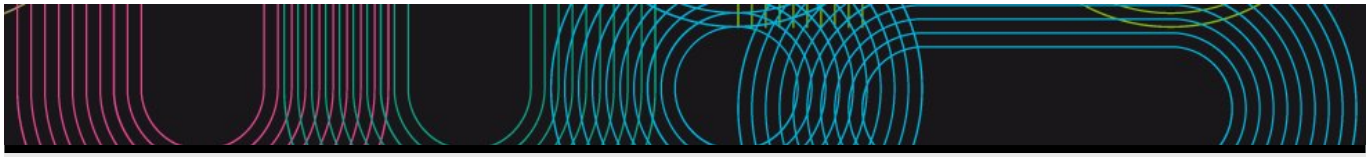

IDENTIFYING DATA				
Navigational systems				
Subject	Navigational systems			
Code	O07G410V01901			
Study programme	Grado en Ingeniería Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	González Jorge, Higinio			
Lecturers	González Jorge, Higinio González de Santos, Luis Miguel			
E-mail	higiniog@uvigo.es			
Web	http://aero.uvigo.es			
General description	This course expose the main procedures and systems used in aircraft navigation. 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	
A2	That the students know how to apply their knowledge to their work or vocation in a professional way and that they possess the competences that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study
A3	That the students have the capability to gather and interpret relevant data (usually within their area of study) to issue judgments that include a reflection on relevant social, scientific or ethical issues
A5	That the students develop those learning capabilities necessary to undertake further studies with a high degree of autonomy.
B1	Capabiliity for design, development and management in the field of aeronautical engineering (in according with what is established in section 5 of order CIN / 308/2009), aerospace vehicles, aerospace propulsion systems, aerospace materials , airport infrastructures, air navigation infrastructures and space management, air traffic and transport management systems.
B6	Capability to participate in flight testing programs for take-off and landing distances, ascent speeds, loss speeds, maneuverability and landing capacities.
C19	Applied knowledge of: science and technology of materials; mechanics and thermodynamics; fluid mechanics; aerodynamics and flight mechanics; navigation and air traffic systems; aerospace technology; theory of structures; airborne transportation; economy and production; projects; environmental impact.
D3	Capability of oral and written communication in native lenguage
D4	Capability of autonomous learning and information management
D6	Capabiliity for interpersonal communication
D8	Capabiliity for critical and self-critical reasoning
D11	Show motivation for quality with sensitivity towards subjects within the scope of the studies

Learning outcomes				
Expected results from this subject	Training and Learning Results			
Understanding of the need for aircraft navigation systems	A2 A3 A5	B1 B6	C19	D3 D4 D6 D8 D11

Understanding of the theoretical foundations and operation of aircarft navigation systems. Understanding of external agents that affect these systems.	A2 A3 A5	B1 B6	C19	D3 D4 D6 D8 D11
Understanding of the methods to ensure the proper working of these systems.	A2 A3 A5	B1 B6	C19	D3 D4 D6 D8 D11

Contents	
Topic	
1. Introduction to aircarft navigation.	1.1. Basic concepts of cartography and geodesy. 1.2. Aeronautical charts. 1.3. Aircarft navigation concept. Observed, estimated, radioelectric and autonomous navigation. 1.4. Terminology (heading, azimuth, magnetic declination, nautical mile, knot, foot, etc.). 1.5. The wind in the air navigation. Wind triangle. 1.6. Orthodromic route. Characteristics, parameters and equations. 1.7. Loxodromic route. Characteristics, parameters and equations. 1.8. The altimetry in air navigation. Standard atmosphere. Pressure, density and temperature. The barometric altimeter.
2. Meteorology and aircarft navigation.	2.1. VMC and IMC weather conditions. Visual and instrumental navigation. VFR and IFR flight rules. 2.2. Basic flight instruments. 2.3. Technical requirements for visual and instrumental flight. 2.4. Organization of the aeronautical meteorological service in Spain through AEMET.
3. Conventional navigation systems.	3.1. Directional radio signals. 3.2. Route beacons. 3.3. Automatic direction finder (ADF). 3.4. Non-directional beacon (NDB). 3.5. High frequency omnidirectional radio beacon (VOR). 3.6. Long Range Navigation systems (LORAN and NavSat).
4. RNAV navigation.	4.1. Three-dimensional navigation system. Course line computer. 4.2. Inertial navigation system (INS). 4.3. Doppler radar.
5. Distance measuring equipment (DME).	5.1. Frequencies 5.2. DME theory. 5.3. Specifications and errors.
6. Instrument landing system (ILS).	6.1. Guide and locator information. Ground and on board systems. 6.2. Glide path. Ground and on board systems. 6.3. Distance information. Radio beacon. Ground and on board systems. 6.4. Compass radio beacons. 6.5. Visual information. VASIS system. 6.6 Category of the ILS.
7. Microwave landing system (MLS).	7.1. MLS principles. 7.2. Ground system. 7.3. On board system.
8. RADAR.	8.1. Introduction. 8.2. Primary RADAR. 8.3. Secondary RADAR. 8.4. Meteorological RADAR.
9. Global Navigation Satellite System (GNSS).	9.1. Principles of satellite navigation. 9.2. GNSS segments. 9.3. GNSS signals. 9.4. Operation of the GNSS system. 9.5. GPS, GLONASS, GALILEO and BEIDOU systems. 9.6. The future of the GNSS system.
10. Air traffic control systems (ATC).	10.1. Review of ATC systems. 10.2. Transponders 10.3. On board systems. 10.4. System operation 10.5. ADSB system. 10.6. Communications, navigation and surveillance in ATC.

11. Traffic alert and collision avoidance system (TCAS).	11.1. TCAS system. 11.2. TCAS operation.
12. Aircarft navigation and unmanned aerial vehicles.	12.1. Airspace. 12.2. Rules for unmanned aerial vehicles. 12.3. On board navigation systems in unmanned aerial vehicles. 12.4. Future trens in unmanned aerial vehicles.
13. Aircraft navigation and safety.	13.1. Governmental aeronautical safety agency (AESA). 13.2. Aircraft navigation services in Spain (ENAIRE). Air traffic management. Aeronautical information service (AIS).

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	26	0	26
Practices through ICT	26	0	26
Mentored work	0	98	98

*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 of the contents of the subject through audiovisual media.
Practices through ICT	Problem solving through software tools such as Matlab, QGIS and Mission Planner.
Mentored work	The student will perform a project that consist of designing, implementing and verifying a navigation system for an unmanned aircraft, based on the GNSS and the INS system.

Personalized assistance

Methodologies	Description
Lecturing	Classroom attention. On-line tutorials. Attention by email.
Practices through ICT	Classroom attention. On-line tutorials. Attention by email.
Mentored work	On-line tutorials. Attention by email.

Assessment

	Description	Qualification	Training and Learning Results			
Lecturing	There will be two partial exams to test the theoretical content of the subject. Each one will have a weight of 20% in the global mark of the subject. Each exam will consist of a total of 30 questions.	40	A2 A3 A5	B1 B6	C19	D3 D4 D6 D8 D11
Practices through ICT	Each practice will define a deliverable that the student must send to the professor before the indicated deadline.	40	A2 A3 A5	B1 B6	C19	D3 D4 D6 D8 D11
Mentored work	The student must deliver a final report with the work done. In addition, the student must perform a presentation.	20	A2 A3 A5	B1 B6	C19	D3 D4 D6 D8 D11

Other comments on the Evaluation

The official exam dates are used for the student to take a global exam of the subject if he/she does not follow the continuous evaluation. This exam will consist of a 100-question test. The mark will correspond to 100% of the subject.

Marks from each of the parties are not kept between different exams.

The schedule of assessment tests officially approved by the EEAE is published on the website:

http://aero.uvigo.es/es/docencia/examenes/

Sources of information

Basic Bibliography

Mike Tooley and David Wyatt, **Aircraft communications and navigation systems**, Elsevier, 2007
Eduardo Huerta, Aldo Mangiaterra y Gustavo Noguera, **GPS. Posicionamiento satelital**, UNR Editora, 2005
Myron Kayton and Walter R. Fried, **Avionics navigation systems**, Wiley, 1997

Complementary Bibliography

Robert Arán Escuer y J. R. Aragoneses Manso, **Sistemas de navegación aérea**, Paraninfo, 1983

Recommendations

Subjects that it is recommended to have taken before

Systems engineering and aerospace communications/O07G410V01925

Contingency plan

Description

In prevention of a health alert caused by COVID-19, the following is established:

Theoretical, practical teaching and tutoring for students are planned to migrate if necessary to 100% virtual teaching, without the need for a physical presence in the classroom.

The evaluation tests will be carried out virtually using the FAITIC and Remote Campus tools.