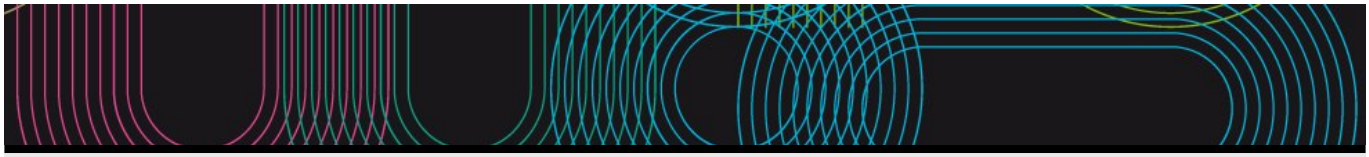
Universidade Vigo

Subject Guide 2019 / 2020



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

Competencies	
Code	
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 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
CT8	Ability of analysis and synthesis
CT9	Capacity for critical reasoning and creativity

Learning outcomes	
Learning outcomes	Competences

Acquire knowledge about unmanned aerial vehicles, their key components, state estimation, basic mechanics, design considerations, agility and maneuverability.	CB3 CB4 CB5 CG3 CG4 CT8 CT9
Know the geometric and mechanical considerations of unmanned aerial vehicles, transformations, rotations, Euler angles, applicability of quaternions, angular velocity, equations of movement of a multi-rotor, linearization.	CB3 CB4 CB5 CG4
Understand the bases of the control and navigation system, PID controls, control in 1D, 2D and 3D of multirotor, generation of trajectories, Euler-Lagrange equations and Splines.	CB3 CB4 CB5 CG3 CG4
Understand the operation of multiple control systems.	CB3 CB4 CB5 CG4 CT6 CT7
Know the sense & avoid devices.	CB3 CB4 CB5 CG4 CG5
Understand the basics of embedded systems in real time.	CB3 CB4 CB5 CG4 CT6 CT7
Know the different existing open hardware controllers and their operation.	CB3 CB4 CB5 CG4 CG5 CT6 CT7

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

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	10	0	10
Autonomous practices through ICT	12.5	12.5	25
Problem solving	12.5	12.5	25
Seminars	3	0	3
Mentored work	8	72	80
Problem and/or exercise solving	2	5	7

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

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

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

Assessment					
	Description	Qualification	Evaluated Competencess		
Autonomous practices through ICT	2 assignments of autonomous practices through ICT, each one will contribute 15% of the overall mark for this course	30			CT8 CT9
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
Problem and/or exercise solving	2 written exams, short answer tests, about the contents and competences taught in the lectures and autonomous practices through ICT. These tests will be short answer, each one will contribute 25% of the overall mark for this course.	50		CG3 CG4	CT8 CT9

Other comments on the Evaluation

ASSESSMENT FOR ASSISTANTS IN 1ST EDITION: CONTINUOUS EVALUATION.

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

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

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

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

ASSESSMENT FOR NON ASSISTANTS IN 1ST EDITION.

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

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

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

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

ASSESSMENT FOR 2ST EDITION AND OTHER EDITIONS

The same assessment for non assisstans in 1st edition

JUSTIFICATION OF ABSENCE

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

Sources of information

Basic Bibliography

Randal Beard, Timothy McLain, **Small Unmanned Aircraft: Theory and Practice**, Princeton University Press, 2012

Complementary Bibliography

Michael Cook, **A Linear Systems Approach to Aircraft Stability and Control**, Butterworth-Heinemann, 2007
Katsuhiro Ogata, **Ingeniería de control moderna**, PRENTICE HALL, 2010
Hassan Gomaa, **Real-time software design for embedded systems**, Cambridge University Press, 2016
Plamen Angelov, **Sense and Avoid in UAS Research and Applications**, John Wiley & Sons, Ltd, 2012
www.librepilot.org,

Recommendations

Subjects that it is recommended to have taken before

(*)Operacións de sistemas aéreos non tripulados/O07M174V01102
(*)Sensores embarcados/O07M174V01104