



Teaching Guide				
Identifying Data				2015/16
Subject (*)	ESTRUTURAS II	Code	730G03036	
Study programme	Grao en Enxeñaría Mecánica			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	2nd four-month period	Fourth	Optativa	6
Language	Spanish			
Teaching method	Face-to-face			
Prerequisites				
Department	Enxeñaría Industrial 2			
Coordinador	Gutierrez Fernandez, Ruth Maria	E-mail	ruth.gutierrez@udc.es	
Lecturers	Gutierrez Fernandez, Ruth Maria	E-mail	ruth.gutierrez@udc.es	
Web	<a href="https://sites.google.com/site/structuralanalysislab/home">https://sites.google.com/site/structuralanalysislab/home</a>			
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
A1	Capacidade para a resolución dos problemas matemáticos que poidan formularse na enxeñaría. Aptitude para aplicar os coñecementos sobre: álgebra lineal; xeometría; xeometría diferencial; cálculo diferencial e integral; ecuacións diferenciais e en derivadas parciais; métodos numéricos; algorítmica numérica; estatística e optimización.
A14	Coñecemento e utilización dos principios da resistencia de materiais.
A23	Coñecementos e capacidades para aplicar os fundamentos da elasticidade e resistencia de materiais ao comportamento de sólidos reais.
A24	Coñecementos e capacidade para o cálculo e deseño de estruturas e construcións industriais.
B2	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
B3	Que os estudantes teñan a capacidade de reunir e interpretar datos relevantes (normalmente dentro da súa área de estudo) para emitiren xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética
B5	Que os estudantes desenvolvan aquelas habilidades de aprendizaxe necesarias para emprenderen estudos posteriores cun alto grao de autonomía
B6	Ser capaz de concibir, deseñar ou poñer en práctica e adoptar un proceso substancial de investigación con rigor científico para resolver calquera problema formulado, así como de comunicar as súas conclusións e os coñecementos e razóns últimas que as sustentan? a un público tanto especializados como leigo dun xeito claro e sen ambigüidades
B7	Ser capaz de realizar unha análise crítica, avaliación e síntese de ideas novas e complexas
B9	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
C1	Utilizar as ferramentas básicas das tecnoloxías da información e as comunicacións (TIC) necesarias para o exercicio da súa profesión e para a aprendizaxe ao longo da súa vida.
C2	Desenvolverse para o exercicio dunha cidadanía aberta, culta, crítica, comprometida, democrática e solidaria, capaz de analizar a realidade, diagnosticar problemas, formular e implantar solucións baseadas no coñecemento e orientadas ao ben común.
C3	Entender a importancia da cultura emprendedora e coñecer os medios ao alcance das persoas emprendedoras.
C4	Valorar criticamente o coñecemento, a tecnoloxía e a información dispoñible para resolver os problemas cos que deben enfrontarse.
C5	Asumir como profesional e cidadán a importancia da aprendizaxe ao longo da vida.
C6	Valorar a importancia que ten a investigación, a innovación e o desenvolvemento tecnolóxico no avance socioeconómico e cultural da sociedade.

## Learning outcomes



Learning outcomes	Study programme competences / results		
Use the main laws of computational analysis of elastic solids and structures	A14 A23 A24	B2 B3 B5 B6 B7 B9	C1 C2 C3 C4 C5 C6
Make mathematical models of mechanical and structural systems	A1 A24	B2 B3 B5 B6 B7 B9	C1 C2 C3 C4 C5 C6
Employ a correct language for the structural engineering field in order to show and to explain information and results		B2 B3 B5 B6 B7 B9	C1 C2 C3 C4 C5 C6
Solve exercises and problems in a reasoned and complete way	A1 A14 A23 A24	B2 B3 B5 B6 B7 B9	C1 C2 C3 C4 C5 C6

Contents	
Topic	Sub-topic
Chapter 1. Formulation of the Finite Element Method FEM for the static problem	Formulation of the structural static problem. Principle of virtual displacements. 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 slave 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. Patch 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 strain.	Plain stress and plain strain elastic problem. Formulation of an isoparametric element 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 / Results	Teaching hours (in-person & virtual)	Student's personal work hours	Total hours
Laboratory practice	A1 A14 A23 A24 B2 B3 B5 B6 B7 B9 C1 C2 C3 C4 C5 C6	14	28	42
Supervised projects	A1 A14 A23 A24 B2 B3 B5 B6 B7 B9 C1 C2 C3 C4 C5 C6	14	28	42
Guest lecture / keynote speech	A1 A14 A23 A24 B2 B3 B5 B6 B7 B9 C1 C2 C3 C4 C5 C6	12	24	36
Seminar	A1 A14 A23 A24 B2 B3 B5 B6 B7 B9 C1 C2 C3 C4 C5 C6	8	16	24
Personalized attention		6	0	6

(\*)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 / keynote speech	Oral lecture supplemented with the use of audiovisual means, aiming transmit knowledge and facilitate the learning within the scope of structural analysis
Seminar	Technique of work in group to solve practical cases, by means of exhibition, discussion, participation and calculation. A calculator is employed.

Personalized attention	
Methodologies	Description
Seminar	Guidance and revision about specific problems posed at the development of the different activities proposed in the course.
Laboratory practice	Revision and help when making supervised projects.
Supervised projects	

Assessment			
Methodologies	Competencies / Results	Description	Qualification



Laboratory practice	A1 A14 A23 A24 B2 B3 B5 B6 B7 B9 C1 C2 C3 C4 C5 C6	Students must systematically attend practices. The proposed activities have to be 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.	40
Supervised projects	A1 A14 A23 A24 B2 B3 B5 B6 B7 B9 C1 C2 C3 C4 C5 C6	The projects include the theoretical and practical contents of the course. They are to 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.	60

### Assessment comments

The student, whose face-to-face work throughout the four-month period is not sufficient for evaluation, will be able to perform an objective test which allow evaluation and qualification.

### Sources of information

<b>Basic</b>	<ul style="list-style-type: none"> <li>- R. Gutiérrez, E. Bayo, A. Loureiro, LE Romera (2010). Estructuras II. Reprografía del Noroeste. Santiago de Compostela</li> <li>- Bathe K.J. (2006). Finite Elements Procedures.. Prentice-Hall, Pearson Education, Inc. USA</li> <li>- Eugenio Oñate (1995). Calculo de estructuras por el método de elementos finitos. CIMNE, Barcelona, España</li> <li>- Dassault Systèmes Simulia Corp. (2011). Abaqus Analysis User?s Manual. © Dassault Systèmes. Providence, RI, USA.</li> </ul>
<b>Complementary</b>	

### Recommendations

#### Subjects that it is recommended to have taken before

RESISTENCIA DOS MATERIAIS/730G03013  
ESTRUTURAS/730G03021  
RESISTENCIA MATERIAIS II/730G03027

#### Subjects that are recommended to be taken simultaneously

#### Subjects that continue the syllabus

#### Other comments

(\*)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.