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300419 - CE-OAT - Space Communications: Mss and Gnss

Coordinating unit: 300 - EETAC - Castelldefels School of Telecommunications and Aerospace Engineering

Teaching unit: 739 - TSC - Department of Signal Theory and Communications

Academic year: 2018

Degree: BACHELOR'S DEGREE IN AIR NAVIGATION ENGINEERING (Syllabus 2010). (Teaching unit Optional)
BACHELOR'S DEGREE IN AEROSPACE SYSTEMS ENGINEERING (Syllabus 2015). (Teaching unit Optional)
BACHELOR'S DEGREE IN AIRPORT ENGINEERING (Syllabus 2010). (Teaching unit Optional)

ECTS credits: 6 Teaching languages: English

Teaching staff

Coordinator: Definit a la infoweb de l'assignatura.

Others: Definit a la infoweb de l'assignatura.

Prior skills

Knowledge of the English language and technical vocabulary in English.
Knowledge relating to the subject Fundamentals of Communications (3A).
Knowledge relating to the subject of Air Navigation, Cosmography and Cartography (3B).
Knowledge relating to the subject Aeronautical Communications (3B).

Requirements

It is advisable that students have personal computer (ideally a laptop) with Internet connection.
Have passed Fundamentals of Communications (3A).
Have passed Air Navigation, Cosmography and Cartography (3B).

Degree competences to which the subject contributes

Specific:

1. CE 23 AERON. Conocimiento adecuado y aplicado a la Ingeniería de: Las operaciones de vuelo de los sistemas aeroespaciales; el impacto ambiental de las infraestructuras; la planificación, diseño e implantación de sistemas para soportar la gestión del tráfico aéreo. (CIN/308/2009, BOE 18.2.2009)
2. CE 24 AERON. Conocimiento adecuado y aplicado a la Ingeniería de: Los métodos de cálculo y de desarrollo de la navegación aérea; el cálculo de los sistemas específicos de la aeronavegación y sus infraestructuras; las actuaciones, maniobras y control de las aeronaves; la normativa aplicable; el funcionamiento y la gestión del transporte aéreo; los sistemas de navegación y circulación aérea; los sistemas de comunicación y vigilancia aérea. (CIN/308/2009, BOE 18.2.2009)
3. CE 25 AERON. Conocimiento aplicado de: Transmisores y receptores; Líneas de transmisión y sistemas radiantes de señales para la navegación aérea; Sistemas de navegación; Instalaciones eléctricas en el sector tierra y sector aire; Mecánica del Vuelo; Cartografía; Cosmografía; Meteorología; Distribución, gestión y economía del transporte aéreo. (CIN/308/2009, BOE 18.2.2009)

Transversal:

4. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.
5. 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.
6. 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.

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7. 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.
8. 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.
9. 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.

Teaching methodology

The teaching methodology is based on:
· Master classes in which the teacher presents the subject contents. These explanations are combined with exercises and case studies posed to students in order to support, in a more practical way, the theoretical explanations.
· Cooperative learning in which students, organized into teams, will solve in class under teacher supervision selected case studies.
· Self learning in which students work on class material at home and perform the tasks proposed in class, for example, directed readings and resolution of problems individually or in groups.

Learning objectives of the subject

At the end of the course "Space Communication: MSS and GNSS", the student should be able to:

· Understand the basic concepts that determine the shape of the orbit and its classification as well as the advantages and disadvantages of each type of orbit.
· Determine the signal to noise ratio (SNR) of a satellite link and know the fundamental limits that affect this type of link.
· Explain the differences between circuit communications and packet mode communications and identify the impact of the delay introduced by the satellite link over IP protocols
· Identify requirements for quality of service and security in the future aeronautical telecommunications network based on IP
· Understand the current state of the mobile satellite service for aeronautical communications.
· Understand the factors that limit the accuracy of the positioning that can be obtained with GPS
· Explain the main features of current GNSS systems: GPS, GLONASS and GALILEO

Study load

Total learning time: 150h	Hours medium group:	39h	26.00%
	Hours small group:	27h	18.00%
	Self study:	84h	56.00%

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Content

Introduction to space environment

Learning time: 26h

Practical classes: 6h
Laboratory classes: 8h
Self study : 12h

Description:
Review of main concepts about orbit physics and orbit classification. History of space communications. Satellite and Earth station subsystem description.

Related activities:
Theory tests
Laboratory practice with Matlab and STK
Collection of problems

Specific objectives:
Pros and cons of satellite communications. FSS and MSS
History of space communications
Orbit classification (LEO,MEO,GEO,HEO)
Description of satellite and Earth station subsystems
Review of orbit physics, Keplerian elements and coordinate systems
GEO satellites: eclipses and Sun interference

Satellite link characterisation

Learning time: 35h

Practical classes: 10h
Laboratory classes: 6h
Self study : 19h

Description:
Satellite link budget calculation. Study of all items influencing satellite link quality: noise, antenna diagrams, tropospheric and ionospheric effects. Introduction to error control tecniques.

Related activities:
Theory tests
Laboratory practice with Matlab and STK
Collection of problems

Specific objectives:
Frequency bands for AMSS
Antenna diagrams for satellite, GES and AES
Satellite free space (LoS) and Non-line-of-Sight (NLoS) propagation (multipath)
Troposphere and Ionosphere effects. Doppler effect
Satellite and Earth station noise models
Satellite link budget: S/N, EIRP and G/T
Transparent satellite repeater vs. regenerative repeater
Introduction to error control techniques (FEC and ARQ techniques)

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VSAT systems and future Aeronautical Telecommunication Network

Learning time: 25h

Practical classes: 8h
Laboratory classes: 2h
Self study : 15h

Description:
VSAT system architecture. Multiple access techniques. IPS based future ATN

Related activities:
Theory tests
Laboratory practice with Matlab and STK
Collection of problems

Specific objectives:
VSAT system architecture: VSAT Earth station and HUB
Multiple access techniques for VSAT systems
Circuit mode vs. packet communications. Review of ISO and TCP/IP layered models
Impact of the satellite link delays on the TCP protocol
IPS based ATN: QoS, IPv6, tunneling, mobile IP, security, VPNs

Aeronautical Mobile Satellite Service (AMSS)

Learning time: 21h

Practical classes: 6h
Laboratory classes: 4h
Self study : 11h

Description:
Role of satellites in ATN

Related activities:
Theory tests
Laboratory practice with Matlab and STK
Collection of problems

Specific objectives:
LEO vs. GEO systems
IRIDIUM and INMARSAT services for AMSS
The role of satellites in future aeronautical communications

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Global Navigation Satellite System (GNSS)	Learning time: 33h Practical classes: 9h Laboratory classes: 7h Self study : 17h

Description:
GNSS: Error sources for precise positioning. GLONASS, GALILEO and augmentation systems

Related activities:
Theory tests
Laboratory practice with Matlab and STK
Collection of problems

Specific objectives:
Introduction. GNSS systems description
PRN signals: M-sequences. Gold sequences. Generation of the GPS signals
Position determination: error sources and achievable positioning precision
GPS receivers and complementary sensors
GLONASS & GALILEO systems
Pseudo-satellites, differential systems and augmentation systems (WAAS, MSAS, EGNOS)

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Planning of activities

MID-TERM EXAMINATION

Hours: 1h 30m
Practical classes: 1h 30m

Description:
To perform an individual evaluation of the students they will take a mid-term exam that will comprise all the contents of the course developed so far. The posed questions may include theoretical or practical application of contents.

Support materials:
Calculator and supporting documentation supplied during the test.

Descriptions of the assignments due and their relation to the assessment:
Examination adequately resolved by the student

Specific objectives:
To assess the skills described above.

FINAL EXAMINATION

Hours: 1h 30m
Practical classes: 1h 30m

Description:
To perform an individual evaluation of the students they will take a final exam that will comprise all the contents of the course developed so far. The posed questions may include theoretical or practical application of contents.

Support materials:
Calculator and supporting documentation supplied during the test.

Descriptions of the assignments due and their relation to the assessment:
Examination adequately resolved by the student

Specific objectives:
To assess the skills described above.

INIVIDUALLY SOLVED PROBLEMS

Hours: 10h
Self study: 10h

Description:
Students must solve, independently and individually, a set of problems on the topics explained in lectures. The statement of the problems will be proposed by the teacher during the course development.

Support materials:
Statement of the problems to be solved (provided by teacher)

Descriptions of the assignments due and their relation to the assessment:
Collection of problems solved correctly

Specific objectives:
It is intended that students practice solving problems and solving by themselves the doubts that arise and/or consult with the teacher

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LABORATORY PRACTICES WITH MATLAB AND STK	Hours: 27h Laboratory classes: 27h

Description:

Students, grouped into small teams, attend to laboratory classes 2h/week (approximately) to program in Matlab and STK selected case studies suggested by the teacher throughout the course. The STK software is an "expert system" and a valuable tool to visualize in 3D the concepts about orbits, spatial environment and communications explained in the theory classes. Matlab allows students to program by their own the proposed case studies so that they can check a posteriori (with STK) if they have solved the problem correctly and also delve into details that the Matlab program may have not contemplated.

Support materials:

· Statement of practice (provided by the teacher during the course development)
· Matlab and satellite and space evironment simulation software "Systems Tool Kit (STK)" of the AGI company <http://www.agi.com>

Descriptions of the assignments due and their relation to the assessment:

Practice report with the requested results in the statement of practice

Specific objectives:

To reinforce the concepts explained in class theory through experimentation and teamwork

Qualification system

The marks will be determined from these components:
1. Basic knowledge in the form of mid-term exam (20%) and final exam (30%)
2. Completion of laboratory tasks (35%)
3. Collection of problems solved individually(10%)
4. Attitude and participation (5%)

Regulations for carrying out activities

Specific rules will be explained before performing each test.

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Bibliography

Basic:

Future aeronautical communications [Recurs electrònic] [on line]. Alemanya: Ed. Intech, 2011Available on: <http://www.intechopen.com/books/future-aeronautical-communications>. ISBN 9789533076256.

Maral, Gérard; Bousquet, Michel. Satellite communications systems: systems, techniques and technology. 5th ed. London: Ed. John Wiley & Sons, 2009. ISBN 9780470714584.

Others resources:

Audiovisual material

Matlab

Computer material

System Tool Kit (STK)