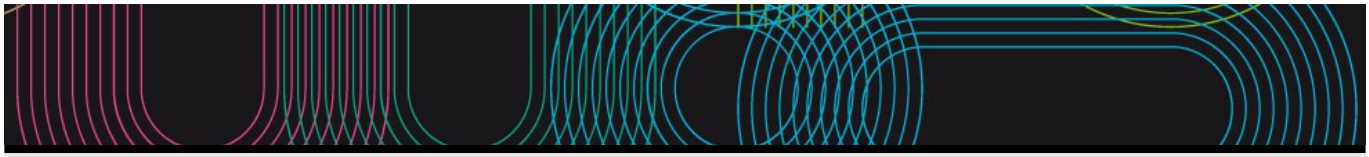

IDENTIFYING DATA				
Navigation systems and satellite communications				
Subject	Navigation systems and satellite communications			
Code	V05G301V01412			
Study programme	Grado en Ingeniería de Tecnologías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Aguado Agelet, Fernando Antonio			
Lecturers	Aguado Agelet, Fernando Antonio Mosquera Nartallo, Carlos			
E-mail	faguado@uvigo.gal			
Web	http://moovi.uvigo.gal			
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.			

Training and Learning Results	
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.

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 (Theoretical).	- System definition - Standards - Regulations - Allocated frequency bands
Elements of a System (Theoretical).	- Ground Segment - Space Segment - Launch Segment - User Segment
Astrodynamics (Theoretical and Practical).	- Orbital mechanics. - Orbit calculation. - Orbit perturbations.
Architecture of the Communication Subsystems (Theoretical)	Subsystems: - Antennas - Payload: transponders
Introduction to Satellite Communications (Theoretical and Practical).	- Main elements in a communications payload - Signal propagation impairments - Link budget - Multibeam satellites
Satellite Communication Services (Theoretical).	- Fixed Satellite Services (FSS) - Broadcast Satellite Services (BSS) - Mobile Satellite Services (MSS)
Introduction to Navigation Systems (GNSS) (Theoretical and Practical)	- 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 B2, B3, C67, C68, D2 and D3 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. Software to be used: Matlab, Python, Excel. Through this methodology the competencies B3, B4, C67, C68 and D3 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 B3, B4, C67, C68 and D3 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 B4, C67, C68, D2 and D3 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 (https://moovi.uvigo.gal/user/profile.php?id=11661). 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.	15	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.	40	B2 C67 D2 B3 C68 D3 B4

Other comments on the Evaluation

Plagiarism is regarded as serious dishonest behavior. If any form of plagiarism is detected in any of the tests or exams, the final grade will be FAIL (0), and the incident will be reported to the corresponding academic authorities for prosecution.

Within a maximum period of one month from the start of the course, the student must choose the assessment method for the ordinary opportunity: global assessment or continuous assessment. In the case of having chosen continuous assessment, the qualification cannot be 'not presented'. However, the students may switch to global assessment one week before the final test.

The extraordinary opportunity will always be assessed by global assessment, although, optionally, part of the grades from the continuous assessment can be taken into account.

Language of instruction: English.

All course documentation will be conducted in English, as well as the presentations.

The assessment of the reports and practices will also be carried out in English.

The final exam can be answered in English, Galician or Spanish.

1.- Ordinary opportunity

Global assessment: There will be a final exam that will include questions and problems related to the contents explained both in the master classes, in the computer classroom practices and in the laboratory practices. It will be necessary to score a 5 out of 10 to pass the exam.

Continuous assessment. The subject will be assessed throughout the course:

 Computer classroom practices: different practices will be carried out. Their assessment will weigh 40% of the final grade.

 Tutored works: different tutored works will be carried out throughout the course. Their assessment will be carried out through the correction of the corresponding reports and this part will weigh 5% of the final grade.

 Laboratory practices: different laboratory practices will be carried out. Their assessment will be carried out through the correction of the corresponding reports and this part will weigh 15% of the final grade.

 Final test: this exam will be the last test of the continuous assessment, and will weigh 40% of the final grade.

A grade will be mandatorily assigned in the continuous assessment mode.

.- Extraordinary opportunity: The students will carry out a single evaluation that will include topics and/or problems related to the contents taught both in master classes, seminars and in the supervised works (100% of the final grade). Students who chose continuous assessment for the first opportunity can, optionally, take this single evaluation over 40% of

the final grade.

3.- End of career call:

It will consist of an exam with questions and problems related to the contents explained both in the master classes, in the computer classroom practices and in the laboratory practices. It will be necessary to score a 5 out of 10 to pass the exam. The proposed and performed practical works and tasks of this course are not recoverable and are only valid for the current course.

4.- Use of Generative Artificial Intelligence

In conducting the academic activities of this subject, the use of generative artificial intelligence (GAI) is permitted. Its use must be ethical, critical, and responsible. If GAI is used, any results it provides should be critically evaluated, and any generated citations or references should be carefully verified. Additionally, it is recommended to declare the use of the tools utilized.

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

Maral and Bousquet, **Satellite Communications Systems: Systems, Techniques and Technology.**,

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/V05G301V01411