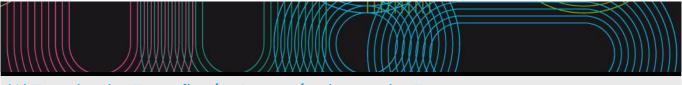
Educational guide 2019 / 2020

Universida_{de}Vigo



(*)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

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

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

IDENTIFYIN	-				
	entos de sistemas aéreos non tripulados				
Subject	(*)Fundamentos de				
	sistemas aéreos				
-	non tripulados				
Code	007M174V01101				
Study	(*)Máster				
programme	Universitario en				
	Operacións e Enxeñería de				
	Sistemas Aéreos				
	non Tripulados				
Descriptors	ECTS Credits Typ	20	Year	Quadme	actor
Descriptors		ndatory	1st	1st	ESTEI
Teaching	#EnglishFriendly	iluator y	130	131	
language	Spanish				
Department					
	Orgeira Crespo, Pedro				
Lecturers	Orgeira Crespo, Pedro				
E-mail	porgeira@uvigo.es				
Web	http://aero.uvigo.es				
General	This subject intends to show the basic elements of an unma	nned serial	vohicle as well as	the descript	tion of the
description	its principles of operation.	illieu aeriai	veriicie as weii as	the descrip	tion of the
description	International students may request from the teachers: a) m_i	aterials and	hibliographic refe	rancas in Er	nalish h)
	tutoring sessions in English, c) exams and assessments in E		bibliographic refe	renees in Er	igiisii, b)
	tatoring sessions in English, c) exams and assessments in E	iigiisii.			
C	•				
Competence Code	cies				Typology
	s and understand knowledge that provides a basis or opportu	nity to be a	riginal in the days	lanmont and	Typology
	s and understand knowledge that provides a basis of opportu plication of ideas, often in a research context	inity to be of	iginai in the deve	юртен анс	ı • KIIOW
	udents know how to apply the knowledge acquired and their	ability to co	vo problems in no	w or	• know
	liar environments within broader (or multidisciplinary) contex				KIIOW
	e students be able to integrate knowledge and face the comp				• know
	ation, which being incomplete or limited, includes reflections				
	application of their knowledge and judgments	on social an	a cancar responsi	Jineies inne	u
	udents acquire general knowledge in unmanned aircraft syste	ems engine	erina		• know
	udents acquire the capabilities to analyze the needs of a com			d aerial	• know
	is and determine the best technological solution for the same				
	e students acquire the knowledge to develop unmanned aeri		r to plan specific	operations.	• know
	ding on the existing needs and to apply the existing technolog			.,,	
	udents know and be able to apply the principles and methodo		search, such as bi	bliographica	al • know
search	es, data collection and analysis and interpretation thereof, as	well as the	presentation of co	nclusions, i	n
a clear	, concise and rigorous way				
CE1 Knowle	edge of the main systems, the on board instruments and the c	control station	on of a non-manne	d aircraft, a	s • know
well as	its influence on security				
CT2 Ability	to communicate orally and in writing in Galician				know
CT8 Ability	of analysis and synthesis				know
CT9 Capacit	ty for critical reasoning and creativity				• know
Learning o	utcomes				
Learning out				Compet	ences
Understand	the operation of a profile of flight, the basic performance of the	he aircraft a	nd surfaces of	CB1	
control.	•			CB2	
				CB3	
				CG1	
				CG3	
				CG4	
				CG5	
				CG5 CE1	
				CG5 CE1 CT2	
				CG5 CE1	

CB2
CDZ
CB3
CG1
CG3
CG4
CG5
CE1
CT2
CT8
CT9
CB1
CB2
CB3
CG1
CG3
CG4
CG5
CE1
CE1 CT2

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.

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		
	DescriptionQualificationEvaluated Cor	mpetencess
Autonomous practices through ICT	50 CB	1
	CB	2
	CB	3
	CG	1
	CG	3
	CG	
	CG	5
	CE	
	CT	
	СТ	
	CT	9
Mentored work	50 CB	1
	CB.	2
	CB.	3
	CG	
	CG	
	CG	
	CG	5
	CE:	
	CT	
	СТ	8
	CT	9

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/007M174V01103

Subjects that are recommended to be taken simultaneously

(*)Operacións de sistemas aéreos non tripulados/O07M174V01102

IDENTIFYIN	IG DATA				
(*)Operació	óns de sistemas aéreos non trip	oulados			
Subject	(*)Operacións de				
	sistemas aéreos				
	non tripulados				
Code	O07M174V01102				
Study	(*)Máster				
programme	Universitario en				
	Operacións e				
	Enxeñería de				
	Sistemas Aéreos				
	non Tripulados				
Descriptors	ECTS Credits		уре	Year	Quadmester
	6	<u></u>	landatory	1st	1st
Teaching	Spanish				
language					
Department					
Coordinator	González Jorge, Higinio				
Lecturers	González Jorge, Higinio				
E-mail	higiniog@uvigo.es				
Web	http://aero.uvigo.es				
General	USC course. More info:				
description	http://www.usc.es/gl/centros/eps/	materia.html?materia=1	29769		
	International students may reque			bibliographic	references in English, b)
	tutoring sessions in English, c) ex			5 1	3 , ,
Competenc	ies				
Code		Typology			
		.) p = . = g y			
Lanuning	utcomos				
Learning out					Competences
Learning out	comes				Competences
Contents					
Topic					
Planning					
		Class hours	Hours o	utside the	Total hours
			classro		
*The informa	ation in the planning table is for gu	idance only and does no	t take into aco	count the het	erogeneity of the students.
	1 3 3	,			
Methodolog					
METHORISM					
	Description Description				
	Description				
	Description				
Personalize	Description ed assistance				
Personalize Assessmen	Description ed assistance t		Eva	luated Compe	tencess
Personalize	Description ed assistance t		Eva	luated Compe	tencess
Personalize Assessmen Description	Description ed assistance t Qualification		Eva	luated Compe	tencess
Personalize Assessmen Description	Description ed assistance t		Eva	luated Compe	etencess
Personalize Assessmen Description	Description ed assistance t Qualification		Eva	luated Compe	etencess
Assessmen Description Other comm	Description ed assistance t Qualification		Eva	luated Compe	rtencess
Assessmen Description Other comm	Description ed assistance t		Eva	luated Compe	tencess
Assessmen Description Other common Sources of Basic Biblio	Description ed assistance t		Eva	luated Compe	tencess
Assessmen Description Other common Sources of Basic Biblio	Description ed assistance t Qualification ments on the Evaluation information ography		Eva	luated Compe	itencess
Assessmen Description Other comm Sources of Basic Biblio	Description ed assistance t Qualification ments on the Evaluation information ography ntary Bibliography		Eva	luated Compe	itencess
Assessmen Description Other commo	Description ed assistance t Qualification ments on the Evaluation information ography ntary Bibliography		Eva	luated Compe	etencess

IDENTIFYIN	G DATA			
	de comunicacións e navegación por radio			
Subject	(*)Sistemas de			
,	comunicacións e			
	navegación por			
	radio			
Code	O07M174V01103			
Study	(*)Máster			
programme	Universitario en			
	Operacións e			
	Enxeñería de			
	Sistemas Aéreos			
	non Tripulados			
Descriptors	ECTS Credits	Туре	Year Quadm	ester
	6	Optional	1st 1st	
Teaching	Spanish			
language	English			
Department				
	Arias Acuña, Alberto Marcos			
Lecturers	Arias Acuña, Alberto Marcos			
	González Valdés, Borja			
E 0	Pino García, Antonio			
E-mail	marcos@com.uvigo.es			
Web	http://aero.uvigo.es	\ 1 1	d hills and a his material and the	
General	International students may request from the teachers		d bibliographic references in E	ngiish, b)
description	tutoring sessions in English, c) exams and assessmen	nts in English.		
Competence	ies			
Code				Typology
	e students be able to integrate knowledge and face th			know
	tion, which being incomplete or limited, includes refle	ections on social a	nd ethical responsibilities linke	ed
to the a	pplication of their knowledge and judgments			
CB4 That th	e students know how to communicate their conclusion	is - and the latest	knowledge and reasons that	know
support	them - to specialized and non-specialized audiences	in a clear and una	mbiguous manner	I.o
	udents have the learning abilities that allow them to co	ontinue studying i	n a way that will have to be	know
	self-directed and autonomous	f to the	- field of consequent assist	
	udents acquire the capabilities to analyze the needs of s and determine the best technological solution for the		e neid of unmanned aeriai	know
	e students acquire the knowledge to develop unmann		or to plan specific energtions	
	ing on the existing needs and to apply the existing ted		or to plan specific operations,	• know
	idents know and be able to apply the principles and m		ocoarch, such as hibliographic	al • know
	es, data collection and analysis and interpretation ther			
	concise and rigorous way	eoi, as well as the	presentation of conclusions,	111
	dge of the geomatic, photogrammetrical and cartogra	nhic principles of	navigation aerotriangulation	• know
	etation and digital processing of images, as well as the			KIIOW
	ned aerial systems and know how to apply the regulat		Albaning in the operation of	
	o work as a team			• know
	y for organization and planning			• know
	of analysis and synthesis			• know
	y for critical reasoning and creativity			• know
	,			
Learning o	itcomes			
Learning out			Compe	tences
	classical systems of communications and navigation		CB3	rences
to know the	ciassical systems of communications and navigation		CG4	
			CT8	
To understa	nd the operation of antenas and the link budget ratio.		CB5	
10 unuersidi	a the operation of uniterias and the link budget fatio.		CG5	
			CT9	
To know rad	onavigation systems such as NDB, VOR/DME e ILS		CG3	
70 KHOW 100	Sile inguition by Seemis Such as 1455, VOINDINE CIES		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 Final exam: it consists of a test for the evaluation of the competences	60	CB3
exercise solving acquired by the students by solving simple problems and short questions of theory.		CB5
4		CG3
		CG4
		CG5
		CE2
		CT7
		CT8
		CT9

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

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/007M174V01202

## Competencies Code Onzialez Jorge, Higinio Lorenzo that integrate an unmanned aerial system, focusing especially on those of descriptions in English, c) exams and assessments in English. **Competencies** Code Onzialez Jorge, Higinio Lorenzo (Course that shows the main sensors that integrate an unmanned aerial systems on the sudents know how to communicate their conclusions - and thick sudents know how to communicate their conclusions - and the latest knowledge and reasons that support them - to specialized and non-specialized and unsupport them - to specialized and unsupport them - to specialized and non-specialized and unsupport them - to specialized and unsupport - them - to specialized and u	IDENTIFYIN	G DATA				
Subject (*)Sensores embarcados Code 007M]74V01104 Study (*)Máster programme Universitario en Operacions e Excelerá de Sistemas Aéreos non Tropulados Descriptors ECTS Credits Type Year Quadmester Encelerá de Sistemas Aéreos Optional 1st						
embarcados Code OO7M174V01104 Study (*)Máster program Universitario en Operacións e Enxeñería de Sistemas Aéros non Tropulados Descriptors ECTS Creditis Type Year Quadmester 6 Optional 1st 1st Facahing Spanish Begartamet Coordinator González Jorge, Higinio Lorenzo Cimadevila, Henrique E-mail higiniog@uvigo.es Web http://nero.uvigo.es General Course that shows the main sensors that integrate an unmanned aerial system, focusing especially on those of 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 Typolog. Can That the students be able to integrate knowledge and face the complexity of formulating judgments from shown information, which being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments CB4 That the students know how to communicate their conclusions - and the latest knowledge and reasons that - know support them - to specialized and non-specialized audiences in a clear and unambiguous manner CB5 That students know how to communicate their conclusions - and the latest knowledge and reasons that - know support them - to specialized and non-specialized audiences in a clear and unambiguous manner CB6 That the students Acquire the capabilities to analyze the needs of a company in the field of unmanned aerial - know systems and determine the best technological solution for the same CG6 That students acquire the capabilities to analyze the needs of a company in the field of unmanned aerial - know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CG7 Tacapacity for organization and planning the knowledge of search, such as bibliographical - know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clea	(/					
Competencies Comp	,	• •				
Competencies Comp	Code					
Universitario en Operacións e Enxeñería de Sistemas Aéreos non Tripulados Descriptors ECTS Credits Type Year Quadmester General Gener						
Operacións e Enxeñería de Sistemas Aéreos non Tripulados Descriptors ECTS Credits Type Year Quadmester 6 Optional 1st 1st Teaching Spanish language English Department Coordinator González Jorge, Higinio Lorenzo Cimadevila, Henrique E-mail higiniog@urigo es Web http://aero.uvigo es General Course that shows the main sensors that integrate an unmanned aerial system, focusing especially on those of 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 Tourse that shows the main sensors that integrate an unmanned aerial system, focusing especially on those of description 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 Tourse that students be able to integrate knowledge and face the complexity of formulating judgments from *know information, which being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments C84 That the students know how to communicate their conclusions - and the latest knowledge and reasons that *know support them *to specialized and non-specialized audiences in a clear and unambiguous manner C85 That students know the capabilities that allow them to continue studying in a way that will have to be *know largely self-directed and autonomous C87 That students acquire the capabilities to analyze the needs of a company in the field of unmanned aerial *know systems and determine the best technological solution for the same C84 That the students acquire the capabilities to analyze the needs of a company in the field of unmanned aerial *know depending on the existing needs and to apply the principles and methodologies of research, such as bibliographical *know depending on the existing nee	-	` '				
Enxeñería de Sistemas Aéreos	programme					
Sistemas Aéreos non Tripulados						
Descriptors ECTS Credits Type Year Quadmester						
Descriptors ECTS Credits Type Year Quadmester						
Feaching Spanish English Eng	Descriptors		Type	Year	Ouadme	ster
Teaching Spanish language English Department Coordinator González Jorge, Higinio Lorenzo Cimadevila, Henrique E-mail higinlog@uvigo.es Web http://aero.uvigo.es General 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 Typolog 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 CB4 That the students know how to communicate their conclusions - and the latest knowledge and reasons that one support them - to specialized and non-specialized audiences in a clear and unambiguous manner CB5 That students have the learning abilities that allow them to continue studying in a way that will have to be alroyed sudents acquire the capabilities to analyze the needs of a company in the field of unmanned aerial - know systems and determine the best technological solution for the same CB4 That the students acquire the capabilities to analyze the needs of a company in the field of unmanned aerial - know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CB4 That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, - know depending on the existing needs and to apply the existing technological tools CB5 That students know and be able to apply the principles and methodologies of research, such as bibliographical - know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CB6 Ability to work	2 000p100					
Ianguage English Department Coordinator González Jorge, Higinio Coordinator González Jorge, Higinio Corenzo Cimadevila, Henrique	Teaching		0 0 1 1 1 1 1			
Department Coordinator Conzález Jorge, Higinio Lecturers González Jorge, Higinio Lorenzo Cimadevila, Henrique E-mail Mighiog@uvigo.es Web http://aero.uvigo.es General Course that shows the main sensors that integrate an unmanned aerial system, focusing especially on those of description 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 Typolog CB3 That the students be able to integrate knowledge and face the complexity of formulating judgments from shown information, which being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments 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 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 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 CG4 That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, show depending on the existing needs and to apply the existing technological tools CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical * know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CF6 Ability to work as a team • know CF7 Capacity for organization and planning • know CF8 Ability to work as a team • know CF9 Capacity for organization and planning • know CF9 Capacity for organization and planning • know CF9 Capacity for organization	_					
Coordinator González Jorge, Higinio Lorenzo Cimadevila, Henrique E-mail higinio@uvigo.es higinio@uvigo.es Web http://aero.uvigo.es General Course that shows the main sensors that integrate an unmanned aerial system, focusing especially on those of description description description 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. Typology		English		,	,	
Lecturers González Jorge, Higinio Lorenzo Cimadevila, Henrique E-mail higiniog@uvigo.es Web http://aero.uvigo.es General Course that shows the main sensors that integrate an unmanned aerial system, focusing especially on those of description 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 Campetencies Code Campetencies Campe		González Jorge Higinio				
Lorenzo Cimadevila, Henrique E-mail higiniog@uigo.es Web http://aero.uvigo.es General Course that shows the main sensors that integrate an unmanned aerial system, focusing especially on those of description 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 Typolog Cas 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 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 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 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 CG4 That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, know depending on the existing needs and to apply the existing technological tools CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CT6 Ability to work as a team						
E-mail higiniog@uvigo.es http://aero.uvigo.es General 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	Lecturers					
Meb	F-mail					
General 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 Typolog: 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 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 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 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 CG4 That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, edepending on the existing needs and to apply the existing technological tools CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way 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 organization and planning • know CB3 CB4 CB5 CG3 CG4 CG5 CT6						
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			o an unmanned aeric	al system facus	ing osposially on	those of
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			e an unmanned aend	ai system, locus	ing especially or	i those of
Competencies Code Code Typology	description		hore, a) materials an	d hibliographic	roforoncos in En	alich h)
Competencies Code Code B3 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 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 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 CG3 That students acquire the capabilities to analyze the needs of a company in the field of unmanned aerial * know systems and determine the best technological solution for the same CG4 That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, * know depending on the existing needs and to apply the existing technological tools CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical * know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CT6 Ability to work as a team **Now** **Now** CT7 Capacity for organization and planning **Now** **Now** CT8 Ability to work as a team **Now** CT8 Ability of analysis and synthesis **CB4** CB5** CG4** CG5** CG6** CG6** CG6** CG6** CG6** CG6** CG7*				u bibliograpilic	references in Eng	giisii, b)
Code 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 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 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 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 CG4 That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, elaboration of the existing needs and to apply the existing technological tools CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way 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 Learning outcomes Competences Know the existing inertial systems and the algorithms used to generate trajectories. CB3 CB4 CB5 CB5 CG6 CG5 CG6 CG6 CG7 CG7 CG7 CG7 CG7 CG7		tutoring sessions in English, c) exams and assess	inents in English.			
Code 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 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 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 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 CG4 That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, elaphonical on the existing needs and to apply the existing technological tools CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way 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 Learning outcomes Competences Know the existing inertial systems and the algorithms used to generate trajectories. CB3 CB4 CB5 CB5 CG6 CG5 CG7 CG6 CG6 CG7 CG7 CG7 CG7 CG7	C 1					
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 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 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 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 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 CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical * know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CT6 Ability to work as a team CT7 Capacity for organization and planning * know CT8 Ability of analysis and synthesis CB3 CB4 CB4 CB5 CB3 CB4 CB5 CG3 CG4 CG5 CG5 CG6 CG6 CG6 CG7 CG7 CG7 CG7 CG7		les				
information, which being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments 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 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 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 CG4 That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, elmow depending on the existing needs and to apply the existing technological tools CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical elevations, in a clear, concise and rigorous way CT6 Ability to work as a team 1 chapacity for organization and planning 2 chapacity for organization and planning 3 know CT7 Capacity for organization and planning 4 know CT8 Ability of analysis and synthesis 5 chow CB3 CB4 CB4 CB5 CG3 CG4 CG4 CG5 CT6 CT6 CT6 CT6 CT6 CT6 CT6						
to the application of their knowledge and judgments 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 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 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 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 CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical * know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way 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 CB3 CB4 CB5 CG3 CG4 CG5 CG5 CT6						
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 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 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 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 CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CT6 Ability to work as a team CT7 Capacity for organization and planning • know CT8 Ability of analysis and synthesis • know CT9 Capacity for critical reasoning and creativity • know CT9 Capacity for critical reasoning and creativity • know Learning outcomes Know the existing inertial systems and the algorithms used to generate trajectories. CB3 CB4 CB5 CG3 CG4 CG5 CT6			effections on social a	na etnicai respo	insibilities linked	
support them - to specialized and non-specialized audiences in a clear and unambiguous manner 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 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 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 CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way 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 CT9 Capacity for critical reasoning and creativity • know CC64 CB5 CC64 CB5 CC64 CC64 CC65 CT6			-to	. I I I		1
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 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 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 CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CT6 Ability to work as a team						• Know
largely self-directed and autonomous 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 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 CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way 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 Learning outcomes Competences Know the existing inertial systems and the algorithms used to generate trajectories. CB3 CB4 CB5 CG3 CG4 CG5 CT6						1
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 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 CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way 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 CG4 CG5 CT6			o continue studying	in a way that wi	ii nave to be	• know
systems and determine the best technological solution for the same 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 CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CT6 Ability to work as a team			la . 	. C. I.I C		1
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 CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way 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 CT9 Capacity for critical reasoning and creativity • know Learning outcomes Know the existing inertial systems and the algorithms used to generate trajectories. CB3 CB4 CB5 CG3 CG4 CG5 CT6				e neid of unmar	ined aeriai	• Know
depending on the existing needs and to apply the existing technological tools CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way 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 Know the existing inertial systems and the algorithms used to generate trajectories. CB3 CB4 CB5 CG3 CG4 CG5 CT6					:C:	. 1
CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way 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 for critical reasoning for cr				or to plan spec	inc operations,	• Know
searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CT6 Ability to work as a team				racas rab such a	a hihliaaranhiaal	
a clear, concise and rigorous way CT6 Ability to work as a team						
CT6 Ability to work as a team			nereor, as well as the	e presentation o	or conclusions, in	
CT7 Capacity for organization and planning CT8 Ability of analysis and synthesis CT9 Capacity for critical reasoning and creativity • know Learning outcomes Learning outcomes Know the existing inertial systems and the algorithms used to generate trajectories. CB3 CB4 CB5 CG3 CG4 CG5 CT6						
CT8 Ability of analysis and synthesis • know CT9 Capacity for critical reasoning and creativity • know Learning outcomes Learning outcomes Know the existing inertial systems and the algorithms used to generate trajectories. CB3 CB4 CB5 CG3 CG4 CG5 CT6						
Learning outcomes Learning outcomes Know the existing inertial systems and the algorithms used to generate trajectories. CB3 CB4 CB5 CG3 CG4 CG5 CT6						
Learning outcomes Learning outcomes Know the existing inertial systems and the algorithms used to generate trajectories. CB3 CB4 CB5 CG3 CG4 CG5 CT6						
Learning outcomes Know the existing inertial systems and the algorithms used to generate trajectories. CB3 CB4 CB5 CG3 CG4 CG5 CT6	CT9 Capacit	y for critical reasoning and creativity				• know
Learning outcomes Know the existing inertial systems and the algorithms used to generate trajectories. CB3 CB4 CB5 CG3 CG4 CG5 CT6						
Know the existing inertial systems and the algorithms used to generate trajectories. CB3 CB4 CB5 CG3 CG4 CG5 CT6						
CB4 CB5 CG3 CG4 CG5 CT6						ences
CB5 CG3 CG4 CG5 CT6	Know the exi	sting inertial systems and the algorithms used to $\mathfrak q$	generate trajectories			
CG3 CG4 CG5 CT6						
CG4 CG5 CT6						
CG5 CT6						
CT6						
					CT7	
CT8						
CT9					C19	

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	CB3
mapping with SLAM-type algorithms.	CB4
	CB5
	CG3
	CG4
	CG5
	CT6
	CT7 CT8
	CT9
Understand the operation of image-based systems, as well as the generation of three-dimensional	CB3
environments based on stereoscopic images and the basic algorithmics for image processing.	CB4
	CB5
	CG3
	CG4
	CG5
	CT6
	CT7
	CT8 CT9
	CIS
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	Practices will be carried out using computers in which students will have to program procedures to
through ICT	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	QualificationEv	aluated Competencess
Autonomous practices	The student will have to submit reports for each of the	60	CB3
through ICT	practices carried out.		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

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

IDENTIFYIN	IG DATA			
(*)Sistemas	s de control			
Subject	(*)Sistemas de			
	control			
Code	O07M174V01105			
Study	(*)Máster			
rogramme	Universitario en			
	Operacións e			
	Enxeñería de			
	Sistemas Aéreos			
	non Tripulados			
Descriptors	ECTS Credits	Туре	Year	Quadmester
	6	Optional	1st	2nd
eaching	#EnglishFriendly			
anguage	Spanish			
	Galician			
Department				
Coordinator	García Rivera, Matías			
ecturers	García Rivera, Matías			
-mail	mgrivera@uvigo.es			
Veb	http://aero.uvigo.es			
General	This course describes fundamental conc	epts, principles and technique	es about unmanr	ned aerial vehicles:
lescription	geometry, mechanics, hardware, contro	l and navigation.		
	English Friendly subject: International st	tudents may request from the	teachers: a) ma	terials and bibliographic
	references in English, b) tutoring session	ns in English, c) exams and as	sessments in En	glish.
Competenc	ies			
ode				Typolo
	e students be able to integrate knowledg	e and face the complexity of f	ormulating judge	

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 bibliographica searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, ir a clear, concise and rigorous way	
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

earning outcomes earning outcomes	Competences
acquire knowledge about unmanned aerial vehicles, their key components, state estimation, basic	CB3
nechanics, design considerations, agility and maneuverability.	
	CB5
	CG3
	CG4
	CT8
	CT9
now the geometric and mechanical considerations of unmanned aerial vehicles, transformations,	CB3
tations, Euler angles, applicability of quaternions, angular velocity, equations of movement of a multi-	CB4
tor, linearization.	CB5
	CG4
nderstand the bases of the control and navigation system, PID controls, control in 1D, 2D and 3D of	CB3
ultirotor, generation of trajectories, Euler-Lagrange equations and Splines.	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
<u> </u>	

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 ti	me.
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	QualificationE	valuated 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 2 assignments of autonomous practices through ICT, each one		30	CT8
practices through I	CT will contribute 15% of the overall mark for this course		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
			СТ9

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

Subject	itiles baseadas en sensores pasivos	
•	(*)Cargas útiles baseadas en	
	sensores pasivos	
Code	007M174V01201	
Study	(*)Máster	
programme	Universitario en	
programme	Operacións e	
	Enxeñería de	
	Sistemas Aéreos	
	non Tripulados	
Descriptors		Quadmester
		2nd
 Teaching	Spanish	
language	Galician	
Department		
Coordinator		
Lecturers	Salgueiro Piñeiro, Jose Ramon	
E-mail	jsalgueiro@gmail.com	
Web	http://aero.uvigo.es	
General	Aims a description and basic study of sensing systems, particularly image systems, which can	be installed on
description	unmaned aerial vehicles, and their most relevant applications.	
•	International students may request from the teachers: a) materials and bibliographic reference	es in English, b)
	tutoring sessions in English, c) exams and assessments in English.	3 . ,
Competenc	ies	
Code		Typology
	e students be able to integrate knowledge and face the complexity of formulating judgments fr	
	ation, which being incomplete or limited, includes reflections on social and ethical responsibilities.	
	to the application of their knowledge and judgments	cs know be
	e students know how to communicate their conclusions - and the latest knowledge and reasons	s that • Know How
	t them - to specialized and non-specialized audiences in a clear and unambiguous manner	o chac i non mon
	udents nave the learning abilities that allow them to continue studying in a way that will have t	o be • know
	udents have the learning abilities that allow them to continue studying in a way that will have t self-directed and autonomous	
	self-directed and autonomous	
largely	self-directed and autonomous	Know HowKnow be
largely CG3 That stu		Know HowKnow be
largely CG3 That stu	self-directed and autonomous udents acquire the capabilities to analyze the needs of a company in the field of unmanned aers s and determine the best technological solution for the same	Know HowKnow be
CG3 That stu systems	self-directed and autonomous udents acquire the capabilities to analyze the needs of a company in the field of unmanned aer	Know How Know be Know How
CG3 That stu system: CG4 That the operation	self-directed and autonomous udents acquire the capabilities to analyze the needs of a company in the field of unmanned aer s and determine the best technological solution for the same e students acquire the knowledge to develop unmanned aerial systems or to plan specific	Know How Know be Know How know
CG3 That stu systems CG4 That the operation	self-directed and autonomous udents acquire the capabilities to analyze the needs of a company in the field of unmanned aers and determine the best technological solution for the same e students acquire the knowledge to develop unmanned aerial systems or to plan specific ons, depending on the existing needs and to apply the existing technological tools	Know How Know How Know How Know How Know How know
CG3 That stu systems CG4 That the operatic CG5 That stu bibliogr	self-directed and autonomous udents acquire the capabilities to analyze the needs of a company in the field of unmanned aer s and determine the best technological solution for the same e students acquire the knowledge to develop unmanned aerial systems or to plan specific ons, depending on the existing needs and to apply the existing technological tools udents know and be able to apply the principles and methodologies of research, such as	Know How Know How Know How Know How Know How know
CG3 That stu system: CG4 That the operatic CG5 That stu bibliogr of conc	self-directed and autonomous udents acquire the capabilities to analyze the needs of a company in the field of unmanned aer s and determine the best technological solution for the same e students acquire the knowledge to develop unmanned aerial systems or to plan specific ons, depending on the existing needs and to apply the existing technological tools udents know and be able to apply the principles and methodologies of research, such as raphical searches, data collection and analysis and interpretation thereof, as well as the presen	• Know Hov • Know Hov • know • know Hov • know • know tation• Know Hov
CG3 That stu system: CG4 That the operation CG5 That stu bibliogr of conc CT2 Ability t	udents acquire the capabilities to analyze the needs of a company in the field of unmanned aer is and determine the best technological solution for the same e students acquire the knowledge to develop unmanned aerial systems or to plan specific ons, depending on the existing needs and to apply the existing technological tools udents know and be able to apply the principles and methodologies of research, such as raphical searches, data collection and analysis and interpretation thereof, as well as the presentusions, in a clear, concise and rigorous way to communicate orally and in writing in Galician	• Know How • Know How • know • know How • know How • know • know How • know How • know How • know
CG3 That stu system: CG4 That the operation CG5 That stu bibliogr of conc CT2 Ability t	udents acquire the capabilities to analyze the needs of a company in the field of unmanned aer is and determine the best technological solution for the same e students acquire the knowledge to develop unmanned aerial systems or to plan specific ons, depending on the existing needs and to apply the existing technological tools udents know and be able to apply the principles and methodologies of research, such as raphical searches, data collection and analysis and interpretation thereof, as well as the presen lusions, in a clear, concise and rigorous way	• Know How • Know be rial • Know How • know • Know How • know tation• Know How • know • know
CG3 That stu system: CG4 That the operation CG5 That stu bibliogr of conc CT2 Ability t	udents acquire the capabilities to analyze the needs of a company in the field of unmanned aer is and determine the best technological solution for the same e students acquire the knowledge to develop unmanned aerial systems or to plan specific ons, depending on the existing needs and to apply the existing technological tools udents know and be able to apply the principles and methodologies of research, such as raphical searches, data collection and analysis and interpretation thereof, as well as the presentusions, in a clear, concise and rigorous way to communicate orally and in writing in Galician	• Know How • Know How • know • know How • know • know • know tation• Know How • know • know • know • Know How • Know How • Know How • Know How
CG3 That stu system: CG4 That the operation CG5 That stu bibliogr of conc CT2 Ability t	udents acquire the capabilities to analyze the needs of a company in the field of unmanned aer is and determine the best technological solution for the same e students acquire the knowledge to develop unmanned aerial systems or to plan specific ons, depending on the existing needs and to apply the existing technological tools udents know and be able to apply the principles and methodologies of research, such as raphical searches, data collection and analysis and interpretation thereof, as well as the presentusions, in a clear, concise and rigorous way to communicate orally and in writing in Galician	• Know How • Know How • know • know How • know • know • know tation• Know How • know • know • know • Know How
CG3 That stu system: CG4 That the operation CG5 That stu bibliogr of conc CT2 Ability t	udents acquire the capabilities to analyze the needs of a company in the field of unmanned aer is and determine the best technological solution for the same e students acquire the knowledge to develop unmanned aerial systems or to plan specific ons, depending on the existing needs and to apply the existing technological tools udents know and be able to apply the principles and methodologies of research, such as raphical searches, data collection and analysis and interpretation thereof, as well as the presentusions, in a clear, concise and rigorous way to communicate orally and in writing in Galician	• Know How • Know be rial • Know How • know • know • know • know • know • Know How
CG3 That stu system: CG4 That the operation CG5 That stu bibliogr of conc CT2 Ability to CT6 Ability to	udents acquire the capabilities to analyze the needs of a company in the field of unmanned aer is and determine the best technological solution for the same e students acquire the knowledge to develop unmanned aerial systems or to plan specific ons, depending on the existing needs and to apply the existing technological tools udents know and be able to apply the principles and methodologies of research, such as raphical searches, data collection and analysis and interpretation thereof, as well as the presentusions, in a clear, concise and rigorous way to communicate orally and in writing in Galician to work as a team	• Know How • Know be rial • Know How • know • know • know • know How • Know be • know • Know How • Know How
CG3 That stu system: CG4 That the operatic CG5 That stu bibliogr of conc CT2 Ability t CT6 Ability t	udents acquire the capabilities to analyze the needs of a company in the field of unmanned aer is and determine the best technological solution for the same estudents acquire the knowledge to develop unmanned aerial systems or to plan specific ons, depending on the existing needs and to apply the existing technological tools udents know and be able to apply the principles and methodologies of research, such as raphical searches, data collection and analysis and interpretation thereof, as well as the presentusions, in a clear, concise and rigorous way to communicate orally and in writing in Galician to work as a team	• Know How • Know How • know How
CG3 That stu system: CG4 That the operatic CG5 That stu bibliogr of conc CT2 Ability t CT6 Ability t CT7 Capacit	udents acquire the capabilities to analyze the needs of a company in the field of unmanned aer is and determine the best technological solution for the same e students acquire the knowledge to develop unmanned aerial systems or to plan specific ons, depending on the existing needs and to apply the existing technological tools udents know and be able to apply the principles and methodologies of research, such as raphical searches, data collection and analysis and interpretation thereof, as well as the presentusions, in a clear, concise and rigorous way to communicate orally and in writing in Galician to work as a team	• Know How • Know be rial • Know How • know • know • know • know • know • Know How
CG3 That stu system: CG4 That the operatic CG5 That stu bibliogr of conc CT2 Ability t CT6 Ability t CT7 Capacit	udents acquire the capabilities to analyze the needs of a company in the field of unmanned aer is and determine the best technological solution for the same estudents acquire the knowledge to develop unmanned aerial systems or to plan specific ons, depending on the existing needs and to apply the existing technological tools udents know and be able to apply the principles and methodologies of research, such as raphical searches, data collection and analysis and interpretation thereof, as well as the presentusions, in a clear, concise and rigorous way to communicate orally and in writing in Galician to work as a team	• Know Hov • Know Hov • know Hov
CG3 That stu system: CG4 That the operatic CG5 That stu bibliogr of conc CT2 Ability t CT6 Ability t CT7 Capacit	udents acquire the capabilities to analyze the needs of a company in the field of unmanned aer is and determine the best technological solution for the same estudents acquire the knowledge to develop unmanned aerial systems or to plan specific ons, depending on the existing needs and to apply the existing technological tools udents know and be able to apply the principles and methodologies of research, such as raphical searches, data collection and analysis and interpretation thereof, as well as the presentusions, in a clear, concise and rigorous way to communicate orally and in writing in Galician to work as a team	• Know How • Know be rial • Know How • know • know • know • know • know • Know How
largely CG3 That stu system: CG4 That the operation CG5 That stu bibliogr of conc. CT2 Ability t CT6 Ability t CT7 Capacit CT8 Ability o CT9 Capacit	self-directed and autonomous udents acquire the capabilities to analyze the needs of a company in the field of unmanned aer is and determine the best technological solution for the same e students acquire the knowledge to develop unmanned aerial systems or to plan specific ions, depending on the existing needs and to apply the existing technological tools udents know and be able to apply the principles and methodologies of research, such as raphical searches, data collection and analysis and interpretation thereof, as well as the presen lusions, in a clear, concise and rigorous way to communicate orally and in writing in Galician to work as a team by for organization and planning of analysis and synthesis by for critical reasoning and creativity	• Know How • Know be rial • Know How • know • know • know • know • know • Know How
CG3 That stu system: CG4 That the operation CG5 That stu bibliogr of conc CT2 Ability t CT6 Ability t CT7 Capacit CT8 Ability of CT9 Capacit	self-directed and autonomous udents acquire the capabilities to analyze the needs of a company in the field of unmanned aer is and determine the best technological solution for the same e students acquire the knowledge to develop unmanned aerial systems or to plan specific ions, depending on the existing needs and to apply the existing technological tools udents know and be able to apply the principles and methodologies of research, such as raphical searches, data collection and analysis and interpretation thereof, as well as the presen lusions, in a clear, concise and rigorous way to communicate orally and in writing in Galician to work as a team by for organization and planning of analysis and synthesis by for critical reasoning and creativity utcomes	• Know How • Know be rial • Know How • know • know How • know • know • know How
CG3 That stu system: CG4 That the operation CG5 That stu bibliogr of conc CT2 Ability t CT6 Ability t CT7 Capacit CT8 Ability of CT9 Capacit	self-directed and autonomous udents acquire the capabilities to analyze the needs of a company in the field of unmanned aer is and determine the best technological solution for the same e students acquire the knowledge to develop unmanned aerial systems or to plan specific ons, depending on the existing needs and to apply the existing technological tools udents know and be able to apply the principles and methodologies of research, such as raphical searches, data collection and analysis and interpretation thereof, as well as the presentusions, in a clear, concise and rigorous way to communicate orally and in writing in Galician to work as a team by for organization and planning of analysis and synthesis by for critical reasoning and creativity utcomes comes	• Know How • Know be rial • Know How • know • know How • know • know How
CG3 That stu system: CG4 That the operation CG5 That stu bibliogr of conc CT2 Ability t CT6 Ability t CT7 Capacit CT8 Ability of CT9 Capacit	self-directed and autonomous udents acquire the capabilities to analyze the needs of a company in the field of unmanned aer s and determine the best technological solution for the same e students acquire the knowledge to develop unmanned aerial systems or to plan specific ons, depending on the existing needs and to apply the existing technological tools udents know and be able to apply the principles and methodologies of research, such as raphical searches, data collection and analysis and interpretation thereof, as well as the presen lusions, in a clear, concise and rigorous way to communicate orally and in writing in Galician to work as a team by for organization and planning of analysis and synthesis by for critical reasoning and creativity utcomes ferent passive sensors existent in aerial applications	• Know Hov • Know be rial • Know Hov • know • know Hov • know • know • know Hov
CG3 That stu system: CG4 That the operation CG5 That stu bibliogr of conc CT2 Ability t CT6 Ability t CT7 Capacit CT8 Ability of CT9 Capacit	self-directed and autonomous udents acquire the capabilities to analyze the needs of a company in the field of unmanned aer s and determine the best technological solution for the same e students acquire the knowledge to develop unmanned aerial systems or to plan specific ones, depending on the existing needs and to apply the existing technological tools udents know and be able to apply the principles and methodologies of research, such as raphical searches, data collection and analysis and interpretation thereof, as well as the presentusions, in a clear, concise and rigorous way to communicate orally and in writing in Galician to work as a team by for organization and planning of analysis and synthesis by for critical reasoning and creativity utcomes icomes ferent passive sensors existent in aerial applications	• Know Hov • Know be rial • Know Hov • know • know Hov • know • know Hov
CG3 That stu system: CG4 That the operation CG5 That stu bibliogr of conc CT2 Ability t CT6 Ability t CT7 Capacit CT8 Ability of CT9 Capacit	self-directed and autonomous udents acquire the capabilities to analyze the needs of a company in the field of unmanned aer is and determine the best technological solution for the same estudents acquire the knowledge to develop unmanned aerial systems or to plan specific ons, depending on the existing needs and to apply the existing technological tools udents know and be able to apply the principles and methodologies of research, such as raphical searches, data collection and analysis and interpretation thereof, as well as the presentusions, in a clear, concise and rigorous way to communicate orally and in writing in Galician to work as a team by for organization and planning of analysis and synthesis by for critical reasoning and creativity utcomes comes ferent passive sensors existent in aerial applications	• Know Hov • Know be rial • Know Hov • know • know Hov • know • know • know Hov
CG3 That stu system: CG4 That the operation CG5 That stu bibliogr of conc CT2 Ability t CT6 Ability t CT7 Capacit CT8 Ability of CT9 Capacit	self-directed and autonomous udents acquire the capabilities to analyze the needs of a company in the field of unmanned aer is and determine the best technological solution for the same e students acquire the knowledge to develop unmanned aerial systems or to plan specific ons, depending on the existing needs and to apply the existing technological tools udents know and be able to apply the principles and methodologies of research, such as raphical searches, data collection and analysis and interpretation thereof, as well as the present lusions, in a clear, concise and rigorous way to communicate orally and in writing in Galician to work as a team by for organization and planning of analysis and synthesis by for critical reasoning and creativity utcomes ferent passive sensors existent in aerial applications	• Know How • Know be rial • Know How • know • know • know • know How • Know be • Know How • Know be

IDENTIFYING DATA

Understand the procedures to calibrate sensors		CB3
		CB4
		CB5
		CG4
		CG5
		CT2
		CT8
		CT9
Learn to mechanically integrate sensors: implem	entation of boresighting and use of gimbal and	CB3
synchronization		CB4
		CG3
		CG4
		CT2
		CT6
		CT7
		CT8
		CT9
Apply algorithms for aerial image processing and	fotogrametry, image classification, object follow-up,	CB3
filters and video processing		CB5
		CG3
		CG4
		CG5
		CT2
		CT6
		CT7
		CT8
		CT9
Know how to integrate images in geographic info	rmation systems	CB3
		CB4
		CB5
		CG4
		CT2
		CT7
		CT8
		CT9
		,
Contents		
Topic	Mathematica Applications Consider consets of security	-i
Sensors for UAVs	Motivation. Applications. Specific aspects of sensing u Technologies for sensors in UAVs. Sensor basic compo	onents. Spectral

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	Use of specific sensing equipment (RGB cameras, thermograhic cameras, espectral cameras, etc)
through ICT	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		aluated Competencess
Autonomous practices	The students will owe to deliver a report on each	50	CB3
through ICT	experience or proposed activity.		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

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

IDENTIFYIN	G DATA			
	tiles baseadas en sensores activos			
Subject	(*)Cargas útiles			
Jubject	baseadas en			
	sensores activos			
Code	O07M174V01202			
Study	(*)Máster			
programme	Universitario en			
programme	Operacións e			
	Enxeñería de			
	Sistemas Aéreos			
	non Tripulados			
Descriptors	ECTS Credits	Typo	Year Quad	mester
Descriptors	6	Type	1st 2nd	illestei
Ta a alaina a		Optional	150 2110	
Teaching	Spanish 5 and the first of the			
language	English			
Department				
Coordinator				
Lecturers	González Jorge, Higinio			
	Lorenzo Cimadevila, Henrique			
E-mail	higiniog@uvigo.es			
Web	http://aero.uvigo.es			
General	This subject shows the principles of operation of LiDA	AR and RADAR ser	nsors, calibration procedures	and data
description	processing.		·	
	International students may request from the teacher	s: a) materials and	d bibliographic references in	English, b)
	tutoring sessions in English, c) exams and assessmen	nts in English.		
Competenc	ies			
Code	165			Typology
	e students be able to integrate knowledge and face th	o comployity of fo	ormulating judgments from	• know
	tion, which being incomplete or limited, includes refle			
	pplication of their knowledge and judgments	ctions on social a	nu ethical responsibilities illi	Keu
	e students know how to communicate their conclusion	oc and the latest	knowledge and reasons that	• know
	them - to specialized and non-specialized audiences			- KIIOW
	idents have the learning abilities that allow them to c			• know
	self-directed and autonomous	ontinue studying i	in a way that will have to be	• KIIOW
		f a gamananıı in th	a field of the manage and a smile	
	udents acquire the capabilities to analyze the needs o		e neid of unmanned aerial	know
	s and determine the best technological solution for the			
	e students acquire the knowledge to develop unmann		or to plan specific operation	s, • know
	ing on the existing needs and to apply the existing te			
	idents know and be able to apply the principles and n			
	es, data collection and analysis and interpretation ther	eof, as well as the	e presentation of conclusions	s, in
	concise and rigorous way			
	o communicate orally and in writing in Galician			• know
	o work as a team			• know
CT7 Capacit	y for organization and planning			• know
CT8 Ability	of analysis and synthesis			know
CT9 Capacit	y for critical reasoning and creativity			know
Learning or	itcomes			
Learning out			Comi	etences
	ferent active sensors existent, LiDAR and RADAR.		CB3	Jeterrees
Know the un	referre delive serisors existent, Liban and Naban.		CB4	
			CB5	
			CG3	
			CG4	
			CG4 CG5	
			CT2	
			CT2	
			CT7	
			CT7	
			CT9	

	CB5
	CG3
	CG4
	CG5
	CT2 CT6
	CT7
	CT8
	CT9
Learn to integrate sensors mechanically, implementation of boresighting, utilization of gimbal and	CB3
synchronization.	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	CB3
segmentation, classification and generation of digital terrain models.	CB3
segmentation, classification and generation of digital terrain models.	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
	СТ9
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 II. Filtering. Data processing III. Rasterization and	
voxelization.	
Data processing IV. Classification.	
Results integration on geographic information	
systems.	

Understand the procedures of calibración of sensors.

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

CB3 CB4

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		aluated 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	40	CB3
	professor		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/007M174V01101

(*)Operacións de sistemas aéreos non tripulados/007M174V01102

(*)Sensores embarcados/O07M174V01104

(*)Sistemas de comunicacións e navegación por radio/007M174V01103

(*)Sistemas de control/007M174V01105

Code OOTM174V01205 Study (*)Master Operacions externas Code OOTM174V01205 Study (*)Master Operacions e Enxekeria de Sistemas Aferos no Tripulados Descriptors ECTS Credits Type Year Quadmester Teaching Spanish Teaching Spanish Teaching Spanish Teaching Spanish Tending Te	IDENTIFYIN	G DATA			
externas Code OVM174V01205 Study (*)Mäster programme Universitatio en Operacións e Enxeñería de Sistemas Aéreos no Tripulados Descriptors ECTS Credits Type Year Quadmester Teaching Spanish Mandatory 1st 2nd Teaching Spanish Sacilician English Department Coordinator González Jorge, Higinio Lecturers Lecturers Lecturers González Jorge, Higinio Lecturers Lecturer	(*)Prácticas	externas			
Code OO7M124V01205 Study ("Master programme Universitatio en Operacións e Enxeñería de Sistemas Aéreos non Tripulados Descriptors ECTS Credits Type Year Quadmester 15 Analysis ("Spanish Language Galician English Bepartment Coordinator González Jorge, Higinio Lecturers González Gonzál	Subject	(*)Prácticas			
Study					
programme Universitation on Operacions on Enwending de Sistemas Aéroos non Tripulados Descriptors ECTS Credits Type Year Quadmester 15 Mandatory 1st 2nd Teaching Spanish S					
Descriptors ECTS Credits Type Year Quadmester 15 Mandatory 1st 2nd Teaching Spanish Ianguage Galician English Department Coordinator González Jorge, Higinio Lecturers González Jorge, Higinio Ecturers González Jorge, Higinio Ecturers González Jorge, Higinio Ecturers González Jorge, Higinio Email higiniog@uvigo.es Web http://secro.uvigo.es Web http://secro.uvig					
Enxeneria de Sistemas Aéroso non Tripulados Descriptors ECTS Credits Type Year Quadmester 15 Mendatory 1st 2nd Tacathing Spanish anguage Galician English Department Coordinator González Jorge, Higinio Lecturers Higinio Lecturers González Jorge, Higinio Lecturers Higinio Lecturers González Jorge, Higinio Lecturers González Jorge, Higinio Lecturers Higinio Lecturers González Jorge, Higinio Lecturers Higinio Lecturers González Jorge, Higinio Lecturers Higinio Lecturers Higinio Lecturers Higinio Higinio Lecturers Higinio Lecturers Higinio Lecturers Higinio Lecturers Higinio	programme				
Descriptors ECTS Credits Type Year Quadrester 15 Mandatory 1st 2nd Teaching Spanish anguage Galician English Department Coordinator González Jorge, Higinio E-mail highinog@vulgo.es Web http://aero.uvigo.es Web http://ae					
non Tripulados Departiptors ECTS Credits 15 Mandatory 1st 2nd Teaching Spanish language Galician English Department Coordinator González Jorge, Higinio Lecturers González Jorge, Higinio Lemail higiniogalourigo es General This course pretends that the student carries out internships in a company of the sector of the unmanned 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 Cade Typology Bil Possess and understand knowledge that provides a basis or opportunity to be original in the development and * know or application of ideas, often in a research context. Bil Possess and understand knowledge that provides a basis or opportunity to be original in the development and * know or application of ideas, often in a research context. Bil Possess and understand knowledge that provides a basis or opportunity to solve problems in new or * know unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study. Bil Possess and understand knowledge and face the complexity of formulating judgments from * know information, which being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments Bil That students when we have 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 Bil That students acquire generia knowledge in unmanned aircraft systems opportunity that will have to be a largely self-directed and autonomous Bil That students acquire learning abilities that allow them to continue studying in a way that will have to be a largely					
Descriptors ECTS Credits Type Year Quadmester 15 Mandatory 1st 2nd Teaching Spanish language Galicine English Department Coordinator González Jorge, Higlinio Lecturers González Alexander S. and Lecturers and Lecturers Jorge Lecturers and Lecturers Jorge Lecturers and Lecturers Jorge Lecturers and Lecturers and Lecturers Jorge Lecturers and Lecturers Jorge Lecturers and L					
Teaching Spanish	Descriptors			Vaar	
Teaching Spanish language Galician English Department Coordinator González Jorge, Higinio Lecturers Gonzále	Descriptors				ester
Image Imag	Tooching		маниасогу	150 2110	
English Department Coordinator González Jorge, Higinio Lecturers González Jorge, Higinio Lecturers González Jorge, Higinio Exmail higiniog@uvigo.es Web http://aero.uvigo.es Web http://aero.uvigo.es Web http://aero.uvigo.es General This course pretends that the student carries out internships in a company of the sector of the unmanned description 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 618 Possess and understand knowledge that provides a basis or opportunity to be original in the development and • know or 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 828 That students know how to apply the knowledge and face the complexity of formulating judgments from • know information, which being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments 829 That students be able to integrate knowledge and face the complexity of formulating judgments from • know support them - to specialized and non-specialized audiences in a clear and unambiguous manner 829 That students acquire learning abilities that allow them to continue studying in a way that will have to be already a students acquire general knowledge in unmanned aircraft systems operations • know already systems and determine the best technological solution for the same systems and determine the best technological solution for the same (S4 That the students acquire general knowledge in unmanned aircraft systems operations • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way 830 That students acquire general knowledge to develop unmanned aerial systems or to pl					
Department Coordinator González Jorge, Higinio Lecturers Hisp/laero.wigo es General This course pretends that the student carries out internships in a company of the sector of the unmanned description incraft 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 • know / or application of ideas, often in a research context 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 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 CB4 That the students know how to compunicate their conclusions - and the latest knowledge and reasons that subject to the subject of the learning abilities that allow them to continue studying in a way that will have to be largely self-directed and autonomous CG3 That students acquire general knowledge in unmanned aircraft systems operations CG4 That students acquire the capabilities to handly the medical systems operations CG5 That students acquire the capabilities to handly the existing technological tools CG5 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 CG4 That students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, • know searches, data collection a	language				
Coordiator González proge, Higinio	Denartment				
Lecturers González jorge, Higinio E-mail higiniog@uvigo.es http://aero.uvigo.es http://aero.uvigo.es http://aero.uvigo.es http://aero.uvigo.es linternational 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 6BI Possess and understand knowledge that provides a basis or opportunity to be original in the development and • know / or application of ideas, often in a research context 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 CB3 That students how how to apply the 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 or support them to specialized and non-specialized audiences in a clear and unambiguous manner 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 CG1 That students acquire general knowledge in unmanned aircraft systems engineering know systems and determine the best technological solution for the same CG3 That students acquire the capabilities to analyze the needs of a company in the field of unmanned aerial systems and setermine the best technological solution for the same CG4 That the students acquire general knowledge in unmanned aircraft systems operations know depending on the existing needs and to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CE1 Knowledge of the gematic, photogrammetrical and cartographic principles of navigation, aerotriang		González Jorge Higinio			
Email highing@uvigo.es					
Web					
General description 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 Ell Possess and understand knowledge that provides a basis or opportunity to be original in the development and • know / or application of ideas, often in a research context El 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 Ell That students how 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 Ell That students be able to integrate knowledge and face the complexity of formulating judgments from • know information, which being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments Ell That students have the learning abilities that allow them to continue studying in a way that will have to be a provided the learning abilities that allow them to continue studying in a way that will have to be a students have the learning abilities that allow them to continue studying in a way that will have to be a systems sugarier the capabilities to analyze the needs of a company in the field of unmanned aerial systems sugarier and the students acquire the capabilities to analyze the needs of a company in the field of unmanned aerial systems and determine the best technological studient same and the superior sugarier studients know and be able to apply the existing technological tools CG5 That students acquire the knowledge to develop unmanned aerial systems or					
description 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 • know / or application of ideas, often in a research context CB2 That students know how to apply the knowledge acquired and their ability to solve problems in new or • know unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study 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 CB4 That the students know how to communicate their conclusions - and the latest knowledge and reasons that supplication of their knowledge and judgments are a clear and unambiguous manner CB5 That students have the learning abilities that allow them to continue studying in a way that will have to be already self-directed and autonomous CG1 That students acquire generic knowledge in unmanned aircraft systems operations CG3 That students acquire generic knowledge in unmanned aircraft systems operations CG4 That the 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 CG4 That students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, in a clear, concise and rigorous way CE5 Knowledge of the main systems, the on board instruments and the control station of a non-manned aircraft, as • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CE6 Capacity of interacting with technical trea			ships in a compa	any of the sector of the unma	nned
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 B1 Possess and understand knowledge that provides a basis or opportunity to be original in the development and * know / or application of ideas, often in a research context S2 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 S3 That the students be able to integrate knowledge and face the complexity of formulating ilgents from information, which being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments and 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 S4 That the students and unamonous S5 That students acquire general knowledge in unmanned aircraft systems engineering • know and the 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 C64 That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations. • know depending on the existing needs and to apply the existing technological tools C65 That students know and be able to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way C62 That students know and be able to apply the principles and methodologies of navigation, aerotriangulation, • know well as its influence on security C63 That students in the students way to the security of the s			isinps in a comp.	any or the sector of the annual	····ca
Competencies Code Typology CB1 Possess and understand knowledge that provides a basis or opportunity to be original in the development and / know / or application of ideas, often in a research context 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. CB3 That the students be able to integrate knowledge and face the complexity of formulating judgments from hinformation, which being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments CB4 That the students how 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 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 CG1 That students acquire generic knowledge in unmanned aircraft systems engineering knowledge in commanded aricraft systems operations knowledge in the students acquire generic knowledge in unmanned aircraft systems operations knowledge in knowledge in commanded aricraft systems of the 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 systems and determine the best technological solution for the same aclear, concise and rigorous way CG5 That students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, experiments and the application of the same aclear, concise and rigorous way CG5 That students favor and be able to apply the principles and methodologies of research, such as bibliographical * know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way			a) materials and	bibliographic references in Er	nglish, b)
Code Region Possess and understand knowledge that provides a basis or opportunity to be original in the development and knowledge and provides a basis or opportunity to be original in the development and provides a palicy of application of ideas, often in a research context Region 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 Region 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 Region That the students know how to communicate their conclusions - and the latest knowledge and reasons that support them - to specialized and non-specialized addiences in a clear and unambiguous manner Region That students have the learning abilities that allow them to continue studying in a way that will have to be a largely self-directed and autonomous Region That students acquire general knowledge in unmanned aircraft systems engineering *know Region That students acquire general knowledge in unmanned aircraft systems operations *know asystems and determine the best technological solution for the same Region That students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, know depending on the existing needs and to apply the existing technological tools Region That students know and be able to apply the principles and methodologies of research, such as bibliographical *know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way Region Regio		tutoring sessions in English, c) exams and assessments	in English.		
Code Region Possess and understand knowledge that provides a basis or opportunity to be original in the development and knowledge and provides a basis or opportunity to be original in the development and provides a palicy of application of ideas, often in a research context Region 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 Region 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 Region That the students know how to communicate their conclusions - and the latest knowledge and reasons that support them - to specialized and non-specialized addiences in a clear and unambiguous manner Region That students have the learning abilities that allow them to continue studying in a way that will have to be a largely self-directed and autonomous Region That students acquire general knowledge in unmanned aircraft systems engineering *know Region That students acquire general knowledge in unmanned aircraft systems operations *know asystems and determine the best technological solution for the same Region That students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, know depending on the existing needs and to apply the existing technological tools Region That students know and be able to apply the principles and methodologies of research, such as bibliographical *know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way Region Regio		-			
Code Region Possess and understand knowledge that provides a basis or opportunity to be original in the development and knowledge and provides a basis or opportunity to be original in the development and provides a palicy of application of ideas, often in a research context Region 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 Region 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 Region That the students know how to communicate their conclusions - and the latest knowledge and reasons that support them - to specialized and non-specialized addiences in a clear and unambiguous manner Region That students have the learning abilities that allow them to continue studying in a way that will have to be a largely self-directed and autonomous Region That students acquire general knowledge in unmanned aircraft systems engineering *know Region That students acquire general knowledge in unmanned aircraft systems operations *know asystems and determine the best technological solution for the same Region That students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, know depending on the existing needs and to apply the existing technological tools Region That students know and be able to apply the principles and methodologies of research, such as bibliographical *know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way Region Regio	Competenc	ies			
CB1 Possess and understand knowledge that provides a basis or opportunity to be original in the development and * know / or application of ideas, often in a research context. 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. 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 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 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 CG1 That students acquire general knowledge in unmanned aircraft systems operations CG3 That students acquire generic knowledge in unmanned aircraft systems operations CG4 That the 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 CG4 That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, expending on the existing needs and to apply the existing technological tools CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical * know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CE2 Knowledge of the main systems, the on board instruments and the control station of a non-manned aircraft, as * know well as its influence on security CE2 Knowledge of the geomatic, photogrammetrical and cartographic p					Typology
or application of ideas, often in a research context		and understand knowledge that provides a basis or on	portunity to be or	iginal in the development and	
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 STA 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 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 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 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 know systems and determine the best technological solution for the same CG4 That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, know depending on the existing needs and to apply the existing technological tools CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical * know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CE1 Knowledge of the main systems, the on board instruments and the control station of a non-manned aircraft, as * know well as its influence on security RE2 Knowledge of the geomatic, photogrammetrical and cartographic principles of navigation, aerotriangulation, know interpretation and digital processing of images, as well as the good practices existing in the operation of u			ortainey to be of	igniai in the development and	
unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study 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 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 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 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 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 CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical * know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CE1 Knowledge of the main systems, the on board instruments and the control station of a non-manned aircraft, as * know well as its influence on security 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 CE3 Capacity of interacting with technical teams i			heir ability to sol	ve problems in new or	• know
information, which being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments 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 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 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 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 CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CE1 Knowledge of the main systems, the on board instruments and the control station of a non-manned aircraft, as • know well as its influence on security 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 CE3 Capacity to interacting with technical teams in planning with unmanned aerial systems chapter of the general commitment in planning with unmanned aerial systems chapter of the general commitment in planning with unmanned aerial systems chow cT3 Ability t					
to the application of their knowledge and judgments 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 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 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 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 CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CE1 Knowledge of the main systems, the on board instruments and the control station of a non-manned aircraft, as • know well as its influence on security 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 CE3 Capacity to develop a technical teams in planning with unmanned aerial systems • know knowledge and professional practice with the aim of achieving a more just and egalitarian society CT2 Ability to communicate orally and in writing in Galician • know CT3 Sustainability and environmental commitment. Equitable, responsible and efficient use of resources • kno	CB3 That the	e students be able to integrate knowledge and face the	complexity of for	mulating judgments from	• 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 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 CG1 That students acquire general knowledge in unmanned aircraft systems engineering • know CG2 That students acquire generic knowledge in unmanned aircraft systems operations • know Systems and determine the best technological solution for the same CG4 That the 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 CG4 That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, elonow depending on the existing needs and to apply the existing technological tools CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CE1 Knowledge of the main systems, the on board instruments and the control station of a non-manned aircraft, as • know well as its influence on security 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 CE3 Capacity to develop a technical project in the field of engineering and operations with unmanned aerial systems of the development of the meaning and application of the gender perspective in the different fields of know knowledge and professional practice with the aim of achieving a more just and egalitarian society CE3 Lapacity to understa			ions on social an	d ethical responsibilities linke	d
support them - to specialized and non-specialized audiences in a clear and unambiguous manner 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 GG1 That students acquire general knowledge in unmanned aircraft systems engineering					
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 CG1 That students acquire general knowledge in unmanned aircraft systems engineering - know CG2 That students acquire general 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 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 CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical * know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CE1 Knowledge of the main systems, the on board instruments and the control station of a non-manned aircraft, as * know well as its influence on security 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 CE3 Capacity to develop a technical teams in planning with unmanned aerial systems - know CE4 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 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 C					know
largely self-directed and autonomous					
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 CG4 That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations, elepanding on the existing needs and to apply the existing technological tools CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CE1 Knowledge of the main systems, the on board instruments and the control station of a non-manned aircraft, as • know well as its influence on security 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 CE3 Capacity of interacting with technical teams in planning with unmanned aerial systems CE4 Capacity to develop a technical project in the field of engineering and operations with unmanned aerial systems CT1 Capacity to understand the meaning and application of the gender perspective in the different fields of know knowledge and professional practice with the aim of achieving a more just and egalitarian society CT2 Ability to communicate orally and in writing in Galician 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 knowledge of the general knowledge			tinue studying in	a way that will have to be	• 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 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 CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical * know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CE1 Knowledge of the main systems, the on board instruments and the control station of a non-manned aircraft, as * know well as its influence on security 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 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 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 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			systems engine	oring	- 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 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 CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CE1 Knowledge of the main systems, the on board instruments and the control station of a non-manned aircraft, as • know well as its influence on security 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 CE3 Capacity of interacting with technical teams in planning with unmanned aerial systems CE4 Capacity to develop a technical project in the field of engineering and operations with unmanned aerial systems CE7 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 CE2 Ability to communicate orally and in writing in Galician • know CE3 Sustainability and environmental commitment. Equitable, responsible and efficient use of resources • know CE4 Development of the innovative and entrepreneurial spirit • know CE5 Ability to interpersonal relationships • know CE6 Ability to work as a team • know CE7 Capacity for organization and planning • know					
Systems and determine the best technological solution for the same CG4 That the students acquire the knowledge to develop unmanned aerial systems or to plan specific operations,					
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 CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CE1 Knowledge of the main systems, the on board instruments and the control station of a non-manned aircraft, as • know well as its influence on security 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 CE3 Capacity of interacting with technical teams in planning with unmanned aerial systems CE4 Capacity to develop a technical project in the field of engineering and operations with unmanned aerial systems 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 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 organization and planning * know CT7 Capacity for organization and planning * know				neid of diffialfiled aerial	KIIOW
depending on the existing needs and to apply the existing technological tools CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CE1 Knowledge of the main systems, the on board instruments and the control station of a non-manned aircraft, as • know well as its influence on security 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 CE3 Capacity of interacting with technical teams in planning with unmanned aerial systems CE4 Capacity to develop a technical project in the field of engineering and operations with unmanned aerial systems 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 CT2 Ability to communicate orally and in writing in Galician 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				or to plan specific operations	• know
CG5 That students know and be able to apply the principles and methodologies of research, such as bibliographical • know searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CE1 Knowledge of the main systems, the on board instruments and the control station of a non-manned aircraft, as • know well as its influence on security 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 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 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 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				or to plan specific operations,	KIIOW
searches, data collection and analysis and interpretation thereof, as well as the presentation of conclusions, in a clear, concise and rigorous way CE1 Knowledge of the main systems, the on board instruments and the control station of a non-manned aircraft, as • know well as its influence on security 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 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 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 CT2 Ability to communicate orally and in writing in Galician • know cost and environmental commitment. Equitable, responsible and efficient use of resources • know cost ability to interpersonal relationships • know cost ability to work as a team • know cost ability to work as a team • know cost ability of analysis and synthesis • know cost and control of the control of a non-manned aerial systems of navigation, aerotriangulation, acrotriangulation, acrotriangulation, acrotriangulation, acrotriangulation, acrotriangulation, acrotriangulation, acrotriangulation, acr				search such as bibliographica	al • know
a clear, concise and rigorous way CE1 Knowledge of the main systems, the on board instruments and the control station of a non-manned aircraft, as • know well as its influence on security 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 CE3 Capacity of interacting with technical teams in planning with unmanned aerial systems CE4 Capacity to develop a technical project in the field of engineering and operations with unmanned aerial systems CT1 Capacity to understand the meaning and application of the gender perspective in the different fields of know knowledge and professional practice with the aim of achieving a more just and egalitarian society CT2 Ability to communicate orally and in writing in Galician 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 know CT7 Capacity for organization and planning know CT8 Ability of analysis and synthesis					
CE1 Knowledge of the main systems, the on board instruments and the control station of a non-manned aircraft, as • know well as its influence on security 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 CE3 Capacity of interacting with technical teams in planning with unmanned aerial systems CE4 Capacity to develop a technical project in the field of engineering and operations with unmanned aerial systems CT1 Capacity to understand the meaning and application of the gender perspective in the different fields of know knowledge and professional practice with the aim of achieving a more just and egalitarian society 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			,	,	
 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 Capacity of interacting with technical teams in planning with unmanned aerial systems Capacity to develop a technical project in the field of engineering and operations with unmanned aerial systems 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 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			the control station	on of a non-manned aircraft, a	s • know
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 CE3 Capacity of interacting with technical teams in planning with unmanned aerial systems CE4 Capacity to develop a technical project in the field of engineering and operations with unmanned aerial systems 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 CT2 Ability to communicate orally and in writing in Galician 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				•	
unmanned aerial systems and know how to apply the regulations in force CE3 Capacity of interacting with technical teams in planning with unmanned aerial systems CE4 Capacity to develop a technical project in the field of engineering and operations with unmanned aerial systems 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 CT2 Ability to communicate orally and in writing in Galician 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	CE2 Knowle	dge of the geomatic, photogrammetrical and cartograph	ic principles of n	avigation, aerotriangulation,	• know
CE3 Capacity of interacting with technical teams in planning with unmanned aerial systems CE4 Capacity to develop a technical project in the field of engineering and operations with unmanned aerial systems 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 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				isting in the operation of	
CE4 Capacity to develop a technical project in the field of engineering and operations with unmanned aerial systems 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 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					
systems 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 CT2 Ability to communicate orally and in writing in Galician 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					
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 CT2 Ability to communicate orally and in writing in Galician 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 cT7 Capacity for organization and planning know CT8 Ability of analysis and synthesis know	•		ng and operation	s with unmanned aerial	know
knowledge and professional practice with the aim of achieving a more just and egalitarian society CT2 Ability to communicate orally and in writing in Galician 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					
CT2Ability to communicate orally and in writing in Galician• knowCT3Sustainability and environmental commitment. Equitable, responsible and efficient use of resources• knowCT4Development of the innovative and entrepreneurial spirit• knowCT5Ability to interpersonal relationships• knowCT6Ability to work as a team• knowCT7Capacity for organization and planning• knowCT8Ability of analysis and synthesis• know					know
CT3 Sustainability and environmental commitment. Equitable, responsible and efficient use of resources CT4 Development of the innovative and entrepreneurial spirit know CT5 Ability to interpersonal relationships cT6 Ability to work as a team cT7 Capacity for organization and planning cT8 Ability of analysis and synthesis know cT8 Ability of analysis and synthesis			a more just and e	egailtarian society	. 1
CT4Development of the innovative and entrepreneurial spirit• knowCT5Ability to interpersonal relationships• knowCT6Ability to work as a team• knowCT7Capacity for organization and planning• knowCT8Ability of analysis and synthesis• know			madala co - t		
CT5Ability to interpersonal relationships• knowCT6Ability to work as a team• knowCT7Capacity for organization and planning• knowCT8Ability of analysis and synthesis• know			onsible and efficie	ent use of resources	
CT6Ability to work as a team• knowCT7Capacity for organization and planning• knowCT8Ability of analysis and synthesis• know					
CT7 Capacity for organization and planning • know CT8 Ability of analysis and synthesis • know					
CT8 Ability of analysis and synthesis • know					
• KNOW		·			
	CIS Capacit	y ioi critical reasoning and creativity			• KHOW

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

MethodologiesDescriptionExternal practicesFace-to-face tutoring and attention by email.

Assessment

Description

QualificationEvaluated Competencess

External practices	Student practice report.	100	001
External practices	Practice tutor report	100	CB1
	i i i i i i i i i i i i i i i i i i i		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			
соприементату выподгарну			
Recommendations			
Subjects that are recommended to be taken simultaneous	ously		
(*)Traballo Fin de Máster/007M174V01206			

IDENTIFYIN	G DATA				
(*)Traballo	Fin de Máster				
Subject	(*)Traballo Fin de				
	Máster				
Code	O07M174V01206				
Study	(*)Máster				
programme	Universitario en				
	Operacións e Enxeñería de				
	Sistemas Aéreos				
	non Tripulados				
Descriptors	ECTS Credits	Туре	Year Quadr	mester	
	9	Mandatory	1st 2nd		
Teaching	Spanish				
language	Galician				
Donartmont	English				
Department Coordinator	González Jorge, Higinio				
Lecturers	González Jorge, Higinio				
E-mail	higiniog@uvigo.es				
Web	http://aero.uvigo.es				
General	The student will carry out an engineering project in the	field of unmanne	d aircraft systems in which	he/she will	
description	put into practice the knowledge acquired throughout th	ne master.	-		
	International students may request from the teachers:		pibliographic references in	English, b)	
	tutoring sessions in English, c) exams and assessments	s in English.			
Competence Code	IES			Typology	
	s and understand knowledge that provides a basis or opp	ortunity to be ori	ninal in the development a	Typology	
	olication of ideas, often in a research context	ortainty to be on	gillar ill tile development a	iid - Kilow	
CB2 That st	udents know how to apply the knowledge acquired and t			• know	
	iar environments within broader (or multidisciplinary) co				
	e students be able to integrate knowledge and face the			• know	
	ation, which being incomplete or limited, includes reflecti application of their knowledge and judgments	ions on social and	etnical responsibilities link	cea	
	e students know how to communicate their conclusions	and the latest kr	nowledge and reasons that	• know	
	them - to specialized and non-specialized audiences in				
	udents have the learning abilities that allow them to con			• know	
	self-directed and autonomous				
	udents acquire general knowledge in unmanned aircraft			• know	
	udents acquire generic knowledge in unmanned aircraft			• know	
	udents acquire the capabilities to analyze the needs of a		ield of unmanned aerial	know	
	s and determine the best technological solution for the s e students acquire the knowledge to develop unmanned		to plan specific operations	s, • know	
	ling on the existing needs and to apply the existing tech		to plan specific operations	s, KIIOW	
	udents know and be able to apply the principles and met		earch, such as bibliographi	cal • know	
	es, data collection and analysis and interpretation therec	of, as well as the p	resentation of conclusions	, in	
	concise and rigorous way				
	dge of the main systems, the on board instruments and	the control statior	n of a non-manned aircraft,	, as • know	
	its influence on security dge of the geomatic, photogrammetrical and cartograph	is principles of pa	vigation aprotriangulation	. • know	
	etation and digital processing of images, as well as the g			, • KIIOW	
	ned aerial systems and know how to apply the regulation		ing in the operation of		
	ry of interacting with technical teams in planning with un		stems	• know	
	ry to develop a technical project in the field of engineering			• know	
system					
	y to understand the meaning and application of the gen			know	
	dge and professional practice with the aim of achieving a	a more just and eq	galitarian society		
	to communicate orally and in writing in Galician	and afficien	-tf	• know	
	ability and environmental commitment. Equitable, responses	insible and efficiel	nt use of resources	• know	
	CT4 Development of the innovative and entrepreneurial spirit • know CT5 Ability to interpersonal relationships • know				
	to work as a team			• know	
	y for organization and planning			• know	
	of analysis and synthesis			• know	
	y 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

C	on	te	nt	S

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

Persona	lized	assistance

Methodologies Description

Mentored work Face-to-face tutoring and email attention

Assessment

Description Qualification Evaluated Competencess

Mentored work	Project report.	100	CB1
	Oral presentation.		CB2
			CB3
			CB4
			CB5
			CG1
			CG2
			CG3
			CG4
			CG5
			CE1
			CE2
			CE3
			CE4
			CT1
			CT2
			CT3
			CT4
			CT5
			CT6
			CT7
			CT8
			CT9
			CT10
Other commen	ts on the Evaluation		
Sources of info			
Basic Bibliogra	phy v Bibliography		
Complementar	у вівноугарну		
Recommendati	ons		
	re recommended to be ta	ken simultaneously	
(*)Practicas exte	rnas/007M174V01205		