300421 - SE-OAT - Space Systems

Coordinating unit: 300 - EETAC - Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 720 - FA - Department of Applied Physics
Academic year: 2014
Degree: BACHELOR'S DEGREE IN AIR NAVIGATION ENGINEERING (Syllabus 2010). (Teaching unit Optional)
BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN NETWORK ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN AIRPORT ENGINEERING (Syllabus 2010). (Teaching unit Optional)
ECTS credits: 6
Teaching languages: Catalan, Spanish, English

Teaching staff
Coordinator: Definit a la infoweb de l'assignatura.
Others: Definit a la infoweb de l'assignatura.

Requirements
· Pre-requirements: Fonaments de Física, Mecànica, Càlcul, Àlgebra i Geometria, Termodinàmica, Mecànica de Fluids, Ampliació de Matemàtiques, Informàtica 1 i 2
· Co-requirements: Fonaments de Comunicació, Ciència i Tecnologia del Materials, Estructures i Resistència de Materials.

Degree competences to which the subject contributes

Specific:
16. CE 19 AERO. Conocimiento aplicado de: la ciencia y tecnología de los materiales; mecánica y termodinámica; mecánica de fluidos; aerodinámica y mecánica del vuelo; sistemas de navegación y circulación aérea; tecnología aeroespacial; teoría de estructuras; transporte aéreo; economía y producción; proyectos; impacto ambiental. (CIN/308/2009, BOE 18.2.2009)

Generical:
7. PROJECT MANAGEMENT - Level 1: To know project management tools carrying out the different phases of the project established by the professor
8. PROJECT MANAGEMENT - Level 2: Define the objectives of a well-defined, narrow scope, and plan development, identifying resources, tasks, shared responsibilities and integration. Use appropriate tools to support project management.
9. PROJECT MANAGEMENT - Level 3: Define the objectives of an extensive project and open, multidisciplinary. Schedule tasks and resources, track and integration of the parties. To evaluate the intermediate and final results, restating the objectives if necessary.

Transversal:
1. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.
2. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.
3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.
4. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 1. Planning oral communication, answering questions properly and writing straightforward texts that are spelt correctly and are grammatically coherent.
5. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral
Learning objectives of the subject

At the end of the subject the student should be able to:

· Identify the drivers of a space mission.
· Evaluate the proper orbit that fulfill the objectives of a space mission.
· Design a first version of a satellite accomplishing the mass limitations, electrical power and cost.
· Determine the basic features for the different satellite subsystems as function of the requirements of the mission.
· Develop a mission starting from the definition of the primary goals.
· Understand the iterative feature of the design of complex engineering systems.
· Team working, evaluate the own and other's work, and accept other points of view about the own work.
# Study load

<table>
<thead>
<tr>
<th></th>
<th>Hours large group:</th>
<th>22.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total learning time:</td>
<td>150h</td>
<td></td>
</tr>
<tr>
<td>Guided activities:</td>
<td>33h</td>
<td>22.00%</td>
</tr>
<tr>
<td>Self study:</td>
<td>84h</td>
<td>56.00%</td>
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</tbody>
</table>
## Content

### 1. Orbital Mechanics

**Learning time:** 27h  
- Theory classes: 6h  
- Guided activities: 6h  
- Self study: 15h

**Description:**
- Newton's principles and universal gravitational law.  
- The restricted two-body problem.  
- Elliptic, parabolic and hyperbolic orbits. Escape velocity  
- Classical orbital elements.  
- Perturbations: high atmosphere effect, radiation pressure, third body.  
- Orbital maneuvering. Interplanetary orbits

**Related activities:**
- AV1: Guided activities of practical applications  
- AV2: Applying Project of Space Systems  
- AV3 & 4: Half and final quarter exam.

### 2. Satellite applications

**Learning time:** 11h  
- Theory classes: 2h 30m  
- Guided activities: 2h 30m  
- Self study: 6h

**Description:**
- Communications.  
- Earth observation. Meteorology.  
- Global positioning: GPS, Glonass and Galileo.  
- Military satellite.  
- Scientific satellite.

**Related activities:**
- AV1: Guided activities of practical applications  
- AV2: Applying Project of Space Systems  
- AV3 & 4: Half and final quarter exam.
### 3. Satellite design

**Learning time:** 7h  
Theory classes: 1h 30m  
Guided activities: 1h 30m  
Self study: 4h

**Description:**  
- Satellite design process.  
- Space mission phases. Requirements and trials.  
- Satellite subsystems. Synergies, interrelations and competence among subsystems.

**Related activities:**  
- AV1: Guided activities of practical applications  
- AV2: Applying Project of Space Systems  
- AV3 & 4: Half and final quarter exam.

### 4. Launch vectors

**Learning time:** 11h  
Theory classes: 2h 30m  
Guided activities: 2h 30m  
Self study: 6h

**Description:**  
- Tsiolkovsky's equation.  
- Nozzles and combustion chambers. Multiphase rockets.  
- Launch dynamics.  
- Solid, liquid and hybrid-fuel rockets. Other propulsion types: ionics and nuclear rockets.

**Related activities:**  
- AV1: Guided activities of practical applications  
- AV2: Applying Project of Space Systems  
- AV3 & 4: Half and final quarter exam.
## 5. Structure subsystem

<table>
<thead>
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<th>Learning time: 12h</th>
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<tbody>
<tr>
<td>Theory classes: 2h 30m</td>
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<tr>
<td>Guided activities: 2h 30m</td>
</tr>
<tr>
<td>Self study : 7h</td>
</tr>
</tbody>
</table>

**Description:**
- Structural materials
- Launch phases.
- Space effects. Whipple Bumper.

**Related activities:**
- AV1: Guided activities of practical applications
- AV2: Applying Project of Space Systems
- AV3 & 4: Half and final quarter exam.

## 6. Power subsystem

<table>
<thead>
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<tbody>
<tr>
<td>Theory classes: 1h 30m</td>
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<tr>
<td>Guided activities: 1h 30m</td>
</tr>
<tr>
<td>Self study : 4h</td>
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</tbody>
</table>

**Description:**
- Determination of the required power.

**Related activities:**
- AV1: Guided activities of practical applications
- AV2: Applying Project of Space Systems
- AV3 & 4: Half and final quarter exam.
## 7. Thermal control subsystem

**Learning time:** 12h  
Theory classes: 2h 30m  
Guided activities: 2h 30m  
Self study : 7h

**Description:**  
- Space enviroment. Thermal balance equation. Thermal mathematical models.  
- Passive systems: absorptance and emittance of surfaces.  
- Active systems: heat tower pipes, shutters.

**Related activities:**  
- AV1: Guided activities of practical applications  
- AV2: Applying Project of Space Systems  
- AV3 & 4: Half and final quarter exam.

## 8. Life support subsystem: manned vehicles

**Learning time:** 7h  
Theory classes: 1h 30m  
Guided activities: 1h 30m  
Self study : 4h

**Description:**  
- Habitability of closed environments.  
- Atmospheric gas control. Temperature and humidity.  
- Artificial gravity.  
- Protection against ionizing radiation.

**Related activities:**  
- AV1: Guided activities of practical applications  
- AV2: Applying Project of Space Systems  
- AV3 & 4: Half and final quarter exam.
## 9. Attitude and control orbit determination subsystem

**Learning time:** 12h  
Theory classes: 2h 30m  
Guided activities: 2h 30m  
Self study: 7h

**Description:**  
- Moments of inertia: the satellite as a rigid body. Euler's equations.  
- Moment biases  
- Earth limb sensor, sun and star sensors.  
- Gyroscopes, magneto-torquers. Gravity gradient stabilization

**Related activities:**  
- AV1: Guided activities of practical applications  
- AV2: Applying Project of Space Systems  
- AV3 & 4: Half and final quarter exam.

## 10. Communications subsystem

**Learning time:** 22h  
Theory classes: 5h  
Guided activities: 5h  
Self study: 12h

**Description:**  
- Link equation. Directional and omnidirectional antennas  
- Data compression.  
- Housekeeping and telemetry.  
- Groundstations.

**Related activities:**  
- AV1: Guided activities of practical applications  
- AV2: Applying Project of Space Systems  
- AV3 & 4: Half and final quarter exam.
11. Computation subsystem

Learning time: 22h
- Theory classes: 5h
- Guided activities: 5h
- Self study: 12h

Description:
- Earth radiation environment, SEUs and Latch-ups.
- Computational requirements
- Space qualified electronics.

Related activities:
- AV1: Guided activities of practical applications
- AV2: Applying Project of Space Systems
- AV3 & 4: Half and final quarter exam.

Planning of activities

<table>
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<tr>
<th>(ENG) (AV1): ACTIVITATS DIRIGIDES D'APLICACIONS PRÀCTIQUES</th>
<th>Hours: 60h</th>
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<tr>
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<td>Self study: 37h</td>
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<table>
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<tr>
<th>(ENG) (AV2): PROJECTE APLICACIÓ DEL SISTEMES ESPACIALS</th>
<th>Hours: 40h</th>
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<td>Guided activities: 10h</td>
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<td>Self study: 30h</td>
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<th>(ENG) (AV3): EXAMEN DE MIG QUADRIMESTRE</th>
<th>Hours: 8h</th>
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<tr>
<td>Self study: 8h</td>
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<tr>
<th>(ENG) (AV4): EXAMEN DE FINAL DE QUADRIMESTRE</th>
<th>Hours: 8h</th>
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<tbody>
<tr>
<td>Self study: 8h</td>
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Qualification system

La nota final se obtendrá a partir de:
- Dos exámenes parciales de teoría y problemas (medio y final de cuatrimestre): 40%
- Proyecto: 40%
- Entregables de problemas y programas: 10%
- Actitud y participación: 10%
Regulations for carrying out activities

Todas las actividades de evaluación propuestas son obligatorias. Un examen, entregable o proyecto no presentado se puntuará con una nota de cero. Los exámenes se realizarán de manera individual. Los entregables de problemas y el proyecto se realizarán en grupo.

Bibliography

Basic:


Complementary:


