19611 - SSE - Space Systems Engineering

Coordinating unit:  300 - EETAC - Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit:  748 - FIS - Department of Physics
Academic year:  2019
Degree:  MASTER'S DEGREE IN AEROSPACE SCIENCE AND TECHNOLOGY (Syllabus 2015). (Teaching unit Compulsory)
ECTS credits:  5  Teaching languages:  English

Teaching staff
Coordinator:  Defined in the course webpage at the EETAC website.

Others:  Defined in the course webpage at the EETAC website.

Prior skills
.- Operativity with the concepts, magnitudes and basic laws of Physics and its principles of conservation.
.- Operationality in the differential and integral calculation, and in the calculation with complex numbers.
.- Operationality with algebraic structures, ordinary differential equations, vector spaces and arrays.
.- Operability with probability distribution and statistical data functions.
.- Operability with the basic magnitudes and principles of Thermodynamics as well as the physical behavior of fluids and gases in different conditions of pressure and temperature.
.- Ability to perform application programs in Matlab / Octave or C # language or similar.

Degree competences to which the subject contributes

Basic:
CB6. (ENG) CB6 - Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación.
CB7. (ENG) CB7 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.
CB9. (ENG) CB9 - Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades.
CB10. (ENG) CB10 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

Specific:
CE5 MAST. (ENG) CE5: Aplicar la ingeniería de sistemas en el entorno aeroespacial para el diseño y la gestión de los distintos aspectos tecnológicos asociados a una misión.

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.
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.
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Teaching methodology

The classes of the subject will be presentational and expositive. Teaching material will be composed of PowerPoint presentations (which can be obtained from the first day) and links to pages of special relevance. Software will also be used, such as SaTrak - for the calculation and representation of orbits. Group work will be one of the essential characteristics of the subject, since the students will have to do a project designing at the basic level the subsystems of a space mission and doing their exposition at the end of the course.

In particular, the teaching methodologies applied during the course will be:

- MD1: Master class
- MD2: Participatory expositive class
- MD4: Problem / project based learning
- MD5: Autonomous work
- MD6: Cooperative work

Learning objectives of the subject

At the end of the course, the student will be able to:

1. Evaluate the best orbit according to the requirements of the mission.
2. Design the prototype of a satellite.
3. Make basic estimates about the different subsystems and their characteristics.
4. Develop the initial phase of a mission based on defined objectives.
5. Get acquaintance about the design of complex systems.
6. Develop team work skills, evaluate your own work and that of others.
7. Accept revisions and perform self-analysis.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours large group: 45h</th>
<th>36.00%</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group: 0h</td>
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<tr>
<td></td>
<td>Hours small group: 0h</td>
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<tr>
<td></td>
<td>Guided activities: 0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Self study: 80h</td>
<td>64.00%</td>
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</table>
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## Content

<table>
<thead>
<tr>
<th>1. Mission analysis and Conceptual Design</th>
<th><strong>Learning time:</strong> 12h 42m</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td></td>
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<tr>
<td>1. Overview of the analysis of a mission</td>
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<tr>
<td><strong>Related activities:</strong></td>
<td></td>
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<tr>
<td>AFP1: Exposition of theoretical contents through lectures.</td>
<td></td>
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<tr>
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<tr>
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<td></td>
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<tr>
<td>AFP8: Tutoring.</td>
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</tbody>
</table>

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<tr>
<th>2. Objectives of a scientific mission. Requirements and Tradeoffs</th>
<th><strong>Learning time:</strong> 16h 36m</th>
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<td><strong>Description:</strong></td>
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<tr>
<td>2. General scientific objectives.</td>
<td></td>
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<tr>
<td>3. Characteristics of scientific payloads.</td>
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<tr>
<td>4. Payload requirements. Requirements of space telescopes.</td>
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<td><strong>Related activities:</strong></td>
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**AFP1: Exposition of theoretical contents through lectures.**

**AFP2: Exposition of contents with student participation.**

**AFP3: Problem solving, with student participation.**

**AFP4: Practical laboratory sessions individually or as a team**

**AFP5: Discussion in the classroom of problems or articles, made by the students and moderated by the teacher.**

**AFP6: Elaboration of cooperative works**

**AFP7: Attendance at seminars and conferences related to the subject matter.**

**AFP8: Tutoring.**

**AFN1: Study and preparation of contents.**

**AFN2: Realization of exercises and theoretical or practical works outside the classroom, individually or in a group.**

**AFN3: Realization of projects proposed by teachers outside the classroom, individually or in groups.**

**AFN4: Preparation and realization of evaluable activities.**
### 3. Orbits and Space Environment.

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<thead>
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<tbody>
<tr>
<td>2. Types of orbit. Orbits depending on its center, altitude, inclination, eccentricity and synchronism.</td>
</tr>
<tr>
<td>5. Effects of the space environment. Orbital disturbances: gravitational, third body, atmospheric friction, solar radiation pressure, terrestrial magnetic field.</td>
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</tbody>
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<tr>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td>Self study : 10h 36m</td>
</tr>
</tbody>
</table>
## 4. Detectors

**Description:**
3. Example of development: INTEGRAL, CLAIRE, MAX ...

**Related activities:**
- AFP1: Exposition of theoretical contents through lectures.
- AFP2: Exposition of contents with student participation.
- AFP3: Problem solving, with student participation.
- AFP4: Practical laboratory sessions individually or as a team
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- AFN4: Preparation and realization of evaluable activities.

**Learning time:** 16h 36m
- Theory classes: 6h
- Self study: 10h 36m
5. Satellite platform.

**Description:**
1. Configuration and structure. Requirements design and process design.

**Related activities:**
- AFP1: Exposition of theoretical contents through lectures.
- AFP2: Exposition of contents with student participation.
- AFP3: Problem solving, with student participation.
- AFP4: Practical laboratory sessions individually or as a team
- AFP5: Discussion in the classroom of problems or articles, made by the students and moderated by the teacher.
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6. Communications

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<tr>
<td>Self study:</td>
<td>10h 36m</td>
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**Description:**
3. Link design. Typology: uplink, downlink, crosslink, forward / return link. Design criteria: orbit, RF spectrum, data rate, duty factor, link availability, access time, etc.
4. PayLoad Data Handling System. Core items. Architecture of the PDHU. Application examples: SIXE, GAIA-

**Related activities:**
- AFP1: Exposition of theoretical contents through lectures.
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- AFN4: Preparation and realization of evaluable activities.
7. Ground and user segment

**Learning time:** 16h 36m
- Theory classes: 6h
- Self study: 10h 36m

**Description:**
1. Design of the ground and user segment.
3. CCSDS standard
4. Office of Control of the Authority
5. Data storage, exploitation and dissemination

**Related activities:**
- AFP1: Exposition of theoretical contents through lectures.
- AFP2: Exposition of contents with student participation.
- AFP3: Problem solving, with student participation.
- AFP4: Practical laboratory sessions individually or as a team
- AFP5: Discussion in the classroom of problems or articles, made by the students and moderated by the teacher.
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- AFN4: Preparation and realization of evaluable activities.
8. Management of space missions

**Description:**
1. Cost estimate.
2. Policy and legislation considerations
3. Quality control

**Related activities:**
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- AFP2: Exposition of contents with student participation.
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**Learning time:** 12h 42m
- Theory classes: 4h 30m
- Self study: 8h 12m

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**Qualification system**

Defined in the course webpage at the EETAC website.

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**Regulations for carrying out activities**

All the evaluation activities proposed are mandatory. An exam, deliverable or project not presented will be scored with a zero note. The examinations will be carried out individually, the project will be carried out in group and the delivery of problems can be both group and individual.

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**Bibliography**

**Basic:**

**Complementary:**