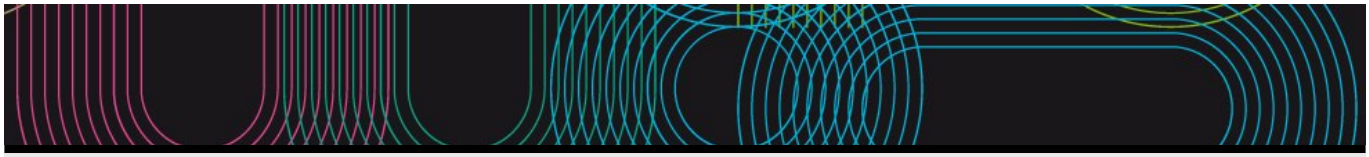

IDENTIFYING DATA				
Remote sensing				
Subject	Remote sensing			
Code	V05G306V01411			
Study programme	Bachelor Degree in Telecommunication Technologies Engineering (BTTE)			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Cuiñas Gómez, Íñigo			
Lecturers	Cuiñas Gómez, Íñigo López Valcárcel, Luis Antonio			
E-mail	inhigo@uvigo.es			
Web	http://moovi.uvigo.gal			
General description	Remote Sensing is the subject devoted to all systems that allow the collection of data related to objects or surface characteristics without physical contact. We begin presenting the principles of Remote Sensing, in visible, infrared and in microwaves spectrum. Special care will be put on active and passive sensors, with a deep explanation of RADAR and optic-electronic systems. Then, the subject involves technological elements and signal processing, with a focus on the applications on Earth surface and other space bodies. The academic language is English.			

Training and Learning Results	
Code	
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.
B7	CG7: The ability to analyze and assess the social and environmental impact of technical solutions.
B9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.
C65	(CE65/OP8)Applying conceptual, theoretical and practical tools of telecommunications in the development and applications of radar and remote sensing systems.
C66	(CE66/OP9) The ability for selection of circuits, subsystems and systems of remote sensing.
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.
D4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Expected results from this subject	Training and Learning Results		
Identify and analyse problems that can be solved with Remote Sensing techniques.	B3 B4 B9	C65	D4
Propose solutions based on RADAR, microwaves, infrared, LIDAR or visible spectrum observation.	B3 B4 B9	C66	D3 D4

Specify sensors and Remote Sensing systems that are more adequate for each application.	B3 B7	C65 C66	D2
Interpret and analyse images taken from satellites.	B3 B4 B9	C65	D2

Contents	
Topic	
Introduction to Remote Sensing	The aim of this topic is to provide a panoramic of the meaning and application of remote sensing of earth, sea and air. Special attention is given to different points of view: from our usual perception of the Earth to its appearance when it is observed from a satellite or another airlifted platform. Besides, the subject shows the historical evolution of Remote Sensing and its implication in the human life, standing out the hits of the space exploration and the different programs that have been designed along the space race. The contents given in group A have an autonomous activity associated, called "The Earth from the air/space", proposed when the subject begins.
Fundamental concepts	The three fundamental concepts of Remote Sensing are the core of this topic: the spectral signature, the classification and the compositions of color. All these are explained after an introduction to the multispectral sensors.
Sensors	Explanation of the concept of sensor, introduction to the different types of sensors, the concept of resolution and calibration. Then, there is at least a session of two hours devoted to the passive sensors (optical-electronic, thermal and radiometers of microwaves) and another session to the active sensors (RADAR and LIDAR). This explanation includes the foundations and operation, its characteristics, advantages and inconvenients, and typical applications. The contents given in group A have several associated practices of laboratory (group B), those called "Sensors calibration", "Passive Sensors: infrared", and "RADAR Fundamentals".
Processing, interpretation and formation of images	This section is a summary of the different techniques of signal processing applied to interpreting and classifying images taken from satellites. It uses an example image to which all different processing techniques are applied and explained. The subject also takes care of the formation of images of big regions of the surface of the Earth from pictures of areas more reduced, by means of the use of mosaics. It shows the process of constructing the mosaic from both satellite and airborne images. All the contents are given in laboratory (group B), for four sessions of 2 hour each. Besides, the works developed in group C will support the contents of this chapter.
Geographic Information Systems (GIS)	It tries to introduce the foundations and applications of the GIS, orienting all the exhibition to the support in the decisions process related with geographic locations. The second part of the session devotes to deepen in the knowledge of applications of GIS by means of the study of practical cases.
Terrestrial exploration	This section devotes to some examples of applications of Remote Sensing in diverse fields: studies of the ground, agriculture, mining, geology. The own actuality at teaching time can determine the applications in which more upsetting is done. The contents given in group A could have associated some of the works developed by students in groups C, depending on the focus of each group challenge.

Meteorology and Oceanography	In this section, the applications that more satellites have used along the history of Remote Sensing are introduced: the meteorology and the oceanography. In Meteorology, we introduce which types of sensors are employed, and we analyse the different parameters of interest, the characteristics regarding resolution and the results of climatic studies along the planet. Regarding Oceanography, the subject focuses on the observed parameters, the sensors, and it also presents images that show the results of the observations both directly and after the application of distinct processed. The contents given in group A could have associated some of the works developed by students in groups C, depending on the focus of each group challenge.
Space exploration	The aim of the subject is to show a panoramic of the space exploration. Beginning with the sensors employed along the years of history of the humanity in the space, the subject shows the main knowledges that we have obtained from the distinct bodies of the solar system and it explains how they arrived to this knowledge (missions, peculiarities of the ships and sensors employed, etc.).

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	17.2	25.8	43
Laboratory practical	4	8	12
Practices through ICT	10	17	27
Mentored work	5	43	48
Presentation	2	4	6
Introductory activities	1	1.2	2.2
Autonomous problem solving	0	2	2
Systematic observation	0	2	2
Essay	0	5	5
Essay questions exam	2.8	0	2.8

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

Methodologies

	Description
Lecturing	The course topics are presented and developed by the lecturer: foundations, theoretical bases, applications, etc. Group A sessions. 1 session/week. 2 hours/session Through this methodology the competencies C65, C66, D2, and B3 are developed.
Laboratory practical	Experimental work on sensor calibration and infrared termography. Group B sessions. 2 sessions/semester. 2 hours/session. Through this methodology the competencies C65, C66, D4, and B4 are developed.
Practices through ICT	Computer-based work on radar fundamentals and satellite imagery processing and interpretation. Group B sessions. 5 sessions/semester. 2 hours/session Through this methodology the competencies B4, B7, B9, D4, and D3 are developed.
Mentored work	The students will be assigned a simulation project. They will developed the project working in groups of 5-7 students. Project class sessions will be devoted to discussion and follow-up of the project. Group C sessions. 6 sessions/semester. 1 hour/session. Additional tutorial sessions will be scheduled if required. Through this methodology the competencies B4, B7, B9, D4, and D3 are developed.

Presentation	The students will present, in an open session, the results of their project. Previously, the students must send, by e-mail to the lecturer, a report summarizing the results. Group C sessions. 1 session/semester. 1 hour/session. Through this methodology the competency B9 is developed.
Introductory activities	Activities focused on taking contact and gathering information on the students, as well as to present the topic. For this activity, one face-to-face hour is reserved in group A, during which the professor presents the topic, explain the practices of laboratory and computer, and what expects of the works in group C. This methodology works on competences C65, C66, and B4
Autonomous problem solving	Homework to check the ability of observing the Earth from space images. B4 and D3 are the used competences.

Personalized assistance

Methodologies	Description
Introductory activities	Time that each professor has reserved to attend and resolve doubts of the students https://www.uvigo.gal/es/universidad/administracion-personal/pdi/inigo-cuinas-gomez
Lecturing	Time that the lecturer of group A has reserved to attend and resolve doubts of the students https://www.uvigo.gal/es/universidad/administracion-personal/pdi/inigo-cuinas-gomez
Laboratory practical	Time that the lecturer of groups B can use to help the students understand the lab practices and to resolve doubts. https://www.uvigo.gal/es/universidad/administracion-personal/pdi/inigo-cuinas-gomez
Practices through ICT	Time that the lecturer of groups B can use to help the students understand the lab practices and to resolve doubts. https://www.uvigo.gal/es/universidad/administracion-personal/pdi/inigo-cuinas-gomez
Mentored work	Time that the lecturer of groups C can use to provide support to the tutored groups, additional to the scheduled meetings. https://www.uvigo.gal/es/universidad/administracion-personal/pdi/inigo-cuinas-gomez
Presentation	Time that the lecturer of groups C can use to help the students in preparing their results presentations. https://www.uvigo.gal/es/universidad/administracion-personal/pdi/inigo-cuinas-gomez
Tests	**Description**
Essay questions exam	The lecture of group A will support the students to solve any doubt related to the tests. https://www.uvigo.gal/es/universidad/administracion-personal/pdi/inigo-cuinas-gomez

Assessment

	Description	Qualification	Training and Learning Results
Lecturing	Essay questions exams: there will be four proofs (10% each), at dates informed to the students at the beginning of the academic year, of 10 minutes length, that allows the student to pass part of the matters.	40	B3 C65 B7 C66
Laboratory practical	Systematic observation: During laboratory practices, the results and the demonstration of having understood the procedure to arrive to them will be evaluated: 1. "Sensors calibration": 5% 2. "Infrared thermography": 10%	15	B4 C66 D3 B9
Practices through ICT	Systematic observation: During the computer practices , the results and the demonstration of having understood the procedure to arrive to them will be evaluated: 1. "Foundations of RADAR": 7% 2. "Image Processing": 13%	20	B4 C65 D2
Mentored work	The works developed in C groups will be evaluated in two parts: the own dynamics of the works and the presentations. The work itself will receive 15% of the final mark of the subject. Each of the members of the work would receive the same mark, as each of them is co-responsible of the development.	15	B7 C66 B9

Presentation	Presentations of the works developed by the groups C. After the presentation, the lecturers will ask questions, individually, to the members of the group. The mark of this part will be given individually, depending on the demonstrated knowledge of each member of the group, and will represent 7% of the total subject mark.	7	B9	D4
Autonomous problem solving	Short solution of a homework	3	B4	D3
Essay questions exam	These exams are used to assess the lecture contents, and they are included in that issue	0	B3 C65 B7 C66	

Other comments on the Evaluation

The subject language is English. **Tests, reports and exams should be written in English.**

Evaluation and grading.

The students can chose any of the following assessment systems:

1.-**Continuous evaluation.** This consist of the following activities

1.1. Four quizzes. They account for 40%of the final grade (10% each).

1.2. Performance at lab classes. It accounts for a 35% of the final grade.

1.3. Simulation project results andreport. 15% of the grade.

1.4. Project presentation. 7% of thegrade.

1.5. Homework. 3% of the final grade.

Missed quizzes and/or lab classes will not be rescheduled.

Students attending to two of the four quizzes will be considered in the continuous assessment system. A student in continuos assessment is considered to be presented to the exam, independently of having taken all assessment events.

Students that want to improve their grade may also attend the exam-only assessment test. Their final grade will be the average between the final exam and the continuous assessment grade.

2.- **Global assessment.** It consists of a 10 questions exam. Time and place are published in the School web page. All material given in the lectures, lab classes and project presentations is subject to questioning.

The extraordinay exam will follow the scheme of global assessment.

The end-of-program exam will also follow the scheme of global assessment.

Ethical code

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.

Sources of information

Basic Bibliography

Iñigo Cuiñas, **Notes of Remote Sensing**, Moovi - UVIGO, 2022

Complementary Bibliography

Emilio Chuvieco Salinero, **Teledetección ambiental: La Observación de la Tierra desde el espacio**, 3, Digital Reasons, 2019

Nicholas M. Short, Sr., **The Remote Sensing Tutorial**, Code 935, Goddard Space Flight Center, 1999

Varios autores, **Exploring the Moon**, NASA, 1997

Águeda Arquero Hidalgo, Consuelo Gonzalo Martín, Estíbaliz Martínez Izquierdo, **Teledetección: Una aproximación desde la superficie al satélite**, Fundación General de la UPM, 2003

Varios autores, **Fundamentals of Remote Sensing**, Canadian Centre for Remote Sensing, 1998

Gerald C. Holst, **Common Sense Approach to Thermal Imaging**, SPIE Optical Engineering Press, 2000

Gary Jedlovec, **Advances in Geoscience and Remote Sensing**, In-Teh, 2009

Iñigo Cuiñas, Verónica Santalla, Ana V. Alejos, María Vera-Isasa, Edita de Lorenzo, Manuel G. Sánche, **Playing LEGO Mindstorms® while Learning Remote Sensing**, International Journal of Engineering Education, vo, 2011

Iñigo Cuiñas, Verónica Santalla, Pablo Torío, **Aprender jugando: fundamentos de Termografía en asignaturas de Teledetección**, Jornada de Innovación Educativa 2012, 2012

Recommendations

Subjects that are recommended to be taken simultaneously

Navigation systems and satellite communications/V05G301V01412

Subjects that it is recommended to have taken before

Microwave Circuits/V05G301V01322
Radio Frequency Circuits/V05G301V01319
Optical Telecommunication Infrastructures/V05G301V01325
Principles of Digital Communications/V05G301V01324
Wireless Systems and Networks/V05G301V01326
Radio Communication Systems/V05G301V01320
Multimedia Signal Processing/V05G301V01321

Other comments

The subject is going to be taught in English.
All the documents will be in English.