Universidad de Alcalá

TEACHING GUIDE

Aerospace Systems Engineering

Master in
Telecommunication Engineering

Universidad de Alcalá

Academic Year 2021/2022

2nd Year - 2nd Semester

Approved by the School Board on July 6, 2021

TEACHING GUIDE

Course Name:	**Aerospace Systems Engineering**
Code:	**201830**
Master in:	**Telecommunication Engineering**
Department and area:	**Automática** **Arquitectura y Tecnología de Computadores**
Type:	**Optional (Specialized)**
ECTS Credits:	**6.0**
Year and semester:	**2nd Year, 2nd Semester**
Teachers:	Por definir
Tutoring schedule:	Consultar al comienzo de la asignatura
Language:	Spanish/ English Friendly

1. COURSE SUMMARY

The course is aimed to provide students with the knowledge and skills necessary to address the specification, design, construction, verification, validation, and project documentation of aerospace systems. The methods and techniques used in the various phases of project development, including standards in the field of study, and the disciplines of Engineering, Quality and Project Management are addressed. The different phases of a project in the field of space are studied, from the call for proposals from the scientific community to the nominal operation of the system in flight. Milestones to be achieved in each of the phases, roles to be performed in the engineering and development scenarios are defined. The course also deals with the management of the whole process: work planning, estimating resources, provision of mechanisms for monitoring, control and quality assurance, and compliance with the deadlines to guarantee the success of the project.

To illustrate these concepts example of development projects in real scientific satellites are taken.
The course will be structured into four thematic blocks. First the special features related to the space environment that largely determine the type of solutions used in aerospace systems are presented. Then, in the second block, management is addressed in aerospace projects, presenting the different phases that compose it and their relationship and dependence between them. In the third block, typical solutions used in aerospace systems are addressed, including technical hardware, management techniques, data processing and aspects of mechanical and thermal design. Finally, in the fourth block, the verification and validation techniques, required in these environments to guarantee reliability and safety requirements, are studied.

2. SKILLS

Basic, Generic and Cross Curricular Skills.

This course contributes to acquire the following generic skills, which are defined in the Section 3 of the Annex to the Orden CIN/355/2009:

en_CGT1 - Skill of analysis and synthesis.

en_CGT2 - Skill of organization and planning.

en_CGT3 - Skill to analyze and search for information from diverse sources

en_CGT4 - Skill to make decisions.

en_CGT5 - Skill to adapt to new situations.

en_CB6 - To have and understand knowledges that provide a basis or opportunity to be original in the development and/or application of ideas, often in a research context

en_CB7 - That students know how to apply the acquired knowledge and problem-solving abilities in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.

en_CB8 - That students be able to integrate knowledge and face the complexity of making judgements based on incomplete or limited information that includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgements.

en_CB9 - That students be able to communicate their findings and the ultimate knowledge and reasons behind them to specialized and non-specialized audiences in a clear and unambiguous manner.

en_CB10 - That students have the learning skills that will enable them to continue studying in a way that will be largely self-directed or autonomous.

en_CT1 - Troubleshooting skill

en_CT2 - Ethical commitment to work

en_CT3 - Skill to work in a team

en_CT4 - Working in a pressure environment

en_CT5 - Motivation for quality

en_CT6 - Ability to integrate knowledge from different scientific areas

Learning Outcomes

After succeeding in this subject the students will be able to:

RA1. Recognize, interpret and apply the main restrictions, standards and design regulations, legislation and problems associated with space engineering and security and defense systems.

RA2. Specify, design, build, verify and document the hardware and software used in aerospace and defense systems.

RA3. Use the techniques of guidance, perception and navigation strategies to guide unmanned vehicles.

RA4. Knowledge and understanding of the social, health and safety, environmental, economic and industrial implications of engineering practice.

RA5. Knowledge and critical understanding of economic, organizational and management issues (such as project management, risk and change management).

RA6. Ability to manage complex technical or professional activities or projects that require new approaches, assuming responsibility for the decisions taken.

RA7. Ability to function effectively in national contexts as a member or leader of a team that can be made up of people from different disciplines and levels, and who can use virtual communication tools.

3. CONTENTS

Contents Blocks	Total number of hours
Part 1: **• Presentation of the specific aspects of space projects. Normalization and standards. Typical phases of a space project.** **• Business opportunities with the European Space Agency Types of programs and participation process in ESA's ITTs.**	**12 hours**
Part 2: • Management of Spatial Projects. Life cycle of a project. Preparation of proposals. Processes to follow in Project Management. Risk management. • Practical examples of Engineering and Management of space projects	16 hours
Part 3: • Principle of electrical design of flight units.Requirements and restrictions. • Considerations applicable to mechanical and thermal design in the field of design and manufacture of flight units • Main effects and risks on electronic components. Reliability mitigation and improvement techniques • RAMS. Mathematical models. Parts, Materials and Processes. Reconfiguration principle. Programmable devices.	12 hours
Part 4: • Planning and development of test plans. Procedures AIV. Test equipment	18 hours
Evaluation: • Presentation of works, evaluation of practices, review of concepts, exam	6 hours

4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

4.1. Credits Distribution

Number of on-site hours:	60 hours
Number of hours of student work:	90
Total hours	150

4.2. Methodological strategies, teaching materials and resources

Lectures and lectures, in combination with practices in the laboratory:

• **Theoretical classes:** these classes will be taught in large groups and in them, through lectures, the teacher will develop the most important concepts for understanding the contents of the subject.
• **Resolution of practical cases:** they will be done in small groups. During the sessions various problems will be raised that can be solved by techniques exposed in class. Guided, we will proceed to the application of these techniques to solve the problem.
• **Partial tests:** during the development of the course the teacher will propose various partial tests to review the acquisition of knowledge and the application of these.
Group and cooperative work
• **Presentation of reports and assignments:** the student must present reports and projects that they have carried out individually or in small groups to their classmates and to the teacher. Presentations will make use of appropriate multimedia techniques.
Work and personal study
• **Readings**
• **Carrying out activities:** exercises, concept maps, examples, search for information.
• **Participation** in forums and activities, generally through the teaching platform of the subject.

Tutorials:
• Tutorials can be both in groups and individually. During these sessions, the professor will be able to evaluate the acquisition of the competences and will review the reports provided by the students on the tasks assigned.

5. ASSESSMENT: procedures, evaluation and grading criteria

Preferably, students will be offered a continuous assessment model that has characteristics of formative assessment in a way that serves as feedback in the teaching-learning process.

5.1. PROCEDURES

The evaluation must be inspired by the criteria of continuous evaluation (Learning Assesment Guidelines, LAG, art 3). However, in compliance with the regulations of the University of Alcalá, an alternative process of final evaluation is made available to the student in accordance with the Learning Assesment Guidelines (last modified in the Governing Board of October 31, 2019) as indicated in Article 10, students will have a period of fifteen days from the start of the course to request in writing to the Director of the Polytechnic School their intention to take the non-continuous evaluation model adducing the reasons that they deem convenient. The evaluation of the learning process of all students who do not apply for it or are denied it will be done, by default, according to the continuous assessment model. The student has two calls to pass the subject, one ordinary and one extraordinary.

Ordinary Call

Continous Assessment:

The main assessment tools will be:

1. Problems (EP). Solving practical problems individually or in small groups. Solving practical problems individually or in small groups.
2. Laboratory Exercises (EL). Performance of laboratory practices and delivery of the corresponding

reports. The evaluation will consider systematic observation, where the teacher will record the main difficulties and skills observed in each student, and the realization of a single memory by practice, by each of the groups of students who have done it.

3. **Assessment** Tests (PE). Performing written tests focused on both practical and theoretical aspects of the subject.

Students must attend 100% of the laboratory sessions and deliver the corresponding reports to all laboratory practices. Recovery sessions will be enabled for those students who have not attended any of the sessions and justify it documentarily.

The students, as a group, will deliver the reports of the laboratory practices following the established schedule. These practices will be evaluated by the professor responsible for the laboratory group, to assess if the objectives indicated in the script of the same have been met.

Assessment through final exam:

In the case of evaluation by means of a final exam, the evaluation elements to be used will be the following:

Extraordinary Call

The procedure will be the same as that described for the assessment by means of a final exam in the ordinary call.

5.2. EVALUATION

EVALUATION CRITERIA

The assessment criteria measure the level in which the competences have been acquired by the student. For that purpose, the following are defined::

CE1 Know the main concepts and ideas of each of the blocks.

CE2 Integrates and applies the contents.

CE3 Consistently elaborates ideas.

CE4 Demonstrates argumentation in ideas and exercises a critical sense.

CE5 Originality and contributions

CE6 Coordination and teamwork

GRADING TOOLS

A continuous evaluation of the student's performance is proposed through a monitoring system of the programmed work considering five basic elements:

Exams (E): 15%. Throughout the course, between 2 and 4 multiple choice tests or short questions may be taken, the content of which will deal with the topics covered in class or at conferences.

Directed jobs (TD): 40%. These are at least two individual or group works that will deal with one on the study of a publication or standard related to the subject and another on the development of an example project. Class presentation with transparencies.

Lab / class assignments (LTC): 25%. Different practices will be proposed throughout the course.

Attendance and participation in class and seminars (APS): 20%. Questions asked in class and during student presentations. Attendance to seminars related to the subject and the laboratory.

GRADING CRITERIA

In the ordinary call-continuous assessment the relationship between the competences, learning outcomes, criteria and evaluation instruments is as follows.

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
CB6-9, CGT1-3, CT1, CT6	RA1, RA2, RA4, RA5, RA7	CE1, CE2	E	15%
CB6-10, CGT1-5, CT1-6	RA1, RA2, RA4, RA5, RA7	CE1-CE6	TD	40%
CB6-10, CGT1-5, CT1-6	RA1, RA2, RA3, RA4, RA5, RA7	CE2, CE4, CE6	APS	20%
CB6-10, CGT1-5, CT1, CT3, CT6	RA2, RA3, RA4, RA5, RA6, RA7	CE1, CE2, CE5, CE6	LTC	25%

In the ordinary call-final evaluation, the relationship between the competences, learning outcomes, criteria and evaluation instruments is as follows.

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
CB6-10, CGT1-5, CT1-6	RA1, RA2, RA3, RA4, RA5, RA6, RA7	CE1, CE2, CE3, CE4, CE5, CE6	EF	100%

Extraordinary call

In the case of the extraordinary call, the same percentages that have been established in the case of the evaluation by means of a final exam will be maintained, giving the option of making the PL or maintaining the mark obtained in the EL (continuous evaluation) or in the PEF (final evaluation), according to the student's decision. In any case, the PL will be made by those students who have not done it in the final exam option in the ordinary call.

6. BIBLIOGRAPHY

6.1. Basic Bibliography

• Guía de los Fundamentos de la Dirección de Proyectos. Norma ANSI/PMI 99-001-2009, 2014, 2017, 4ª, 5ª y 6ª Edición. Guía del PMBOK, 2009, 2014 y 2017 respectivamente.

• Project Management Tools and Techniques: A Practical Guide, Deborah Sater Carstens, Gary L. Richardson, Ronald B. Smith, 2017 by CRC Press

• Information Technology Project Management. Jack T. Marchewk Jhon Whiley & Sons, 2009.

• Dirección y Gestión de Proyectos. Un enfoque práctico. Alberto Domingo Ajenjo 2ª Edición. Editorial Rama empresa, 2005.

• Project Management Theory and Practice, Third Edition, Gary L. Richardson, Brad M. Jackson. CRC Press, Taylor & Francis Group, 2018.

• Systems Engineering Principles and Practice, 2nd edition, Kossiakoff, Sweet et al., Wiley 2011.

• Organizaciones de Estandarización y Certificación: http://www.ecss.nl/, www.pmi.org, www.prince-officialsite.com, www.aeipro.com, www.iso.org.

• Forstecue P, Start John, Swinerd Graham. Spacrecraft Systems Engineering. Editorial Wiley. Tercera edición, 2003. ISBN 0-470-85102-3

• J.J. Sellers. Understanding Space. An Introduction to Astronautics. McGraw-Hill. ISBN 0-073407755

• Alan C. Tribble. The Space Environment: Implications for Spacecraft DesignPrinceton University Press. ISBN: 0691102996

6.2. Additional Bibliography

• Agencia Espacial Europea (ESA): www.esa.int, http://emits.esa.int http://www.esa.int/SPECIALS/industry_how_to_do_business

• Agencia Espacial Estadounidense (NASA): www.nasa.gov y https://standards.nasa.gov

• Recomendaciones de ECSS http://www.ecss.nl

Disclosure Note

The University of Alcalá guarantees to its students that, if due to health requirements the competent authorities do not allow the total or partial attendance of the teaching activities, the teaching plans will achieve their objectives through a teaching-learning and evaluation methodology in online format, which will return to the face-to-face mode as soon as these impediments cease.