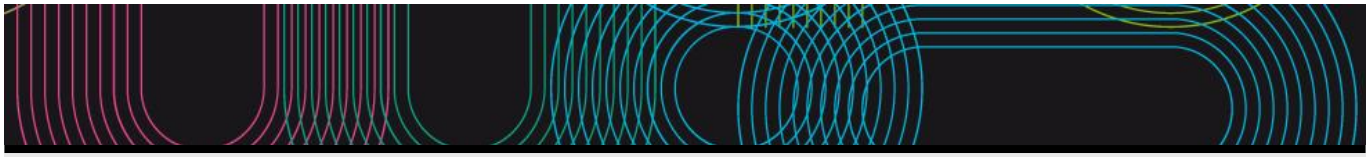

(*)Escola de Enxeñaría Aeronáutica e do Espazo

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).

Grado en Ingeniería Aeroespacial

Subjects

Year 3rd

Code	Name	Quadmester	Total Cr.
O07G410V01501	Aerospace manufacturing	1st	6
O07G410V01921	Solid mechanics and aerospace structures	1st	9
O07G410V01922	Fluid mechanics II and CFD	1st	9
O07G410V01923	Aerodynamics and aeroelasticity	2nd	9
O07G410V01925	Systems engineering and aerospace communications	2nd	6
O07G410V01931	Air-jet and aeronautic alternative engines	1st	6
O07G410V01932	Mechanical design, FEM and vibrations	2nd	9
O07G410V01933	Space vehicles	2nd	6
O07G410V01941	Numerical calculation	1st	6

O07G410V01942	Aerospace alloys and compound materials	2nd	9
O07G410V01943	Analytic and orbital mechanics	2nd	6

IDENTIFYING DATA				
Fabricación aeroespacial				
Subject	Fabricación aeroespacial			
Code	O07G410V01501			
Study programme	Grao en Enxeñaría Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3	1c
Teaching language	Castelán			
Department				
Coordinator	Carou Porto, Diego			
Lecturers	Carou Porto, Diego			
E-mail	diecapor@uvigo.es			
Web	http://aero.uvigo.es			
General description	Esta materia introduce os fundamentos dos procesos de fabricación (deseño, tecnoloxías, planificación, simulación e control de calidade) no ámbito da fabricación aeroespacial.			

Resultados de Formación e Aprendizaxe	
Code	
A2	Que os estudantes saiban aplicar os seus coñecementos ao seu traballo ou vocación dunha forma profesional e posúan as competencias que adoitan demostrarse por medio da elaboración e defensa de argumentos e a resolución de problemas dentro da súa área de estudo
A3	Que os estudantes teñan a capacidade de reunir e interpretar datos relevantes (normalmente dentro da súa área de estudo) para emitir xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética
A5	Que os estudantes desenvolvesen aquelas habilidades de aprendizaxe necesarias para emprender estudos posteriores cun alto grao de autonomía
B1	Capacidade para o deseño, desenvolvemento e xestión no ámbito da enxeñaría aeronáutica que teñan por obxecto, de acordo cos coñecementos adquiridos segundo o establecido no apartado 5 da orde CIN/308/2009, os vehículos aeroespaciais, os sistemas de propulsión aeroespacial, os materiais aeroespaciais, as infraestruturas aeroportuarias, as infraestruturas de *aeronavegación e calquera sistema de xestión do espazo, do tráfico e do transporte aéreo.
B2	Planificación, redacción, dirección e xestión de proxectos, cálculo e fabricación no ámbito da enxeñaría aeronáutica que teñan por obxecto, de acordo cos coñecementos adquiridos segundo o establecido no apartado 5 da orde CIN/308/2009, os vehículos aeroespaciais, os sistemas de propulsión aeroespacial, os materiais aeroespaciais, as infraestruturas aeroportuarias, as infraestruturas de aeronavegación e calquera sistema de xestión do espazo, do tráfico e do transporte aéreo.
C11	Comprender as prestacións tecnolóxicas, as técnicas de optimización dos materiais e a modificación das súas propiedades mediante tratamentos.
C12	Comprender os procesos de fabricación.
C19	Coñecemento aplicado de: a ciencia e tecnoloxía dos materiais; mecánica e termodinámica; mecánica de fluídos; aerodinámica e mecánica do voo; sistemas de navegación e circulación aérea; tecnoloxía aeroespacial; teoría de estruturas; transporte aéreo; economía e produción; proxectos; impacto ambiental.
C25	Coñecemento adecuado e aplicado á Enxeñaría de: os métodos de cálculo de deseño e proxecto aeronáutico; o uso da experimentación aerodinámica e dos parámetros máis significativos na aplicación teórica; o manexo das técnicas experimentais, equipamento e instrumentos de medida propios da disciplina; a simulación, deseño, análise e interpretación de experimentación e operacións en voo; os sistemas de mantemento e certificación de aeronaves.
C26	Coñecemento aplicado de: aerodinámica; mecánica e termodinámica, mecánica do voo, enxeñaría de aeronaves (á fixa e ás rotatorias), teoría de estruturas.
C32	Coñecemento adecuado e aplicado á Enxeñaría de: Os métodos de cálculo e de desenvolvemento dos materiais e sistemas da defensa; o manexo das técnicas experimentais, equipamento e instrumentos de medida propios da disciplina; a simulación numérica dos procesos físico-matemáticos máis significativos; as técnicas de inspección, de control de calidade e de detección de fallos; os métodos e técnicas de reparación máis adecuados.
D2	Liderado, iniciativa e espírito emprendedor
D3	Capacidade de comunicación oral e escrita na lingua nativa
D4	Capacidade de aprendizaxe autónoma e xestión da información
D6	Capacidade de comunicación interpersoal
D8	Capacidade de razoamento crítico e autocrítico
D11	Ter motivación pola calidade con sensibilidade cara a temas do ámbito dos estudos
D13	Sustentabilidade e compromiso ambiental. Uso equitativo, responsable e eficiente dos recursos

Resultados previstos na materia	
Expected results from this subject	Training and Learning Results

Coñecemento dos principios xerais sobre deseño xeométrico, funcional e os específicos dos elementos e instalacións propias das especialidades.	A2 A3 A5	B1 B2	C12	D2 D3 D4 D8 D11 D13
Interpretación, confección e xestión de documentos técnicos, para o deseño conceptual, preliminar e detalle de modelos físicos e sistemas	A2 A3 A5	B1 B2	C11 C12 C19 C25 C26 C32	D4 D8
Criterios de calidade e análise destes deseños. O alumno ou alumna coñece os procesos de produción, os seus principais parámetros definitorios e o seu campo de aplicación.	A2 A3 A5	B1 B2	C12	D2 D3 D4 D6 D8 D11 D13
O alumno ou a alumna coñece toda a información necesaria para levar a cabo un proceso de produción.	A2 A3 A5	B1 B2	C12	D2 D3 D4 D8 D11 D13
O alumno ou a alumna é capaz de realizar un informe que permita a execución exitosa dun proceso de produción.	A2 A3 A5	B1 B2	C12	D2 D3 D4 D8 D11 D13

Contidos	
Topic	
Bloque *I	1. Integración do deseño e fabricación 2. Conformado por deformación plástica 3. Conformado por mecanizado 4. Conformado de plásticos 5. Conformado por moldeo 6. Pulvimetalurxia 7. Fabricación aditiva 8. Conformado de materiais compostos 9. Técnicas de unión e ensamblaje 10. Metroloxía
Bloque *II	Simulación de procesos de fabricación

Planificación			
	Class hours	Hours outside the classroom	Total hours
Lección maxistral	10	20	30
Lección maxistral	7	16	23
Resolución de problemas	12.5	21.5	34
Aprendizaxe colaborativa	1	2	3
Prácticas con apoio das TIC	15	35	50
Prácticas de laboratorio	3	3	6
Saídas de estudo	1.5	0	1.5
Exame de preguntas obxectivas	2.5	0	2.5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Metodoloxía docente	
	Description
Lección maxistral	Exposición por parte do profesor dos contidos fundamentais da materia.
Lección maxistral	Exposición por parte do profesor dos contidos fundamentais da materia.
Resolución de problemas	Presentación e resolución por parte do profesor de problemas relativos aos procesos de fabricación estudados de maneira teórica coa participación activa das/os estudantes.

Aprendizaxe colaborativa	O profesor exporá temas de estudo que as/os estudantes traballarán de maneira autónoma para elaborar contidos adicionais de maneira *colaborativa.
Prácticas con apoio das TIC	Introdución ao emprego de software de simulación de procesos de fabricación por parte do profesor. Coas instrucións recibidas e traballo autónomo, as/os estudantes poderán resolver problemas específicos que permitan mellorar o seu coñecemento sobre os procesos estudados.
Prácticas de laboratorio	Introdución ao traballo con equipos de fabricación no laboratorio.
Saídas de estudo	Visitas a empresas, centros tecnolóxicos e outras entidades de interese.

Atención personalizada

Methodologies	Description
Lección maxistral	Prestarase atención ao estudantado no horario lectivo como no de titorías.
Resolución de problemas	Prestarase atención ao estudantado no horario lectivo como no de titorías.
Prácticas con apoio das TIC	Prestarase atención ao estudantado no horario lectivo como no de titorías.
Aprendizaxe colaborativa	Prestarase atención ao estudantado no horario lectivo como no de titorías.
Prácticas de laboratorio	Prestarase atención ao estudantado no horario lectivo como no de titorías.
Saídas de estudo	Prestarase atención ao estudantado no horario lectivo como no de titorías.
Lección maxistral	Prestarase atención ao estudantado no horario lectivo como no de titorías.

Avaliación

	Description	Qualification	Training and Learning Results		
Lección maxistral	Proba escrita 1	40	A2 A5	C12	D4 D8
Lección maxistral	Proba escrita 2	30			
Resolución de problemas	Entrega de problemas propostos resoltos	5	A2 A5	C12	D2 D3 D4 D8
Aprendizaxe colaborativa	Participación en actividades propostas	5	A2 A3 A5	C12	D2 D3 D4 D6 D8 D13
Prácticas con apoio das TIC	Entrega de memorias de prácticas	20	A2 A5	C12	D2 D3 D4 D8 D11

Other comments on the Evaluation

O modelo de avaliación é avaliación continua.

O/A estudante ten dereito a optar pola avaliación global segundo o procedemento e o prazo que estableza o centro para cada convocatoria. O exame global consistirá nun exame escrito en data oficial que cubra todos os aspectos avaliados en avaliación continua.

PRIMEIRA OPORTUNIDADE:

A materia avalíase en base a catro parámetros:

-Exames teórico-prácticos (nota máxima 7 puntos). Consistirán en dúas probas. A primeira durante o desenvolvemento do curso e a segunda na data oficial de exame. Nestas probas avalíanse os coñecementos teóricos da materia, cuestións relacionadas cos problemas e prácticas mediante un exame tipo test e resposta curta. O primeiro exame valórase en 4 puntos e o segundo en 3 puntos.

-Resolución de problemas (nota máxima 0,5 puntos). Avaliarase a entrega da resolución aos problemas expostos durante o curso nos prazos establecidos.

-Aprendizaxe colaborativo (nota máxima 0,5 puntos). Deberase participar nas actividades propostas durante o curso. Este apartado será avaliado en grupo.

-Prácticas (nota máxima 2 puntos). Avaliarase a entrega das memorias de prácticas durante o curso nos prazos establecidos.

Aprobarán a materia aqueles alumnos que consigan unha nota igual ou superior a 5 puntos. Non se fará media no caso de que no conxunto dos exames teórico-prácticos a nota sexa inferior a 4,5; sendo a nota final de actas suspenso ata o máximo permitido. Non é posible recuperar ningunha proba a posteriori, salvo causa xustificada.

SEGUNDA OPORTUNIDADE:

O método de Avaliación é o mesmo que o descrito para a PRIMEIRA OPORTUNIDADE. Poderanse gardar traballos da primeira oportunidade con cualificación >5. En ningún caso gardarase a cualificación dos exames.

OUTRAS CONSIDERACIÓNS:

En caso de detección de plaxio en calquera das probas, a cualificación final será de SUSPENSO (0) e o feito será comunicado á dirección do Centro para os efectos oportunos.As probas desenvolveranse durante o cuadrimestre. O exame teórico-práctico inicial desenvolverase en data a definir e indicada ás/os estudantes con antelación suficiente.O calendario de probas de avaliación aprobado oficialmente pola Xunta de Centro da EEAE atópase publicado na páxina web http://aero.uvigo.es/gl/docencia/exames

A evaluación fin de carreira seguirá os mesmos criterios ca evaluación de 2ª oportunidade.

Bibliografía. Fontes de información

Basic Bibliography

Serope Kalpakjian, Steven Schmid, **Manufacturing Engineering and Technology**, 9780136681656, 8, Pearson Education, 2020

Mikell P. Groover, **Fundamentos de manufactura moderna: materiales, procesos y sistemas**, 3, Prentice-Hall, 2007

Mikell P. Groover, **Principles of modern manufacturing**, 5, John Wiley & Sons, 2013

Complementary Bibliography

J.T. Black, Ronald A. Kohser, **DeGarmo□s Materials and Processes in Manufacturing**, 9781119492825, 13, Wiley, 2019

A. Sartal, D. Carou, J.P. Davim, **Enabling Technologies for the Successful Deployment of Industry 4.0**, 9781032240602, 1, CRC Press, 2020

Recomendacións

Subjects that continue the syllabus

Tecnoloxías para conformado de materiais aeroespaciais/O07G410V01913

IDENTIFYING DATA

Solid mechanics and aerospace structures

Subject	Solid mechanics and aerospace structures			
Code	O07G410V01921			
Study programme	Grado en Ingeniería Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	9	Optional	3rd	1st
Teaching language	Spanish Galician			
Department				
Coordinator	Comesaña Piñeiro, Rafael Conde Carnero, Borja			
Lecturers	Bendaña Jácome, Ricardo Javier Comesaña Piñeiro, Rafael Conde Carnero, Borja			
E-mail	bconde@uvigo.es racomesana@uvigo.es			
Web	http://http://aero.uvigo.es/			
General description	Introduction to the mechanics of solids and aeronautical structures			

Training and Learning Results

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
C20	Appropriate knowledge applied to engineering: mechanics of fracture of the continuous media and their dynamic behavior, fatigue of structural instability and aeroelasticity.
C26	Applied knowledge of aerodynamics; mechanics and thermodynamics, flight mechanics, aircraft engineering (fixed and rotary wings), theory of structures.
C33	Applied knowledge of aerodynamics, flight mechanics, air defense engineering (ballistics, missiles and air systems), space propulsion, material science and technology, structure theory.
D3	Capability of oral and written communication in native lenguage
D4	Capability of autonomous learning and information management
D5	Capability to solve problems and draw decisions
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

Expected results from this subject

Expected results from this subject	Training and Learning Results		
Understanding of the equations and general principles of the continuum, as well as the adequate selection of the different behavior models for deformable solids.	A2	C26 C33	D4 D5 D11
Analysis of solids and structures subjected to stresses above the elastic limit and cyclic loads.	A3	C20	D4 D6 D8 D11
Knowledge, understanding, application, analysis and synthesis of the theory of structures.	A3	C26 C33	D3 D4 D5 D6 D8 D11
Knowledge of the most outstanding aspects of structural behavior in aircraft	A2 A3	C20 C26 C33	D4 D5 D8

Contents

Topic	
Introduction to the characteristics and configuration of the aeronautical structures.	- Loads on the structure. - Structural elements. Structure of the fuselage: monocoque, semimonocoque. Structure of wing and of tail.
Symmetrical structures.	- Symmetrical structures.
Efforts produced by bending moments and shear forces	- Theorem of the sharp flow. - Sharp efforts. - Combined bending in symmetrical structures.
Torsion.	- Sections no circular. Rectangular section. - Open sections of small thickness. Enclosed sections of small thickness. Enclosed multicellular sections. - Centre of torsion. - Bending-Torsion.
Analysis of tensions in wings.	- Analysis of tensions in wings.
Analysis of tensions in fuselages.	- Analysis of tensions in fuselages.
Introduction to the structural integrity	- Requirements of resistance and rigidity. Factor last of security. - Fatigue. Criteria of fatigue based in tensions. - Criteria of fatigue based in deformations. - Introduction to the mechanics of the fracture. Criteria of tolerance to the damage. Margin of security and factor of reservation.
Elements subjected to axial forces and bending moments	- Elements subjected to axial forces and bending moments. Ultimate bending moment.
Problems of buckling and instabilities.	- Introduction to the theory of the stability - Global buckling. Primary instability of columns of stable section. - Beam-column buckling. Crippling. - Instability of flat and curved panels - Local buckling of of thin wall beams - Stiffened panels. Failure modes for compression and shearing.
Unions in aeronautical structures.	- Unions in aeronautical structures.
Theory of plates and shells	- Structural elements type plate and shell. - Basic hypotheses of calculation. - Flexure of plates and shells. - Plate buckling.
Finite elements method (FEM).	- Linear static analysis with elements type sweep, elasticity 2D and 3D, plates and shells. - Introduction to software of FEM simulation - Structural instability. Buckling by FEM. - Introduction to the static analysis no-linear of structures: no-geometrical linearity, no-linearity of the material (plasticity), no-linearity been due to boundary conditions.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	47	56	103
Laboratory practical	24	30	54
Autonomous problem solving	0	60.5	60.5
Essay questions exam	3.5	0	3.5
Objective questions exam	2	0	2
Problem and/or exercise solving	2	0	2

*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 in the classroom of the basic knowledges of the matter.
Laboratory practical	Realisation of practices in laboratory and/or realisation of practices in computer classroom and/or resolution of practical problems.
Autonomous problem solving	Resolution of problems and/or exercises of autonomous form by part of the students.

Personalized assistance

Methodologies	Description
Laboratory practical	In the practices will try in the measure of the possible attend personally to all the doubts that arise along the development of the practices

Assessment

	Description	Qualification	Training and Learning Results		
Laboratory practical	Assistance and active participation in the practical classes. Resolution of problems and/or exercises of autonomous form.	10	A2 A3	C20 C26 C33	D3 D4 D5 D8 D11
Essay questions exam	Examination at the end of the course on the whole of the content addressed by the subject.	30	A2	C20 C26 C33	D3 D4 D5 D6 D8
Objective questions exam	Proof that that includes questions with different alternative of answer. The student selects an answer between a number limited of possibilities. In the dates established by the centre when concluding the teaching of the matter.	30	A2 A3	C20 C26 C33	D3 D4 D5 D8
Problem and/or exercise solving	Proof in which the student has to solve a series of problems and/or exercises in a time/condition established/ace by the educational team.	30	A2 A3	C20 C26	D3 D4 D5 D8

Other comments on the Evaluation

The evaluation will be continuous, unless the students waive it through the relevant official procedure. In this case, the evaluation will be carried out exclusively by means of a written exam, covering 100% of the qualification. This specific approach to evaluation will be called global evaluation. The qualification obtained for the laboratory practices will be kept for the evaluation in the second opportunity and the opportunity for the end of the degree. In these calls, the remaining 90% of the qualification will be obtained through a written exam, on the dates established by the center, about the theoretical and/or practical contents.

Students who officially renounce continuous assessment

In this case, the grade obtained in the final exam will represent 100% of the grade.

The student has the right to opt for the global evaluation according to the procedure and the term established by the center for each call.

Laboratory practices

The face-to-face part corresponding to each practice is carried out on a specific date, so it is not possible to recover the absences. Those practices not carried out in which the student presents an official supporting document (doctor, court,...) due to unavoidable reasons of force majeure will be excused promptly and exceptionally.

Assessment tests

The evaluation test schedule officially approved by the EEAE Center Board can be found on the website: http://aero.uvigo.es/gl/docencia/exames. The maximum duration of the exam will be 3 hours if there is no break or 5 hours if there is an intermediate break (with a maximum of 3 hours for each part).

The use of any electronic device during the evaluation tests will not be allowed unless expressly authorized. The fact of introducing an unauthorized electronic device into the exam room will be considered a reason for failing the subject in this academic year and the overall grade will be fail (0.0).

ethical commitment

The student is expected to exhibit appropriate ethical behavior. In the case of detecting unethical behavior (copying, use of unauthorized electronic devices and others) it will be considered that the student does not meet the necessary requirements to pass the subject. In this case, the overall grade for this academic year will be fail (0.0).

Observation

In case of discrepancy in the versions of this guide between languages, the Spanish version prevails.

Sources of information

Basic Bibliography

E. de la Fuente Tremps, **Introducción al análisis de las Estructuras Aeronáuticas**, 1ª, Garceta, 2014
T. H. G. Megson, **Aircraft Structures for engineering students**, 4ª, Elsevier, 2003
Eugenio Oñate Ibáñez de Navarra, **Cálculo de estructuras por el método de elementos finitos**, CIMNE, 1995

Complementary Bibliography

S.P. Timoshenko, **Theory of plates and shells**, 1ª, McGraw Hill, 1940
Darrol Stinton, **The anatomy of the aeroplane.**, 1ª, BPS Profesional Book, 1985
John Cutler, **Understanding Aircraft Structures**, 1ª, Blackwell Science, 1992
Bruce K. donalson, **Analysis of Aircraft Structures**, 1ª, McGRAW-HILL. International Editions, 1993

Recommendations

Subjects that it is recommended to have taken before

Graphic expression: Graphic expression/O07G410V01105
Physics: Physics I/O07G410V01103
Physics: Physics II/O07G410V01202
Mathematics: Linear algebra/O07G410V01102
Mathematics: Calculus I/O07G410V01101
Mathematics: Calculus II/O07G410V01201
Materials science and technology/O07G410V01304
Mathematics: Statistics/O07G410V01401
Classical mechanics/O07G410V01305
Resistance of materials and resilience/O07G410V01405
Thermodynamics/O07G410V01303

IDENTIFYING DATA				
Fluid mechanics II and CFD				
Subject	Fluid mechanics II and CFD			
Code	O07G410V01922			
Study programme	Grado en Ingeniería Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	9	Optional	3rd	1st
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Rodríguez Pérez, Luis Suárez Porto, Eduardo			
Lecturers	Rodríguez Pérez, Luis Suárez Porto, Eduardo			
E-mail	lurodriguez@uvigo.es suarez@uvigo.es			
Web	http://aero.uvigo.es			
General description	Knowledge, understanding and application of concepts and techniques of Fluid Mechanics in Aerospace Engineering. Part of the subject is presented as an introduction to computational fluid dynamics which, starting from a knowledge of fluid conservation equations (already acquired by students in previous subjects) allows the student to carry out simple simulations involving a fluid. as a means of work. English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results	
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.
C16	Appropriate knowledge applied to engineering: Concepts and laws that govern the processes of transfer of energy, the movement of fluids, the mechanisms of transmission of heat and the interchange of matter and its role in the analysis of the main propulsion systems in aerospace engineering.
C18	Appropriate knowledge applied to the engineering: foundations of fluid mechanics; basic principles of control and automation of flight; main characteristics and physical and mechanical properties of the materials.
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.
C20	Appropriate knowledge applied to engineering: mechanics of fracture of the continuous media and their dynamic behavior, fatigue of structural instability and aeroelasticity.
C22	Appropriate knowledge applied to engineering: foundations of fluid mechanics that describe the flow in all regimes, to determine the distributions of pressures and forces on an aircraft.
C25	Appropriate knowledge applied to engineering: methods of design calculations and aeronautical projects; use of aerodynamic experimentation and the most significant parameters in the theoretical application; management of experimental techniques, equipment and measuring instruments; simulation, design, analysis and interpretation of experimentation and operations in flight; systems of maintenance and certification of aircrafts.
C26	Applied knowledge of aerodynamics; mechanics and thermodynamics, flight mechanics, aircraft engineering (fixed and rotary wings), theory of structures.
C28	Appropriate knowledge applied to engineering: foundations of fluid mechanics that describe the flow in any regime and determine the distribution of pressures and aerodynamic forces.
D3	Capability of oral and written communication in native lenguage
D4	Capability of autonomous learning and information management
D5	Capability to solve problems and draw decisions
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

Expected results from this subject

Expected results from this subject	Training and Learning Results		
Conocimiento y comprensión de los principales conceptos y técnicas de la Mecánica de Fluidos	A3	C16 C18 C19 C22 C28	D4 D5 D8 D11
Capacidad para aplicar los principales conceptos y técnicas de la Mecánica de Fluidos a las Ciencias de la Ingeniería	A2 A3 A5	C16 C18 C19 C20 C22 C25 C26 C28	D3 D4 D5 D6 D8 D11
Comprensión de los procedimientos básicos de la dinámica de fluidos computacional	A5	C16 C18 C19 C22 C25 C26 C28	D4 D5 D8 D11

Contents	
Topic	
CFD. General equations and transport phenomena	Topic 1: Summary of the general equations. Integral notation Differential notation Conservative form. Compact notation Most common limit models Most common boundary conditions
CFD. Turbulence	Topic 2: Introduction to turbulence Introduction Kolmogorov scale Infeasibility of direct numerical simulation Turbulence models: RANS models: -Reynolds and Favre averages -Averaged equations. Apparent Reynolds stresses. closure problem - Boussinesq hypothesis: algebraic models, of one equation and of two equations - Wall laws. High and low Reynolds number models - Reynolds apparent stress transport models LES Models: Description

CFD. Introduction to Computational Fluid Dynamic	Topic 3: FVM methods of numerical resolution of the Navier-Stokes equations. Finite Volume Methods (FVM): - Introduction - Discretization of the computational domain - Discretization of fluid equations - Discretized equations in FVM - Discretization of boundary conditions incompressible flows. pressure equation - Artificial compressibility methods - Pressure-velocity couplings - Most common numerical resolution acceleration methods Topic 4: Introduction to the use of different software (OpenFoam and Fluent*) for numerical simulation of fluids. Practices in computer room. *The use of these software will be conditioned to the availability of use licenses by of the center as well as the correct installation of the same in the assigned computer room Applications: - Laminar flow inside a cavity - Flow in a stream mixing device - Aerodynamic forces on bodies: Flow around an obstacle. laminar flow and turbulent flow Calculation of Kármán street after a blunt body Incompressible flow over airfoil Transonic flow over airfoil -Numerical simulation exercises/projects to be resolved more independently by students.
Fluid Mechanics II. Ideal flows. Irrotational flows.	Topic 1: Irrotational movements. Irrotationality conditions Irrotational Equations of Motion Initial and boundary conditions irrotational movement of liquids superposition principle Speed potential at great distances from an obstacle Irrotational plane motion of liquids: Elementary solutions. Current in nooks and corners. Current around a cylinder with circulation Two-dimensional irrotational motion of gases Prandtl□Meyer expansion Topic 2: Movements with surfaces of discontinuity Equations for the jump of fluid magnitudes in a discontinuity Normal and tangential discontinuities normal shock waves oblique shock waves Application: Almost one-dimensional movement of ideal fluids: Critical area. Movement in nozzles. Loading and unloading in warehouses. Shock waves. Relation of Hugoniot.
Fluid Mechanics II. One dimensional unsteady flow of ideal fluids	Topic 3: Non-stationary one-dimensional motion of ideal fluids. Effect of compressibility in liquids Opening and closing of valves. water hammer Equations of unsteady unidirectional motion in gases. simple waves
Fluid Mechanics II. Low Reynolds flows	Topic 4: Movement at low Reynolds numbers Equations. Initial and boundary conditions Application to incompressible fluids. Movements around a cylinder and a sphere Lubrication: Reynolds Equation of Lubrication 3D. Applications. cylindrical bearing, gas lubrication, rectangular skid, ...

Fluid Mechanics II. Boundary layer	Topic 5: Laminar boundary layer Incompressible laminar boundary layer. similarity solutions. Boundary layer on flat plate. Blausian solution Compressible laminar boundary layer Thermal boundary layer at low speeds
Fluid Mechanics II. Laboratory practicals	-Aerodynamic bench test: boundary layer measurement - Low speed wind tunnel test Pressure distribution on blunt body - Pressure distribution in convergent and convergent-divergent nozzles. Shock waves. sonic blocking

Planning

	Class hours	Hours outside the classroom	Total hours
Laboratory practical	4	5	9
Lecturing	33	35	68
Project based learning	8	18.5	26.5
Practices through ICT	8	0	8
Problem solving	22	73	95
Project	0	15	15
Essay questions exam	1.5	0	1.5
Essay questions exam	1	0	1
Essay questions exam	1	0	1

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

Methodologies

	Description
Laboratory practical	Realización de las prácticas de laboratorio
Lecturing	Exposición de la teoría Traslación de problemas de fluidos a modelos matemáticos para ser resueltos numéricamente
Project based learning	Planteamiento y resolución numérica de problemas propuestos aplicados a flujos de fluidos
Practices through ICT	Planteamiento y resolución de modelos aplicados a flujos de fluidos
Problem solving	Resolución de problemas y/o ejercicios de forma autónoma por parte del alumno para comprender y caracterizar los distintos tipos de movimientos de fluidos y sus simplificaciones

Personalized assistance

Methodologies	**Description**
Laboratory practical	All doubts that arise throughout the development of the practices will be attended personally
Problem solving	As far as possible, all doubts that arise during the resolution of the problems will be addressed.
Practices through ICT	In the practices, as much as possible, we will try to organize the group of students in different practices. All doubts that arise throughout the development of the practices will be attended personally
Tests	**Description**
Project	Doubts that arise throughout the development of the project will be addressed in tutorials

Assessment

	Description	Qualification	Training and Learning Results		
Project based learning	Preparation and delivery of the proposed CFD simulation report to the student	20	A2 A3 A5	C16 C18 C19 C20 C22 C25 C26 C28	D3 D4 D5 D6 D8 D11

Practices through ICT	Assistance and active participation in CFD practices	1.5	A2 A3 A5	C16 C18 C19 C20 C22 C25 C26 C28	D3 D4 D5 D6 D8 D11
Problem solving	Attendance to the problem solving sessions and delivery of the proposed problems. MFII	3.5	A2 A3 A5	C16 C18 C19 C20 C22 C25 C26 C28	D3 D4 D5 D6 D8 D11
Essay questions exam	Realization of written tests, resolution of exercises, practical cases. MFII	30	A2 A3 A5	C16 C18 C19 C20 C22 C25 C26 C28	D3 D4 D5 D8
Essay questions exam	Realization of written tests, resolution of cases and CFD concepts.	10	A2 A3 A5	C19 C20 C26 C28	D3 D5 D8 D11
Essay questions exam	Realization of written tests, resolution of exercises, practical cases. MFII	35	A3 A5	C18 C19 C22 C25 C26	D4 D5 D8

Other comments on the Evaluation

First call: The evaluation system will be continuous assessment for all students, nevertheless the student has the right to opt for the exam-only assessment according to the procedure and the deadline established by the centre for each call, in which case they will have the possibility of taking a final exam, 5 hours long, (with a break) with a weight of 100% of the grade.

If a student participates in any of the qualifying tests within the continuous assessment, it will be considered as presented to the subject. The continuous assessment is considered until July, so the qualifications achieved in all the activities carried out previously, are maintained until the July call, it will not be saved from one year to another.

The continuous assessment of the subject will be carried out through the following tests and weights:

- 35% Written continuous assessment test on knowledge of MFII.
- 30% Written continuous assessment test on knowledge of MFII.
- 20%. Delivery of the CFD Project/s of numerical simulation proposed to the students by the teaching staff.
- 10% Continuous assessment written test on CFD knowledge
- 3.5% Attendance, delivery of problems proposed by the faculty, and active participation in practical classes and MFII problem solving.
- 1.5% Attendance, delivery of problems proposed by the teaching staff, and active participation in the CFD practice classes.

To pass the subject it will be necessary to obtain a minimum (2 out of 10), in each and every one of the tests carried out, and achieve a 5 out of 10 in the total evaluations.

Second call: All the qualifications obtained previously in each of the continuous assessment tests of the first edition can be maintained from the fist to the second call, the students are going to decide which activities are evaluated again in the second call, with the exception of evacuations concerning to attendance.

End-of -program call, exam-only assessment option with a weight of 100% of the grade.

The student is expected to exhibit appropriate ethical behaviour. In case of detecting unethical behaviour (copying, plagiarism, use of unauthorized electronic devices, for example), it will be considered that the student does not meet the necessary requirements to pass the subject. Depending on the type of unethical behavior detected, it could be concluded that the student did not achieve the necessary skills.

The use of any electronic device during the evaluation tests will not be allowed unless expressly authorized. The fact of introducing an unauthorized electronic device into the exam room will be considered a reason for not passing the subject in this academic year and the overall grade will be failed (0.0).

Sources of information

Basic Bibliography

White, F.M, **Viscous fluid flow**, 3rd ed., McGraw-Hill, 2006

Panton, R. L., **Incompressible Flow**, 4th Edition, Wiley, 2013

Anderson, **Modern Compressible Flow**, 3nd Ed., Mc Graw Hill, 1992

BARRERO & PÉREZ-SABORID, **Fundamentos y aplicaciones de la Mecánica de Fluidos**, Mc Graw Hill, 2005

BLAZEK, J., **Computacional Fluid Dynamics: Principles and Applications**, Elsevier, 2001

H K Versteeg and W Malalasekera, **An Introduction to Computational Fluid Dynamics THE FINITE VOLUME METHOD**, 2nd Ed., Prentice Hall, 2007

Complementary Bibliography

Kundu , C., **Fluid Mechanics**, 4th Edition,, Academic Press, 2010

SCHLICHTING, H, **Boundary Layer Theory**, Mc Graw Hill, 1987

FERZIGER, J., MILOVAN, P., **Computational Methods for fluid Dynamics,**, Springer, 1999

F. Moukalled L. Mangani M. Darwish, **The Finite Volume Method in Computational Fluid Dynamics An Advanced Introduction with OpenFOAM® and Matlab®**, Springer, 2016

WILCOX, **Turbulence Modeling**, DCW Industries, 2004

www.openfoam.com,

Recommendations

Subjects that it is recommended to have taken before

Mathematics: Mathematical methods/O07G410V01301
Fluid mechanics/O07G410V01402

Other comments

Dedicate the indicated time to assigned personal work, as well as resort to personal tutorials with the teacher to resolve any possible doubts that may arise during the student's personal work

A full follow-up of the subject is recommended, as well as an active attitude in the classes.

IDENTIFYING DATA				
Aerodynamics and aeroelasticity				
Subject	Aerodynamics and aeroelasticity			
Code	O07G410V01923			
Study programme	Grado en Ingeniería Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	9	Optional	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Navarro Medina, Fermín			
Lecturers	Navarro Medina, Fermín			
E-mail	fermin.navarro.medina@uvigo.es			
Web	http://aero.uvigo.es			
General description	The subject includes the aerodynamic forces that determine the dynamics of the flight and the role of the different variables involved in the aerodynamic phenomena of profiles, wings, and nozzles, considering both compressible and incompressible flow. An introduction to aeroelasticity is also made. 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.			

Training and Learning Results	
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.
C20	Appropriate knowledge applied to engineering: mechanics of fracture of the continuous media and their dynamic behavior, fatigue of structural instability and aeroelasticity.
C22	Appropriate knowledge applied to engineering: foundations of fluid mechanics that describe the flow in all regimes, to determine the distributions of pressures and forces on an aircraft.
C25	Appropriate knowledge applied to engineering: methods of design calculations and aeronautical projects; use of aerodynamic experimentation and the most significant parameters in the theoretical application; management of experimental techniques, equipment and measuring instruments; simulation, design, analysis and interpretation of experimentation and operations in flight; systems of maintenance and certification of aircrafts.
C26	Applied knowledge of aerodynamics; mechanics and thermodynamics, flight mechanics, aircraft engineering (fixed and rotary wings), theory of structures.
C28	Appropriate knowledge applied to engineering: foundations of fluid mechanics that describe the flow in any regime and determine the distribution of pressures and aerodynamic forces.
D3	Capability of oral and written communication in native lenguage
D4	Capability of autonomous learning and information management
D5	Capability to solve problems and draw decisions
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

Expected results from this subject	Training and Learning Results		
- Knowledge, understanding, application and analysis of the aerodynamic phenomena and of the laws that govern his performance;	A2 A3	C22 C26 C28	D3 D4
- Knowledge, understanding and synthesis of the foundations of the flight of the aircraft	A3 A5	C22 C25 C26	D5 D6
- Knowledge, understanding, application, analysis and synthesis of the methods applied to the study of aeroelasticity;	A2 A3	C20 C25 C28	D8 D11
- Knowledge, understanding, application, analysis and synthesis of the aeroelasticity of a profile, from the static point of view (problems of torsional divergence and of investment of control) and dynamic (problems of flutter and buffet)	A3 A5	C20 C25 C28	D3 D4

- Knowledge, understanding, application, analysis and synthesis of aeroelasticity of one-dimensional and two-dimensional structures.;	A3	C20 C22 C26	D6 D8
- Knowledge and understanding of the most important appearances of experimental aeroelasticity, and more specifically of the essays in earth and in flight of aerostructures	A5	C20 C25	D8

Contents	
Topic	
1. Aerodynamics of flow incompresible	Subject 1.1: Introduction Subject 1.2: Foundations and principles of the aerodynamic Subject 1.3: Foundations of the flow incompresible Subject 1.4: Flow incompresible on profiles Subject 1.5: Flow incompresible on finite wings Subject 1.6: Flow incompresible three-dimensional
2. Aerodynamics of compressible flow	Subject 2.1: Aerodynamics in subsonic and supersonic regimes Subject 2.2: linear Theory of compressible flow in profiles
3. Aeroelasticity	Subject 3.1: Introduction to the aeroelasticity Subject 3.2: Aeroelasticity static Subject 3.3: Aeroelasticity dynamic

Planning			
	Class hours	Hours outside the classroom	Total hours
Laboratory practical	15	10	25
Previous studies	0	26.5	26.5
Mentored work	8	25	33
Problem solving	18.5	55	73.5
Workshops	2	0	2
Lecturing	30	10	40
Problem solving	1.5	0	1.5
Objective questions exam	3.5	0	3.5
Report of practices, practicum and external practices	0	20	20
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Laboratory practical	Realisation of practices programmed using the wind tunnel and manufacturing processes of test models. The realisation of the practice requires the preparation of it by means of a previous design, the assistance to the sessions of practices and the realisation of a report by the students.
Previous studies	Study of the student of autonomous form, with the support of the professor if like this it requires it according to the procedures established by the university
Mentored work	The mentored work consists on the development of a aerodynamic project based on aircraft airfoils and wings. The work is done by groups of students, and they have booked sessions with the professor for monitoring and tutoring. The work is coordinated with other one in the subject Fixed-wing and rotary wing aircrafts.
Problem solving	Resolution of problems and/or exercises that treat punctual appearances of the contents of the course, developed by the professor and/or the students in the classroom
Workshops	Workshop of software of aerodynamic simulation, whose utilisation serves of support for the rest of the subject, so much for the resolution of problems, as for the preparation of the practices.
Lecturing	Exhibition of a subject or resolution of problems by part of the professor according to a previously established script
Problem solving	Partial exam 1 based on the resolution of problems and/or conceptual questions about the contents of the subject between topics 1 and 2.

Personalized assistance	
Methodologies	**Description**
Previous studies	The student studies of autonomous form, with the support of the professor if like this it requires it according to the procedures established by the university
Workshops	Workshop of software of aerodynamic simulation, whose utilisation serves of support for the rest of the subject, so much for the resolution of problems, as for the preparation of the practices. The workshop will be guided by the professor of the subject.

Assessment

	Description	Qualification	Training and Learning Results		
Mentored work	The mentored work consists on the development of a aerodynamic project based on aircraft airfoils and wings. The work is done by groups of students, and they have booked sessions with the professor for monitoring and tutoring.	35	A2 A3	C20 C22 C26 C28	D3 D4 D5 D6 D8
Problem solving	(*)Examen parcial 1 basado en la resolución de problemas y/o preguntas conceptuales sobre los contenidos de la asignatura de entre los temas 1 y 2. Se puede recuperar en una prueba sobre los mismos temas, el día del examen en fecha oficial si la nota del parcial es inferior a 5.0.	30			
Objective questions exam	Resolution of problems and/or conceptual questions on the contents of the subject (intermediate exam 5% and final exam 55%)	30	A2 A3 A5	C20 C22 C25 C26 C28	D3 D4 D5
Report of practices, practicum and external practices	Report of the works made in the laboratory, and of the design of the profile and the wing.	5	A2 A3 A5	C20 C22 C25 C26 C28	D3 D4 D6 D11

Other comments on the Evaluation

First call

In order to pass the subject on the 1st opportunity, it will be necessary to obtain a score greater than 5 points out of 10 in the joint evaluation of the continuous assessment during the development of the classes and the exam on the official date. In addition, the qualification of the partial exam 1 (or of the recovery on the official date) together with that of the partial exam 2 must be greater than 5 points out of 10. The final qualification of the continuous evaluation will be obtained according to the indicated percentages. In the case of not fulfilling both conditions, the final mark will be the result of the minimum of the average mark of continuous evaluation and 4.0.

For the exam-only assessment, an exam will be carried out on the day of the official date, which includes all the contents of the subject. The qualification of said exam to pass the subject will be 5 points out of 10.

The evaluation testing calendar officially approved by the EEAE Center Board is published on the web http://aero.uvigo.es/gl/docencia/exames

Continuous assessment tests will be carried out during school hours"

The student has the right to opt for the global assessment according to the procedure and the deadline established by the centre for each call.

Second call

The student must submit to the extraordinary exam of all the contents of the subject, which will be 100% of the grade, if the final grade of continuous assessment is less than 5 points out of 10.

You will also have to take the ordinary exam in the following cases : Obtain a grade below 5 points out of 10 in the final exam of continuous evaluation.

End-of-program call

For the end of degree evaluation, an exam will be held on the day of the official date, which includes all the contents of the subject. The qualification of said exam to pass the subject will be 5 points out of 10.

Sources of information

Basic Bibliography

John D. Anderson Jr, **Fundamentals of Aerodynamics**, McGraw-Hill Education, 2016

John J. Bertín, **Aerodynamics for engineers**, Pearso, 2013

Raymond L. Bisplinghoff, **Principles of Aeroelasticity**, Dover Books, 2013

José Meseguer Ruiz, Ángel Sanz Andrés, **Aerodinámica básica**, 2ª, Gaceta, grupo editorial, 2010

Complementary Bibliography

Recommendations
Subjects that continue the syllabus
Mechanics of flight/O07G410V01924
Subjects that are recommended to be taken simultaneously
Fluid mechanics II and CFD/O07G410V01922
Subjects that it is recommended to have taken before
Physics: Physics I/O07G410V01103 Physics: Physics II/O07G410V01202 Fluid mechanics/O07G410V01402

IDENTIFYING DATA

Systems engineering and aerospace communications

Subject	Systems engineering and aerospace communications			
Code	O07G410V01925			
Study programme	Grado en Ingeniería Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Isasi de Vicente, Fernando Guillermo			
Lecturers	Isasi de Vicente, Fernando Guillermo			
E-mail	fisasi@uvigo.es			
Web	http:// aero.uvigo.es			
General description	Introduction to the engineering of systems and to the systems of communications with aerospace vehicles. 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.			

Training and Learning Results

Code	
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.
B4	Verification and certification in the field of aeronautical engineering that aim, in accordance with the knowledge acquired (in accordance 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.
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.
D2	Leadership, initiative and entrepreneurship
D3	Capability of oral and written communication in native lenguage
D4	Capability of autonomous learning and information management
D5	Capability to solve problems and draw decisions
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
D13	Sustainability and environmental commitment. Equitable, responsible and efficient use of resources

Expected results from this subject

Expected results from this subject	Training and Learning Results			
Understanding, knowledge and application of the national and international standards applied to the aerospace engineering. Understanding of the concept of System Engineering.	A3 A5	B1 B4		D2 D3 D4 D5 D6 D8 D11
Compression, knowledge of the systems of communications in aerospace vehicles		B4	C19	D5 D6 D8 D13

Contents

Topic	
Concept of Engineering of Systems	Need of an engineering of systems. Simple examples
Standard nations and Internaciones of Engineering of Systems in Aerospace projects	Study of the most used standards in: aerial Systems spatial Systems common Points
Application to national and international projects of Engineering of Systems.	Examples: aerial System: commercial aerial navigation spatial System: nano-hammer satellites
Introduction	Basic concepts of aerial navigation and communications
Direction finding	Principles Applications
VOR	Principle of operation Description Use
DME/TACAN	Principle of operation Description Use
ILS	Principle of operation Description Use
Primary radar	Principle of operation Description Use
Secondary radar	Principle of operation Description Use
GPS	Principle of operation Description Use
Augmented reality systems	Principle of operation Description Use

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	30	75.5	105.5
Laboratory practical	20	22	42
Problem and/or exercise solving	2.5	0	2.5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	Lecture with help of blackboard and computer. These lectures treat about the theory of the subject. With this methodology work the competitions CG1, CG4, CB3, CB5, CE19, CT8 and CT5. This is a grupal activity.
Laboratory practical	Use of simulators of systems of communications and/or navigation. Use of basic tools in the engineering of systems. With this methodology work the competitions CG1, CG4, CB3, CE19, CT2, CT4, CT5, CT6, CT11 and CT13. It is a grupal.activity.

Personalized assistance	
Methodologies	**Description**
Lecturing	Tutor sessions will be scheduled by the professor when a student sends an email asking for it. They will be at the professor's virtual office.
Laboratory practical	In the practices of laboratory the student can ask professor to resolve doubts. Tutor sessions will be scheduled by the professor when a student sends an email asking for it. They will be at the professor's virtual office.

Assessment

	Description	Qualification	Training and Learning Results
Laboratory practical	Evaluation of group work and individual questions during the practical sessions. Cross asessment surveys can vary final marks as well. Also, cross assesment surveys may affect the marks. The continuous assessment tests will be carried out during the lectures' schedule.	20	A5 B1 C19 D4 B4 D5 D6 D8 D13
Problem and/or exercise solving	Tests will have short practical questions and theoretical questions about the contents of magistral lectures. There are two tests during the course: one about the middle of course about the first half of subject and other at the end of lectures. These tests worth 40% of final mark. The second test will cover the second half of the subject for students who have got a mark better than 3/10 in the middle course test. If a student didn't got a mark over 3/10 in a test or wants to improve mark, will make the test about all subject. In this case, the test will cover all subject. If the mark got in the first half part of test is not better than the one got in the continuous assesment tests, the mark will be the latter. The continuous assessment tests will be carried out during the lectrues' schedule.	80	A5 B4 C19 D4 D5 D8

Other comments on the Evaluation

In the case that a student failed more than 20% of practice sessions, he / she will not be able to pass the subject by continuous assesment. The first and second calls will evaluate the whole subject. In the case that he / she prefers and has done laboratory practices and obtained more than a 3/10 in them, the student can do only the theoretical part. This theoretical part weighs 80% of the mark, the other 20% will be the mark obtained during the course. If the student has not practiced, they may be asked in a written exam or in the laboratory, weighing the mark of practices by 20% and the theory of 80%. Students who officially resign to the continuous assessment, the mark obtained in a corresponding exam will represent 100% of the qualification. The evaluation test calendar officially approved by the EEAE Center Board is published on the website http://aero.uvigo.es/gl/docencia/exames

Plagiarism is regarded as serious dishonest behavior. If any form of plagiarism is detected in any of the tests or exams, the final grade will be FAIL (0), and the incident will be reported to the corresponding academic authorities for prosecution.

The student has the right to opt for the global assessment according to the procedure and the deadline established by the centre for each call.

In the end-of-program call assessment, the criteria shall be the same as in the second-call examination.

Sources of information

Basic Bibliography

Jean-Luc Voirin, **Model-based System and Architecture Engineering with the Arcadia Method: https://www.elsevier.com/books/model-based-system-and-architecture-engineering-with-the-arcadia-method/voirin/978-1-78548-169-7**, 1, Elsevier (Free download from the University), 2017

Pascal Roques, **Systems Architecture Modeling with the Arcadia Method: https://www.elsevier.com/books/systems-architecture-modeling-with-the-arcadia-method/roques/978-1-78548-168-0**, 1, Elsevier (Free download from the University), 2017

Alexander V. NebylovJoseph Watson, **Aerospace Navigation Systems**, 1, WIley, 2016

ETSIA/EUITA/EIAE, **Sistemas y Equipos electrónicos para la navegación aérea**, 1, ETSIA/EUITA/EIAE,

Complementary Bibliography

NASA, **System engineering handbook**, Rev. 1,

Benjamin S. Blanchard, **SYSTEM ENGINEERING MANAGEMENT**, 5, Wiley, 2016

Recommendations

Subjects that it is recommended to have taken before

Electronics and automation/O07G410V01403

IDENTIFYING DATA

Aerorreactores e motores alternativos aeronáuticos

Subject	Aerorreactores e motores alternativos aeronáuticos			
Code	O07G410V01931			
Study programme	Grao en Enxeñaría Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	3	1c
Teaching language	Castelán Galego			
Department				
Coordinator	García Seoane, Santiago			
Lecturers	García Seoane, Santiago			
E-mail	santiago.garcia.seoane@uvigo.es			
Web	http://aero.uvigo.es			
General description	Coñecemento básico do funcionamento dos sistemas de propulsión empregados na industria aeroespacial.			

Resultados de Formación e Aprendizaxe

Code	
A2	Que os estudantes saiban aplicar os seus coñecementos ao seu traballo ou vocación dunha forma profesional e posúan as competencias que adoitan demostrarse por medio da elaboración e defensa de argumentos e a resolución de problemas dentro da súa área de estudo
A3	Que os estudantes teñan a capacidade de reunir e interpretar datos relevantes (normalmente dentro da súa área de estudo) para emitir xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética
A5	Que os estudantes desenvolvesen aquelas habilidades de aprendizaxe necesarias para emprender estudos posteriores cun alto grao de autonomía
B1	Capacidade para o deseño, desenvolvemento e xestión no ámbito da enxeñaría aeronáutica que teñan por obxecto, de acordo cos coñecementos adquiridos segundo o establecido no apartado 5 da orde CIN/308/2009, os vehículos aeroespaciais, os sistemas de propulsión aeroespacial, os materiais aeroespaciais, as infraestruturas aeroportuarias, as infraestruturas de *aeronavegación e calquera sistema de xestión do espazo, do tráfico e do transporte aéreo.
B7	Capacidade de analizar e valorar o impacto social e medioambiental das solucións técnicas.
C21	Coñecemento adecuado e aplicado á Enxeñaría de: Os fundamentos de sustentabilidade, mantenibilidad e operatividade dos vehículos aeroespaciais.
C23	Coñecemento adecuado e aplicado á Enxeñaría de: Os fenómenos físicos do voo, as súas cualidades e o seu control, as forzas aerodinámicas, e propulsivas, as actuacións, a estabilidade.
D3	Capacidade de comunicación oral e escrita na lingua nativa
D4	Capacidade de aprendizaxe autónoma e xestión da información
D6	Capacidade de comunicación interpersoal
D8	Capacidade de razoamento crítico e autocrítico
D11	Ter motivación pola calidade con sensibilidade cara a temas do ámbito dos estudos
D13	Sustentabilidade e compromiso ambiental. Uso equitativo, responsable e eficiente dos recursos

Resultados previstos na materia

Expected results from this subject	Training and Learning Results			
- Coñecer as necesidades propulsivas das aeronaves	A2 A3 A5		C23	
- Coñecer os empuxes e resistencias relacionados cos aerorreactores	A2 A3 A5	B1	C23	
- Coñecer e cuantificar de forma aplicada o proceso de combustión dos aerorreactores e o rendemento da combustión	A2 A3 A5	B1	C21	D13
- Saber realizar un balance enerxético diferenciando e calculando os rendementos involucrados	A2 A3 A5			
- Saber resolver problemas relacionados co cálculo dos ciclos termodinámicos e as características dos aerorreactores; así como o efecto das características e calidade dos compoñentes	A2 A3 A5			

- Coñecer os diferentes aerorreactores e saber obter os sistemas óptimos baixo o punto de vista propulsivo	A2 A3 A5	B7		
- Dimensionar os compoñentes que interveñen no sistema propulsivo	A2 A3 A5	B7		
- Coñecer o efecto das condicións de voo: velocidade e altitude no funcionamento dos aerorreactores	A3 A5	B1	C23	
- Coñecer os problemas ambientais dos aerorreactores e as súas posibles solucións	A2 A3 A5	B7	C21	D13
- Redactar informes técnicos e facer exposicións orais técnicas relacionadas co anterior	A2 A3			D3 D4 D6 D8 D11
- Resolver problemas derivados do ámbito da materia de forma autónoma e en colaboración con outro	A2 A3			D3 D4 D6 D8
- Coñecemento, comprensión, aplicación, análise e síntese da influencia de parámetros de operación e deseño sobre as actuacións dos motores alternativos aeronáuticos e os seus sistemas	A2 A3 A5		C21 C23	D8
- Coñecemento dos aspectos máis destacados dos ensaios dos motores alternativos	A2 A3 A5	B7	C21 C23	
- Utilizar ferramentas informáticas de cálculo de actuacións de aerorreactores	A2 A3 A5	B1	C23	D4 D8

Contidos

Topic	
1.- Motores alternativos de combustión interna	1.1.- Necesidades propulsivas das aeronaves 1.2.- Ciclos 1.3.- Renovación da carga 1.4.- Alimentación de combustible 1.5.- Combustión 1.6.- Sobrealimentación 1.7.- Turboalimentación 1.8.- Actuacións 1.9.- Elementos construtivos do motor alternativo
2.- Aerorreactores	2.1.- Turbinas de gas 2.2.- Análises do ciclo dun aerorreactor 2.3.- Aplicación das ecuacións integrais da Mecánica de Fluídos aos Aerorreactores: Continuidade: gasto másico; Cantidade de movemento: empuxes e resistencias; Enerxía: rendementos 2.4.- Comportamento motor e propulsor dos aerorreactores 2.5.- Turbohélices e a súa optimización 2.6.- Turbofanes e a súa optimización; turbofanes de fluxo mesturado; turbofanes avanzados 2.7.- Sistemas incrementadores de empuxe 2.8.- Actuacións de compoñentes 2.9.- Actuacións de aerorreactores 2.10- Problemas ambientais derivados do funcionamento dos aerorreactores

Planificación

	Class hours	Hours outside the classroom	Total hours
Lección maxistral	30	0	30
Prácticas de laboratorio	20	0	20
Estudo previo	0	87	87
Exame de preguntas de desenvolvemento	1.5	0	1.5
Resolución de problemas e/ou exercicios	1	0	1
Exame de preguntas de desenvolvemento	1.5	0	1.5
Resolución de problemas e/ou exercicios	1	0	1
Informe de prácticas, prácticum e prácticas externas	0	8	8

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

Metodoloxía docente	
	Description
Lección maxistral	Docencia en aula con apoio audiovisual
Prácticas de laboratorio	Prácticas de laboratorio, prácticas informáticas e saídas de estudo
Estudo previo	Preparación para o seguimento da materia, procura de información e preparación das probas de avaliación

Atención personalizada	
Tests	**Description**
Exame de preguntas de desenvolvemento	Prestarase atención colectiva e/ou persoalmente ás dúbidas que xurdan ao longo do desenvolvemento das probas escritas
Resolución de problemas e/ou exercicios	Prestarase atención colectiva e/ou persoalmente ás dúbidas que xurdan ao longo do desenvolvemento das probas escritas
Exame de preguntas de desenvolvemento	Prestarase atención colectiva e/ou persoalmente ás dúbidas que xurdan ao longo do desenvolvemento das probas escritas
Resolución de problemas e/ou exercicios	Prestarase atención colectiva e/ou persoalmente ás dúbidas que xurdan ao longo do desenvolvemento das probas escritas
Informe de prácticas, prácticum e prácticas externas	Atenderase persoalmente a todas as dúbidas que xurdan ao longo do desenvolvemento das prácticas e atenderase en titorías as dúbidas que xurdan ao preparar o informe de prácticas

Avaliación				
	Description	Qualification	Training and Learning Results	
Exame de preguntas de desenvolvemento	Exame escrito de preguntas curtas e resolución de problemas	20	A2 A3 A5	B1 B7 C21 C23 D3 D4 D8 D11 D13
Resolución de problemas e/ou exercicios	Exame escrito de solución de problemas Tema Motores de Combustión Interna Alternativos	20	A2 A3 A5	B1 B7 C21 C23 D3 D4 D8 D11 D13
Exame de preguntas de desenvolvemento	Exame escrito de preguntas Tema Aerorreactores	20	A2 A3 A5	B1 B7 C21 C23 D3 D4 D8 D11 D13
Resolución de problemas e/ou exercicios	Exame escrito de solución de problemas Tema Aerorreactores	20	A2 A3 A5	B1 B7 C21 C23 D3 D4 D8 D11 D13
Informe de prácticas, prácticum e prácticas externas	Informe das prácticas de laboratorio (solución dos exercicios propostos nas sesións de prácticas)	20	A2 A3 A5	B1 B7 C21 C23 D3 D4 D6 D8 D11 D13

Other comments on the Evaluation

O calendario de probas de evaluación aprobado oficialmente pola Xunta de Centro dá EEAE publícase na web http://aero.uvigo.es/gl/docencia/exames/.

Evaluación continua (primeira oportunidad, primeira convocatoria)

Para superar a materia na evaluación continua na primeira convocatoria se requerirá obter unha calificación superior a 5 puntos sobre 10 na valoración conxunta da evaluación continua durante o desenvolvemento das clases e o exame na data

oficial (é condición necesaria obter unha puntuación mínima de 4 puntos sobre 10 en cada unha das probas). A calificación final se obtendrá de acordo ás porcentaxes indicadas. As probas puntuables da evaluación continua se realizarán durante as horas lectivas da materia, polo que se require a asistencia regular ás clases e prácticas por parte do alumnado.

Evaluación global (segunda oportunidad, segunda convocatoria)

O/A estudante ten dereito a optar pola evaluación global según o procedemento e o prazo que estableza o centro para cada convocatoria.

O/A estudante deberá presentarse ao exame de segunda convocatoria de todos os contidos da materia, que supondrá o 100% da nota, nos seguintes supostos:

- A non realización dalgunha das probas da evaluación continua dentro dos prazos establecidos para os mesmos

- Obter unha nota inferior a 5 puntos sobre 10 na valoración conxunta da evaluación continua

- Obter unha nota inferior a 4 puntos sobre 10 nunha ou varias das probas da evaluación continua

- Obter unha nota inferior a 5 puntos sobre 10 na valoración da evaluación global (para estudantes que optasen a evaluación global en primeira convocatoria)

Evaluación fin de carreira

Para superar a materia na evaluación fin de carreira se requerirá obter unha calificación superior a 5 puntos sobre 10 no exame de todos os contidos da materia, que supondrá o 100% da nota.

Bibliografía. Fontes de información

Basic Bibliography

F. PAYRI / J. M. DESANTES, **MOTORES DE COMBUSTIÓN INTERNA ALTERNATIVOS**, EDITORIAL REVERTE, 2011

MARTÍN CUESTA ÁLVAREZ, **MOTORES DE REACCIÓN**, 9ª EDICIÓN, EDICIONES PARANINFO, 2001

ANTONIO ESTEBAN OÑATE, **CONOCIMIENTOS DEL AVIÓN (LIBROS II Y III)**, 7ª EDICIÓN, EDICIONES PARANINFO, 2019

A.G. VELÁZQUEZ / J.R. ARIAS / F. SASTRE, **MOTORES ALTERNATIVOS**, 3ª EDICIÓN, GARCETA GRUPO EDITORIAL, 2021

Complementary Bibliography

JACK D. MATTINGLY, **ELEMENTS OF PROPULSION: GAS TURBINES AND ROCKETS**, AIAA EDUCATION SERIES, 2006

GORDON C. OATES, **AEROTHERMODYNAMICS OF GAS TURBINE AND ROCKET PROPULSION**, AIAA EDUCATION SERIES, 1997

CLAUDIO MATAIX, **TURBOMÁQUINAS TÉRMICAS**, 3ª EDICIÓN, DOSSAT EDICIONES, 2011

BORJA GALMÉS BELMONTE, **MOTORES DE REACCIÓN Y TURBINAS DE GAS**, 2ª EDICIÓN, EDICIONES PARANINFO, 2018

ALLAN T. KIRKPATRICK, **INTERNAL COMBUSTION ENGINES APPLIED THERMOSCIENCES**, 4TH EDITION, ED. WILEY-BLACKWELL, 2020

Recomendacións

Subjects that it is recommended to have taken before

Física: Física I/O07G410V01103
Física: Física II/O07G410V01202
Química: Química/O07G410V01203
Tecnoloxía aeroespacial/O07G410V01205
Mecánica de fluídos/O07G410V01402
Termodinámica/O07G410V01303

IDENTIFYING DATA				
Deseño mecánico, MEF e vibracións				
Subject	Deseño mecánico, MEF e vibracións			
Code	O07G410V01932			
Study programme	Grao en Enxeñaría Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	9	Optional	3	2c
Teaching language	Castelán Galego			
Department				
Coordinator	Fernández González, Santiago			
Lecturers	Fernández González, Santiago			
E-mail	santiago.fernandez.gonzalez2@uvigo.es			
Web	http://aero.uvigo.es			
General description	Esta materia introduce ao deseño mecánico, ao método de elementos finitos e ao estudo das vibracións mecánicas.			

Resultados de Formación e Aprendizaxe	
Code	
A2	Que os estudantes saiban aplicar os seus coñecementos ao seu traballo ou vocación dunha forma profesional e posúan as competencias que adoitan demostrarse por medio da elaboración e defensa de argumentos e a resolución de problemas dentro da súa área de estudo
A3	Que os estudantes teñan a capacidade de reunir e interpretar datos relevantes (normalmente dentro da súa área de estudo) para emitir xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética
A5	Que os estudantes desenvolvesen aquelas habilidades de aprendizaxe necesarias para emprender estudos posteriores cun alto grao de autonomía
B1	Capacidade para o deseño, desenvolvemento e xestión no ámbito da enxeñaría aeronáutica que teñan por obxecto, de acordo cos coñecementos adquiridos segundo o establecido no apartado 5 da orde CIN/308/2009, os vehículos aeroespaciais, os sistemas de propulsión aeroespacial, os materiais aeroespaciais, as infraestruturas aeroportuarias, as infraestruturas de *aeronavegación e calquera sistema de xestión do espazo, do tráfico e do transporte aéreo.
B2	Planificación, redacción, dirección e xestión de proxectos, cálculo e fabricación no ámbito da enxeñaría aeronáutica que teñan por obxecto, de acordo cos coñecementos adquiridos segundo o establecido no apartado 5 da orde CIN/308/2009, os vehículos aeroespaciais, os sistemas de propulsión aeroespacial, os materiais aeroespaciais, as infraestruturas aeroportuarias, as infraestruturas de aeronavegación e calquera sistema de xestión do espazo, do tráfico e do transporte aéreo.
C20	Coñecemento adecuado e aplicado á Enxeñaría de: A mecánica de fractura do medio continuo e as formulacións dinámicas, de fatiga de inestabilidade estrutural e de aeroelasticidad.
C22	Coñecemento adecuado e aplicado á Enxeñaría de: Os fundamentos da mecánica de fluídos que describen o fluxo en todos os réximes, para determinar as distribucións de presións e as forzas sobre as aeronaves.
C25	Coñecemento adecuado e aplicado á Enxeñaría de: os métodos de cálculo de deseño e proxecto aeronáutico; o uso da experimentación aerodinámica e dos parámetros máis significativos na aplicación teórica; o manexo das técnicas experimentais, equipamento e instrumentos de medida propios da disciplina; a simulación, deseño, análise e interpretación de experimentación e operacións en voo; os sistemas de mantemento e certificación de aeronaves.
D3	Capacidade de comunicación oral e escrita na lingua nativa
D4	Capacidade de aprendizaxe autónoma e xestión da información
D5	Capacidade de resolución de problemas e toma de decisións
D6	Capacidade de comunicación interpersoal
D8	Capacidade de razoamento crítico e autocrítico
D11	Ter motivación pola calidade con sensibilidade cara a temas do ámbito dos estudos

Resultados previstos na materia					
Expected results from this subject	Training and Learning Results				
Coñecemento, comprensión e aplicación de elementos mecánicos.	A2 A3 A5	B1 B2	C20 C22 C25	D3 D4 D5 D6 D8 D11	

Coñecemento dos aspectos máis destacados das cualidades dos Sistemas mecánicos: modos de fallo e fiabilidade.	A2 A3 A5	B1 B2	C20 C22 C25	D3 D4 D5 D6 D8 D11
Capacidade para identificar e resolver problemas mecánicos.	A2 A3 A5	B1 B2	C20 C22 C25	D3 D4 D5 D6 D8 D11
Comprensión do método dos elementos finitos.	A2 A3 A5	B1 B2	C20 C22 C25	D3 D4 D5 D6 D8 D11
Resolución de problemas relativamente complexos en mecánica de medios continuos mediante a selección do modelo de comportamento e da formulación adecuada para o mesmo.	A2 A3 A5	B1 B2	C20 C22 C25	D3 D4 D5 D6 D8 D11
Coñecemento, comprensión, aplicación, análise e síntese dos métodos aplicados ao estudo da resposta de aeronaves fronte a cargas non estacionarias.	A2 A3 A5	B1 B2	C20 C22 C25	D3 D4 D5 D6 D8 D11
Coñecemento, comprensión, aplicación, análise e síntese dos sistemas vibratorios dun grao de liberdade, de múltiples graos de liberdade e continuos.	A2 A3 A5	B1 B2	C20 C22 C25	D3 D4 D5 D6 D8 D11
Coñecemento, comprensión, aplicación, análise e síntese dos métodos aproximados de cálculo para os sistemas continuos.	A2 A3 A5	B1 B2	C20 C22 C25	D3 D4 D5 D6 D8 D11

Contidos	
Topic	
Deseño de sistemas mecánicos	- Introducción ao deseño mecánico. - Materiais, propiedades mecánicas, ensaios en laboratorio. - Teoría de mecanismos.
Elementos mecánicos	- Deseño de elementos mecánicos; eixes e árbores, engranaxes, rodamentos, freos, embragues, unións... - Aplicación ao campo da aeronáutica.
Modos de fallo e fiabilidade	- Teorías de fallo en deseño estático. - Teorías de fallo en deseño dinámico, fatiga. - Predición dos modos de fallo, estimación de vida dos elementos (fiabilidade).
Teoría dos elementos finitos (MEF) lineal con énfase en dinámica de sólidos deformables	- Fundamentos. - Xeometría dos elementos. - Coordenadas nodais. - Xeración de mallas.
Introdución á resolución de problemas non lineais por elementos finitos	- Ecuacións e conectividade entre elementos. - Imposición de ligaduras. - Determinación da matriz de inercia, elástica e de amortiguamento.
Xeneralidades sobre sistemas vibratorios. Modelos aplicables á análise de vibracións en aeronaves	- Introdución ás vibracións mecánicas. Tipoloxía. - Clasificación das vibracións mecánicas. - Elementos básicos na vibración; elasticidade e amortiguamento.
Sistemas dun grao de liberdade	- Obtención das ecuacións diferenciais do movemento. - Vibracións lonxitudinais e torsionais. - Vibracións libres, amortiguadas, forzadas externamente.

Sistemas de varios graos de liberdade	- Métodos de desenvolvemento e análise matemática. - Obtención das matrices de elasticidade e amortiguamento. - Resposta dos sistemas a excitacións externas.
Sistemas continuos	- Tipoloxía de vibracións mecánicas. Vibracións transversais. - Frecuencias naturais, condicións límite. - Formulación e desenvolvemento de ecuacións. - Pulsacións propias.
Métodos aproximados, vibracións autoexcitadas e vibracións non lineais.	- Excitacións non deterministas. - Propiedades estatísticas. - Correlación.

Planificación

	Class hours	Hours outside the classroom	Total hours
Lección maxistral	35	70	105
Prácticas de laboratorio	20	0	20
Resolución de problemas	20	67	87
Informe de prácticas, prácticum e prácticas externas	0	9.5	9.5
Resolución de problemas e/ou exercicios	2	0	2
Resolución de problemas e/ou exercicios	1.5	0	1.5

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

Metodoloxía docente

	Description
Lección maxistral	- Clase maxistral na que se expoñen os contidos teoricos e prácticos por medios tradicionais (encerado) e recursos multimedia.
Prácticas de laboratorio	- Realización de tarefas prácticas en laboratorio con soporte informático.
Resolución de problemas	- Actividade na que se formulan problemas e/ou exercicios relacionados coa materia.

Atención personalizada

Methodologies	**Description**
Lección maxistral	O profesorado axudará ao estudante a resolver de maneira individual ou colectiva as dúbidas e dificultades que atopen na comprensión dos contidos teóricos da materia. Tutorías individuais ou en grupos reducidos co profesorado da materia. Opción de realizar as tutorias de forma online.
Prácticas de laboratorio	O profesor axudará ao estudante a resolver as dificultades que poida atopar na resolución de prácticas a realizar en laboratorio (con computador). Tutorías individuais ou en grupos reducidos co profesorado da materia. Opción de realizar as tutorias online.
Resolución de problemas	O profesor axudará ao estudante a resolver as dificultades que poida atopar na resolución de ejercicios prácticos. Tutorías individuais ou en grupos reducidos co profesorado da materia. Opción de realizar as tutorias online.
Tests	**Description**
Informe de prácticas, prácticum e prácticas externas	O profesorado atenderá ao estudante de forma presencial ou online nas revisións a efectuar dos informes de prácticas realizadas, despexando as súas dúbidas.
Resolución de problemas e/ou exercicios	O profesorado atenderá ao estudante de forma presencial ou online nas revisións a efectuar dos problemas prantexados nos exames parciais, despexando as súas dúbidas.
Resolución de problemas e/ou exercicios	O profesorado atenderá ao estudante de forma presencial ou online nas revisións a efectuar dos problemas prantexados nos exames parciais, despexando as súas dúbidas.

Avaliación

	Description	Qualification	Training and Learning Results			
Informe de prácticas, prácticum e prácticas externas	Avaliaranse os informes achegados polos estudantes da realización das prácticas en laboratorio.	20	A2 A3 A5	B1 B2	C20 C22 C25	D3 D4 D5 D6 D8 D11

Resolución de problemas e/ou exercicios	Avaliaranse a resolución dos problemas realizados polos estudantes nas probas parciais durante o curso. 1º Parcial (P1).	40	A2 A3 A5	B1 B2	C20 C22 C25	D3 D4 D5 D6 D8 D11
Resolución de problemas e/ou exercicios	Avaliaranse a resolución dos problemas realizados polos estudantes nas probas parciais durante o curso. 2º Parcial (P2)	40	A2 A3 A5	B1 B2	C20 C22 C25	D3 D4 D5 D6 D8 D11

Other comments on the Evaluation

As probas a realizar durante o curso serán as seguintes:
1.- Un parcial (P1) a realizar durante o curso en horario lectivo. Cun peso do 40% no total da Evaluación Continua (EC). Se o estudante aproba P1, a calificación obtida conservarase no exame global de 1ª oportunidade (E1) e no exame global de 2ª oportunidade (E2).
2.- Un parcial (P2) coincidindo co exame global de 1ª oportunidade (E1) establecido polo centro. Contará cun peso do 40% do total da nota de EC.
3.- A entrega obligatoria das Memorias (M) asociadas as prácticas. Cun peso do 20% do total da EC, memorias a realizar en horas non presenciais e a entregar nas últimas datas do curso. A asistencia ás prácticas non é obrigatoria pero si a entrega de tódalas memorías asociadas a elas.Se o estudante supera M, a calificación obtida conservarase no exame E1 e no exame E2.
As tres probas anteriores; P1, P2, M, compoñen as probas da EC.
4.- Un exame global de 1ª oportunidade (E1).
5.- Un exame global de 2ª oportunidade (E2).
A asinatura poderase aprobar/superar dalgunha das seguintes formas:
1.- O estudantado que queira aprobar na modalidade de EC deberá ter aprobada cada unha das probas que a compoñen; P1+P2+M.
Sen menoscabo do anterior, os estudantes que queiran mellorar nota poderán presentarse de forma voluntaria os exames globais (E1/E2) sendo evaluados pola maior das notas obtidas entre a EC e E1/E2.
2.- Os estudantes que non se atopen no anterior punto, poderán supera-la asinatura presentándose ós exames globais establecidos oficialmente polo centro (E1/E2).
O estudante ten dereito a optar pola avaliación global segundo o procedemento e o prazo que estableza o centro para cada convocatoria.

Exame fin de grao.O estudante que se presente ó exame fin de carreira será avaliado ó completo ca nota obtida en dito exame.
Nota: Considerarase que calqueira das probas anteriormente descritas están aprobadas cando o estudante obteña unha nota igual ou superior a 5 ptos.
A duración máxima do exame será de 4 horas si se fai de forma continua ou de 5 horas si hai unha pausa intermedia (neste caso a duración máxima de cada parte non superará as 2,5 horas).

O calendario de probas de avaliación aprobado oficialmente pola Xunta de Centro dá EEAE publícase na web http://aero.uvigo.es/gl/docencia/exames.

Compromiso ético:

Esperase que o estudante presente un comportamiento ético adecuado. No caso de detectar un comportamiento non ético (copia, plaxio, utilización de aparatos electrónicos non autorizados, e outros) considerarase que o estudante non reúne os requisitos necesarios para superar a materia. Neste caso a calificación global no presente curso académico será de suspenso (0).

Bibliografía. Fontes de información

Basic Bibliography

Shigley, **Diseño en ingeniería mecánica**, Octava, McGrawHill, 2008
Singeresu S. Rao, **Vibraciones mecánicas**, Quinta, Pearson, 2012

Complementary Bibliography

A.S.Hall, A.R. Holowenco, H.R.Laughlin, **Diseño mecánico, teoría y 320 Problemas resueltos**, Serie Schaum,
William W. Seto, **Vibraciones mecánicas, teoría y 225 problemas resueltos**, Serie Schaum,
Justo Nieto, **Síntesis de mecanismos**, Editorial AC,

Recomendacións

Subjects that it is recommended to have taken before

Expresión gráfica: Expresión gráfica/O07G410V01105
Física: Física II/O07G410V01202
Informática: Informática/O07G410V01104
Matemáticas: Cálculo II/O07G410V01201
Ciencia e tecnoloxía dos materiais/O07G410V01304
Resistencia de materiais e elasticidade/O07G410V01405

IDENTIFYING DATA				
Space vehicles				
Subject	Space vehicles			
Code	O07G410V01933			
Study programme	Grado en Ingeniería Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Ulloa Sande, Carlos			
Lecturers	Ulloa Sande, Carlos			
E-mail	carlos.ulloa@uvigo.es			
Web	http://aero.uvigo.es			
General description	The space vehicles operate in a very different environment than the earth. This environment is critical when defining the design requirements of the space vehicles. In addition to the space environment, it is under the scope of this subject the study of the necessary concepts of orbital mechanics for the understanding of the main application orbits, maneuvers and perturbations of the space vehicles. Main subsystems of a space vehicle are studied, as well, with special attention to the subsystem of thermal control and the subsystem of attitude control. Labs are included using specific material and simulation software of mission analysis. 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.			

Training and Learning Results	
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.
C24	Appropriate knowledge applied to engineering: systems of aircrafts and automatic systems of flight control of the aerospace vehicles.
D3	Capability of oral and written communication in native lenguage
D4	Capability of autonomous learning and information management
D6	Capabiliity for interpersonal communication
D11	Show motivation for quality with sensitivity towards subjects within the scope of the studies
D13	Sustainability and environmental commitment. Equitable, responsible and efficient use of resources

Expected results from this subject	Training and Learning Results			
Knowledge, understanding, application and analysis of the basic configurations, subsystems and missions of space vehicles.	A2 A3 A5	B1 B6	C24	D3 D4 D6 D11 D13
- Capacity for the analysis of the mission, of the type of law of guided and space path	A2 A3 A5	B1 B6	C24	D3 D4 D6 D11 D13

- Knowledge, understanding, application and analysis of the thermal control of the space vehicle	A2 A3 A5	B1 B6	C24	D3 D4 D6 D11 D13
- Knowledge, understanding, application and analysis of control of attitude and orbit of the space vehicle	A2 A3 A5	B1 B6	C24	D3 D4 D6 D11 D13
- Knowledge and understanding of the system of essays and of the support of earth of the space vehicle	A2 A3 A5	B1 B6	C24	D3 D4 D6 D11 D13

Contents	
Topic	
BLOCK 1: Introduction	Lesson 1.1: Brief historical review. Lesson 1.2: Classification of space vehicles Lesson 1.3: Types of subsystems of space vehicles Lesson 1.4: The solar system. Lesson 1.5: The space and planetary surroundings.
BLOCK 2: Orbital Mechanics	Lesson 2.1: Systems of reference and time. Lesson 2.2: The two-body problem. Time laws and orbital elements. Lesson 2.3: Tracks, coverage and visibility Lesson 2.4: Perturbations Lesson 2.5: Types of orbits Lesson 2.6: The three-body problem
BLOCK 3: Analysis of mission	Lesson 3.1: Space maneuvers Lesson 3.2: Rendezvous Lesson 3.3: Lunar and interplanetary missions
BLOCK 4: Subsystems	Lesson 4.1: Propulsion systems and launch vehicles Lesson 4.2: Space vehicles structures Lesson 4.3: System of attitude control Lesson 4.4: System of thermal control Lesson 4.5: Electrical , communications, command and telemetry systems Lesson 4.6: Ground segment Lesson 4.7: Laboratory tests

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	28	0	28
Laboratory practical	12	6	18
Seminars	0	2	2
Previous studies	0	79.5	79.5
Mentored work	10	10	20
Objective questions exam	2.5	0	2.5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	Classroom lecture
Laboratory practical	Practicum with different subsystems of space vehicles Practicum of simulation of analysis of mission Essays and reports about space vehicles
Seminars	Tutorials in small groups
Previous studies	Autonomous work
Mentored work	Mentored work

Personalized assistance	
Methodologies	**Description**
Seminars	Small group tutoring with the teachers of the subject. The tutorials will be held, by appointment, in the theacher's office or in the teacher's virtual office, on the Remote Campus.

Assessment

	Description	Qualification	Training and Learning Results			
Laboratory practical	Laboratory report	10	A2 A3 A5	B1 B6	C24	D3 D4 D11 D13
Mentored work	Reports and presentations of the work proposed during the course of the course within the practical sessions	20	A2 A3 A5	B1 B6	C24	D3 D4 D6 D11 D13
Objective questions exam	Partial examination of short questions and problems (30%) (Percentage can be divided into shorter tests) Final examination of short questions and problems (40%)	70	A2 A3 A5	B1 B6	C24	D3 D4 D11 D13

Other comments on the Evaluation

First Call:

(1) Students who follow the course by Continuous Assessment:

In order to pass the subject at the first opportunity, through Continuous Assessment, it will be necessary:

-A grade in the Continuous Assessment final exam of at least 5.0.

-Attend at least 80% of the practical sessions.

-Submit all the practical reports and assignments for the subject, obtaining at least a grade of 3 in each of them.

In the case of not meeting these conditions, the final mark will be the result of the minimum of the average mark of EC and 4.9.

Continuous assessment tests will be carried out during school hours, whenever possible. The final Continuous Assessment exam will be held on the date approved by the center for the first call.

(2) Students who wish to be evaluated by exam-only assessment:

The evaluation of the course at the first call will be carried out, by default, through Continuous Assessment. The student body has the right to opt for the exam-only assessment according to the procedure and the period established by the center for each call, which may not exceed one month.

The grade obtained in this exam will represent 100% of the final grade. The student must obtain a minimum grade of 5.0 in this exam. This exam may have a part to be taken in a computer room and/or laboratory, and will include all of the material taught, as well as the content covered in all the practical sessions and assignments.

The exam-only assessment exam will be carried out on the date approved by the center for the first call.

Second call and end-of-program call:

Students who have not passed the subject at the first call may take an exam that will account for 100% of the final grade. The student must obtain a minimum grade of 5.0 in this exam. This exam may have a part to be taken in a computer room and/or laboratory, and will include all of the material taught, as well as the content covered in all the practical sessions and assignments.

The second call and end of degree exams will be held on the dates approved by the center for each call.

Other considerations:

In case of detection of plagiarism in any qualification element, the qualification in said item will be 0 and the fact will be communicated to the direction of the Center for the appropriate effects.

The evaluation test schedule officially approved by the Board of the EEAE Center is published on the website http://aero.uvigo.es/es/docencia/examenes

Sources of information

Basic Bibliography

H.D. Curtis, **Orbital Mechanics for Engineering Students**, ELSEVIER, 2014

P. Fortescue, **Spacecraft Systems Engineering**, 4, Wiley, 2011

M.D. Griffin y J.R. French, **Space Vehicle Design**, AIAA Education Series, 2004

Charles Brown, **Elements of Spacecraft design**, AIAA Education Series, 2002

Complementary Bibliography

Bong Wie, **Space vehicle Dynamics and Control.**, AIAA Education Series, 1998

R. Karam, **Satellite Thermal Control for Systems Engineers**, AIAA Education Series, 1998

Recommendations

Subjects that it is recommended to have taken before

Physics: Physics I/O07G410V01103

Physics: Physics II/O07G410V01202

Aerospace technology/O07G410V01205

Classical mechanics/O07G410V01305

IDENTIFYING DATA				
Numerical calculation				
Subject	Numerical calculation			
Code	O07G410V01941			
Study programme	Grado en Ingeniería Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	3rd	1st
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Cid Iglesias, María Begoña			
Lecturers	Cid Iglesias, María Begoña			
E-mail	bego@dma.uvigo.es			
Web	http://aero.uvigo.es			
General description	The objective of this subject is that the students know and master different techniques and methods necessary for other subjects as well as for professional practice: the main numerical methods to solve large linear and non-linear systems, initial value and contour problems and the application of the finite element method. 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.			

Training and Learning Results	
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.
B2	Planning, documentation, project management, calculation and manufacturing in the field of aeronautical engineering (in accordance with what is established in section 5 of order CIN / 308/2009), aerospace vehicles, propulsion systems, aerospace materials, airport infrastructures, air navigation infrastructures and space management, air traffic and transport management systems.
C32	Appropriate knowledge applied to engineering: methods of calculation and development of materials and defence systems; management of experimental techniques, equipment and measuring instruments; numerical simulation of the most significant physical-mathematical processes; inspection, quality control and fault detection techniques; their most appropriate methods and repair techniques.
D3	Capability of oral and written communication in native lenguage
D4	Capability of autonomous learning and information management
D5	Capability to solve problems and draw decisions
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

Expected results from this subject	Training and Learning Results			
LO1: Knowledge, understanding and application of numerical methods for solving typical Aerospace Technology models and problems.	A2 A3 A5	B2	C32	D3 D4 D5 D6 D8 D11
LO2: Know and use a numerical simulation software tool that uses the finite element method.	A2 A3 A5	B2	C32	D3 D4 D5 D6 D8 D11

Contents	
Topic	
Numerical resolution of big linear systems and non-linear systems	1. Direct methods 2. Methods iterativos. 3. Preconditioners. 4. Methods based in descent algorithms. 5. Methods for non-linear systems.
Methods for initial value and boundary value problems	1. Methods for initial value problems 2. Systems of ordinary differential equations. 3. Methods for boundary value problems.
Finite difference method for partial differential equations	1. FDM for elliptical PDE. 2. FDM for parabolic PDE. 3. FDM for hiperbolic PDE.
Finite element method	1. FEM in one dimension. 2. FEM in higher dimension. 3. FEM for vectorial problems. 4. FEM for evolutionary problems.

Planning	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	0	1
Lecturing	25	60	85
Problem solving	6	12	18
Autonomous problem solving	0	13.5	13.5
Practices through ICT	18	12	30
Essay questions exam	2.5	0	2.5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	Description
Introductory activities	Activities directed to take contact and gather information on the students, as well as to present the subject.
Lecturing	The professor will expose in the theoretical classes the contents of the matter that illustrate with numerous examples and applications. The students will have basic texts of reference for the follow-up of the subject.
Problem solving	Approach, analysis, resolution and debate of a problem or exercise related with the matter given, so much by part of the educational as of the students. To illustrate and complete the explanation of each lesson and to help to that the student purchase the necessary capacities.
Autonomous problem solving	The student will have to resolve similar exercises to the realised in class to purchase the necessary capacities.
Practices through ICT	They will use computer tools to resolve problems and exercises and apply the knowledges obtained in the classes of theory, and the student will have to resolve similar exercises to purchase the necessary capacities.

Personalized assistance	
Methodologies	**Description**
Problem solving	The professor will attend personally the doubts and queries of the studentes. They will attend doubts in shape face-to-face, especially in the classes of problems and laboratory and in tutorials, as of form no face-to-face, by the available telematic systems for the subject.
Lecturing	The professor will attend personally the doubts and queries of the studentes. They will attend doubts in shape face-to-face, especially in the classes of problems and laboratory and in tutorials, as of form no face-to-face, by the available telematic systems for the subject.
Autonomous problem solving	The professor will attend personally the doubts and queries of the studentes. They will attend doubts in shape face-to-face, especially in the classes of problems and laboratory and in tutorials, as of form no face-to-face, by the available telematic systems for the subject.

Assessment			
	Description	Qualification	Training and Learning Results

Problem solving	There will be a written test for each of the parts of the subject in order to evaluate the resolution of exercises and/or problems in an autonomous way. Each test will have a weight of 20%. LO1	40	A2 A3 A5	B2	C32	D3 D4 D5 D6 D8 D11
Practices through ICT	Assistance and correct realisation of the practices by means of computer programs. LO1, LO2	20	A3 A5	B2	C32	D4 D5 D8
Essay questions exam	Realization of a final exam in which they collect the corresponding contents to the master sessions and to the resolution of problems. LO1	40	A2 A3 A5	B2	C32	D3 D4 D5 D6 D8 D11

Other comments on the Evaluation

The preferred mode of assessment is continuous assessment. The student has the right to opt for the overall assessment (100% of the grade on the official date) according to the procedure and deadline established by the centre for each call.

In any call it is necessary to obtain 5 points to pass the subject. In order to pass the subject, it is necessary to complete the laboratory practices obtain 5 out of 10 in that practices and obtain a 5 out of 10 in the final exam. In the case of not achieving this minimum in any of the parts, the final mark that will appear in the certificate will be the corresponding one, limited to a maximum of 4.8 points. (*)

The maximum duration of any exam will be 3 hours.

Second call evaluation:

Taking an exam in which the learning outcomes and the attainment of the competences indicated in the teaching guide will be assessed. A 5 out of 10 must be obtained with a weight in the final grade of 80%. The criteria indicated in (*) will also apply.

If the student does not achieve a 5 out of 10 in the laboratory practicals, he/she will have to take an additional test to pass this part, which represents 20% of the final grade.

Exam-only assesment procedure (any call):

Theoretical and practical assessment: An examination to assess learning outcomes and achievement of the competencies listed in the teacher's guide. Students must achieve a 5 out of 10, rating 80%.

Practical evaluation of computer practices: It is essential to perform this test to pass the subject. It will consist of a practical examination on the topics covered in the computer practices during the course. 5 out of 10 must be obtained to compute with the theoretical part, rating 20%.

The criteria indicated in (*) will also apply.

Evaluation dates:

The evaluation schedule officially approved by the EEAE is published on the website http://aero.uvigo.es/es/docencia/examenes/

Ethical commitment:

Students are expected to exhibit appropriate ethical behaviour. In case to detect an ethical behaviour no suitable (copy, plagiarism, utilisation of electronic devices non authorised, and others) will consider that the/the student/to does not gather the necessary requirements to surpass the subject. In this case the global qualification in the present academic course will be of suspense (0.0).

It remembers the prohibition of the use of mobile devices or portable computers in exercises and practical since the Royal decree 1791/2010, of 30 December, by which approves the Statute of the University Student, establishes in his article 13.2.d), relative to the duties of the university students, the duty of :

"*Abstain of the utilisation or cooperation in fraudulent procedures in the proofs of evaluation, in the works that realise or in official documents of the university*".

Sources of information

Basic Bibliography

Burden, R.; Faires, J., **Análisis Numérico**, Iberoamericana,

Kreyszig, E., **Advanced engineering mathematics**, Wiley,

LeVeque, R.J., **Finite difference methods for ordinary and partial differential equations**, Siam,

Reddy, J. N., **An introduction to the finite element method**, McGraw-Hill,

Complementary Bibliography

Chapra, S., Canale, R., **Métodos numéricos para ingenieros**, McGraw-Hill,

Conde, L.; Winter,G., **Métodos y algoritmos básicos del álgebra numérica**, Reverté,

Grau, J. - Torres, R., **Introducción a la mecánica de fluidos y transferencia de calor con COMSOL Multiphysics**, Addlink,

Quintela,P., **Matemáticas en ingeniería con Matlab**, Universidade de Santiago de Compostela,

Taylor, R.L.; Nithiarasu, P.; Zienkiewicz, O.C., **The finite element method**, Oxford,

Recommendations

Subjects that it is recommended to have taken before

Mathematics: Linear algebra/O07G410V01102
Mathematics: Calculus I/O07G410V01101
Mathematics: Calculus II/O07G410V01201
Mathematics: Mathematical methods/O07G410V01301

IDENTIFYING DATA				
Aerospace alloys and compound materials				
Subject	Aerospace alloys and compound materials			
Code	O07G410V01942			
Study programme	Grado en Ingeniería Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	9	Optional	3rd	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Álvarez González, David			
Lecturers	Álvarez González, David			
E-mail	davidag@uvigo.es			
Web	http://faitic.uvigo.es/			
General description	This course has to be considered as the continuation of Materials Science and Technology taught in the second year of the degree. In this course we will deepen in the study of the most used materials in the aerospace industry. We will study the light materials (metallic alloys and composite materials) used in the fuselage, wings and stabilizers, as well as the high performance alloys that are used in engines, landing gear and other elements of high responsibility. The most relevant mechanical and surface properties for its application will be presented. Some of the methods used to join materials as well as those used for tensting will be also addressed. English Friendly course: 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.			

Training and Learning Results	
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.
C11	Understand the technological benefits, the techniques of optimization of the materials and the modification of their properties through treatments.
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.
C30	Appropriate knowledge applied to engineering: technological benefits, techniques of optimization of the materials used in the aerospace sector and the processes of treatments to modify their mechanical properties.
C32	Appropriate knowledge applied to engineering: methods of calculation and development of materials and defence systems; management of experimental techniques, equipment and measuring instruments; numerical simulation of the most significant physical-mathematical processes; inspection, quality control and fault detection techniques; their most appropriate methods and repair techniques.
C33	Applied knowledge of aerodynamics, flight mechanics, air defense engineering (ballistics, missiles and air systems), space propulsion, material science and technology, structure theory.
D3	Capability of oral and written communication in native lenguage
D4	Capability of autonomous learning and information management
D5	Capability to solve problems and draw decisions
D8	Capabiliity for critical and self-critical reasoning
D11	Show motivation for quality with sensitivity towards subjects within the scope of the studies
D13	Sustainability and environmental commitment. Equitable, responsible and efficient use of resources

Expected results from this subject	Training and Learning Results		
Knowledge, understanding and application of the materials employed in the aerospace sector: capacity to identify his differences.	A3	C11 C19 C30 C33	D4 D8 D11 D13

Knowledge, understanding and application of the materials used in the aerospace sector: tools for the determination of the behaviour and properties.	A3 A5	C11 C32 C33	D4 D5 D8 D11
Knowledge, understanding and application of the materials employed in the aerospace sector: methods of manufacture and optimización.	A2 A3 A5	C11 C19 C32 C33	D3 D4 D5 D11 D13

Contents	
Topic	
Lesson 1.- General characteristics of materials used in the aerospace industry	Design requirements, accreditation and certification of evolution two materiais
Lesson 2.- Light alloys: Aluminium alloys. Magensium and Berilium alloys	Aluminium alloys: Processing and heat treatments. Classification. Main aluminium alloys for aerospace applications. Magnesium alloys for aerospace applications. Berilium alloy.Main aerospace applications
Lesson 3.- Ultra high strength steels	High resistance stelels: quench and tempering steels. PH Steels. Stainless steels. UHS steels. Maraging. Steels.
Lesson 4.- Titanium Alloys	Introduction to titanium alloys: physical metallurgy and processsing. Properties of titanium alloys.Aerospace applications. Titanium sponge.
Lesson 5.- Superallloys and special alloys.	Ni and Co based Superalloys. Structural intermetallics: titanium, Ni and Fe alluminides. Shape memory Alloys. Superplastic alloys. Aerospace applications. Metal matrix composites
Lesson 6.- Polymer Matrix Composites	General characteristics. Fibers and Matrix: carbon fibers. Ceramic Fibers (glass, Boron). Organic fibers (aramide, polyethilene), Metallic fibers. Resins (epoxi, poyester, fenolic). Prepregs. Sandwich cores. Thermoplastic matrix. Fibre Metal Laminate (FML) Manufacturing processes. Structural adhesives.
Lesson 7.- Ceramic materials for aerospace	General characteristics. UHT ceramics. Borides, carbides, nitrides. Applications (TBC's, propulsion systems, heatshields). Ceramic matrix composites
Lesson 8.- Materials Selection	Introduction to the material selection process. Ashby method (CES Edupack). Material selection maps.

Planning			
	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	0	1
Lecturing	46	115.5	161.5
Mentored work	1	20	21
Studies excursion	8	0	8
Laboratory practical	14	2	16
Problem solving	5	5	10
Objective questions exam	2	0	2
Presentation	0.5	3	3.5
Portfolio / dossier	1	1	2
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Introductory activities	Course presentation. Description of the teaching and evaluation methods. Presentation of the course contents and groups designation.
Lecturing	Teacher explains, clarifies and organizes the main concepts of the lesson, formulating and answering questions, motivating students for further study. Knowledge/skills across the course will be done . by means of an exam according to the official calendar published in web http://aero.uvigo.es/gl/docencia/exame This exam will include objective and short answer questions
Mentored work	Students will develop a work in small groups, selecting the topic among those proposed by the teacher. This activity will be evaluated through the public defense of work, using previously known criteria
Studies excursion	Visits in small group made to any of the companies in the aeronautical sector. If visits are not possible, they will be replaced by lectures given by specialists in the sector. The students must present a report of the visit made that will be included in their dossier

Laboratory practical	Activities for the practical application of the acquired knowledge. It is developed in the laboratory and with specialized equipment. They will be evaluated through a practices report
Problem solving	Resolution of problems and exercises related to the subject. They will be evaluated through the autonomous resolution of proposed exercises that will be incorporated into the student's dossier

Personalized assistance

Methodologies	Description
Lecturing	Attention that the teachers individually provide to the students to help them to solve the doubts and difficulties they can find in understanding the contents of the subject.
Laboratory practical	Individual attention to the students to help them to solve the difficulties in the development of laboratory classes
Problem solving	Time in which the teacher helps the student to solve the difficulties that can be found in solving problems and practical exercises
Mentored work	Individual attention for helping students to develope the group work

Assessment

	Description	Qualification	Training and Learning Results		
Problem solving	Throughout the course, students will carry out a series of online questionnaires in which, through multiple choice questions and solving exercises, they must show their understanding of the basic concepts and their rapid application to problems related to the aeronautical materials	10	A2 A5	C30	D4 D8
Objective questions exam	Written individual exam in which the student will answer solme questions related to the subject presented in the classroom, demonstrating good understanding of the basic concepts, ability to organize the information and to connect concepts	40	A2 A3	C32	D4 D8
Presentation	Oral exam in which the students present to the teachers and the classmates the work developed in small groups Students shuld demonstrate the acquired knowledge and its communication abiliity. They must answer the questions by the teahcer and the rest of the students. the evaluation will follow previously known criteria	30	A2 A3 A5		D4 D5 D8 D11 D13
Portfolio / dossier	In the portfolio, a compilation is done of the reports or the answer to the questions related to the laboratory practices done, as well as the summary visits to the selected companies. The quality of the information, clarity of exposition and adjustment of the regulations, if applicable, will be assessed.	20	A3 A5	C32 C33	D5 D8 D11 D13

Other comments on the Evaluation

The complete evaluation of the learning process and the skills developed by the student will be carried out through continuous assessment and a final written exam.

*-**Continuous assessment**: Weighing 60% of the total grade, will consist of activities performed throughout the entire semester (Online questionnaires: 10%; Individual or group work: 30%; Portfolio: 20%).Face-to-face presentation will be held during school hours*

*- The **written exam** (40%) consists of objective questions, short questions, and test questions. It will be held on the dates set in the evaluation alendar officially approved by the EEAE staff. It is published on the website http: //aero.uvigo.eres/gl/docencia/excursos.*

To pass the course, it will be necessary to achieve a minimum grade of 30% in each one of the assessment types. If this criterion is not reached, the maximum grade that the student can achieve is a 4/10.

***Second call exam** (June / July) the student who regularly attends the course, and has passed the continuous assessment, will be able to choose between maintaining the grade obtained in these tests and taking only the written exam with a value 40%, or renouncing to the the continuous assessment mark and take an exam that evaluate all the skills, with 100% of the score. This decision must be communicated in the period established by the School or by the teaching staff of th course. The same nethodology will be applied in the end of program call.*

The student has the right to opt for the exam -only assesment according to the procedure and the deadline established by the centre for each call.

***Ethical conduct**: As members of the University of Vigo, students are expected to promote an ethical culture and academic integrity. Any attempt to obtain an academic advantage by dishonest or unfair means is considered to be a lack of integrity that is unacceptable.*

In the event the teacher detects unethical behavior by a student (cheating or copy in the written exam through any method, use of electronic devices if not expressly authorized, plagiarism, recycling/resubmitting work...) the student will be graded with FAIL (0,0) in the final grade. I this behaviour is repeated, the facts will be referred to the EEAE director for his consideration.

Sources of information

Basic Bibliography

Ashby, M.; Shercliff, H.; Cebon, D., **Materials. Engieneering, Science, Processing and Design**, 3ª, Elsevier, B.H., 2014

Antonio Miravete, director, **Materiales Compuestos, I y II**, 1ª, Reverté, 2007

Complementary Bibliography

Prasad, N.E.; Wanhill, R.J.H., Editors, **Aerospace Materials and Material Tecnologies, vo:1,2**, 1ª, Springer, 2017

Daniel Gay, **Composite Materials**, 3ª, CRC Press, 2015

F.C, Campbell, **Manufacturing technology for Aerospace Structural Materials**, 1ª, Elsevier, 2006

Peter Morgan, **Carbon fibers and their composites**, 1ª, Taylor &Francis, 2005

Recommendations

Subjects that continue the syllabus

Materials for the aerospace industry/O07G410V01903

Subjects that are recommended to be taken simultaneously

Aerodynamics and aeroelasticity/O07G410V01923
Aerospace manufacturing/O07G410V01501

Subjects that it is recommended to have taken before

Chemistry: Chemistry/O07G410V01203
Aerospace technology/O07G410V01205
Materials science and technology/O07G410V01304
Resistance of materials and resilience/O07G410V01405

Other comments

In the event of inconsistency or discrepancy between the different linguistic versions of this publication, the Galician language version shall prevail

IDENTIFYING DATA				
Analytic and orbital mechanics				
Subject	Analytic and orbital mechanics			
Code	O07G410V01943			
Study programme	Grado en Ingeniería Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Tommasini , Daniele			
Lecturers	Tommasini , Daniele			
E-mail	daniele@uvigo.es			
Web	http://http://aero.uvigo.es/			
General description	We will study the methods of Lagrangian and Hamiltonian Analytical Mechanics, and apply them in particular to the orbital mechanics of space vehicles. 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.			

Training and Learning Results	
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.
B6	Capability to participate in flight testing programs for take-off and landing distances, ascent speeds, loss speeds, maneuverability and landing capacities.
C24	Appropriate knowledge applied to engineering: systems of aircrafts and automatic systems of flight control of the aerospace vehicles.
C26	Applied knowledge of aerodynamics; mechanics and thermodynamics, flight mechanics, aircraft engineering (fixed and rotary wings), theory of structures.
C33	Applied knowledge of aerodynamics, flight mechanics, air defense engineering (ballistics, missiles and air systems), space propulsion, material science and technology, structure theory.
D3	Capability of oral and written communication in native lenguage
D4	Capability of autonomous learning and information management
D5	Capability to solve problems and draw decisions
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

Expected results from this subject	Training and Learning Results			
Knowledge, understanding, application, analysis and synthesis of methods and techniques of Analytical Mechanics; specifically, of Lagrange and Hamilton-Jacobi equations, canonical transformations, and equilibrium, stability and oscillations of dynamical systems with N degrees of freedom.	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11
Knowledge and understanding of the dynamics of attitude of the space vehicles	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11

Knowledge, understanding, application, analysis and synthesis of the problems of astrodynamics related with the movement of the centre of masses of a spacecraft; namely, the Keplerian orbits, and the real orbits as conditioned by the different perturbations, the osculating orbits and the usual numerical methods in astrodynamics.	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11

Contents	
Topic	
Analytical Mechanics	Introduction to Lagrangian Mechanics
	Introduction to Hamiltonian Mechanics
	Dynamical systems: examples; linearisation; Lyapunov stability; numerical integration
Orbital Mechanics	Kepler Movement
	Perturbative Forces: modeling; numerical methods for orbit determination and orbital elements computations
	Attitude Dynamics

Planning			
	Class hours	Hours outside the classroom	Total hours
Problem solving	12	18	30
Practices through ICT	12	18	30
Lecturing	26	39	65
Essay questions exam	1.25	0	1.25
Report of practices, practicum and external practices	0	22.5	22.5
Essay questions exam	1.25	0	1.25
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Problem solving	Solution of problems with the active participation of the students
Practices through ICT	The teacher will explain the theory
Lecturing	El docente expondrá la teoría en lecciones magistrales

Personalized assistance	
Methodologies	**Description**
Problem solving	The student will participate in the process of solving problems under the supervision of the teacher.
Practices through ICT	The student will take part in the resolution of numerical problems with the help of the teacher
Tests	**Description**
Report of practices, practicum and external practices	The student will take part in the elaboration of the practice reports of the practices with the help of the teacher

Assessment						
	Description	Qualification	Training and Learning Results			
Problem solving	Assistance and active participation in the classes of problem solving	5	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11
Practices through ICT	Assistance and active participation in the computer practices	5	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11

Essay questions exam	First partial essay question exam	30	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11
Report of practices, practicum and external practices	Elaboration of a report describing the methodology and the results of the computer practices	30	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11
Essay questions exam	Second partial essay question exam	30	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11

Other comments on the Evaluation

The evaluations of the continuous assessment will be realized during the classes.

In the continuous assessment, the practices and the proofs are mandatory and liberatory. While the practices are not recoverable, the students that do not have been able to realize the first partial essay question exam-or have not passed it- will be allowed to repeat it in the day of the final examination, in which the second partial essay question exam will also be done.

The student has the right to opt for the exam-only assessment according to the procedure and the deadline established by the centre for each call. In this case, the student will be evaluated only through the exam (100% in this case).

All these criteria apply to both the first and the second call.

In the end-of-program call, the student will be evaluated only through the exam (100% in this case).

The dates of the final exams are published on the website of the EEAE in the web page http://aero.uvigo.es/gl/docencia/exames.

The dates of the first partial essay question exam will be communicated at the beginning of course.

Sources of information

Basic Bibliography

Howard Curtis, **Orbital Mechanics for Engeneering Students 3rd Edition**, 3ª, Elsevier, 2014

H. Schaub, J. L. Junkins, **Analytical Mechanics of Space Systems**, AIAA Education Series, 2009

Oliver Montenbruck; Eberhard Gill, **Satellite Orbits: Models, Methods and Applications**, Springer; HAR/CDR edition (September 2, 2011), 2011

J. E. Prussing, B. A. Conway, **Orbital Mechanics**, 2ª, Oxford University Press, 2012

A. E. Roy, **Orbital Motion, Fourth Edition**, 4ª, CRC Press,

William T. Thomson, **Introduction to Space Dynamics**, Dover Publications, 1985

D. A. Vallado, **Fundamentals of Astrodynamics and Applications**, Springer, 2007

Complementary Bibliography

D. Tommasini, **Apuntes de la asignatura**,

R.R. Bate, D.D. Mueller, J.E. White, **Fundamentals of Astrodynamics (Dover Books on Aeronautical Engineering) Revised ed. Edition**,

P.C. Hughes, **Spacecraft Attitude Dynamics**, Dover Publications, 2004

Recommendations

Subjects that it is recommended to have taken before

Physics: Physics I/O07G410V01103
Computer science/O07G410V01104
Mathematics: Linear algebra/O07G410V01102
Mathematics: Calculus I/O07G410V01101
Mathematics: Calculus II/O07G410V01201