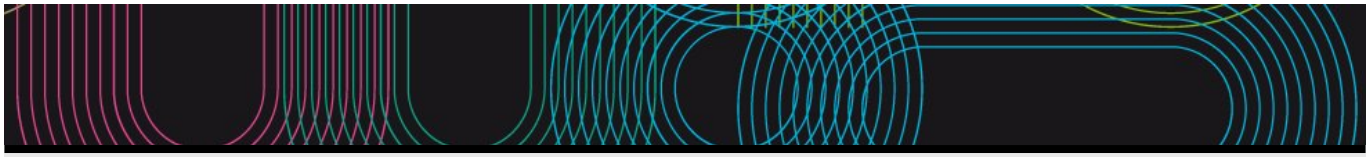

IDENTIFYING DATA				
Resistance of materials and resilience				
Subject	Resistance of materials and resilience			
Code	O07G410V01405			
Study programme	(*)Grao en Enxeñaría Aeroespacial			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Conde Carnero, Borja			
Lecturers	Bendaña Jácome, Ricardo Javier Conde Carnero, Borja			
E-mail	bconde@uvigo.es			
Web	http://aero.uvigo.es			
General description	Foundations of the theory of elasticity and strength of materials. Applications to the field of Aerospace Engineering. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies	
Code	
CG1	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.
CG2	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.
CG4	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.
CE7	Understand the behavior of structures before their request in conditions of service and critical situations.
CE15	Appropriate knowledge applied to engineering: Principles of the mechanics of continuous media and techniques for the calculation of their responses.
CE18	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.
CE19	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.
CT1	Capability of analysis, organization and planification.
CT3	Capability of oral and written communication in native lenguage
CT4	Capability of autonomous learning and information management
CT5	Capability to solve problems and draw decisions
CT6	Capabiliity for interpersonal communication
CT8	Capabiliity for critical and self-critical reasoning

Learning outcomes

Learning outcomes	Competences		
Understanding, analysis and calculation of simple problems of structural elements under linear behaviour	CG1	CE7 CE15 CE18 CE19	CT1 CT4 CT5 CT8
Understanding of the basic theory and solution of some fundamental problems in linear elasticity of solids	CG1 CG4	CE7 CE15 CE18 CE19	CT1 CT3 CT4 CT5 CT8
Knowledge, understanding and application of analysis methods	CG1 CG2 CG4	CE7 CE15 CE18 CE19	CT1 CT3 CT4 CT5 CT8
Application, analysis and synthesis of structures	CG1 CG2 CG4	CE7 CE15 CE18	CT1 CT3 CT4 CT5 CT6 CT8

Contents	
Topic	
1.- Introduction to the study of elasticity and strength of materials	1.1.- Aim of elasticity and strength of materials. 1.2.- Concept of deformable solid. 1.3.- The beam element. 1.4.- Static equilibrium and elastic equilibrium. 1.5.- Stress resultants. 1.6.- Concept of stress.
2.- Internal forces	2.1.- Introduction. 2.2.- Internal forces in a beam. 2.3.- Relations between internal forces and external forces. 2.4.- Sign convention. 2.5.- Relations among load, shear, and bending moment. 2.6.- Internal forces diagrams.
3.- Axial loading	3.1.- Introduction. 3.2.- Stresses. 3.3.- Strains. 3.4.- Statically indeterminate problems.
4.- Bending	4.1.- Pure bending. 4.2.- Symmetric and unsymmetric bending. 4.3.- Bending and axial loading. 4.4.- Deflections due to bending. 4.5.- Differential equation for deflection. 4.6.- Mohr's theorems. 4.7.- The conjugate-beam method. 4.8.- Statically indeterminate beams.
5.- Torsion	5.1.- Circular section.
6.- Energy methods in structural analysis	6.1.- Introduction. 6.2.- Strain energy of a beam. 6.3.- Maxwell-Betti reciprocal work theorem. 6.4.- Castigliano's theorem.
7.- Stress analysis	7.1.- Components of the stress vector. 7.2.- Equilibrium of the elementary parallelepiped. 7.3.- Stress tensor. 7.4.- Principal stresses and directions. 7.5.- Spherical and deviatoric stress tensors. 7.6.- Mohr's circle.
8.- Strain analysis	8.1.- Deformation of the elementary parallelepiped. 8.2.- Concept of strain. 8.3.- Strain tensor. 8.4.- Principal strains and directions. 8.5.- Changes of volume, area and length. 8.6.- Mohr's circle.

9.- Elastic solid	9.1.- Mechanical behaviour of the materials. 9.2.- Material constitutive models. 9.3.- The linear elastic model. 9.4.- Two-dimensional elasticity. 9.5.- The elastic problem. 9.6.- Yielding criteria.
10.- Matrix analysis of structures	10.1.- Introduction to the direct stiffness method. 10.2.- Stiffness matrix of truss and beam elements. 10.3.- Global stiffness matrix assembly. 10.4.- Application of the boundary conditions. 10.5.- Response of the structure: displacements, support reactions and member forces. 10.6.- Particular cases.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	32	60	92
Laboratory practical	18	37.5	55.5
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
Lecturing	Exposition in the classroom of the basic theory of the subject.
Laboratory practical	Resolution of problems related with the theoretical contents.

Personalized assistance

Methodologies	Description
Lecturing	
Laboratory practical	

Assessment

	Description	Qualification	Evaluated Competencess		
Laboratory practical	Attendance to and active participation in the practical sessions. Resolution of problems and/or exercises by the student.	10	CG1 CG2 CG4	CE7 CE15 CE18 CE19	CT1 CT3 CT4 CT5 CT8
Essay questions exam	Examination of the contents of all the subject.	90		CE7 CE15 CE18 CE19	CT1 CT3 CT5 CT8

Other comments on the Evaluation

Students that officially renounce to the continuous assessment

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

Practical sessions

Each practical session is on a specific date, thus it is not possible to recover them. Exceptionally, non-attended sessions could be justified by means of an official certificate (doctor, court, etc.).

Evaluation test

The dates of evaluation tests officially approved by the EEAE can be found in the following webpage: http://aero.uvigo.es/gl/docencia/exames. The maximum time of the examen will be 3 hours if a break is not contemplated, or 5 hours when including a break (being 3 hours the maximum time for each part).

The use of any electronic device during the evaluation test will not be allowed unless expressly authorized. The fact of introducing an electronic device not authorized in the exam room will be considered a reason for not passing the subject in the current academic year, and the overall rating will be 0.0.

Ethical commitment

It is expected from the student an appropriate behaviour. In the case of detecting unethical behaviour (copy, plagiarism, use of unauthorized electronic devices and others) it is considered that the student does not meet the necessary requirements to pass the subject. Thus, the overall grade in this academic year will be 0.0.

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

Sources of information

Basic Bibliography

Ricardo Bendaña, **Ejercicios de resistencia de materiales y cálculo de estructuras para ingenieros**, Galiza Editora, 2005

Manuel Vazquez, **Resistencia de materiales**, Noela, 2000

Luis Ortiz Berrocal, **Resistencia de materiales**, McGraw-Hill, 2007

Manuel Vazquez, **Cálculo matricial de estructuras**, Coleg. Ofic. Ing. Tec. Obras Publicas, 1999

Complementary Bibliography

J. A. González Taboada, **Fundamentos y problemas de tensiones y deformaciones en materiales elásticos**, Tórculo, 2008

T. H. G. Megson, **Aircraft Structures for engineering students**, Elsevier, 2003

Recommendations

Subjects that continue the syllabus

Solid mechanics and aerospace structures/O07G410V01921

Subjects that it is recommended to have taken before

Graphic expression: Graphic expression/O07G410V01105
Physics: Physics I/O07G410V01103
Physics: Physics II/O07G410V01202
Mathematics: Calculus I/O07G410V01101
Mathematics: Calculus II/O07G410V01201