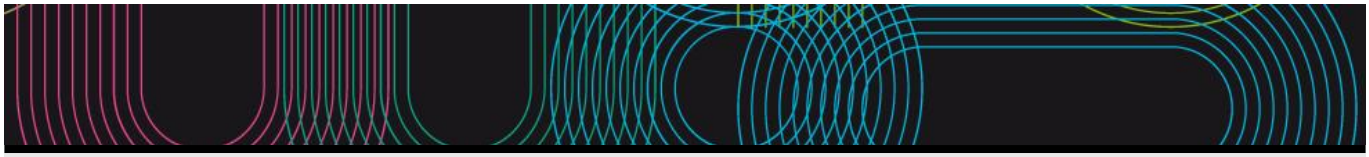

(*)Escola de Enxeñaría Aeronáutica e do Espazo

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		1st	6
O07M174V01102		1st	6
O07M174V01103		1st	6
O07M174V01104		1st	6
O07M174V01105		2nd	6
O07M174V01106		1st	6
O07M174V01107		1st	6
O07M174V01108		1st	6
O07M174V01201		2nd	6
O07M174V01202		2nd	6
O07M174V01203		2nd	6

O07M174V01204		2nd	6
O07M174V01205		2nd	15
O07M174V01206		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	Choose	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 aims to introduce the basic foundations that underlie the flight of any UAV: Aerodynamics, Flight Mechanics, and Propulsion. Its operating principles are described and the general concepts are reviewed. International students may request teachers: a) materials and bibliographic references to follow the subject in English, b) attend tutorials in English, c) tests and evaluations in English.			

Competencies	
Code	
A1	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
A2	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
A3	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
B1	That students acquire general knowledge in unmanned aircraft systems engineering
B3	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
B4	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
B5	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
C1	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
D2	Ability to communicate orally and in writing in Galician
D8	Ability of analysis and synthesis
D9	Capacity for critical reasoning and creativity

Learning outcomes	
Expected results from this subject	Training and Learning Results
Learn the main aerodynamic principles, flight mechanics and propulsion employed in UAV	A1 A2 A3 B1 B3 B4 B5 C1 D2 D8 D9

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.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	21	40	61
Problem solving	21	45	66
Problem and/or exercise solving	3	0	3
Report of practices, practicum and external practices	0	20	20
*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.
Problem solving	Content presentation using audiovisual means. The contents will be upload to the e-learning platform.

Personalized assistance	
Methodologies	**Description**
Lecturing	e-mail and one-to-one tutorials
Problem solving	e-mail and one-to-one tutorials

Assessment			
	Description	Qualification	Training and Learning Results

Problem solving	(*)Los alumnos para aprobar deben entregar todos los informes de prácticas y problemas requeridos durante el curso. Todos deben alcanzar de forma individual una nota mínima de un 5 sobre 10. En la evaluación ordinaria, se requiere una evaluación de 5 sobre 10 para considerar el examen aprobado. En la evaluación extraordinaria, los alumnos deben entregar todos aquellos informes de prácticas y problemas que no alcanzasen de forma individual una nota mínima de un 5. Igualmente, se requiere una evaluación de 5 sobre 10 para considerar el examen aprobado.	80	A1 A2 A3	B1 B3 B4 B5	C1	D2 D8 D9
Report of practices, practicum and external practices		20	A1 A2 A3	B1 B3 B4 B5	C1	D2 D8 D9

Other comments on the Evaluation

Students will deliver all the required reports during the course. All have to reach at least a 5/10 score to pass.
In June evaluation, a 5/10 is needed for students to pass the exam.
In July evaluation, a 5/10 score is also needed in the exam, as well as having scored a 5/10 on required reports.

Sources of information

Basic Bibliography

Complementary Bibliography

Jeffrey D. Barton, **Fundamentals of small unmanned aircraft flight**,
Aviation Civil Aviation Organization, **Unmanned aircraft systems**,
Mouhamed Abdulla, Jaroslav V. Svoboda, Luis Rodrigues, **Avionics made simple**,
Bon Dewitt, **Unmanned aerial systems for mapping**,
Sergio Esteban Ronceso, **Fundamentos de Ingeniería Aeroespacial**,
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

Contingency plan

Description

In the case of sanitary alert by COVID19, all the teaching, lectures and evaluation will be 100 % virtual.

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	Choose	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

Learning outcomes	
Expected results from this subject	Training and Learning Results

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	Training and Learning Results

Other comments on the Evaluation

Sources of information
Basic Bibliography
Complementary Bibliography

Recommendations

Contingency plan
Description

In the event of a COVID19 health alert, all teaching, tutorization and assessment will become 100% virtual.

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	Choose	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	
A3	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
A4	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
A5	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
B3	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
B4	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
B5	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
C2	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
D6	Ability to work as a team
D7	Capacity for organization and planning
D8	Ability of analysis and synthesis
D9	Capacity for critical reasoning and creativity

Learning outcomes	
Expected results from this subject	Training and Learning Results
To know the classical systems of communications and navigation	A3 B4 D8
To understand the operation of antenas and the link budget ratio.	A5 B5 D9
To know radionavigation systems such as NDB, VOR/DME e ILS	B3 B4 C2 D7

To understand the operation of a GNSS positioning system	A4 B3 C2 D6
To learn the characteristics of automatic surveillance systems based in ADS-B and ADS-C	A5 B4 D6

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
Practices through ICT	14	14	28
Mentored work	7	63	70
Case studies	14	14	28
Problem and/or exercise solving	2	4	6
Report of practices, practicum and external practices	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
Practices through ICT	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.
Practices through ICT	We attend each student individually.
Case studies	We attend each student individually.
Mentored work	We attend each student individually.

Assessment	Description	Qualification	Training and Learning Results			
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	A3 A5	B3 B4 B5	C2	D7 D8 D9
Report of practices, practicum and external practices	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	A4 A5	B3 B4 B5	C2	D6

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

Contingency plan

Description

In case of health alert that prevents physical attendance at classrooms and laboratories,
(i) face-to-face learning (A- and B-groups) will be replaced by emergency remote teaching,
(ii) tutoring will be done exclusively in a virtual way (via email or via the UVigo Remote platform which allows live connections)
(iii) alternatives to unrealised laboratory practices (C-groups) that require the use of specific material and cannot be virtualised shall be sought,
(iv) the assessment shall be carried out virtually via the UVigo Remote platform under conditions which shall be described at the appropriate time

(*) but which shall try to be as close as possible to what would be the case in the absence of a health alert.

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	Choose	Year	Quadmester
	6	Optional	1st	1st
Teaching language	Spanish English			
Department				
Coordinator	González Jorge, Higinio			
Lecturers	González Jorge, Higinio Martínez Sánchez, Joaquín			
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	
A3	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
A4	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
A5	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
B3	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
B4	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
B5	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
D6	Ability to work as a team
D7	Capacity for organization and planning
D8	Ability of analysis and synthesis
D9	Capacity for critical reasoning and creativity

Learning outcomes	
Expected results from this subject	Training and Learning Results
Know the existing inertial systems and the algorithms used to generate trajectories.	A3 A4 A5 B3 B4 B5 D6 D7 D8 D9
New	

Learn to integrate the results of GNSS systems and inertial systems.	A3 A4 A5 B3 B4 B5 D6 D7 D8 D9
Know the barometric systems used in UAS.	A3 A4 A5 B3 B4 B5 D6 D7 D8 D9
Know the operation of systems based on pitot tube and ultrasound.	A3 A4 A5 B3 B4 B5 D6 D7 D8 D9
Understand of a LiDAR system, the data it provides (point clouds) and the possibilities it offers for indoor mapping with SLAM-type algorithms.	A3 A4 A5 B3 B4 B5 D6 D7 D8 D9
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.	A3 A4 A5 B3 B4 B5 D6 D7 D8 D9

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
ICT suppoted practices (Repeated, Dont Use)	22	22	44
Mentored work	7	63	70
Report of practices, practicum and external practices	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
ICT suppoted practices (Repeated, Dont Use)	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.
ICT suppoted practices (Repeated, Dont Use)	Face to face tutoring. Attention by email.
Mentored work	Face to face tutoring. Attention by email.

Assessment					
	Description	Qualification	Training and Learning Results		
ICT suppoted practices (Repeated, Dont Use)	The student will have to submit reports for each of the practices carried out.	60	A3 A4 A5	B3 B4 B5	D6 D7 D8 D9
Mentored work	The student will have to deliver solved problems raised by the teacher.	40	A3 A4 A5	B3 B4 B5	D6 D7 D8 D9

Other comments on the Evaluation

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

In the July assessment, students must submit all those practice reports and problems that do not individually reach a minimum grade of 5.

Sources of information

Basic Bibliography

Eduardo Huerta, Aldo Mangiaterra, Gustavo Noguera, **GPS - Posicionamiento satelital**, UNR Editora, 2005

Oliver J. Woodman, **An introduction to inertial navigation**, Uniersity of Cambridge, 2007

José Bosch, Manuel Carmona, **Instrumentación electrónica avanzada**, Departament d'Electronica, Universitat de Barcelon, 2012

Omar Bustillos Ponte, **Instrumentación industrial**, Escuela de Ingeniería y Ciencias Aplicadas, Univer, 2001

Fabian Inostroza, **Filtros**, 2015

Greg Welch, Gary Bischop, **An introduction to the Kalman filter**, Department of Computer Science, University of Nort, 2006

Lindsay Kleeman, **Understanding and applying Kalman filtering**, Department of Electrical and Computer Systems Eng.,

James Hays, **Introduction to computer vision**,

Jan Erik Solem, **Programming Computer Vision with Python**,

Jamie Carter et al., **An introduction to LiDAR technology, data and applications**, National Oceanic and Atmospheric Administration,

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

Contingency plan

Description

In the event of a COVID19 health alert, all teaching, tutorization and assessment will become 100% virtual.

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	Choose	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	
A3	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
A4	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
A5	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
B3	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
B4	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
B5	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
D6	Ability to work as a team
D7	Capacity for organization and planning
D8	Ability of analysis and synthesis
D9	Capacity for critical reasoning and creativity

Learning outcomes	
Expected results from this subject	Training and Learning Results
Acquire knowledge about unmanned aerial vehicles, their key components, state estimation, basic mechanics, design considerations, agility and maneuverability.	A3 A4 A5 B3 B4 D8 D9
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.	A3 A4 A5 B4

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.	A3 A4 A5 B3 B4
Understand the operation of multiple control systems.	A3 A4 A5 B4 D6 D7
Know the sense & avoid devices.	A3 A4 A5 B4 B5
Understand the basics of embedded systems in real time.	A3 A4 A5 B4 D6 D7
Know the different existing open hardware controllers and their operation.	A3 A4 A5 B4 B5 D6 D7

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
ICT suppoted practices (Repeated, Dont Use)	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.
ICT suppoted practices (Repeated, Dont Use)	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.
ICT suppoted practices (Repeated, Dont Use)	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	Training and Learning Results		
ICT suppoted practices (Repeated, Dont Use)	2 assignments of autonomous practices through ICT, each one will contribute 15% of the overall mark for this course	30			D8 D9
Mentored work	1 assignment of supervised work, it will contribute 20% of the overall mark for this course	20	A3 A4 A5	B3 B4 B5	D6 D7 D8 D9
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		B3 B4	D8 D9

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

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

In the case of health alert by COVID19, all teaching, tutoring and evaluation will be 100% virtual.

=== ADAPTATION OF THE METHODOLOGIES ===
* Teaching methodologies maintained
All of them

* Teaching methodologies modified
None of them

* Non-attendance mechanisms for student attention (tutoring)
https://campusremotouvigo.gal/ and https://faitic.uvigo.es

* Modifications (if applicable) of the contents
No modifications

* Additional bibliography to facilitate self-learning
No additional bibliography

* Other modifications
For laboratory practices, the practices that require specific equipment will be replaced by another simulated or virtualized one. Eventually, alternative practices that do not require such equipment will be proposed. These practices may be an autonomous format in anticipation of reconciliation and / or connectivity problems.

=== ADAPTATION OF THE TESTS ===
* Tests already carried out
All tests already carried out maintain their weight

* Pending tests that are maintained
All pending tests maintain their weight

* Tests that are modified
No tests are modified

* New tests
No new test

* Additional Information
Due to the exceptional situation, due to the impossibility of being able to do the tests in person, virtual means will be used to carry out the tests.
The means provided by the University, currently https://campusremotouvigo.gal/ and https://faitic.uvigo.es will be used. They may also be supplemented by other means.

IDENTIFYING DATA				
(*)Aplicacións no sector agroforestal				
Subject	(*)Aplicacións no sector agroforestal			
Code	O07M174V01106			
Study programme	(*)Máster Universitario en Operacións e Enxeñería de Sistemas Aéreos non Tripulados			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	1st	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA				
(*)Recursos naturais				
Subject	(*)Recursos naturais			
Code	O07M174V01107			
Study programme	(*)Máster Universitario en Operacións e Enxeñería de Sistemas Aéreos non Tripulados			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	1st	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA				
(*)Xestión do territorio e urbanismo				
Subject	(*)Xestión do territorio e urbanismo			
Code	O07M174V01108			
Study programme	(*)Máster Universitario en Operacións e Enxeñería de Sistemas Aéreos non Tripulados			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	1st	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

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	Choose	Year	Quadmester
	6	Optional	1st	2nd
Teaching language	Spanish Galician			
Department				
Coordinator	Salgueiro Piñeiro, Jose Ramon			
Lecturers	Salgueiro Piñeiro, Jose Ramon			
E-mail	jrs@uvigo.es			
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	
A3	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
A4	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
A5	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
B3	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
B4	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
B5	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
D2	Ability to communicate orally and in writing in Galician
D6	Ability to work as a team
D7	Capacity for organization and planning
D8	Ability of analysis and synthesis
D9	Capacity for critical reasoning and creativity

Learning outcomes	
Expected results from this subject	Training and Learning Results
Know the different passive sensors existent in aerial applications	A3 A5 B4 D2 D8
Understand the procedures to calibrate sensors	A3 A4 A5 B4 B5 D2 D8 D9

Learn to mechanically integrate sensors: implementation of boresighting and use of gimbal and synchronization	A3 A4 B3 B4 D2 D6 D7 D8 D9
Apply algorithms for aerial image processing and fotogrametry, image classification, object follow-up, filters and video processing	A3 A5 B3 B4 B5 D2 D6 D7 D8 D9
Know how to integrate images in geographic information systems	A3 A4 A5 B4 D2 D7 D8 D9

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
ICT suppoted practices (Repeated, Dont Use)	22	22	44
Mentored work	7	63	70
Report of practices, practicum and external practices	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
ICT suppoted practices (Repeated, Dont Use)	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
ICT suppoted practices (Repeated, Dont Use)	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	Training and Learning Results		
ICT suppoted practices (Repeated, Dont Use)	The students will owe to deliver a report on each experience or proposed activity.	50	A3 A4 A5	B3 B4 B5	D2 D6 D7 D8 D9
Mentored work	The students will owe to solve propossed problems.	50	A3 A4 A5	B3 B4 B5	D2 D6 D7 D8 D9

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**,

Shenk, T., **Introduction to Photogrammetry**,

A Brief Introduction to Photogrammetry and Remote Sensing,

Introducción a la fotogrametría,

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

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===
* Teaching methodologies maintained

* Teaching methodologies modified

* Non-attendance mechanisms for student attention (tutoring)

* Modifications (if applicable) of the contents

* Additional bibliography to facilitate self-learning

* Other modifications

=== ADAPTATION OF THE TESTS ===
* Tests already carried out
Test XX: [Previous Weight 00%] [Proposed Weight 00%]
...

* Pending tests that are maintained
Test XX: [Previous Weight 00%] [Proposed Weight 00%]
...

* Tests that are modified
[Previous test] => [New test]

* New tests

* Additional Information

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	Choose	Year	Quadmester
	6	Optional	1st	2nd
Teaching language	Spanish English			
Department				
Coordinator	González Jorge, Higinio			
Lecturers	González Jorge, Higinio Martínez Sánchez, Joaquín			
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	
A3	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
A4	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
A5	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
B3	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
B4	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
B5	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
D2	Ability to communicate orally and in writing in Galician
D6	Ability to work as a team
D7	Capacity for organization and planning
D8	Ability of analysis and synthesis
D9	Capacity for critical reasoning and creativity

Learning outcomes	
Expected results from this subject	Training and Learning Results
Know the different active sensors existent, LiDAR and RADAR.	A3 A4 A5 B3 B4 B5 D2 D6 D7 D8 D9

Understand the procedures of calibración of sensors.	A3 A4 A5 B3 B4 B5 D2 D6 D7 D8 D9
Learn to integrate sensors mechanically, implementation of boresighting, utilization of gimbal and synchronization.	A3 A4 A5 B3 B4 B5 D2 D6 D7 D8 D9
Know different techniques of LiDAR and RADAR data processing and the algorithms for operations of segmentation, classificaiton and generation of digital terrain models.	A3 A4 A5 B3 B4 B5 D2 D6 D7 D8 D9
Know how to integrate LiDAR and RADAR data in geographic information systems.	A3 A4 A5 B3 B4 B5 D2 D6 D7 D8 D9

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
ICT suppoted practices (Repeated, Dont Use)	22	22	44

Report of practices, practicum and external practices	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.
ICT suppoted practices (Repeated, Dont Use)	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.
ICT suppoted practices (Repeated, Dont Use)	Face to face tutorials. Attention by email.
Mentored work	Face to face tutorials. Attention by email.

Assessment

	Description	Qualification	Training and Learning Results		
Mentored work	The student will have to deliver problems solved by the professor	40	A3 A4 A5	B3 B5	D2 D6 D7 D8 D9
ICT suppoted practices (Repeated, Dont Use)	The student will have to deliver reports for each of the practices carried out	60	A3 A4 A5	B3 B4 B5	D2 D6 D7 D8 D9

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,

Jamie Carter et al., **An introduction to LiDAR technology, data and applications**, National Oceanic and Atmospheric Administration,

Francesc Rocadenbosch, **Introduction to LiDAR remote sensing systems**, Universitat Politecnica de Catalunya,

Frank A Ranking, **LiDAR applications in surveying and engineering**,

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,

David Jenn, **RADAR fundamentals**, US Navy Postgraduade School,

RADAR range equation,

RADAR tutorial,

Andy Myrick et al, **Synthetic Aperture RADAR (SAR)**, Lincoln Laboratory - MIT,

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

Contingency plan

Description

In the event of a COVID19 health alert, all teaching, tutorization and assessment will become 100% virtual.

IDENTIFYING DATA				
(*)Enxeñaría civil, Industrial e Arquitectura				
Subject	(*)Enxeñaría civil, Industrial e Arquitectura			
Code	O07M174V01203			
Study programme	(*)Máster Universitario en Operacións e Enxeñería de Sistemas Aéreos non Tripulados			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	1st	2nd
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA				
(*)Visión por computador para UAVS				
Subject	(*)Visión por computador para UAVS			
Code	O07M174V01204			
Study programme	(*)Máster Universitario en Operacións e Enxeñería de Sistemas Aéreos non Tripulados			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	1st	2nd
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

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	Choose	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	
A1	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
A2	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
A3	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
A4	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
A5	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
B1	That students acquire general knowledge in unmanned aircraft systems engineering
B2	That students acquire generic knowledge in unmanned aircraft systems operations
B3	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
B4	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
B5	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
C1	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
C2	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
C3	Capacity of interacting with technical teams in planning with unmanned aerial systems
C4	Capacity to develop a technical project in the field of engineering and operations with unmanned aerial systems
D1	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
D2	Ability to communicate orally and in writing in Galician
D3	Sustainability and environmental commitment. Equitable, responsible and efficient use of resources
D4	Development of the innovative and entrepreneurial spirit
D5	Ability to interpersonal relationships
D6	Ability to work as a team
D7	Capacity for organization and planning
D8	Ability of analysis and synthesis
D9	Capacity for critical reasoning and creativity
D10	Guidance to quality and continuous improvement

Learning outcomes

Expected results from this subject	Training and Learning Results
Develop an internship in a company in a professional environment related to the master	A1 A2 A3 A4 A5 B1 B2 B3 B4 B5 C1 C2 C3 C4 D1 D2 D3 D4 D5 D6 D7 D8 D9 D10

Contents

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

Planning

	Class hours	Hours outside the classroom	Total hours
Practicum, External practices and clinical practices	0	370	370
Report of practices, practicum and external practices(Repetida non usar)	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
Practicum, External practices and clinical practices	

Personalized assistance

Methodologies	Description
Practicum, External practices and clinical practices	Face-to-face tutoring and attention by email.

Assessment

	Description	Qualification	Training and Learning Results			
Practicum, External practices and clinical practices	Student practice report. Practice tutor report	100	A1 A2 A3 A4 A5	B1 B2 B3 B4 B5	C1 C2 C3 C4	D1 D2 D3 D4 D5 D6 D7 D8 D9 D10

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

Contingency plan

Description

In the event of a COVID19 health alert, all teaching, tutorization and assessment will become 100% virtual. In the specific case of internships, the students will be provided with companies that allow them to carry out the activity remotely.

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	Choose	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	
A1	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
A2	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
A3	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
A4	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
A5	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
B1	That students acquire general knowledge in unmanned aircraft systems engineering
B2	That students acquire generic knowledge in unmanned aircraft systems operations
B3	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
B4	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
B5	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
C1	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
C2	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
C3	Capacity of interacting with technical teams in planning with unmanned aerial systems
C4	Capacity to develop a technical project in the field of engineering and operations with unmanned aerial systems
D1	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
D2	Ability to communicate orally and in writing in Galician
D3	Sustainability and environmental commitment. Equitable, responsible and efficient use of resources
D4	Development of the innovative and entrepreneurial spirit
D5	Ability to interpersonal relationships
D6	Ability to work as a team
D7	Capacity for organization and planning
D8	Ability of analysis and synthesis
D9	Capacity for critical reasoning and creativity
D10	Guidance to quality and continuous improvement

Learning outcomes

Expected results from this subject	Training and Learning Results
Be able to develop a technical project in the field of operation with unmanned aircraft systems.	A1 A2 A3 A4 A5 B1 B2 B3 B4 B5 C1 C2 C3 C4 D1 D2 D3 D4 D5 D6 D7 D8 D9 D10

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	Training and Learning Results			
Mentored work	Project report. Oral presentation.	100	A1 A2 A3 A4 A5	B1 B2 B3 B4 B5	C1 C2 C3 C4	D1 D2 D3 D4 D5 D6 D7 D8 D9 D10

Other comments on the Evaluation

Sources of information

Basic Bibliography

Complementary Bibliography

Recommendations

Subjects that are recommended to be taken simultaneously

(*)Prácticas externas/O07M174V01205

Contingency plan

Description

In the event of a COVID19 health alert, all teaching, tutorization and assessment will become 100% virtual. There is a commitment that all lines of TFM activity adapt to this situation, facilitating the student's remote work.