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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

presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.
6. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.
10. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
11. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.
12. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.
13. TEAMWORK - Level 3. Managing and making work groups effective. Resolving possible conflicts, valuing working with others, assessing the effectiveness of a team and presenting the final results.
14. EFFECTIVE USE OF INFORMATI0N RESOURCES - Level 1. Identifying information needs. Using collections, premises and services that are available for designing and executing simple searches that are suited to the topic.
15. EFFECTIVE USE OF INFORMATI0N RESOURCES - Level 2. Designing and executing a good strategy for advanced searches using specialized information resources, once the various parts of an academic document have been identified and bibliographical references provided. Choosing suitable information based on its relevance and quality.

Teaching methodology

Las clases de la asignatura serán presenciales y expositivas. El material docente estará compuesto por presentaciones PowerPoint (que obtendrán desde el primer día) y enlaces en páginas web de especial relevancia. También se hará uso de software como SaTrak ¿cálculo y representación de órbitas¿ y una introducción al programa STK ¿diseño avanzado de misiones espaciales. El trabajo en grupo será una de las características esenciales de la asignatura, puesto que los alumnos tendrán que diseñar uno de los subsistemas de un satélite espacial y exponer su trabajo al final de curso.

La expresión oral y escrita se trabajará explícitamente en las sesiones de AD de problemas (discusión de los métodos empleados y resolución de problemas en la pizarra) y en el proyecto. El aprendizaje autónomo se guiará mediante textos e información en páginas web sobre conceptos teóricos de la asignatura y/o vídeos explicativos. El proyecto también será una herramienta de trabajo de aprendizaje autónomo puesto que los estudiantes tendrán que adquirir conocimientos mas allá de lo explicado en las clases de teoría y realizar gran parte del proyecto de manera autónoma. Estas tres competencias genéricas se evaluarán en las diferentes actividades de evaluación en que están implicadas (ver la descripción detallada de las AVV1-4).

Se realizarán varias actividades no obligatorias, como por ejemplo la observación de satélites desde tierra -en especial los de la familia Iridium y la International Space Station- y la visita a empresas del sector aeroespacial de nuestro entorno inmediato.

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 missionl.
· 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.
· Develope 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.

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Study load

Total learning time: 150h	Hours large group:	33h	22.00%
	Guided activities:	33h	22.00%
	Self study:	84h	56.00%

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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, raditation pressure, third body.
· Orbital maneuvering. Interplanetary orbits

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

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3. Satellite desing

Learning time: 7h

Theory classes: 1h 30m
Guided activities: 1h 30m
Self study : 4h

Description:
· Satellite desing process.
· Space mission phases. Requiriments and trials.
· Satellite subsystems. Sinergies, interelations and competence among subsystems.

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

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5. Structure subsystem

Learning time: 12h

Theory classes: 2h 30m
Guided activities: 2h 30m
Self study : 7h

Description:
· Structural materials
· Launch phases.
· Space effects. Whipple Bumper.

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

6. Power subsystem

Learning time: 7h

Theory classes: 1h 30m
Guided activities: 1h 30m
Self study : 4h

Description:
· Determination of the required power.
· Power sources. Batteries. Fotovoltaic systems. Fuel cell. Active and passive nuclear systems.

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

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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 matematical models.
· Passive systems: absorptance and emittance of surfaces.
· Acyive systems: heat tower pipes, shutters.

Related activities:
· AV1: Guided activities of practical applications
· AV2: Applying Porject 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 enviroments.
· Atmospheric gase control. Temperature and humity.
· Artificial gravity.
· Protectition against ionizing radiation.

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

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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 Porject 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 compresion.
· Housekeeping and telemetry.
· Groundstations.

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

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11. Computation subsystem	Learning time: 22h Theory classes: 5h Guided activities: 5h Self study : 12h

Description:
· Earth radiation enviroment. SEUs and Latch-ups.
· Computational requirements
· Space qualified electronics.

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

Planning of activities

(ENG) (AV1): ACTIVITATS DIRIGIDES D'APLICACIONS PRÀCTIQUES	Hours: 60h Guided activities: 23h Self study: 37h
(ENG) (AV2): PROJECTE APLICACIÓ DEL SISTEMES ESPACIALS	Hours: 40h Guided activities: 10h Self study: 30h
(ENG) (AV3): EXAMEN DE MIG QUADRIMESTRE	Hours: 8h Self study: 8h
(ENG) (AV4): EXAMEN DE FINAL DE QUADRIMESTRE	Hours: 8h Self study: 8h

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%

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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:

Wertz, James R.; Larson, Wiley J. Space mission analysis and design. 3a ed. Dordrecht: Ed. Kluwer Academic, 1999. ISBN 9781881883104.

Fortescue, Peter W.; Stark, John; Swinerd, Graham. Spacecraft systems engineering [Recurs electrònic] [on line]. 4th ed. Hoboken: Ed. Wiley, 2011Available on: <http://site.ebrary.com/lib/upcatalunya/docDetail.action?docID=10494538&p00=spacecraft%20systems%20engineering>. ISBN 9781119971016.

Complementary:

Messerschmid, E.; Bertrand, R. Space stations: systems and utilization. Berlin: Ed. Springer, 1999. ISBN 354065464X.

Heinz Hermann, K. Handbook of astronautical engineering. New York: Ed. McGraw-Hill, 1961.

Thomson, William T. Introduction to space dynamics. New York: Ed. Dover, 1986. ISBN 0486651134.

Sutton, George P.; Biblarz, O. Rocket propulsion elements. 7a ed. New York: Ed. John Wiley & Sons, 2001. ISBN 0471326429.