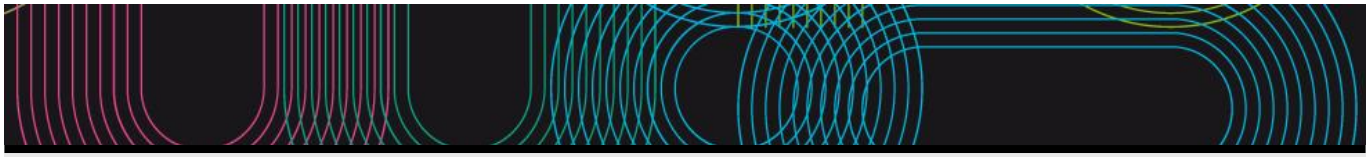

(*)Escola de Enxeñaría Aeronáutica e do Espazo

Presentation

The School of Aeronautic and Space Engineering (EEAE) of the University of Vigo at the Campus of Ourense offers the degrees of the University of Vigo that are related both to bachelor's and to master's level in the field of aeronautical or aerospace engineering.

More information about the Center and its degrees is found in this document or on the web page (http://aero.uvigo.es).

Address

Escola de Enxeñaría Aeronáutica e do Espazo

Pavillón Manuel Martínez-Risco
Campus universitario
32004 Ourense

Tel.: +34 988 368 823
Web: http://aero.uvigo.es

Regulations and legislation

The information is available on the Center's web site (http://aero.uvigo.es in the section: School -> Regulations).

(*)Máster Universitario en Operacións e Enxeñería de Sistemas Aéreos non Tripulados

Subjects

Year 1st

Code	Name	Quadmester	Total Cr.
O07M174V01101	Fundamentos de sistemas aéreos non tripulados	1st	6
O07M174V01102	Operacións de sistemas aéreos non tripulados	1st	6
O07M174V01103	Sistemas de comunicacións e navegación por radio	1st	6
O07M174V01104	Sensores embarcados	1st	6
O07M174V01105	Sistemas de control	2nd	6
O07M174V01201	Cargas útiles baseadas en sensores pasivos	2nd	6
O07M174V01202	Cargas útiles baseadas en sensores activos	2nd	6

O07M174V01205	Prácticas externas	2nd	15
O07M174V01206	Traballo Fin de Máster	2nd	9

IDENTIFYING DATA

(*)Fundamentos de sistemas aéreos non tripulados

Subject	(*)Fundamentos de sistemas aéreos non tripulados			
Code	O07M174V01101			
Study programme	(*)Máster Universitario en Operacións e Enxeñería de Sistemas Aéreos non Tripulados			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	1st	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Orgeira Crespo, Pedro			
Lecturers	Orgeira Crespo, Pedro			
E-mail	porgeira@uvigo.es			
Web	http://aero.uvigo.es			
General description	This subject intends to show the basic elements of an unmanned aerial vehicle as well as the description of the its principles of operation. International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies

Code		Typology
CB1	Possess and understand knowledge that provides a basis or opportunity to be original in the development and / or application of ideas, often in a research context	• know
CB2	That students know how to apply the knowledge acquired and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study	• know
CB3	That the students be able to integrate knowledge and face the complexity of formulating judgments from information, which being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments	• know
CG1	That students acquire general knowledge in unmanned aircraft systems engineering	• know
CG3	That students acquire the capabilities to analyze the needs of a company in the field of unmanned aerial systems and determine the best technological solution for the same	• know
CG4	That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, depending on the existing needs and to apply the existing technological tools	• know
CG5	That students know and be able to apply the principles and methodologies of research, such as bibliographical searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way	• know
CE1	Knowledge of the main systems, the on board instruments and the control station of a non-manned aircraft, as well as its influence on security	• know
CT2	Ability to communicate orally and in writing in Galician	• know
CT8	Ability of analysis and synthesis	• know
CT9	Capacity for critical reasoning and creativity	• know

Learning outcomes

Learning outcomes	Competences
Understand the operation of a profile of flight, the basic performance of the aircraft and surfaces of control.	CB1 CB2 CB3 CG1 CG3 CG4 CG5 CE1 CT2 CT8 CT9

Learn which are the main propulsion and structures employed in unmanned air vehicles	CB1 CB2 CB3 CG1 CG3 CG4 CG5 CE1 CT2 CT8 CT9
Know the main useful payloads	CB1 CB2 CB3 CG1 CG3 CG4 CG5 CE1 CT2 CT8 CT9

Contents	
Topic	
Introduction	Historical approximation to unmanned aerial vehicles. Ranking of the aircraft and his systems of propulsion. Terrestrial infrastructures. Management of aerial traffic. Legal environment.
Unmanned air vehicles	Principles of flight. Aircraft performance. General description of fixed wing aircraft . Controls of flight. Structure. Main instruments and systems. General description of helicopters. Controls of flight. Main instruments and systems. Multicopters.
Fluid mechanics priinciples	Compresivility. Viscosity. Limit layer and turbulence. Reynolds number. Mach number. Bernoulli's equation.. ISA.
Aerodynamics principles	Airfoils in incompresible flow. Flat plate. Cilinder. Kutta condition. Prandtl.
Introduction to the propulsion of aircraft.	Propellers: Theory of Froude; theory of the element of shovel. Propellerr adaptation. Aero jets. Push power, specific impulse and control of push in electric propulsion.
Flight mechanics	Basic flight equations. Cruisse flight, ascend, descent and gliding. Banking. Wind effect. Actuators. Stability and control.
Navigation systems	Avionics introduction Navigation sensors and systems. Inertial navigation. Integrated navigation. Kalman filter. GPS positioning.
Brushless control	Information gathering. Calculation and treatment of PID signals Control signal command.
Main payloads	Digital cameras. LIDAR. RADAR.

Other payloads	Liquid disperson systems. Environmental sensors. Transport of light payloads.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	10	0	10
Autonomous practices through ICT	22	22	44
Mentored work	7	63	70
Practices report	0	10	10
Problem and/or exercise solving	3	13	16

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

Methodologies

	Description
Lecturing	Content presentation using audiovisual means. The contents will be upload to the e-learning platform.
Autonomous practices through ICT	Practical activities in laboratory and computer room, to put in practice the outcome of the subject.
Mentored work	A group activity to have an overview of the subject through a real project.

Personalized assistance

Methodologies	Description
Lecturing	e-mail and one-to-one tutorials
Autonomous practices through ICT	e-mail and one-to-one tutorials
Mentored work	e-mail and one-to-one tutorials

Assessment

	Description	Qualification	Evaluated Competencess
Autonomous practices through ICT		50	CB1 CB2 CB3 CG1 CG3 CG4 CG5 CE1 CT2 CT8 CT9
Mentored work		50	CB1 CB2 CB3 CG1 CG3 CG4 CG5 CE1 CT2 CT8 CT9

Other comments on the Evaluation

Students to pass must submit all practice reports and problems. Everyone must individually achieve a minimum grade of 5.

In the July evaluation students must submit all reports of practices and problems that do not individually reach a minimum grade of 5.

Sources of information

Basic Bibliography

Complementary Bibliography

Jeffrey D. Barton, Fundamentals of small unmanned aircraft flight, http://www.jhuapl.edu/techdigest/TD/td3102/31_02-Barton.pdf

Aviation Civil Aviation Organization, Unmanned aircraft systems, https://www.icao.int/Meetings/UAS/Documents/Circular%20328_en.pdf

Mouhamed Abdulla, Jaroslav V. Svoboda, Luis Rodrigues, Avionics made simple, http://www.drmoe.org/research/avionics_made_simple.pdf

Bon Dewitt, Unmanned aerial systems for mapping, https://c.ymcdn.com/sites/www.fsms.org/resource/resmgr/2016/61st_annual_conference/education/PDFs/Unmanned_Aerial_Systems.pdf

Sergio Esteban Ronceso, Fundamentos de Ingeniería Aeroespacial, http://aero.us.es/iia/index_IIA.html

John Anderson, Fundamentos de aerodinámica, 6, McGraw Hill, 2017,

Miguel Ángel Gómez Tierno, Mecánica de vuelo, 2, Garceta, 2012,

Antonio Esteban Oñate, Conocimientos del avión, 1, Paraninfo, 2007,

Recommendations

Subjects that continue the syllabus

(*)Sistemas de comunicacións e navegación por radio/O07M174V01103

Subjects that are recommended to be taken simultaneously

(*)Operacións de sistemas aéreos non tripulados/O07M174V01102

IDENTIFYING DATA

(*)Operacións de sistemas aéreos non tripulados

Subject	(*)Operacións de sistemas aéreos non tripulados			
Code	O07M174V01102			
Study programme	(*)Máster Universitario en Operacións e Enxeñería de Sistemas Aéreos non Tripulados			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	1st	1st
Teaching language	Spanish			
Department				
Coordinator	González Jorge, Higinio			
Lecturers	González Jorge, Higinio			
E-mail	higiniog@uvigo.es			
Web	http://aero.uvigo.es			
General description	USC course. More info: http://www.usc.es/gl/centros/eps/materia.html?materia=129769 International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies

Code	Typology

Learning outcomes

Learning outcomes	Competences

Contents

Topic

Planning

	Class hours	Hours outside the classroom	Total hours

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

Methodologies

	Description

Personalized assistance

Assessment

Description	Qualification	Evaluated Competencess

Other comments on the Evaluation

Sources of information

Basic Bibliography

Complementary Bibliography

Recommendations

IDENTIFYING DATA				
(*)Sistemas de comunicacións e navegación por radio				
Subject	(*)Sistemas de comunicacións e navegación por radio			
Code	O07M174V01103			
Study programme	(*)Máster Universitario en Operacións e Enxeñería de Sistemas Aéreos non Tripulados			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	1st	1st
Teaching language	Spanish English			
Department				
Coordinator	Arias Acuña, Alberto Marcos			
Lecturers	Arias Acuña, Alberto Marcos González Valdés, Borja Pino García, Antonio			
E-mail	marcos@com.uvigo.es			
Web	http://aero.uvigo.es			
General description	International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies		
Code		Typology
CB3	That the students be able to integrate knowledge and face the complexity of formulating judgments from information, which being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments	• know
CB4	That the students know how to communicate their conclusions - and the latest knowledge and reasons that support them - to specialized and non-specialized audiences in a clear and unambiguous manner	• know
CB5	That students have the learning abilities that allow them to continue studying in a way that will have to be largely self-directed and autonomous	• know
CG3	That students acquire the capabilities to analyze the needs of a company in the field of unmanned aerial systems and determine the best technological solution for the same	• know
CG4	That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, depending on the existing needs and to apply the existing technological tools	• know
CG5	That students know and be able to apply the principles and methodologies of research, such as bibliographical searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way	• know
CE2	Knowledge of the geomatic, photogrammetrical and cartographic principles of navigation, aerotriangulation, interpretation and digital processing of images, as well as the good practices existing in the operation of unmanned aerial systems and know how to apply the regulations in force	• know
CT6	Ability to work as a team	• know
CT7	Capacity for organization and planning	• know
CT8	Ability of analysis and synthesis	• know
CT9	Capacity for critical reasoning and creativity	• know

Learning outcomes	
Learning outcomes	Competences
To know the classical systems of communications and navigation	CB3 CG4 CT8
To understand the operation of antenas and the link budget ratio.	CB5 CG5 CT9
To know radionavigation systems such as NDB, VOR/DME e ILS	CG3 CG4 CE2 CT7

To understand the operation of a GNSS positioning system	CB4 CG3 CE2 CT6
To learn the characteristics of automatic surveillance systems based in ADS-B and ADS-C	CB5 CG4 CT6

Contents	
Topic	
Classical communication and navigation systems	Classical communication systems Classical navigation ystems
Antennas and link budget	Antennas Link budget
Navigation systems	NDB VOR/DME ILS
GNSS positioning systems	GPS, GLONAS, GALILEO, BEIDU. Differential positioning, RTK. User, space and control Segment Augmentation systems such as SBAS and EGNOS
Automatic surveillance systems	ADS-B ADS-C

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	10	0	10
Computer practices	14	14	28
Mentored work	7	63	70
Case studies	14	14	28
Problem and/or exercise solving	2	4	6
Practices report	1	7	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	It will be 2 session of group tutoring of 2:30 h
Computer practices	It will be 2 session of group tutoring of 2:30 h
Mentored work	It will be 2 session of group tutoring of 2:30 h
Case studies	It will be 2 session of group tutoring of 2:30 h

Personalized assistance	
Methodologies	Description
Lecturing	In this methodology, we take care of and answer all the questions that each student can do.
Computer practices	We attend each student individually.
Case studies	We attend each student individually.
Mentored work	We attend each student individually.

Assessment			
	Description	Qualification	Evaluated Competencess
Problem and/or exercise solving	Final exam: it consists of a test for the evaluation of the competences acquired by the students by solving simple problems and short questions of theory.	60	CB3 CB5 CG3 CG4 CG5 CE2 CT7 CT8 CT9

Practices report	Participation in activities on the part of the students, especially of the practices, delivering a final memory of the same. This section corresponds to the continuous assessment of the student.	40	CB4 CB5 CG3 CG4 CG5 CE2 CT6

Other comments on the Evaluation

The final examination, will represent 60% for the students that opt by continuous evaluation and 100% of the final note in case of not opting by the continuous evaluation.

In case of detection of plagiarism in any of the works/proofs realized, the final qualification of the subject will be of "fail (0)" and the professors will communicate to the direction of the school this so that they can take the actions that consider appropriate.

Sources of information

Basic Bibliography

Marcos Arias Acuña, Oscar Rubiños López, Radiocomunicación, 1a, Andavira Editora, 2011,

José María Hernando Rábanos, Transmisión por Radio, 6a, Editorial Universitaria Ramón Areces, 2008,

John Griffits, Radio Wave Propagation and Antennas. An Introduction, 1st, Prentice Hall, 1985,

Complementary Bibliography

Robert R. Collin, Antennas and Radiowave Propagation, 1st, Mc Graw Hill, 1985,

Constantine A. Balanis, Antenna Theory. Analysis and Design, 3rd, Wiley, 2005,

ITU-R, Recommendations,

Recommendations

Subjects that continue the syllabus

(*)Cargas útiles baseadas en sensores activos/O07M174V01202

IDENTIFYING DATA				
(*)Sensores embarcados				
Subject	(*)Sensores embarcados			
Code	O07M174V01104			
Study programme	(*)Máster Universitario en Operacións e Enxeñería de Sistemas Aéreos non Tripulados			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	1st	1st
Teaching language	Spanish English			
Department				
Coordinator	González Jorge, Higinio			
Lecturers	González Jorge, Higinio Lorenzo Cimadevila, Henrique			
E-mail	higiniog@uvigo.es			
Web	http://aero.uvigo.es			
General description	Course that shows the main sensors that integrate an unmanned aerial system, focusing especially on those of the navigation system. International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies		
Code		Typology
CB3	That the students be able to integrate knowledge and face the complexity of formulating judgments from information, which being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments	• know
CB4	That the students know how to communicate their conclusions - and the latest knowledge and reasons that support them - to specialized and non-specialized audiences in a clear and unambiguous manner	• know
CB5	That students have the learning abilities that allow them to continue studying in a way that will have to be largely self-directed and autonomous	• know
CG3	That students acquire the capabilities to analyze the needs of a company in the field of unmanned aerial systems and determine the best technological solution for the same	• know
CG4	That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, depending on the existing needs and to apply the existing technological tools	• know
CG5	That students know and be able to apply the principles and methodologies of research, such as bibliographical searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way	• know
CT6	Ability to work as a team	• know
CT7	Capacity for organization and planning	• know
CT8	Ability of analysis and synthesis	• know
CT9	Capacity for critical reasoning and creativity	• know

Learning outcomes	
Learning outcomes	Competences
Know the existing inertial systems and the algorithms used to generate trajectories.	CB3 CB4 CB5 CG3 CG4 CG5 CT6 CT7 CT8 CT9

Learn to integrate the results of GNSS systems and inertial systems.	CB3 CB4 CB5 CG3 CG4 CG5 CT6 CT7 CT8 CT9
Know the barometric systems used in UAS.	CB3 CB4 CB5 CG3 CG4 CG5 CT6 CT7 CT8 CT9
Know the operation of systems based on pitot tube and ultrasound.	CB3 CB4 CB5 CG3 CG4 CG5 CT6 CT7 CT8 CT9
Understand of a LiDAR system, the data it provides (point clouds) and the possibilities it offers for indoor mapping with SLAM-type algorithms.	CB3 CB4 CB5 CG3 CG4 CG5 CT6 CT7 CT8 CT9
Understand the operation of image-based systems, as well as the generation of three-dimensional environments based on stereoscopic images and the basic algorithmics for image processing.	CB3 CB4 CB5 CG3 CG4 CG5 CT6 CT7 CT8 CT9

Contents
Topic
Inertial systems (accelerometers, gyroscopes and magnetometers.
Navigation. Complementary filter
Navigation. Kalman filter
Barometric systems, systems based on pitot tube and ultrasound systems.
LiDAR systems.
Basic processing of LiDAR data. Indoor navigation and SLAM.
Image based systems.
Image processing I
Image processing II
Photogrammetry and steoroscopic systems

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	10	0	10
Autonomous practices through ICT	22	22	44
Mentored work	7	63	70
Practices report	0	10	10
Problem and/or exercise solving	3	13	16

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

Methodologies

	Description
Lecturing	Presentation of the contents using audiovisual media. The contents are uploaded on the online training platform
Autonomous practices through ICT	Practices will be carried out using computers in which students will have to program procedures to acquire sensor data or carry out signal conditioning operations
Mentored work	Small projects will be proposed that students must implement

Personalized assistance

Methodologies	Description
Lecturing	Face to face tutoring. Attention by email.
Autonomous practices through ICT	Face to face tutoring. Attention by email.
Mentored work	Face to face tutoring. Attention by email.

Assessment

	Description	Qualification	Evaluated Competencess
Autonomous practices through ICT	The student will have to submit reports for each of the practices carried out.	60	CB3 CB4 CB5 CG3 CG4 CG5 CT6 CT7 CT8 CT9
Mentored work	The student will have to deliver solved problems raised by the teacher.	40	CB3 CB4 CB5 CG3 CG4 CG5 CT6 CT7 CT8 CT9

Other comments on the Evaluation

Sources of information

Basic Bibliography

Eduardo Huerta, Aldo Mangiaterra, Gustavo Noguera, GPS - Posicionamiento satelital, UNR Editora, 2005, https://www.fceia.unr.edu.ar/gps/GGSR/libro_gps.pdf

Oliver J. Woodman, An introduction to inertial navigation, Uniersity of Cambridge, 2007, https://www.cl.cam.ac.uk/techreports/UCAM-CL-TR-696.pdf

José Bosch, Manuel Carmona, Instrumentación electrónica avanzada, Departament d'Electronica, Universitat de Barcelon, 2012, http://diposit.ub.edu/dspace/bitstream/2445/34483/1/Instrumentaci%c3%b3n%20Electr%c3%b3nica%20Avanzada-Instrumentaci%c3%b3n%20Inteligente.pdf

Omar Bustillos Ponte, Instrumentación industrial, Escuela de Ingeniería y Ciencias Aplicadas, Univer, 2001, https://informatica.uv.es/iiguia/INS/material/InstrumentacionULPGC/TodoCompleto.pdf

Fabian Inostroza, Filtros, 2015, http://www2.udec.cl/~fabianinostroza/filtro_comp.pdf

Greg Welch, Gary Bischop, An introduction to the Kalman filter, Department of Computer Science, University of Nort, 2006, https://www.cs.unc.edu/~welch/media/pdf/kalman_intro.pdf
Lindsay Kleeman, Understanding and applying Kalman filtering, Department of Electrical and Computer Systems Eng., http://biorobotics.ri.cmu.edu/papers/sbp_papers/integrated3/kleeman_kalman_basics.pdf
James Hays, Introduction to computer vision, https://cs.brown.edu/courses/cs143/lectures/01.pdf
Jan Erik Solem, Programming Computer Vision with Python, http://programmingcomputervision.com/downloads/ProgrammingComputerVision_CCdraft.pdf
Jamie Carter et al., An introduction to LiDAR technology, data and applications, National Oceanic and Atmospheric Administration, https://coast.noaa.gov/data/digitalcoast/pdf/lidar-101.pdf

Complementary Bibliography

Recommendations

Subjects that continue the syllabus

(*)Sistemas de control/O07M174V01105

Subjects that it is recommended to have taken before

(*)Fundamentos de sistemas aéreos non tripulados/O07M174V01101
(*)Operacións de sistemas aéreos non tripulados/O07M174V01102
(*)Sistemas de comunicacións e navegación por radio/O07M174V01103

IDENTIFYING DATA				
(*)Sistemas de control				
Subject	(*)Sistemas de control			
Code	O07M174V01105			
Study programme	(*)Máster Universitario en Operacións e Enxeñería de Sistemas Aéreos non Tripulados			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	1st	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	García Rivera, Matías			
Lecturers	García Rivera, Matías			
E-mail	mgrivera@uvigo.es			
Web	http://aero.uvigo.es			
General description	This course describes fundamental concepts, principles and techniques about unmanned aerial vehicles: geometry, mechanics, hardware, control and navigation. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies		
Code		Typology
CB3	That the students be able to integrate knowledge and face the complexity of formulating judgments from information, which being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments	• know
CB4	That the students know how to communicate their conclusions - and the latest knowledge and reasons that support them - to specialized and non-specialized audiences in a clear and unambiguous manner	• know
CB5	That students have the learning abilities that allow them to continue studying in a way that will have to be largely self-directed and autonomous	• know
CG3	That students acquire the capabilities to analyze the needs of a company in the field of unmanned aerial systems and determine the best technological solution for the same	• know
CG4	That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, depending on the existing needs and to apply the existing technological tools	• know
CG5	That students know and be able to apply the principles and methodologies of research, such as bibliographical searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way	• know
CT6	Ability to work as a team	• know
CT7	Capacity for organization and planning	• know
CT8	Ability of analysis and synthesis	• know
CT9	Capacity for critical reasoning and creativity	• know

Learning outcomes	
Learning outcomes	Competences
Acquire knowledge about unmanned aerial vehicles, their key components, state estimation, basic mechanics, design considerations, agility and maneuverability.	CB3 CB4 CB5 CG3 CG4 CT8 CT9
Know the geometric and mechanical considerations of unmanned aerial vehicles, transformations, rotations, Euler angles, applicability of quaternions, angular velocity, equations of movement of a multi-rotor, linearization.	CB3 CB4 CB5 CG4
Understand the bases of the control and navigation system, PID controls, control in 1D, 2D and 3D of multirotor, generation of trajectories, Euler-Lagrange equations and Splines.	CB3 CB4 CB5 CG3 CG4

Understand the operation of multiple control systems.	CB3 CB4 CB5 CG4 CT6 CT7
Know the sense & avoid devices.	CB3 CB4 CB5 CG4 CG5
Understand the basics of embedded systems in real time.	CB3 CB4 CB5 CG4 CT6 CT7
Know the different existing open hardware controllers and their operation.	CB3 CB4 CB5 CG4 CG5 CT6 CT7

Contents	
Topic	
Introduction to unmanned aerial vehicles.	Multi-rotors.
Key components of autonomous flight.	Estimation of states. Basic mechanics Design considerations Agility and maneuverability Selection of components.
Geometry and mechanics.	Transformations Rotations Angles of Euler. Quaternions Angular velocity. Newton-Euler equations. Main axes and main moments of inertia. Equations of movement of a multi-rotor. Linearization
Control and navigation.	PID control. 1D, 2D and 3D control of multirotor. Paths. Euler-Lagrange equations. Splines.
Control of multiple systems.	
Sense & avoid devices.	
Fundamentals of embedded systems in real time.	
Open hardware controllers.	

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	10	0	10
Autonomous practices through ICT	12.5	12.5	25
Problem solving	12.5	12.5	25
Seminars	3	0	3
Mentored work	8	72	80
Problem and/or exercise solving	2	5	7
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	Exhibition by the teacher of the contents on the subject.

Autonomous practices through ICT	Activities of application of knowledge to concrete situations and acquisition of basic and procedural skills related to the subject. They are developed through ICT in an autonomous way.
Problem solving	Activity in which problems related to the subject are formulated. The students must develop the solutions. The objective is that the students apply the theoretical contents in the resolution of small programming problems.
Seminars	Orientation activity for students.
Mentored work	The student, individually or in groups, prepares a document on the topic of the subject or prepares seminars, investigations, reports, essays, summaries of readings, conferences, etc.

Personalized assistance

Methodologies	Description
Mentored work	Tutorials in the teacher's office. It is advisable to go to these tutorials when difficulties appear in the development of the supervised work, or when the time dedicated to the non-contact activities significantly exceeds the time set in the planning.
Autonomous practices through ICT	Tutorials in the teacher's office. It is advisable to attend these tutorials when difficulties arise in the development of autonomous practices through ICT, or when the time spent on non-contact activities significantly exceeds the time set in the planning.

Assessment

	Description	Qualification	Evaluated Competencess
Mentored work	1 assignment of supervised work, it will contribute 20% of the overall mark for this course	20	CB3 CB4 CB5 CG3 CG4 CG5 CT6 CT7 CT8 CT9
Autonomous practices through ICT	2 assignments of autonomous practices through ICT, each one will contribute 15% of the overall mark for this course	30	CT8 CT9
Problem and/or exercise solving	2 written exams, short answer tests, about the contents and competences taught in the lectures and autonomous practices through ICT. These tests will be short answer, each one will contribute 25% of the overall mark for this course.	50	CG3 CG4 CT8 CT9

Other comments on the Evaluation

ASSESSMENT FOR ASSISTANTS IN 1ST EDITION: CONTINUOUS EVALUATION.

For the students attending the 1st edition (continuous evaluation) the following tests and deliveries will be made:

- 1 assignment of supervised work, it will contribute 20% of the overall mark for this course;
- 2 assignments of autonomous practices through ICT, each one will contribute 15% of the overall mark for this course;
- 2 written exams, short answer tests, about the contents and competences taught in the lectures and autonomous practices through ICT. These tests will be short answer, each one will contribute 25% of the overall mark for this course.

To pass the subject it is mandatory that the student make all the assignments and all the written exams, and that in each assignment and written exam obtain a mark equal to or higher than 4.0.

In the case of not making any assignments or written exam, or obtain in any assignments or written exam a mark lower than 4.0, if the overall mark is higher than 5, the final mark in the minutes will be 4.9, fail.

ASSESSMENT FOR NON ASSISTANTS IN 1ST EDITION.

For the students attending the 1st edition (non continuous evaluation) the following tests and deliveries will be made:

- 1 assignment of supervised work, it will contribute 20% of the overall mark for this course;
- 2 assignments of autonomous practices through ICT, each one will contribute 15% of the overall mark for this course;
- 1 written exam about the contents and competences taught in the lectures and autonomous practices through ICT. This test will be short answer and it will contribute 50% of the overall mark for this course.

To pass the subject it is mandatory that the student make all the assignments and all the written exams, and that in each assignment and written exam obtain a mark equal to or higher than 4.0.

In the case of not making any assignments or written exam, or obtain in any assignments or written exam a mark lower than 4.0, if the overall mark is higher than 5, the final mark in the minutes will be 4.9, fail.

ASSESSMENT FOR 2ST EDITION AND OTHER EDITIONS

The same assessment for non assisstans in 1st edition

JUSTIFICATION OF ABSENCE

To be able to justify the absence to a exam is required a Certificate of Absence or a Consultation and Hospitalization Certificate (also called P10) issued by the SERGAS doctor, or a certificate issued by a doctor. A proof of the doctor's appointment will not be valid

Sources of information
Basic Bibliography
Randal Beard, Timothy McLain, Small Unmanned Aircraft: Theory and Practice, Princeton University Press, 2012,
Complementary Bibliography
Michael Cook, A Linear Systems Approach to Aircraft Stability and Control, Butterworth-Heinemann, 2007,
Katsuhiro Ogata, Ingeniería de control moderna, PRENTICE HALL, 2010,
Hassan Gomaa, Real-time software design for embedded systems, Cambridge University Press, 2016,
Plamen Angelov, Sense and Avoid in UAS Research and Applications, John Wiley & Sons, Ltd, 2012,
www.librepilot.org,

Recommendations

Subjects that it is recommended to have taken before
(*)Operacións de sistemas aéreos non tripulados/O07M174V01102
(*)Sensores embarcados/O07M174V01104

IDENTIFYING DATA				
(*)Cargas útiles baseadas en sensores pasivos				
Subject	(*)Cargas útiles baseadas en sensores pasivos			
Code	O07M174V01201			
Study programme	(*)Máster Universitario en Operacións e Enxeñería de Sistemas Aéreos non Tripulados			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	1st	2nd
Teaching language	Spanish Galician			
Department				
Coordinator	Salgueiro Piñeiro, Jose Ramon			
Lecturers	Salgueiro Piñeiro, Jose Ramon			
E-mail	jsalgueiro@gmail.com			
Web	http://aero.uvigo.es			
General description	Aims a description and basic study of sensing systems, particularly image systems, which can be installed on unmaned aerial vehicles, and their most relevant applications. International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies		
Code		Typology
CB3	That the students be able to integrate knowledge and face the complexity of formulating judgments from information, which being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments	• Know How • Know be
CB4	That the students know how to communicate their conclusions - and the latest knowledge and reasons that support them - to specialized and non-specialized audiences in a clear and unambiguous manner	• Know How
CB5	That students have the learning abilities that allow them to continue studying in a way that will have to be largely self-directed and autonomous	• know • Know How • Know be
CG3	That students acquire the capabilities to analyze the needs of a company in the field of unmanned aerial systems and determine the best technological solution for the same	• Know How
CG4	That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, depending on the existing needs and to apply the existing technological tools	• know • Know How
CG5	That students know and be able to apply the principles and methodologies of research, such as bibliographical searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way	• know • Know How
CT2	Ability to communicate orally and in writing in Galician	• know • Know How
CT6	Ability to work as a team	• Know How • Know be
CT7	Capacity for organization and planning	• know • Know How • Know be
CT8	Ability of analysis and synthesis	• Know How
CT9	Capacity for critical reasoning and creativity	• Know How • Know be

Learning outcomes	
Learning outcomes	Competences
Know the different passive sensors existent in aerial applications	CB3 CB5 CG4 CT2 CT8

Understand the procedures to calibrate sensors	CB3 CB4 CB5 CG4 CG5 CT2 CT8 CT9
Learn to mechanically integrate sensors: implementation of boresighting and use of gimbal and synchronization	CB3 CB4 CG3 CG4 CT2 CT6 CT7 CT8 CT9
Apply algorithms for aerial image processing and fotogrametry, image classification, object follow-up, filters and video processing	CB3 CB5 CG3 CG4 CG5 CT2 CT6 CT7 CT8 CT9
Know how to integrate images in geographic information systems	CB3 CB4 CB5 CG4 CT2 CT7 CT8 CT9

Contents	
Topic	
Sensors for UAVs	Motivation. Applications. Specific aspects of sensing using UAVs. Technologies for sensors in UAVs. Sensor basic components. Spectral regions of interest. UAV platforms for sensing. Integration of sensors in UAVs: gimbal systems. Image sensing in UAVs
Radiation: measurement and detection	Propagation of electromagnetic radiation. Light rays and wavefronts. Power flux. Radiometric magnitudes and units. Radiation sources: emission and reflection. Kirchoff's law. Lambertian sources. Atmospheric transmission. Photon detectors: CCD and CMOS sensors. Thermal detectors. Sources of noise.
Optical systems	Centered system. Conjugate points. Perfect system. Abbe and Herschel conditions. Paraxial optics. Cardinal elements. Optical system coupling. Lenses. Mirrors. Aberrations. Aperture and field stops. Resolving power of optical systems.
Sensors of image	Optical systems for cameras. Transversal and angular field. Basic design of lenses: teleobjetive and wide-angular lenses. Image plane irradiancie. Horizontal and vertical view fields. Instantaneous field of view. Image systems for UAVs. Signal to noise ratio. Noise equivalente power, radiance and irradiancie. Noise equivalente differential reflectance. Spatial resolution: PSF and MTF.
Thermografic image	Thermal detectors. Emittance and atmospheric transmission. Thermal contrast. Noise equivalent temperature difference. Thermal resolution. Thermographic systems for UAVs. Applications.
Multispectral image	Multispectral and Hyperspectral systems. Spectral image. Image at the focal plane. Spectral systems for UAVs. Band filters. Prism separation. Interferometers. Fourier transform spectrometers. Diffraction grating spectrometers.
8. Analysis of data and image processing	Metadata. Digital image. Motion video. Image definition. Object recognition and tracking. Image quality scale (NIIRS). Probability discrimination. Atmospheric correction. Image processing. Photogrammetry.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	10	0	10
Autonomous practices through ICT	22	22	44
Mentored work	7	63	70
Practices report	0	10	10
Problem and/or exercise solving	3	13	16

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

Methodologies	
	Description
Lecturing	Content presentation in the classroom
Autonomous practices through ICT	Use of specific sensing equipment (RGB cameras, thermograhic cameras, espectral cameras, etc) on UAV platforms and realization of proofs in flights.
Mentored work	Proposal of problems, activities or projects related to the contents of the subject that the students should develop by means of design, calculation and/or simulación.

Personalized assistance	
Methodologies	Description
Autonomous practices through ICT	Personal interviews and remote attention by means of the email
Mentored work	Personal interviews and remote attention by means of the email

Assessment			
	Description	Qualification	Evaluated Competencess
Autonomous practices through ICT	The students will owe to deliver a report on each experience or proposed activity.	50	CB3 CB4 CB5 CG3 CG4 CG5 CT2 CT6 CT7 CT8 CT9
Mentored work	The students will owe to solve propossed problems.	50	CB3 CB4 CB5 CG3 CG4 CG5 CT2 CT6 CT7 CT8 CT9

Other comments on the Evaluation

Sources of information

Basic Bibliography

Grant, Barbara, Getting Started with UAV Imaging Systems, SPIE, 2016,

Grant, Barbara, Field Guide to Radiometry, SPIE, 2009,

Holst, Gerald C., Common sense approach to thermal imaging, SPIE, 2000,

Wolfe, William L., Introduction to imaging spectrometers, SPIE, 1997,

Complementary Bibliography

Slater, P. N., Remote sensing: optics and optical systems, Addison Wesley, 1980,
Palmer, James M. y Grant, Barbara G., The Art of Radiometry, SPIE, 2009,
Dereniak, Eustace L., Optical radiation detectors, John Wiley & Sons, 1984,
Willers, Cornelius J., Electro-optical system analysis and design: aradiometry perspective, SPIE, 2013,
Chuvieco, Emilio, Fundamentos de teledetección espacial, segunda ed., Ediciones Rialp, 1995,
Hays, James, Computer Vision, https://www.cc.gatech.edu/~hays/compvision/
Shenk, T., Introduction to Photogrammetry, http://www.mat.uc.pt/~gil/downloads/IntroPhoto.pdf
A Brief Introduction to Photogrammetry and Remote Sensing, https://www.gislounge.com/a-brief-introduction-to-photogrammetry-and-remote-sensing/
Introducción a la fotogrametría, http://www.cartesia.org/data/apuntes/fotogrametria/Introduccion_a_la_Fotogrametria.pdf
Olaya, Victor, Sistemas de información geográfica, 2014,
Martínez-Corral, M. et al., Instrumentos ópticos y optométricos: teoría y prácticas, Universidad de Valencia, 1998,
Mejías Arias, P. et al., Óptica geométrica, Síntesis, 1999,
Hetch, E., Óptica, tercera ed., Adison Wesley, 2000,

Recommendations

Subjects that continue the syllabus

(*)Prácticas externas/O07M174V01205
(*)Traballo Fin de Máster/O07M174V01206

Subjects that it is recommended to have taken before

(*)Fundamentos de sistemas aéreos non tripulados/O07M174V01101
(*)Operacións de sistemas aéreos non tripulados/O07M174V01102
(*)Sensores embarcados/O07M174V01104
(*)Sistemas de comunicacións e navegación por radio/O07M174V01103
(*)Sistemas de control/O07M174V01105

IDENTIFYING DATA				
(*)Cargas útiles baseadas en sensores activos				
Subject	(*)Cargas útiles baseadas en sensores activos			
Code	O07M174V01202			
Study programme	(*)Máster Universitario en Operacións e Enxeñería de Sistemas Aéreos non Tripulados			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	1st	2nd
Teaching language	Spanish English			
Department				
Coordinator	González Jorge, Higinio			
Lecturers	González Jorge, Higinio Lorenzo Cimadevila, Henrique			
E-mail	higiniog@uvigo.es			
Web	http://aero.uvigo.es			
General description	This subject shows the principles of operation of LiDAR and RADAR sensors, calibration procedures and data processing. International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies		
Code		Typology
CB3	That the students be able to integrate knowledge and face the complexity of formulating judgments from information, which being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments	• know
CB4	That the students know how to communicate their conclusions - and the latest knowledge and reasons that support them - to specialized and non-specialized audiences in a clear and unambiguous manner	• know
CB5	That students have the learning abilities that allow them to continue studying in a way that will have to be largely self-directed and autonomous	• know
CG3	That students acquire the capabilities to analyze the needs of a company in the field of unmanned aerial systems and determine the best technological solution for the same	• know
CG4	That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, depending on the existing needs and to apply the existing technological tools	• know
CG5	That students know and be able to apply the principles and methodologies of research, such as bibliographical searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way	• know
CT2	Ability to communicate orally and in writing in Galician	• know
CT6	Ability to work as a team	• know
CT7	Capacity for organization and planning	• know
CT8	Ability of analysis and synthesis	• know
CT9	Capacity for critical reasoning and creativity	• know

Learning outcomes	
Learning outcomes	Competences
Know the different active sensors existent, LiDAR and RADAR.	CB3 CB4 CB5 CG3 CG4 CG5 CT2 CT6 CT7 CT8 CT9

Understand the procedures of calibración of sensors.	CB3 CB4 CB5 CG3 CG4 CG5 CT2 CT6 CT7 CT8 CT9
Learn to integrate sensors mechanically, implementation of boresighting, utilization of gimbal and synchronization.	CB3 CB4 CB5 CG3 CG4 CG5 CT2 CT6 CT7 CT8 CT9
Know different techniques of LiDAR and RADAR data processing and the algorithms for operations of segmentation, classificaiton and generation of digital terrain models.	CB3 CB4 CB5 CG3 CG4 CG5 CT2 CT6 CT7 CT8 CT9
Know how to integrate LiDAR and RADAR data in geographic information systems.	CB3 CB4 CB5 CG3 CG4 CG5 CT2 CT6 CT7 CT8 CT9

Contents
Topic
LiDAR sensors.
RADAR sensors.
Sensor synchronization and range calibration
Orientation calibration. Boresighting.
UAS-LiDAR system for data acquisition.
Data processing I. Registration and geopossitioning.
Data processing II. Filtering.
Data processing III. Rasterization and voxelization.
Data processing IV. Classification.
Results integration on geographic information systems.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	10	0	10
Mentored work	7	63	70
Autonomous practices through ICT	22	22	44

Practices report	0	10	10
Problem and/or exercise solving	3	13	16

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

Methodologies

	Description
Lecturing	Presentation of the contents using audiovisual media. The contents will be downloaded from the online platform.
Mentored work	Small projects that students should implement will be considered.
Autonomous practices through ICT	Practices will be carried out using computers in which the students will have to program a LiDAR data acquisition or perform the processing of LiDAR point clouds.

Personalized assistance

Methodologies	Description
Lecturing	Face to face tutorials. Attention by email.
Autonomous practices through ICT	Face to face tutorials. Attention by email.
Mentored work	Face to face tutorials. Attention by email.

Assessment

	Description	Qualification	Evaluated Competencess
Autonomous practices through ICT	The student will have to deliver reports for each of the practices carried out	60	CB3 CB4 CB5 CG3 CG4 CG5 CT2 CT6 CT7 CT8 CT9
Mentored work	The student will have to deliver problems solved by the professor	40	CB3 CB4 CB5 CG3 CG5 CT2 CT6 CT7 CT8 CT9

Other comments on the Evaluation

Students to pass must submit all practice reports and problems. Everyone must individually achieve a minimum grade of 5.

In the July evaluation students must submit all reports of practices and problems that do not individually reach a minimum grade of 5.

Sources of information

Basic Bibliography

Light detectiong and ranging (LiDAR), Portland State University, http://web.pdx.edu/~jduh/courses/geog493f12/Week04.pdf

Jamie Carter et al., An introduction to LiDAR technology, data and applications, National Oceanic and Atmospheric Administration, https://coast.noaa.gov/data/digitalcoast/pdf/lidar-101.pdf

Francesc Rocadenbosch, Introduction to LiDAR remote sensing systems, Universitat Politecnica de Catalunya, https://www.grss-ieee.org/wp-content/uploads/2010/06/IGARSS07.pdf

Frank A Ranking, LiDAR applications in surveying and engineering, http://www.ncgisconference.com/2013/documents/pdfs/Rankin_Thu_130.pdf
Demetrios Gatziolis, Hans-Erik Andersen, A guide to LiDAR data acquisition and processing for the forests of the Pacific Northwest, United States Department of Agriculture, https://www.fs.fed.us/pnw/pubs/pnw_gtr768.pdf
David Jenn, RADAR fundamentals, US Navy Postgraduade School, http://faculty.nps.edu/jenn/Seminars/RadarFundamentals.pdf
RADAR range equation, http://www.ece.uah.edu/courses/material/EE619-2011/RadarRangeEquation(2)2011.pdf
RADAR tutorial, http://www.radartutorial.eu/druck/Book1.pdf
Andy Myrick et al, Synthetic Aperture RADAR (SAR), Lincoln Laboratory - MIT, https://www.egr.msu.edu/classes/ece480/capstone/spring12/group05/docs/presentations/TechLecture_Team5.pdf

Complementary Bibliography

Recommendations

Subjects that continue the syllabus

(*)Prácticas externas/O07M174V01205
(*)Traballo Fin de Máster/O07M174V01206

Subjects that it is recommended to have taken before

(*)Fundamentos de sistemas aéreos non tripulados/O07M174V01101
(*)Operacións de sistemas aéreos non tripulados/O07M174V01102
(*)Sensores embarcados/O07M174V01104
(*)Sistemas de comunicacións e navegación por radio/O07M174V01103
(*)Sistemas de control/O07M174V01105

IDENTIFYING DATA

(*)Prácticas externas

Subject	(*)Prácticas externas			
Code	O07M174V01205			
Study programme	(*)Máster Universitario en Operacións e Enxeñería de Sistemas Aéreos non Tripulados			
Descriptors	ECTS Credits	Type	Year	Quadmester
	15	Mandatory	1st	2nd
Teaching language	Spanish Galician English			
Department				
Coordinator	González Jorge, Higinio			
Lecturers	González Jorge, Higinio			
E-mail	higiniog@uvigo.es			
Web	http://aero.uvigo.es			
General description	This course pretends that the student carries out internships in a company of the sector of the unmanned aircraft systems. International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies

Code		Typology
CB1	Possess and understand knowledge that provides a basis or opportunity to be original in the development and / or application of ideas, often in a research context	• know
CB2	That students know how to apply the knowledge acquired and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study	• know
CB3	That the students be able to integrate knowledge and face the complexity of formulating judgments from information, which being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments	• know
CB4	That the students know how to communicate their conclusions - and the latest knowledge and reasons that support them - to specialized and non-specialized audiences in a clear and unambiguous manner	• know
CB5	That students have the learning abilities that allow them to continue studying in a way that will have to be largely self-directed and autonomous	• know
CG1	That students acquire general knowledge in unmanned aircraft systems engineering	• know
CG2	That students acquire generic knowledge in unmanned aircraft systems operations	• know
CG3	That students acquire the capabilities to analyze the needs of a company in the field of unmanned aerial systems and determine the best technological solution for the same	• know
CG4	That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, depending on the existing needs and to apply the existing technological tools	• know
CG5	That students know and be able to apply the principles and methodologies of research, such as bibliographical searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way	• know
CE1	Knowledge of the main systems, the on board instruments and the control station of a non-manned aircraft, as well as its influence on security	• know
CE2	Knowledge of the geomatic, photogrammetrical and cartographic principles of navigation, aerotriangulation, interpretation and digital processing of images, as well as the good practices existing in the operation of unmanned aerial systems and know how to apply the regulations in force	• know
CE3	Capacity of interacting with technical teams in planning with unmanned aerial systems	• know
CE4	Capacity to develop a technical project in the field of engineering and operations with unmanned aerial systems	• know
CT1	Capacity to understand the meaning and application of the gender perspective in the different fields of knowledge and professional practice with the aim of achieving a more just and egalitarian society	• know
CT2	Ability to communicate orally and in writing in Galician	• know
CT3	Sustainability and environmental commitment. Equitable, responsible and efficient use of resources	• know
CT4	Development of the innovative and entrepreneurial spirit	• know
CT5	Ability to interpersonal relationships	• know
CT6	Ability to work as a team	• know
CT7	Capacity for organization and planning	• know
CT8	Ability of analysis and synthesis	• know
CT9	Capacity for critical reasoning and creativity	• know

Learning outcomes	
Learning outcomes	Competences
Develop an internship in a company in a professional environment related to the master	CB1 CB2 CB3 CB4 CB5 CG1 CG2 CG3 CG4 CG5 CE1 CE2 CE3 CE4 CT1 CT2 CT3 CT4 CT5 CT6 CT7 CT8 CT9 CT10

Contents
Topic
(*)Prácticas nun entorno profesional relacionado ca temática da titulación.

Planning			
	Class hours	Hours outside the classroom	Total hours
External practices	0	370	370
Report of external practices	0	5	5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
External practices	

Personalized assistance	
Methodologies	Description
External practices	Face-to-face tutoring and attention by email.

Assessment			
	Description	Qualification	Evaluated Competencess

External practices	Student practice report. Practice tutor report	100	CB1 CB2 CB3 CB4 CB5 CG1 CG2 CG3 CG4 CG5 CE1 CE2 CE3 CE4 CT1 CT2 CT3 CT4 CT5 CT6 CT7 CT8 CT9 CT10

Other comments on the Evaluation

Sources of information

Basic Bibliography

Complementary Bibliography

Recommendations

Subjects that are recommended to be taken simultaneously

(*)Traballo Fin de Máster/O07M174V01206

IDENTIFYING DATA				
(*)Traballo Fin de Máster				
Subject	(*)Traballo Fin de Máster			
Code	O07M174V01206			
Study programme	(*)Máster Universitario en Operacións e Enxeñería de Sistemas Aéreos non Tripulados			
Descriptors	ECTS Credits	Type	Year	Quadmester
	9	Mandatory	1st	2nd
Teaching language	Spanish Galician English			
Department				
Coordinator	González Jorge, Higinio			
Lecturers	González Jorge, Higinio			
E-mail	higiniog@uvigo.es			
Web	http://aero.uvigo.es			
General description	The student will carry out an engineering project in the field of unmanned aircraft systems in which he/she will put into practice the knowledge acquired throughout the master. International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies		
Code		Typology
CB1	Possess and understand knowledge that provides a basis or opportunity to be original in the development and / or application of ideas, often in a research context	• know
CB2	That students know how to apply the knowledge acquired and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study	• know
CB3	That the students be able to integrate knowledge and face the complexity of formulating judgments from information, which being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments	• know
CB4	That the students know how to communicate their conclusions - and the latest knowledge and reasons that support them - to specialized and non-specialized audiences in a clear and unambiguous manner	• know
CB5	That students have the learning abilities that allow them to continue studying in a way that will have to be largely self-directed and autonomous	• know
CG1	That students acquire general knowledge in unmanned aircraft systems engineering	• know
CG2	That students acquire generic knowledge in unmanned aircraft systems operations	• know
CG3	That students acquire the capabilities to analyze the needs of a company in the field of unmanned aerial systems and determine the best technological solution for the same	• know
CG4	That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, depending on the existing needs and to apply the existing technological tools	• know
CG5	That students know and be able to apply the principles and methodologies of research, such as bibliographical searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way	• know
CE1	Knowledge of the main systems, the on board instruments and the control station of a non-manned aircraft, as well as its influence on security	• know
CE2	Knowledge of the geomatic, photogrammetrical and cartographic principles of navigation, aerotriangulation, interpretation and digital processing of images, as well as the good practices existing in the operation of unmanned aerial systems and know how to apply the regulations in force	• know
CE3	Capacity of interacting with technical teams in planning with unmanned aerial systems	• know
CE4	Capacity to develop a technical project in the field of engineering and operations with unmanned aerial systems	• know
CT1	Capacity to understand the meaning and application of the gender perspective in the different fields of knowledge and professional practice with the aim of achieving a more just and egalitarian society	• know
CT2	Ability to communicate orally and in writing in Galician	• know
CT3	Sustainability and environmental commitment. Equitable, responsible and efficient use of resources	• know
CT4	Development of the innovative and entrepreneurial spirit	• know
CT5	Ability to interpersonal relationships	• know
CT6	Ability to work as a team	• know
CT7	Capacity for organization and planning	• know
CT8	Ability of analysis and synthesis	• know
CT9	Capacity for critical reasoning and creativity	• know

Learning outcomes	
Learning outcomes	Competences
Be able to develop a technical project in the field of operation with unmanned aircraft systems.	CB1 CB2 CB3 CB4 CB5 CG1 CG2 CG3 CG4 CG5 CE1 CE2 CE3 CE4 CT1 CT2 CT3 CT4 CT5 CT6 CT7 CT8 CT9 CT10

Contents
Topic
Project in the field of unmanned aircraft systems engineering.
Project in the field of unmanned aircraft systems operations.

Planning			
	Class hours	Hours outside the classroom	Total hours
Mentored work	0	215	215
Essay	1	9	10
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Mentored work	

Personalized assistance	
Methodologies	Description
Mentored work	Face-to-face tutoring and email attention

Assessment		
Description	Qualification	Evaluated Competencess

Mentored work	Project report. Oral presentation.	100	CB1 CB2 CB3 CB4 CB5 CG1 CG2 CG3 CG4 CG5 CE1 CE2 CE3 CE4 CT1 CT2 CT3 CT4 CT5 CT6 CT7 CT8 CT9 CT10

Other comments on the Evaluation

Sources of information

Basic Bibliography

Complementary Bibliography

Recommendations

Subjects that are recommended to be taken simultaneously

(*)Prácticas externas/O07M174V01205