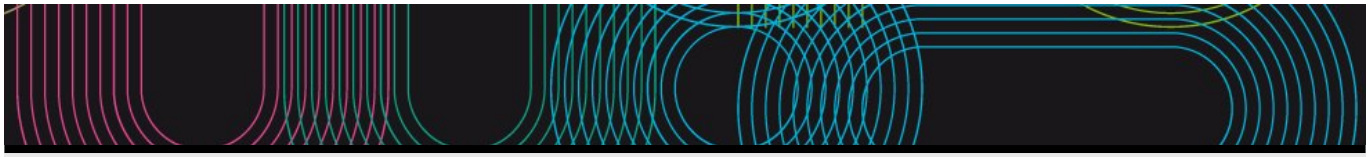

IDENTIFYING DATA				
Elasticity and additional topics in resistance of materials				
Subject	Elasticity and additional topics in resistance of materials			
Code	P52G381V01303			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Val García, Jesús del			
Lecturers	Eirís Barca, Antonio Val García, Jesús del			
E-mail	jesusdv@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The subject Elasticity and Advanced Strength of Materials is a subject of the specific mechanic block that is taught in the first quadmester of the third academic year in the CUD-ENM. The subject is continuation and extension of the subject Strength of Materials of second-year. To establish the general equations that govern the mechanical behaviour of the deformable solids, it is necessary to complement the equations of the statics, kinematics and dynamics, with equations that relate the stress and deformations in the surroundings of the point. In the case of small deformations, it is checked that in most of materials the process of deformation is reversible, in terms of elastic behaviour. Then, it is established as the goal of the "Theory of the Elasticity" the study of the deformable solids with elastic behaviour. The mathematical formulation of all these theories drives to equations of big complexity and the finding of exact solutions remain limited to some particular cases. For the case of one-dimensional or two-dimensional solids, it is possible to establish simplifying hypothesis regarding to the stress distribution. This is the approach of the "Strength of Materials" that allows to attach the study of those deformable solids that admit simplifying hypothesis in relation to its stress and deformational states. The teaching of this subject pursues that the students aquire the basic knowledge related with the capacity to know and understand the behaviour of the elastic solid under any type of load. Besides they reinforce the basic concepts of the stress analysis so that it can be applied to the design and calculation of structural elements and elements of machines. The elasticity and strength of materials establishes the criteria that allow to determine the most convenient material, the shape and the most adapted dimensions that the elements of a structure or a machine need to resist the action of the external loads without an excessive economic cost. Likewise, the students are initiated in the handling of computational programs to calculate efforts, of trips and tensions of basic structural systems.			

Training and Learning Results	
Code	
B3	Knowledge in basic and technological subjects that will enable students to learn new methods and theories, and provide them the versatility to adapt to new situations.
B4	Ability to solve problems with initiative, decision making, creativity, critical thinking and the ability to communicate and transmit knowledge and skills in the field of Industrial Engineering in Mechanical specialty.
C22	Knowledge and skills to apply the fundamentals of elasticity and strength of materials to the actual behavior of solids.
D2	Problems resolution.
D5	Information Management.
D9	Apply knowledge.
D10	Self learning and work.
D17	Team working.

Expected results from this subject

Expected results from this subject	Training and Learning Results		
Kowledge of the elasticity fundamentals	B3	C22	
Further deepening on mechanics of materials and stress analysis	B3 B4	C22	D2 D10
Knowledge of deformations in beams and shafts	B3 B4	C22	D2 D9
Ability to apply the knowledge of elasticity and mechanics of materials, and to analyze the mechanical performance of machines, structures, and general structural elements	B4	C22	D2 D5 D9
Ability to take decisions about suitable material, shape and dimensions for a structural element subjected to a specific load	B4	C22	D2 D5 D9 D17
Knowledge of different solving methods for structural problems and ability to choose the most suitable method for each specific problem	B4	C22	D2 D5 D9
ENAEE learning outcome: KNOWLEDGE and UNDERSTANDING: LO1.2.- knowledge and understanding of the mathematics and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes [level of achievement (basic (1), intermediate (2) and advanced (3)) for this learning outcome: Intermediate (2)].	B3	C22	
ENAEE learning outcome: ENGINEERING ANALYSIS: LO2.2.- ability to identify, formulate and solve engineering problems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to recognise the importance of non-technical societal, health and safety, environmental, economic and industrial constraints [Level of achievement: Intermediate (2)].	B4		D2 D9
ENAEE learning outcome: RESEARCH AND INNOVATION: LO4.3 Ability to perform experimental investigation, understand the results and draw conclusions in the study field [Level of achievement: Intermediate (2)].		C22	D9
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.1.- understanding of applicable techniques and methods of analysis, design and investigation and of their limitations in their field of study [Level of achievement: Intermediate (2)].		C22	D9

Contents

Topic	
1. Fundamentals of elasticity	1.1. Introduction to Elasticity 1.1.1. Goals of Elasticity and Strength of Materials 1.2. Definition of stress in elastic solids 1.2.1. Stress tensor 1.2.2. Principal stresses and principal directions 1.2.3. Graphic representation of three-dimensional stress. Mohr´s Circles 1.3. Deformation analysis in continuum media 1.3.1. State of strain at a point 1.3.2. Strain tensor 1.3.3. Graphic representation of deformational state. Mohr´s Circles 1.4. Stress-Strain relations 1.4.1 Generalized Hooke´s laws 1.5. Thin-wall pressure vessels
2. Criteria for initiation of inelastic material behavior. Failure condition	2.1. Plastic deformation of materials. Failure condition 2.2.Maximum normal stress theory or Rankine theory 2.3. Maximum normal strain theory or Sain-Venant theory 2.4. Maximum shear stress theory or Coulomb theory 2.5. Maximum strain energy theory or Beltrami-Haigh theory 2.6. Maximum distorsion energy theory or von Mises theory 2.7. Comments about failure theories. Safety factor
3. Torsion	3.1 Torsion of a prismatic bar of circular cross section. Coulomb□s theory 3.2. Design of transmission shafts 3.3. Strain energy stored by torsion 3.4. Statically indeterminate torsion members
4. Bending	4.1. Pure bending. Flexure Navier formula 4.2. Simple bending. Shear stresses. Zhuravski expression 4.3. Combined bending. Normal stresses. Neutral axis. Kern of the cross-section 4.4. Strain analysis. Beam deflection and slope. Curvature-moment ratio. Beam differential equation 4.5. Statically indeterminate beams. General method

5. Combined loadings	5.1. Combined Loadings 5.2. Combined bending and torsion in bars of circular cross section 5.3. Bending of beams of nonsymmetrical section. Shear center 5.4. Combined axial and bending load in non-slender bodies 5.5. Thin-wall pressure vessels
6. Lateral bending. Buckling	6.1. Buckling. Introduction 6.2. Centric compression load in slender column. Euler critical load 6.3. The effect of end conditions on critical load 6.4. Eccentric load in slender column 6.5. Validity range in Euler buckling theory. Design formulas for columns 6.6. Bucking coefficients method for column design
7. Strain energy. Energy methods	7.1. Strain energy concept 7.2. External loads and strain relations. Influence coefficients concept 7.3. Strain energy expressions. Clapeyron theorem 7.4. Principle of virtual works. 7.5. Castigliano´s theorems
8. Experimental methods in elasticity	8.1. Electrical strain gages method. Fundamentals 8.2. Electrical strain gages. Data analysis 8.3. Photoelasticity. Fundamentals 8.4. Basic optical concepts in photoelasticity 8.5. Photoelasticity equipment. Interpretation of the stress contours

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	42	70
Problem solving	7	0	7
Seminars	15	7	22
Laboratory practical	14	14	28
Essay questions exam	14	4	18
Essay	2	3	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	Presentation of the contents of the subject matter, theoretical bases and/or guidelines of a work, exercise or project to be developed by the student. Presentations and blackboard will be used in combination. At the beginning of the course, students are given a notebook with all the slides used by the teachers. Therefore, the students have the work material at their disposal prior to the presentation, thus focusing the effort of the lecturer and the students on the presentation and understanding of the knowledge and not simply on the transmission of knowledge. In any case, paper reproductions of transparencies should never be considered as substitutes for texts or notes, but as complementary material. The aim is to give the student the possibility to contrast his class notes with them and, in this way, to help him to better understand the ideas conveyed by the lecturer.
Problem solving	Activity in which problems and/or exercises related to the subject are formulated. The student must develop the appropriate or correct solutions through the exercise of routines, the application of formulas or algorithms, the application of transformation procedures of the available information and the interpretation of the results. It is usually used as a complement to the lectures.
Seminars	Intensive course of 15 hours for those students who have failed the course in the first call, prior to the exam in in the second call. Group tutorials with the lecturer.
Laboratory practical	Activities for the application of knowledge to concrete situations and the acquisition of basic and procedural skills related to the subject matter. They are developed in special spaces with specialized equipment (laboratories, computer classrooms, etc.).

Personalized assistance

Methodologies	Description

Lecturing	In the field of tutorial action, there are two types of actions: academic tutoring and personalized tutoring. In the first case, the students will have at their disposal hours of tutorials in which they can ask any question related to the contents, organization and planning of the subject, etc. The tutorials can be individualized, but group tutorials will be encouraged for the resolution of problems related to the activities to be carried out in group. In the personalized tutorials, each student, individually, will be able to discuss with the lecturer any problem that is preventing him/her from following the subject properly, in order to find some kind of solution between both of them. By combining both types of tutorial action, the aim is to compensate for the different learning rhythms through attention to diversity. The lecturers of the subject will personally answer the students' questions and queries, both in person, according to the schedule that will be published on the center's web page, and through telematic means (e-mail, videoconference, Moovi online teaching platform, etc.) under the modality of previous appointment.

Assessment

	Description	Qualification	Training and Learning Results		
Laboratory practical	The evaluation of the practices will be valued by checking the memories of practices (MP) that the student will have to deliver	20	B4	C22	D2 D5 D9 D10
Essay questions exam	Written tests: theoretical questions and problems. The purpose of the written tests is to evaluate the learning of all the theoretical contents selected for the course. - Final exam (PF): 40% - Intermediate exams (PI): 30% (PI1 15%, PI2 15%)	70	B3 B4		D2 D9
Essay	During the course of the subject, evaluable activities will be proposed (evaluable problems or work) with the aim of having students solve them autonomously and / or expose them in their own class. - Evaluable activities (AE): 10%	10	B3 B4	C22	D2 D9 D10

Other comments on the Evaluation

The evaluation criteria for each section will be published at the beginning of the quadmester. The relevant information will be provided to the students through the virtual platform Moovi.

The final evaluation of student will be the sum of the grades obtained in each one of the parts previously mentioned, being his/her grade of continuous evaluation (NEC):

NEC = 0.4*PF + 0.15*PI1 + 0.15PI2 + 0.2*MP + 0.1*AE

However, some minimum requirements will be demanded, in some of the sections, to guarantee a balance between all types of competencies

If the NEC is inferior to 5, the student will have to attend to the ordinary exam of all the contents of the subject, that will suppose 100% of the grade. Therefore, the student must sit for the regular exam in the following cases:

1. Failure to complete or submit any of the previous items.
2. Obtaining a grade lower than 4 points out of 10 in the final exam of continuous evaluation.

In either of these two cases, the continuous evaluation grade will be the minimum of the continuous evaluation grade calculated with the above formula and 4 points.

In any case, the student who has passed the continuous evaluation will be offered the opportunity to take the regular exam in order to obtain a higher grade.

ACADEMIC INTEGRITY: Students are expected to show adequate ethical behaviour, committing to act honestly. Based on article 42.1 of the R*egulation on the evaluation, qualification and quality of teaching and the student learning process of the University of Vigo , as well as point 6 of the fifth rule of Order DEF/711/2022, of July 18th, which establishes the requirements for evaluation, progress, and ongoing enrolment in military educational training centres for incorporation into the ranks of the Armed Forces*, **any violation of academic integrity in the assessment process, as well as the cooperation in it will result in the assignment of a failing grade to the student (zero) for the entire course in the corresponding assessment opportunity**, regardless of the percentage of importance that the test in question had in the overall continuous assessment and independently of other disciplinary actions that may be applied.

Sources of information

Basic Bibliography

Hibbeler R.C., **Mecánica de Materiales**, 8ª Edición,
Gere J. M. y Timoshenko S. P., **Resistencia de Materiales**,
Craig R R., **Mechanics of Materials**, 3ª Edición,
Luis Ortiz-Berrocal, **Resistencia de Materiales**, 3ª Edición,
Solaguren-Beascoa F., **Elasticidad y resistencia de materiales**, 1º Edición,

Complementary Bibliography

Hibbeler R.C., **Mechanics of Materials, SI Edition**, 9th Edition in SI units,
Gere J. M. y Goodno B. J., **Mechanics of Materials**, 8th Edition in SI units,
Luis Ortiz-Berrocal, **Elasticidad**, 3ª Edición,
Philpot T. A., **Mechanics of materials: an integrated learning systems**, 2nd Edition,
Rodríguez Avial M., **Problemas de elasticidad y resistencia de materiales**,
de la Fuente Tremps, E., Hernando Díaz, J.L., Torres Sánchez, R., **Resistencia de Materiales. Teoría y problemas resueltos**, 1º Edición,
de la Fuente Tremps, E., Hernando Díaz, J.L., Torres Sánchez, R., **El sólido deformable. Una introducción a la teoría de la elasticidad**, 1º Edición,

Recommendations

Subjects that continue the syllabus

Machine design/P52G381V01405
Theory of structures and industrial constructions/P52G381V01404