the lectures and self-sutdy	Student work on quizzes	Team work	Individual project preparation
26	8	14	12
		ECTS credits:	3 (90 hours)

BIBLIOGRAPHY

Basic bibliography

- ECSS Standards – Open distribution
- Specific aerospace notes and papers

Complementary bibliography

- Space Mission Analysis and Design. James R. Wertz & Wiley J. Larson – Third Edition

[2] A detailed work plan of the subject can be found in the course summary sheet (see following page). Nevertheless, this schedule is tentative and may vary to accommodate the rhythm of the class.

		IN-CLASS ACTIVITIES			OUT-OF-CLASS ACTIVITIES				LEARNING OUTCOMES
TOPIC	**Week**	**h/w**	**LECTURE & PROBLEM SOLVING**	**ASSESMENT**	**h/w**	**SELF-STUDY**	**LAB PREPARATION AND REPORTING**	**OTHER ACTIVITIES**	**Learning Outcomes**
Course presentation and Introduction to space market	1 & 2	2,5	Course presentation and Introduction to space market		1	Review and self-study (3h)			RA1
Main electrical and electronic systems and equipmentes in an S/C: Power S/S	2 & 3	4,5	Main electrical and electronic systems and equipmentes in an S/C Power S/S		3	Review, self-study and problem-solving (4h)			RA2
Main electrical and electronic systems and equipmentes in an S/C: Data handling S/S and equipments	4 & 5	3	Main electrical and electronic systems and equipmentes in an S/C: Data handling S/S and equipments		2	Review, self-study and problem-solving (4h)		Project Team-preparation (1h)	RA2
Power S/S sizing - In class activity Equipment sizing - In class activity	6	2	Power S/S sizing - In class activity Equipment sizing - In class activity		1	Review, self-study and problem-solving (5h)		Project Team-preparation (1h)	RA2
Requirement engineering: process and tools Specification preparation	7	2	Requirement engineering: process and tools Specification preparation		4	Review, self-study and problem-solving (6h)		Project Team-preparation (2h)	RA3, RA4
Mid-Term Exam	8	1,5	Requirement engineering: process and tools Specification preparation		4			Project Team-preparation (2h)	RA3, RA4
Detailed design: Components selection Electronic parts engineering	9	2	Detailed design: Components selection Electronic parts engineering	Mid-term exam (1h)	1	Review and self-study (2h)		Project Team-preparation (2h)	RA5, RA6
Work flow at Industry - isit to facilities (SENER)	10	2	Industrial day at SENER. Desing/development cases and supply chain overview.		2		Individ. Paper preparation (3h)		RA6, RA8
Work flow at Industry - isit to facilities (SENER)	11	2	Industrial day at SENER. Desing/development cases and supply chain overview.		2		Project Team-preparation (1,5h) Individ. Paper preparation (3h)		RA6, RA8
Work flow at Industry - isit to facilities (SENER)	12	2	Industrial day at SENER. Desing/development cases and supply chain overview.		2		Project Team-preparation (1,5h) Individ. Paper preparation (3h)		RA1, RA6, RA8
Equipment development cycle: phases, tools and facilities, design metodology, design documentation	13	2,5	Equipment development cycle: phases, tools and facilities, design metodology, design documentation		2	Review and self-study (2h)	Project Team-preparation (3h) Individ. Paper preparation (3h)		RA3
Final Presentations (2h)	14	2	Final Presentations (2h)		2				RA9