Teaching Guide				
Identifying Data				2018/19
Subject (*)	Theory of Structures II		Code	730G03036
Study programme	Grao en Enxeñaría Mecánica			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	2nd four-month period	Fourth	Optional	6
Language	Spanish			
Teaching method	Face-to-face			
Prerequisites				
Department	Enxeñaría Naval e Industrial			
Coordinador	Gutierrez Fernandez, Ruth Maria	E-mail	ruth.gutierrez@udc.es	
Lecturers	Gutierrez Fernandez, Ruth Maria	E-mail	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	
Code	Study programme competences
A1	Capacidade para a resolución dos problemas matemáticos que poidan formularse na enxeñaría. Aptitude para aplicar os coñecementos sobre: álxebra 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		
Use the main laws of computational analysis of elastic solids and structures	A14 A23 A24	B3 B5 B6 B9	C1 C3 C5
Properly apply theoretical concepts in the laboratory. Make mathematical models of mechanical and structural systems	A1 A24	B2 B5 B6	C2 C4 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 B6 B7	C1 C2 C3 C4 C5 C6

Contents	
Topic	Sub-topic
Chapter 0. The following topics develop the contents set up in the verification memory.	The finite element method; structural elements; numerical analysis of structures by means of computer programs. Mechanics of soil and foundations.
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 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 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	Ordinary class hours	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	10	20	30
Supervised projects	A1 A14 A23 A24 B2 B3 B5 B6 B7 B9 C1 C2 C3 C4 C5 C6	14	38.5	52.5
Guest lecture / keynote speech	A14 A23 A24 B5 B9 C1 C2 C3 C4 C5 C6	10	30	40
Seminar	A1 A14 A23 A24 B2 B3 B5 B6 B7 B9 C1 C2 C3 C4 C5 C6	8	16	24
Personalized attention		3.5	0	3.5
(*)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 Laboratory practice Supervised projects	Guidance and revision about specific problems posed at the development of the different activities proposed in the course. Revision and help when making supervised projects.

Assessment			
Methodologies	Competencies	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.	30

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.	70

Assessment comments
Students, whose presence throughout the semester where insufficient to track their work, by academic waiver or other causes, must also develop and present practices and tutored work for their evaluation. The follow-up of this work shall be carried out in tutoring sessions. 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 improve practices and tutored work. The tracking is done in tutorial sessions. The assessment is done through presentation of practices and tutored work pending and/or improved. The process of evaluation may include, in addition to the presentation of practices and tutored work, a practical session, individually or in group, in which the student addresses manually or with the computer the problems posed by the teacher.

Sources of information	
Basic	- R. Gutiérrez, E. Bayo, A. Loureiro, LE Romera (2010). Estructuras II. Reprografía del Noroeste. Santiago de Compostela - 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 - Dassault Systèmes Simulia Corp. (2011). Abaqus Analysis User?s Manual. © Dassault Systèmes. Providence, RI, USA.
Complementary	

Recommendations
Subjects that it is recommended to have taken before
Strength of Materials/730G03013 Theory of Structures /730G03021 Strength of Materials II/730G03027
Subjects that are recommended to be taken simultaneously
Subjects that continue the syllabus
Other comments

To help achieve a sustained immediate
environment and meet the objective of the action number 5: "Teaching and
healthy and sustainable environmental and social research" of the
"Plan of action Green Campus Ferrol": Documentary work presented in this matter: * Should be requested in virtual format or computer support * Will take place through Moodle, in digital format without having to
print them * Should be required on paper: -Not be they used plastic   -There will be double-side printing.   -Will use recycled paper.   -Prevent printing drafts. You should make a sustainable use of
resources and the prevention of negative impacts on the natural environment