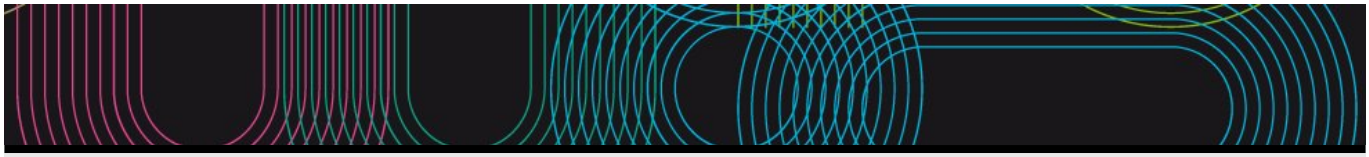

IDENTIFYING DATA				
Navigation systems and satellite communications				
Subject	Navigation systems and satellite communications			
Code	V05G300V01912			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Aguado Agelet, Fernando Antonio			
Lecturers	Aguado Agelet, Fernando Antonio Mosquera Nartallo, Carlos			
E-mail	faguado@tsc.uvigo.es			
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
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)
Introduction to Navigation Systems (GNSS)	- GPS, Galileo, Glonass, and other systems.

Planning	Class hours	Hours outside the classroom	Total hours
Lecturing	21	42	63
Practices through ICT	13	39	52
Laboratory practical	4	8	12
Mentored work	3	9	12
Problem and/or exercise solving	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
Lecturing	We describe the different aspects of the subject providing all the necessary educational material, including the possibility of using the flipped learning methodology. Through this methodology the competencies CG2, CG3, CG67, CG68, CT2 and CT3 are developed.
Practices through ICT	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 practical	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.
Mentored work	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 assistance	
Methodologies	**Description**
Mentored work	The students will have the opportunity to attend tutorial hours (face-to-face or virtually) 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

Practices through ICT	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	
Laboratory practical	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	
Mentored work	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	
Problem and/or exercise solving	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

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 can use English, Spanish or Galego to respond the final test.

The subject will be evaluated through one of two possible procedures. At the beginning of the term, the student will choose the assessment methodology, exam-based or continuous evaluation:

Exam-based evaluation:

- The final 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 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.
- Final 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.
- A grade will be necessarily assigned to those students taking the course in continuous evaluation mode.

Second call: 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). Those students following the continuous evaluation can optionally take this exam for the 45% of the final grade.

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.

End of program call: There will be an exam with 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.

Improper behavior in the form of cheating in any of the assesment tests and reports will result in failing the course, and will be reported to the Director of the Telecommunication Engineering School.

Sources of information

Basic Bibliography

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

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

Carlos Mosquera, **Satellite Communication Systems: Class notes**, 2017

Complementary Bibliography

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

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 / Organizacion de Aviación Civil Internacional**, 2009,

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

Radio Communication Systems/V05G300V01512

Contingency plan

Description

=== ADAPTATION OF THE METHODOLOGIES TO COMPLETE VIRTUAL TEACHING ACTIVITIES===

GROUP A

* Teaching methodologies modified

They could be reinforced with the flipped learning methodology.

* Planning modified

No modification of the planning is contemplated

* Tests modified

No modification of the tests is contemplated. The tests will be done at home.

GROUP B

* Teaching methodologies modified

They could be reinforced with the flipped learning methodology.

* Planning modified

For the GPS lab activity, the measuring of GPS data signals using the lab equipment will be substituted by collecting data using free IOS and/or Android APPs.

The visit to the Ground Station during operation of a satellite will be substituted by a remote class, including the remote operation of the satellite using a VPN to access to the Ground Segment Software.

For the GNURadio activity, the simulation will use pre-recorded data instead of using live data during a pass of an NOAA

satellite. For the simulation of the AX.25 protocol, the radio transceivers will be simulated by a representative GNU block or by pre-recorded data.

* Tests modified

No modification of the tests is contemplated. The tests will be done at home.