



IDENTIFYING DATA

Navigation systems and satellite communications

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|---------------------|--|----------|------|------------|
| Subject | Navigation systems and satellite communications | | | |
| Code | V05G300V01912 | | | |
| Study programme | Degree in Telecommunications Technologies Engineering | | | |
| Descriptors | ECTS Credits | Choose | Year | Quadmester |
| | 6 | Optional | 4th | 1st |
| Teaching language | English | | | |
| Department | | | | |
| Coordinator | Aguado Agelet, Fernando Antonio | | | |
| Lecturers | Aguado Agelet, Fernando Antonio Mosquera Nartallo, Carlos | | | |
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| Web | http://faitic.uvigo.es | | | |
| General description | The contents of this course cover the basics of satellite navigation and satellite communication systems: GPS and Galileo, the different segments of satellite communication systems, and an introduction to the planning and development standards. The course will be entirely conducted in English; the use of Spanish or Galego will be optionally allowed in the last exam. | | | |

Competencies

| | |
|------|--|
| Code | |
| B2 | CG2: The knowledge, comprehension and ability to apply the needed legislation during the development of the Technical Telecommunication Engineer profession and aptitude to manage compulsory specifications, procedures and laws. |
| B3 | CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations |
| B4 | CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity. |
| C67 | (CE67/OP10) Applying conceptual, theoretical and practical tools of telecommunications in the development and applications of navigation and satellite communications systems. |
| C68 | (CE68/OP11) The ability for selection of navigation and satellite communications systems and subsystems. |
| D2 | CT2 Understanding Engineering within a framework of sustainable development. |
| D3 | CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc. |

Learning outcomes

| Expected results from this subject | Training and Learning Results | | |
|---|-------------------------------|------------|----------|
| To know the planning and development standards of satellite systems. | B2 B3 | C67 C68 | D3 |
| To know the different alternatives of communication and navigation satellite systems, their different segments (space, ground and user) and the type of orbits. | B3 B4 | C67 C68 | D2 D3 |
| To know the more usual systems and services for satellite communications, including their technological capabilities and limitations. | B3 | C67 C68 | D3 |
| To know and apply satellite navigation systems: GPS, Galileo, and other systems. | B2 B3 B4 | C67 C68 | D2 D3 |

| Contents | |
|--|--|
| Topic | |
| Introduction | - System definition - Standards - Regulations - Allocated frequency bands |
| Elements of a System | - Ground Segment - Space Segment - Launch Segment - User Segment |
| Introduction to Navigation Systems (GNSS) | - GPS, Galileo, Glonass, and other systems. |
| Architecture of the Communication Subsystems | Subsystems: - Antennas - Payload: transponders |
| Introduction to Satellite Communications | - Main elements in a communications payload - Signal propagation impairments - Link budget - Multibeam satellites |
| Satellite Communication Services | - Fixed Satellite Services (FSS) - Broadcast Satellite Services (BSS) - Mobile Satellite Services (MSS) |

| Planning | | | |
|----------------------------|-------------|-----------------------------|-------------|
| | Class hours | Hours outside the classroom | Total hours |
| Master Session | 21 | 42 | 63 |
| Practice in computer rooms | 13 | 39 | 52 |
| Laboratory practises | 4 | 8 | 12 |
| Tutored works | 3 | 9 | 12 |
| Short answer tests | 1 | 10 | 11 |

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

| Methodologies | |
|----------------------------|--|
| | Description |
| Master Session | We describe the different aspects of the subject providing all the necessary educational material. Through this methodology the competencies CG2, CG3, CG67, CG68, CT2 and CT3 are developed. |
| Practice in computer rooms | Every student will apply the theoretical knowledge to different practical tasks covering the main part of the contents of the subject with the help of the software suites. Through this methodology the competencies CG3, CG4, CG67, CG68 and CT3 are developed. |
| Laboratory practises | Every student will apply in a practical way the different theoretical knowledge in a specific context. Through this methodology the competencies CG3, CG4, CG67, CG68 and CT3 are developed. |
| Tutored works | The student will work in groups, with the support of the university lecturers, to apply, extend and personalize the contents covered in the theoretical and laboratory hours. Through this methodology the competencies CG4, CG67, CG68, CT2 and CT3 are developed. |

| Personalized attention | |
|-------------------------------|--|
| Methodologies | Description |
| Tutored works | The students will have the opportunity to attend tutorial hours with the university lecturers in the schedule that will be established and published in the subject web-page. They may also send their queries by email. |

| Assessment | | | |
|----------------------------|--|---------------|-------------------------------|
| | Description | Qualification | Training and Learning Results |
| Practice in computer rooms | The students will perform laboratory practice where they will work with concepts studied in the theoretical classes. The practices will be carried out in groups of 2 people. The final grade will be individual, including the assessment of the student's participation during the sessions as well as the individual final report and, in some practices an individual test. | 40 | B3 C67 D3 B4 C68 |

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|----------------------|---|----|------------------------------|
| Laboratory practises | Each student will perform field practices. The evaluation will be performed by means of a report for a total weight of 10% of the final mark. The practices will be carried out in groups of 2 people. The final grade will be individual, including the assessment of the student's participation during the sessions as well as the individual final report and, in some practices an individual test. | 10 | B3 C67 D3 B4 C68 |
| Tutored works | The evaluation of the group work will be taken into account as well as the understanding, maturity, importance and originality of the work and interaction between the group. The tutored works will be carried out in groups of 2 people. The final grade will be individual, including the assessment of the student's participation during the sessions as well as the individual final report. | 5 | B3 C67 D2 B4 C68 D3 |
| Short answer tests | A final test to evaluate the contents presented in the master sessions. The test will be individual with time limit. | 45 | B2 C67 D2 B3 C68 D3 B4 |

Other comments on the Evaluation

At the beginning of the term, the student will choose the assessment methodology: final exam or continuous evaluation.

The teaching language will be English.

Both, documentation and presentations of this subject will be exclusively in English.

English shall be used for writing the reports to evaluate the laboratory practices and the tutored works.

The students may use either English, Spanish or Galego to respond the short answer test.

The subject will be evaluated through one of the following mechanisms:

Final exam:

- The exam will include questions and/or numerical problems related with the contents presented in master sessions, laboratory practices and tutored works. It will be necessary to obtain 5 points over 10 to pass the exam.

Continuous evaluation (the students who choose the continuous evaluation method will not be allowed to attend the final exam in the first call). The subject will be assessed throughout the entire term:

- **Laboratory practices:** each student will have to perform different tasks with a total weight of 40% of the final mark.
- **Tutored works:** each student will participate in different tutored works proposed during the lecture period. This part will be evaluated by written reports. These reports will have a total weight of 5% of the final mark.
- **Outdoor study/field practices:** each student will perform field practices. A report must be turned in to get a maximum score of 10% of the final grade.
- **Short answer test:** This exam will be the final assessment of the continuous evaluation, and it will have a total weight of 45% of the final mark.

Make-up exam (second exam): the student will have to take an exam which will include questions and/or numerical problems related with the contents presented in the master sessions, the laboratory practices and the tutored works (100% of the final mark). Optionally, they could take a partial exam on the contents of the master session (45% of the final mark).

All the different grades are only valid for the current course, and will expire after the second call in case someone needs to take the course again.

Sources of information

James R. Wertz, David F. Everett and Jeffery J. Puschell, **Space Mission Engineering: The New SMAD**, 4th.,

Maral and Bousquet, **Satellite Communications Systems: Systems, Techniques and Technology**., 5th. December 2009,

<http://www.ecss.nl>,

Teresa M. Braun, **Satellite Communications, Payload and System**, 1st. 2012,

E. Lutz, M. Werner, A. Jahn, **Satellite Systems for Personal and Broadband Communications**, 1st. 2000,

Organización de Aviación Civil Internacional, **Telecomunicaciones aeronáuticas : Anexo 10 al Convenio sobre aviación civil internacional. Volumen III, Sistemas de telecomunicaciones / Organización de Aviación Civil Internacional**, 2009,

Elliott D. Kaplan, Christopher J. Hegarty, editors, **Understanding GPS : principles and applications**, 2nd. 2006,

Bernhard Hofmann-Wellenhof, Herbert Lichtenegger, Elmar Wasle, **GNSS - global navigation satellite systems : GPS, GLONASS, Galileo, and more**, 1st. 2007,

http://www.trimble.com/gps_tutorial/,

<http://www.insidegnss.com/magazine>,

<http://igs.bkg.bund.de/>,

<http://waas.stanford.edu/index.html>,

Recommendations

Subjects that are recommended to be taken simultaneously

Remote sensing/V05G300V01911

Subjects that it is recommended to have taken before

Signal Transmission and Reception Techniques/V05G300V01404

Electromagnetic Transmission/V05G300V01303

Radio Communication Systems/V05G300V01512