

Teaching Guide						
Identifying Data				2023/24		
Subject (*)	FEM of Structures			Code	730G03069	
Study programme	Grao en Enxeñaría Mecánica					
		Desc	riptors			
Cycle	Period	Ye	ar	Туре	Credits	
Graduate	1st four-month period	Fo	urth	Optional	6	
Language	Spanish					
Teaching method	Face-to-face					
Prerequisites						
Department	Enxeñaría Naval e Industrial					
Coordinador	Gutierrez Fernandez, Ruth Maria E-mail			ruth.gutierrez@uc	ruth.gutierrez@udc.es	
Lecturers	Gutierrez Fernandez, Ruth Maria E-mail		ruth.gutierrez@ud	ruth.gutierrez@udc.es		
Web	https://sites.google.com/site/structuralanalysislab/home					
General description	This course is intended for the acquisition of the specific skills to design solids and structures under tension and					
	compression forces, and bending and torsion moments. Besides, you will know how calculate the stress field and the					
	deformations in solids and structures.					

	Study programme competences / results
Code	Study programme competences / results
B5	CB05 - Que os estudantes desenvolvan aquelas habilidades de aprendizaxe necesarias para emprenderen estudos posteriores cun alto
	grao de autonomía
B7	B5 - Ser capaz de realizar unha análise crítica, avaliación e síntese de ideas novas e complexas
B9	B8 - Adquirir unha formación metodolóxica que garanta o desenvolvemento de proxectos de investigación (de carácter cuantitativo e/ou
	cualitativo) cunha finalidade estratéxica e que contribúan a situarnos na vangarda do coñecemento

Learning outcomes			
Learning outcomes		Study programme	
	con	npetenc	es/
	results		
Use the main laws of computational analysis of elastic solids and structures		B5	
		B7	
		В9	
Solve exercises and problems in a reasoned and complete way		B5	
		B7	
		B9	
Properly apply theoretical concepts in the laboratory. Make mathematical models of mechanical and structural systems		B5	
		B7	
		B9	
Employ a correct language for the structural engineering field in order to show and to explain information and results		B5	
		B7	
		B9	

Contents			
Торіс	Sub-topic		
Chapter 0. The following topics develop the contents set up in	Finite element method; structural elements; numerical analysis of structures using		
the verification memory.	computer programs.		
Chapter 1. Formulation of the Finite Element Method FEM for	Formulation of the structural static problem. Principle of virtual displacements.		
the static problem	Discretization. Interpolation. Stiffness matrix and Load vector. Assembly.		
	Transformation of element local and structure global degrees of freedom.		



Chapter 2. Formulation of the FEM for the dynamic problem	Formulation of the structural dynamic problem. Mass and damping matrices.
	Imposition of displacement boundary conditions. Master and sleeve degrees of
	freedom. Displacement, deformation and stress fields
Chapter 3. Approximating element displacement field	Classification of various elastic problems. Generalized stress-strain matrices.
	Interpolation functions for generalized coordinate finite element family. Lagrange and
	Serendip elements. Lagrange interpolation. Convergence criteria of FEM. Parcel test
Chapter 4. Isoparametric elements	Introduction. Isoparametric elements. Geometric and natural coordinate system. Finite
	elements with a variable number of nodes.
Chapter 5. Isoparametric elements for plain stress and plain	Plain stress and plain strain elastic problem. Formulation of an isoparametric element
strain.	for plain stress. Jacobian matrix of isoparametric transformation. Singularities.
	Discretization errors. Mass and stiffness matrices.
Chapter 6. Computational issues.	Numerical integration. Method of Newton-Cotes. Gauss quadrature. Two-dimensional
	and three-dimensional integration. Full integration, reduced integration, selective
	integration. Recommendations for the type and order of integration. Construction of
	the numerical stiffness matrix of two-dimensional isoparametric linear element.
	Volume and surface load vectors. Thermal loads. Convergence criteria for
	isoparametric elements.
Chapter 7. Beam structural elements	Introduction. Euler-Bernoulli beam theory, Timoshenko beam theory. Equilibrium
	equations of beams. Formulation of the Hermitian beam finite element.
	Two-dimensional beam element. Three-dimensional beam element
Chapter 8. Plate and Shell elements	Behaviour of elastic plates. Kirchhoff plate theory. Reissner-Mindlin plate theory.
	Formulation of a finite element for plates. Equilibrium equations. Behaviour of elastic
	Shells. A flat Shell finite element.

Planning				
Methodologies / tests	Competencies /	Teaching hours	Student?s personal	Total hours
	Results	(in-person & virtual)	work hours	
Laboratory practice	B5 B7 B9	6	12	18
Supervised projects	B5 B7 B9	16	36	52
Guest lecture / keynote speech	B5 B7 B9	24	39	63
Problem solving	B5 B7 B9	6	9	15
Personalized attention		2	0	2
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(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies			
Methodologies	Description		
Laboratory practice	Methodology that allows the realization of activities of practical character, with computer, such as modelization, analysis and		
	simulation of mechanical and structural elements, as well as experimental studies in the workshop of structures, for studying		
	its deformation and resistance		
Supervised projects	Methodology designed to promote autonomous learning of students, solving a problem that involves the contents of the course		
	and involves specific skills, under teacher supervision.		
Guest lecture /	Oral lecture supplemented with the use of audiovisual means, aiming transmit knowledge and facilitate the learning within the		
keynote speech	scope of structural analysis		
Problem solving	Técnica a través da cal hai que resolver unha situación problemática específica, a partir da		
	coñecemento que se traballou e que pode ter máis dunha solución.		

	Personalized attention
Methodologies	Description



Laboratory practiceGuidance and revision about specific problems posed at the development of the different activities proposed in the course.Supervised projectsRevision and help when making supervised projects.

Assessment				
Methodologies	Competencies /	Description	Qualification	
	Results			
Laboratory practice	B5 B7 B9	Students must systematically attend practices. The proposed activities have to be	30	
		done along the practical sessions, in order to be revised and evaluated by the teacher.		
		The practices that aren?t developed during the practical classes, and periodically		
		revised by the teacher will not be considered in the qualification.		
		The evaluation process of the laboratory lessons includes a two hour practice session,		
		where the student solves with the computer the problems proposed by the teacher,		
		individually.		
Supervised projects	B5 B7 B9	The projects include the theoretical and practical contents of the course. They are to	70	
		be done individually. The projects will be developed during the practical sessions		
		along the course and completed at home on the student personal work hours. The		
		tasks will be followed and revised during the practical lessons. If the projects aren?t		
		matured during the practical classes, nor periodically revised by the teacher, will not		
		be considered in the qualification.		

Assessment comments

Students, whose presence throughout thesemester where insufficient to track their work, by academic waiver or othercauses, must also develop and present practices and tutored work for theirevaluation. The follow-up of this work shall be carried out in tutoringsessions. In this case, the process of evaluation may include in addition to the presentation of practices and tutored work, a practice session, individually or in group, in which the student addresses manually or with the computer the problems raised by the teacher.

For the second chance you can present or improvepractices and tutored work. The tracking is done in tutorial sessions. Theassessment is done through presentation of practices and tutored work pendingand/or improved. The process of evaluation may include, in addition to the presentation of practices and tutored work, a practical session, individually in group, in which the student addresses manually or with the computer the problems posed by the teacher.

The evaluation criteria of the early December call will be the same as those of the second opportunity of the previous year.

Proven

fraud in any work, test or evaluation will directly lead to a failing

grade of "0" in the work, test or evaluation in question, without the option to resubmit it in the extraordinary or advanced call

	Sources of information
Basic	 - R. Gutiérrez, E. Bayo, A. Loureiro, LE Romera (2010). Estructuras II. Reprografía del Noroeste. Santiago de Compostela - Dassault Systèmes Simulia Corp. (2014). Abaqus Documentation. © Dassault Systèmes. Providence, RI, USA. - Bathe K.J. (2006). Finite Elements Procedures Prentice-Hall, Pearson Education, Inc. USA - Eugenio Oñate (1995). Calculo de estructuras por el método de elementos finitos. CIMNE, Barcelona, España
Complementary	

Recommendations	
Subjects that it is recommended to have taken before	
Strength of Materials/730G03013	
heory of Structures /730G03021	
Subjects that are recommended to be taken simultaneously	



Tecnology and Design of Structures/730G03071

Subjects that continue the syllabus

Theory of Vibration/730G03040

Structural Typologies/730G03070

Other comments

<p help achieve a sustained immediateenvironment and meet the objective of the action number 5: "Teaching andhealthy and sustainable environmental and social research" of the "Plan of action Green Campus Ferrol":</p><p work presented in this matter: </p><p Should be requested in virtual format or computer support </p><p Will take place through Moodle, in digital format without having toprint them </p><p Should be required on paper:</p><p -Not be&nbsp; they used plastic </p><p -There will be double-sideprinting.&:nbsp;&:nbsp p; </p><p -Will use recycled paper. ; </p><p -Prevent printing drafts. </p><p should make a sustainable use ofresources and the prevention of negative impacts on the natural environment</p> By decision of the EPEF quality commission, theoptional subjects cannot work more than the basic skills already mentioned inthis teaching guide. However, in the subject "Structure modeling usingfinite elements" the following specific competences of the degree are alsoworked on: A1 FB1 - Ability to solve mathematical problems thatmay arise in engineering. Ability to apply knowledge of: linear algebra; geometry; differential geometry; differential and integral calculus; differential and partial derivative equations; numerical methods; numericalalgorithmic; statistics and optimization. & nbsp; A23 TEM4 - Knowledge and skills to apply thefundamentals of elasticity and resistance of materials to the behavior of realsolids. & nbsp; The basic competences of all the electives are worked on together with these specificcompetences, which are initially acquired in other compulsory subjects, and arereinforced and consolidated in this elective.

(*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.