



Teaching Guide

Identifying Data					2020/21
Subject (*)	Structures 4	Code	630G02034		
Study programme	Grao en Estudos de Arquitectura				
Descriptors					
Cycle	Period	Year	Type	Credits	
Graduate	1st four-month period	Fourth	Obligatory	6	
Language	Spanish				
Teaching method	Face-to-face				
Prerequisites					
Department	Construcións e Estruturas Arquitectónicas, Cívís e AeronáuticasEnxeñaría Civil				
Coordinador	Perez Valcarcel, Juan Bautista	E-mail	juan.pvalcarcel@udc.es		
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Web	moodle.udc.es				
General description	Structures 4 is a core subject that is taught in the 4th Course. The objective is to introduce the student to the design and calculation of reinforced concrete structures at a professional level. For this, emphasis will be placed both on the basic concepts of behavior of reinforced concrete, as well as its practical concretion and its adaptation to current regulations. It is about developing the students' abilities to give a concrete and buildable answer to the structural problems that will present themselves in architectural practice and to be able to apply responsibly, but also critically, the calculation regulations and to be able to assume their variations in the future.				



<p>Contingency plan</p>	<p>Two contingency plans have been designed.</p> <p>SCENARIO 1</p> <p>A first scenario is proposed in which, due to the capacity of the classrooms or other types of reasons, it is not feasible to do face-to-face teaching in expository classes (master sessions), while interactive and workshop teaching, as they are smaller groups of students can continue to be taught in person.</p> <p>In this situation, the only change foreseen affects the teaching methodology used in the master sessions that will be held in online format with the help of the Teams platform included in Office365.</p> <p>There are no changes in the content of the subject, nor in the mechanisms of personalized attention to the student, nor in the evaluation criteria.</p> <p>SCENARIO 2</p> <p>A second scenario is proposed in which, in the event of possible confinement, any type of classroom teaching is not feasible. In such case, the planned changes are as follows:</p> <p>1. Modifications to us No changes are made</p> <p>2. Methodologies</p> <p>* Teaching methodologies that are maintained None</p> <p>* Teaching methodologies that are modified Master session, problem solving, workshop, diagrams, mixed test.</p> <p>The impossibility of continuing to use both methodologies in face-to-face format requires the adoption of alternative strategies that facilitate learning regardless of possible contingencies related to the equipment and connection of the student body. Therefore, it is chosen to provide the necessary documentation through the Moodle platform to continue advancing in the training program, and the rest of the tasks are carried out with the help of the Teams platform included in Office365.</p> <p>3. Mechanisms of personalized attention to or students Moodle, virtual forum.</p> <p>The forum remains open throughout the school period, with teachers responding to possible queries both during virtual sessions and during official tutoring hours.</p> <p>Teams, virtual meetings and channels.</p> <p>Communication channels (general and by groups) are kept open so that the student can make inquiries.</p> <p>4. Modifications under evaluation Mixed tests. Rating weight 70%</p> <p>To be developed online through Forms or some other institutional tool that facilitates the electronic contribution of answers, images or other types of documents that allow assessing the level of competence acquired by the student in the subject.</p> <p>Practices and / or Workshop. Weight in the 30% rating. The general practice that will take place in the workshop and the practices carried out during the course are included in this section..</p> <p>* Observations of assessment: The indicated evaluation criteria are maintained.</p> <p>Students who, for justified reasons related to computer equipment or connection, duly accredited, could not take the exams corresponding to the mixed tests online, will have the right to carry out these mixed tests orally, an essential requirement being to request it by email the same day of the exam, after which they will be opportunely summoned for its realization.</p> <p>5. Modifications of the bibliography or webgraphy</p>
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No changes are made



Study programme competences / results	
Code	Study programme competences / results
A12	Ability to conceive, calculate, design, integrate in buildings and urban units and execute building structures (T)
A17	Ability to apply technical and construction standards and regulations
A18	Ability to maintain building structures, foundations and civil works
A44	Ability to develop civil work projects (T)
A63	Development, presentation and public review before a university jury of an original academic work individually elaborated and linked to any of the subjects previously studied
B1	Students have demonstrated knowledge and understanding in a field of study that is based on the general secondary education, and is usually at a level which, although it is supported by advanced textbooks, includes some aspects that imply knowledge of the forefront of their field of study
B2	Students can apply their knowledge to their work or vocation in a professional way and have competences that can be displayed by means of elaborating and sustaining arguments and solving problems in their field of study
B3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgements that include reflection on relevant social, scientific or ethical issues
B4	Students can communicate information, ideas, problems and solutions to both specialist and non-specialist public
B5	Students have developed those learning skills necessary to undertake further studies with a high level of autonomy
B6	Knowing the history and theories of architecture and the arts, technologies and human sciences related to architecture
B9	Understanding the problems of the structural design, construction and engineering associated with building design and technical solutions
B11	“Knowing the industries, organizations, regulations and procedures involved in translating design concepts into buildings and integrating plans into planning”
C1	Adequate oral and written expression in the official languages.
C3	Using ICT in working contexts and lifelong learning.
C4	Exercising an open, educated, critical, committed, democratic and caring citizenship, being able to analyse facts, diagnose problems, formulate and implement solutions based on knowledge and solutions for the common good
C5	Understanding the importance of entrepreneurial culture and the useful means for enterprising people.
C6	Critically evaluate the knowledge, technology and information available to solve the problems they must face
C7	Assuming as professionals and citizens the importance of learning throughout life
C8	Valuing the importance of research, innovation and technological development for the socioeconomic and cultural progress of society.

Learning outcomes			
Learning outcomes	Study programme competences / results		
	results		
Representar convenientemente diferentes tipoloxías de estruturas de formigón armado, no ámbito da edificación e a nivel de proxecto de execución	A12 A17 A18 A63	B1 B2 B3 B4 B6 B9 B11	C1 C3 C4 C5 C6 C7 C8
Adquirir os coñecementos básicos relativos ás características físicas e mecánicas do formigón armado	A17	B1 B2 B3 B4 B5 B6 B9 B11	



Coñecer e saber aplicar os métodos de cálculo de estruturas de formigón armado	A12 A17 A18 A44 A63		C3 C4 C5 C6 C7 C8
Deseñar e calcular diferentes elementos e sistemas estruturais en formigón armado, no ámbito da edificación	A12 A17 A18 A44 A63	B1 B2 B3 B4 B5 B6 B9	C6 C7 C8
Familiarizarse coa consulta, interpretación e aplicación da normativa vixente no ámbito das estruturas de edificación de formigón armado	A12 A17 A18		
Iniciarse na utilización de aplicacións informáticas de análise estrutural, e de ferramentas básicas ligadas á implantación das tecnoloxías da información e das comunicacións	A12 A44		C3 C6 C7
Fomentar o desenvolvemento de capacidades e actitudes de carácter autónomo (tendencia á aprendizaxe continua, habilidade para resolver problemas de forma efectiva, capacidades de análise e síntese, organización e planificación persoal, xestión produtiva da información) ou cooperativa (comunicación efectiva, comportamento fundamentado en responsabilidades compartidas)		B1 B2 B3 B4 B5 B6 B9 B11	C1 C3 C4 C5 C6 C7 C8

Contents	
Topic	Sub-topic
TIPOLOXÍA E REPRESENTACIÓN	Tipoloxías estruturais en formigón armado Representación de proxectos de estruturas
TIPIFICACIÓN DE FORMIGÓNS	Materiais constitutivos Características mecánicas Durabilidade Especificación de formigóns
BASES DE CÁLCULO	Estados límite Rexións B e D Dominios de deformación
FLEXIÓN SIMPLE	Disposicións relativas ás armaduras Diagramas parábola-rectángulo e rectangular Limitación de ductilidade Métodos aproximados Gráficos de dimensionado Formigóns de alta resistencia Seccións transversais en T



SECCIÓNS CON AXIL E MOMENTO: FLEXIÓN COMPOSTA	Tracción simple Compresión simple Tracción composta Armaduras asimétricas Armaduras simétricas
FLEXIÓN ESVIADA	Ábacos adimensionais en roseta Método simplificado por redución a flexión recta
ESFORZOS CORTANTE E RASANTE	Mecanismo resistente Tratamento na Instrución Resistencia a rasante en xuntas entre formigóns.
TORSIÓN	Torsiós principais e secundarias Mecanismo resistente Determinación de armaduras Interacción entre torsión e outros esforzos
ANCORAXE E EMPALME DE ARMADURAS	Ancoraxe de barras corrugadas Ancoraxe de grupos de barras Empalme de armaduras pasivas
ORGANIZACIÓN DE ARMADURAS	Armado de vigas Armado de soportes Solucións construtivas
ESTADOS LÍMITE DE SERVIZO	Fisuras Deformación Limitación por canto Métodos de estimación de frecha
PÓRTICOS	Criterios de deseño Modelaxe Métodos de análise Redondeo parabólico Efecto de muros e tabiques Inestabilidade
FORXADOS UNIDIRECCIONAIS	Funcións Tipoloxías Consideracións de deseño Estados límite últimos Estados límite de servizo Aspectos construtivos
FORXADOS BIDIRECCIONAIS.	Tipoloxías e elementos constitutivos Consideracións de deseño Método directo Método de asimilación a engrellado Aspectos construtivos Cortante e punzonamento Estimación de deformacións
PLACAS, LOUSAS PREFABRICADAS E SOLUCIÓNS MIXTAS	Teoría xeral de sistemas bidimensionais Métodos de análise de placas Prelousas e lousas alveolares Forxados de chapa colaborante



REXIÓNS D	Método de bielas e tirantes Comprobación de tirantes e nodos Vigas parede Ménsulas cortas
EDIFICIOS EN ALTURA	Condições funcionais e estruturais Consideracións específicas de deseño Sistemas de estabilización lateral
PATOLOXÍA	Accións agresivas Corrosión de armaduras Lume Fisuras Coqueras, disgregacións e desagregacións Lesións por asentos Lesións por deformacións excesivas

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Guest lecture / keynote speech	A12 A17 A18 A44 A63 B1 B2 B3 B4 B5 B6 B9 B11	30	25	55
Problem solving	A12 A17 A18 A44 A63 B1 B2 B3 B4 B5 B6 B9 B11 C1 C3 C4 C5 C6 C7 C8	13	48	61
Workshop	A12 A17 A18 A44 A63 B2 B3 B4 B5 B6 B9 B11 C1 C3 C4 C5 C6 C7 C8	12	15	27
Diagramming	A12 A17 A18	0	2	2
Mixed objective/subjective test	A17 A18 A44 A63 B1 B2 B3 B4 B5 B6 B9 B11 C1 C3 C4 C5 C6 C7 C8	4	0	4
Personalized attention		1	0	1

(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
Methodologies	Description
Guest lecture / keynote speech	A relevant fraction of the face-to-face activity uses the expository method, whose responsibility rests fundamentally on the teaching staff, either orally or with the complement of audiovisual media. However, and independently of the foregoing, during these sessions a certain participation rate is sought by the students, enhancing their involvement, encouraging the feedback of the process (and therefore the bidirectional character of the communication), and energizing the learning mechanisms through interaction techniques.



Problem solving	<p>Practical tests will be carried out, designed from previously worked contents, and that must be solved in a limited time. The progressive nature of such tests obeys to the criteria of continuous evaluation, so that the conclusions of each phase can serve to redirect the teaching and learning processes conveniently, adapting them to the particularities of the group in order to reach the purported competences.</p> <p>These tests are organized in the development of an architectural project and will progressively incorporate the different topics that are developed in theory. To this end the student must design a concrete framed building in the first week of the course and progressively draw the type of structure, resizing its elements, calculating a representative frame of it, assembling the indicated sections and completely solving the assembly of frames and slabs that are indicated in each case. From this work, partial deliveries of each of these aspects will be made. The complete work will be delivered in a final portfolio that will develop the whole structure of the building.</p>
Workshop	The subject participates in Workshop 5, where Projects 6, Construction 5 and Urban Planning 4 are also integrated. The workshop is conceived as a work and exchange space conceived to facilitate the confluence of the contents of the different subjects around the architectural project, and therefore it is based on multidisciplinary integration on the resolution of practical cases.
Diagramming	It is intended that the student develops during the course the capabilities of analysis and synthesis through the preparation of synoptic documents. The aim is to reinforce meaningful learning through the structured synthesis of the main contents worked on. The elaboration is understood progressive, ordering of continued form concepts and expressions, schematizing processes of analysis
Mixed objective/subjective test	Written tests are proposed as a tool for diagnostic, formative and additive evaluation. The design is adjusted in each statement to the profile of knowledge and skills that is intended to assess, focusing on the understanding of the theoretical content and the skills associated with the analysis and resolution of practical cases.

Personalized attention

Methodologies	Description
Workshop Problem solving	<p>Unha metodoloxía orientada cara á aprendizaxe require a consideración das singularidades que distancian a uns alumnos doutros dentro dun mesmo grupo, en termos de formación previa, posibles carencias, actitudes e aptitudes, expectativas e motivacións. Por elo enténdese necesaria unha dedicación adicional estruturada basicamente mediante tutorías presenciais ou virtuais, cuxo froito depende en gran medida do nivel de implicación do discente. Co obxecto de facilitar o seguimento da súa evolución ao longo do curso, ao principio do mesmo débese cumprimentar correctamente a correspondente ficha de alumno.</p> <p>Do mesmo modo, e dado o carácter progresivo da materia, é aconsellable resolver todas as posibles dúbidas a medida en que van xurdindo, á maior brevidade e facendo uso das correspondentes tutorías.</p> <p>Esta cuestión intensifícase, si cabe, no desenvolvemento dos proxectos propostos a nivel de taller, cuxa metodoloxía só adquire sentido se se produce un contacto regular e periódico co profesorado a fin de optimizar e, no seu caso, reconducir as actividades en curso.</p> <p>As probas propostas poderán ser revisadas tras a súa cualificación, dentro dos prazos establecidos, a efectos de constatar os posibles erros cometidos e servir, en consecuencia, a unha mellor función formativa dos procesos de avaliación continua.</p>

Assessment

Methodologies	Competencies / Results	Description	Qualification
Mixed objective/subjective test	A17 A18 A44 A63 B1 B2 B3 B4 B5 B6 B9 B11 C1 C3 C4 C5 C6 C7 C8	Dichas pruebas contemplarán la resolución de ejercicios teóricos-prácticos y el desarrollo de determinados aspectos vinculados al proyecto de estructuras de edificación. La configuración de las mismas, así como los oportunos criterios de calificación, serán definidos expresamente en cada enunciado.	80



Workshop	A12 A17 A18 A44 A63 B2 B3 B4 B5 B6 B9 B11 C1 C3 C4 C5 C6 C7 C8	Se valorarán los resultados obtenidos en el taller teniendo en cuenta la complejidad de la solución y su adecuación a la propuesta arquitectónica, así como su desarrollo tanto a nivel de cálculo como gráfico.	20
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Assessment comments

The evaluation, as a system for collecting information aimed at the issuance of value judgments (and, where appropriate, merit) on the learning process, requires continuous development with constant involvement of the student. With this premise, attendance and participation are fundamental, so that an unjustified and repetitive absence has an unfavorable impact on the grade obtained by the course, in a similar proportion to a lack of participation or a negative attitude. The correction criteria include not only the accuracy of the results, but also the clarity of the presentation, the structure of the analysis carried out, the use of units, the correct application of the normative criteria, and the terminology used. A preferential itinerary is established through continuous evaluation, which is configured through mixed tests, practical activities and the development of the workshop project. To be able to participate in the mixed tests, it is necessary to have submitted the student file within the established period and to comply with an attendance of not less than 70%, including all the regulated activities of the subject. The attendance status will not be required of students with part-time enrollment. The mixed tests represent 80% of the final grade, while the remaining 20% comes from the practical activities and workshop development. In order to pass the subject per course, in addition to the aforementioned requirements, a global grade of no less than 5 (out of 10) must be achieved, including in the practical and workshop part a minimum grade of 2 (out of 10). Students who do not pass the subject per course may examine the pending parts in each of the two official opportunities of the same course. In both the note of practices and workshop obtained will be kept.

Sources of information

Basic	<ul style="list-style-type: none">- Pérez Valcárcel, J. (2012). 1. Introducción a las estructuras de hormigón armado. A Coruña. Reprografía del Noroeste- (2009). DB Se Seguridad Estructural. Bases de cálculo. Madrid. Ministerio de Vivienda, Boletín Oficial del Estado- Pérez Valcárcel, J. (2011). 2. Armado de secciones de hormigón. A Coruña. Reprografía del Noroeste- Pérez Valcárcel, J. (2010). 5. Pórticos de hormigón armado. A Coruña. Reprografía del Noroeste- Pérez Valcárcel, J.; Aragón Fitera, J. (2010). 6. Forjados de hormigón. A Coruña. Reprografía del Noroeste- Pérez Valcárcel, J. (2011). 7. Placas y forjados reticulares. A Coruña. Reprografía del Noroeste- Jiménez Montoya, P.; García Meseguer, A.; Morán Cabré, F.; Arroyo Portero, J.C. (2010). Hormigón armado. Barcelona. Gustavo Gili- Calavera, J. (2008). Proyecto y cálculo de estructuras de hormigón : en masa, armado y pretensado. Madrid. Intemac- (2008). EHE-08 Instrucción de Hormigón Estructural. Madrid. Ministerio de Fomento, Centro de Publicaciones- Pérez Valcárcel, J.; Martín Gutiérrez, E. (2017). Diseño de estructuras de hormigón armado. A Coruña. Reprografía del Noroeste
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Complementary	<ul style="list-style-type: none">- López R. Muñiz, M. (1999). Construcción y cálculo en hormigón armado. Madrid. Colegio Oficial de Aparejadores y Arquitectos Técnicos- (2002). Guía de aplicación de la Instrucción de Hormigón Estructural. Edificación. Madrid. Ministerio de Fomento- Fernández Cánovas, M. (2013). Hormigón. Adaptado a la Instrucción de Recepción de Cementos RC-08 y a la Instrucción de Hormigón Estructural EHE-08. Madrid. Garceta Grupo Editorial- Calavera, J. (2002). Cálculo, construcción, patología y rehabilitación de forjados de edificación unidireccionales y sin vigas-hormigón metálicos y mixtos. Madrid. Intemac- Murcia Vela, J.; Aguado de Cea, A.; Marí Bernat, A.R. (1993). Hormigón armado y pretensado. Barcelona. Universidad Politécnica de Cataluña- Regalado Tesoro, F. (1996). Biblioteca de detalles constructivos prácticos de hormigón armado en estructuras de edificación. Madrid. Cype Ingenieros- Fernández Cánovas, M. (1994). Patología y terapéutica del hormigón armado. Madrid. Colegio de Ingenieros de Caminos, Canales y Puertos- Leonhardt, F. (1986). Estructuras de hormigón armado. Buenos Aires. El Ateneo- Regalado Tesoro, F. (1999). Cortante y punzonamiento. Teoría y práctica: propuestas alternativas a la EHE. Madrid. Cype Ingenieros- Regalado Tesoro, F. (1999). Los forjados de los edificios: pasado, presente y futuro. Madrid. Cype Ingenieros- Regalado Tesoro, F. (1999). Los pilares: criterios para su proyecto, cálculo y reparación. Madrid. Cype Ingenieros- Regalado Tesoro, F. (2003). Los forjados reticulares diseño, análisis, construcción y patología. Madrid. Cype Ingenieros
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Recommendations

Subjects that it is recommended to have taken before

Structures 1/630G01019

Structures 2/630G01023

Structures 3/630G01028

Subjects that are recommended to be taken simultaneously

Projects 6/630G01026

Urban Planning 4/630G01032

Construction 5/630G01033

Subjects that continue the syllabus

Structures 5/630G01038

Other comments

<p>Las materias que se recomienda cursar de forma simultánea integran, conjuntamente con Estructuras 4, el Taller 7. </p>

(*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.