| Teaching Guide | | | | |
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| Identifying Data | | | | 2023/24 |
| 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, Civís e AeronáuticasEnxeñaría Civil | | | |
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| Web | campusvirtual.udc.gal | | | |
| General description | Structures 4 is a compulsory subject enrolled in the 4th year (7th semester) of the Degree in Architecture Studies. The axis of its competency objectives is to introduce the student to the design and calculation of reinforced concrete structures in the field of building at a professional level. This approach is understood in its broadest sense, which corresponds to the project of structures in all its aspects, including design, dimensioning, representation and execution, all in accordance with the applicable regulatory context. | | | |

| 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 | | | |
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| Learning outcomes | Study programme competences / results | | |
| Represent satisfactorily different typologies of reinforced concrete structures, in the field of construction and at the level of the execution project. | A12<br>A17<br>A18<br>A63 | B1<br>B2<br>B3<br>B4<br>B6<br>B9<br>B11 | C1<br>C3<br>C4<br>C5<br>C6<br>C7<br>C8 |
| Acquire basic knowledge regarding the physical and mechanical characteristics of reinforced concrete. | A17 | B1<br>B2<br>B3<br>B4<br>B5<br>B6<br>B9<br>B11 | |
| Know and know how to apply the calculation methods of reinforced concrete structures. | A12<br>A17<br>A18<br>A44<br>A63 | | C3<br>C4<br>C5<br>C6<br>C7<br>C8 |
| Design and calculate different elements and structural systems in reinforced concrete, in the field of building. | A12<br>A17<br>A18<br>A44<br>A63 | B1<br>B2<br>B3<br>B4<br>B5<br>B6<br>B9 | C6<br>C7<br>C8 |
| Become familiar with the query, interpretation and application of current regulations in the field of reinforced concrete building structures. | A12<br>A17<br>A18 | | |
| Be initiated in the use of computer applications for structural analysis, and basic tools linked to the implementation of information and communication technologies. | A12<br>A44 | | C3<br>C6<br>C7 |
| To promote the development of autonomous capacities and attitudes (tendency to continuous learning, ability to solve problems effectively, analysis and synthesis capacities, organization and personal planning, productive information management) or collaborative (effective communication, behaviour based on shared responsibilities). | | B1<br>B2<br>B3<br>B4<br>B5<br>B6<br>B9<br>B11 | C1<br>C3<br>C4<br>C5<br>C6<br>C7<br>C8 |

| Contents | |
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| Topic | Sub-topic |

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| Typologies and representation | Structural typologies in reinforced concrete<br>Representation of structural projects |
| Concrete typification | Constitutive materials<br>Mechanical characteristics<br>Durability<br>Specifications |
| Calculation basis | Limit states<br>Characteristic stress diagrams<br>Regions B and D<br>Strain domains |
| Uniaxial bending | Reinforcement arrangement<br>Rectangle diagram<br>Ductility limitation<br>Dimensional charts<br>Dimensionless abacuses<br>T cross sections |
| Combined bending and axial load | Simple tension<br>Simple compression<br>Combined bending and tension<br>Combined bending and compression<br>Asymmetric reinforcement<br>Symmetric reinforcement<br>Instability |
| Unsymmetric bending | Dimensionless abacus on rosette<br>Simplified method for reduction to uniaxial bending |
| Shear stresses | Resistant mechanism<br>Treatment in regulation<br>Shear resistance between concretes of different ages |
| Torsion | Main and secondary torsions<br>Resistant mechanism<br>Calculation procedure |
| Anchoring and splicing reinforcement | Corrugated bar anchor<br>Anchoring of groups of bars<br>Passive reinforcement splicing |
| Reinforcement arrangement | Beams reinforcement<br>Pillars reinforcement<br>Constructive solutions |
| Service limit states | Cracking<br>Deformation<br>Limitation by minimum height<br>Limitation by height<br>Calculation of deflections |
| One-way slabs | Features<br>Typology<br>Design considerations<br>Ultimate limit states<br>Service limit states<br>Constructive aspects<br>Pre-slabs, prestressed hollow core slabs and mixed solutions |

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| Bidirectional slabs | Typology and constituent elements<br>Design considerations<br>Analysis Considerations<br>Punching shear<br>Constructive aspects |
| D regions | Strut and tie models<br>Wall beams<br>Short cantilevers |

| Planning | | | | |
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| 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 | |
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| Methodologies | Description |
| Guest lecture / keynote speech | A relevant fraction of the face-to-face activity uses the expository method, whose responsibility falls mainly on the teaching staff, either orally or with the addition of audiovisual media. However, and regardless of the above, during these sessions the aim is to achieve a certain quota of participation by the students, enhancing their involvement, promoting feedback on the process (and therefore the two-way nature of communication), and energizing the learning mechanisms through interaction techniques. |
| Problem solving | There will be practical tests, designed from the previously worked content, and which must be solved in a limited time. The progressive nature of such tests obeys the criteria of continuous evaluation, so that the conclusions of each phase can serve to redirect the teaching and learning processes appropriately, adapting them to the particularities of the group in order to achieve the intended competences. |
| Workshop | The subject participates in the 7th semester workshop, where Projects 6, Construction 5 and Urban Planning 4 are also integrated. The workshop is conceived as a work and exchange space designed to facilitate the confluence of the contents of the different subjects around the architectural project, and therefore is based on the multidisciplinary integration on the resolution of practical cases. |
| Diagramming | It is intended that the student develop the analysis and synthesis skills during the course through the preparation of synoptic documents. In this way, an attempt is made to reinforce meaningful learning through the structured synthesis of the main contents worked on. The elaboration is understood as progressive, continuously ordering concepts and expressions, outlining analysis processes, and influencing the deduction of possible relationships between the successive themes of the program. |

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| Mixed objective/subjective test | Written tests are proposed as a diagnostic, formative and summative evaluation tool. The design adjusts in each statement to the profile of knowledge and abilities that it is intended to value, influencing the understanding of the theoretical contents and the skills associated with the analysis and resolution of practical cases. |

| Personalized attention | |
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| **Methodologies** | **Description** |
| Workshop<br>Problem solving | A learning-oriented methodology requires the consideration of the singularities that distance some students from others within the same group, in terms of previous training, possible deficiencies, attitudes and skills, expectations and motivations. For this reason, it is understood that an additional dedication is basically structured through face-to-face or virtual tutoring, the fruit of which depends largely on the level of involvement of the student. In order to facilitate the monitoring of their evolution throughout the course, at the beginning of the course they must correctly fill in the corresponding student virtual card.<br>Likewise, and given the progressive nature of the subject, it is advisable to solve all possible doubts as they arise, as soon as possible and using the corresponding tutorials.<br>This question is intensified, if possible, in the development of the projects proposed at the workshop level, whose methodology only makes sense if there is regular and periodic contact with the teaching staff in order to optimize and, where appropriate, redirect the activities in progress.<br>The proposed tests may be reviewed after their qualification, within the established deadlines, in order to verify the errors made and consequently serve a better formative function of the continuous evaluation processes. |

| Assessment | | | |
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| **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 | These tests will contemplate the resolution of theoretical-practical exercises and the development of certain aspects related to the project of building structures. Its configuration, as well as the appropriate qualification criteria, will be expressly defined in each statement. | 80 |
| Workshop | A12 A17 A18 A44 A63 B2 B3 B4 B5 B6 B9 B11 C1 C3 C4 C5 C6 C7 C8 | The results obtained in the workshop will be assessed taking into account the complexity of the solution and its adequacy to the architectural proposal, as well as its development considering both the analysis and calculation aspects and the graphic representation. | 20 |

| Assessment comments |
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Assessment, as
a system for collecting information aimed at the issuance of value judgments (and in its case of merit) on the learning process, requires continuous development with constant student involvement. With this premise, the attendance and participation of the student are understood as fundamental, so that an unjustified and repetitive absence can have 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 structuring of the analysis carried out, the use of units, the correct application of the normative criteria, and the terminology used.
The continuous
evaluation system is configured with mixed tests (theoretical-practical exam) that will be carried out during the school period, and workshop practice, each of these items representing the percentage indicated above on the overall grade.
In order to
carry out the intermediate mixed tests, the following are necessary requirements:
· Having
delivered the student virtual card correctly within the stipulated period.
· Attendance
not less than 80% in the corresponding period, applicable in each of the categories of face-to-face classes (expository, interactive and workshop). This condition will not be required of students with part-time enrollment.
In order to
pass the subject per course, the following requirements must be met:
· Have
obtained in each of the intermediate mixed tests a rating of not less than 5 out of 10.
· Have
obtained a grade of not less than 1 out of 5 in the workshop exercise.
Students who
have not passed the subject per course will be retested for the pending parts (mixed tests) in the two official opportunities of the same course. In both cases, the grade obtained from the workshop will be kept, given that the delivery of this exercise is unique, on the date defined for this purpose.
The students
who have passed the subject of projects 6, in order to approve structures 4, will have to develop their workshop proposal on the subject developed in the course in which they have passed projects 6, in any case requiring adequate follow-up during the period of workshop teaching.
Any finding
of plagiarism or relevant breach of the conditions established for the development of deliveries and/or exams will result in a failure grade (0) in the matter and in the corresponding call, invalidating any assessment obtained in all previous assessment activities, facing subsequent calls.

**Sources of information**

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| **Basic** | Proyecto de estructuras de hormigón armado. Martín, E.; Pérez Valcárcel, J. Reprografía del Noroeste. 2022.Jiménez Montoya esencial. Hormigón armado. Arroyo Portero, J.C. et al. Cinter Divulgación Técnica. 2018.Código Estructural. Real Decreto y Articulado (volumen I). Anejos 1-18 (volumen II). Dimensionado y comprobación de estructuras de hormigón (volumen III). Dimensionado y comprobación de estructuras de acero (volumen IV). Dimensionado y comprobación de estructuras mixtas (volumen V). Ministerio de Transportes, Movilidad y Agenda Urbana. 2022.Código Estructural. DAPP Publicaciones Jurídicas. 2021.Código Técnico de la Edificación. Documento Básico SE-A. DB SE. Seguridad estructural. Bases de cálculo. DB SE-AE. Seguridad estructural. Acciones. Ministerio de la vivienda. 2009.RC-16 Instrucción para la recepción de cementos. Ministerio de Fomento. 2016.Guía de aplicación de la Instrucción de Hormigón Estructural (EHE-08). Ministerio de Fomento. 2014. |
| **Complementary** | Jiménez Montoya. Hormigón Armado. García Meseguer, A. et al. Gustavo Gili. 2009.Proyecto y cálculo de estructuras de hormigón. En masa, armado y pretensado. Calavera, J. Intemac. 2008.Patología de estructuras de hormigón armado y pretensado. Calavera, J. Intemac. 2005.Cálculo, construcción, patología y rehabilitación de forjados de edificación. Unidirecciones y sin vigas. Hormigón, metálicos y mixtos. Calavera, J. Intemac. 2002.Fichas de ejecución de obras de hormigón. Calavera, J. Intemac. 2009.Ejecución y control de estructuras de hormigón. Calavera, J. Intemac. 2004.Manual de detalles constructivos. Calavera, J. Intemac. 1993.Los pilares. Criterios básicos para su proyecto, cálculo y reparación. Regalado, F. Cype Ingenieros. 2001.Los forjados de los edificios. Pasado, presente y futuro. Regalado, F. Cype Ingenieros. 1999.Los forjados reticulares. Diseño, análisis, construcción y patología. Regalado, F. Cype Ingenieros, 2003.Biblioteca de detalles constructivos, metálicos, de hormigón y mixtos. Regalado, F. et al. Cype Ingenieros. 2004.Estructuras de hormigón armado. Tomo III. Bases para el armado de estructuras. Leonhardt, F. El Ateneo. 1990.Estructuras de hormigón armado. Tomo IV. Verificación de la capacidad de uso. Leonhardt, F. El Ateneo. 1985.Patología y terapéutica del hormigón armado. Fernández, M. Colegio de Ingenieros de Caminos, Canales y Puertos. 1994.Curso de hormigón armado según la EH-88. Rodríguez, L.F. Servicio de Publicaciones del Colegio Oficial de Arquitectos de Madrid. 1990.Construcción y cálculo en hormigón armado. López, M. Colegio Oficial de Aparejadores y Arquitectos Técnicos de Madrid. 1999.CYPECAD 2021. Diseño y cálculo de estructuras de hormigón basados en procesos BIM. Reyes, A.M. Anaya Multimedia. 2021. |

| Recommendations |
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| **Subjects that it is recommended to have taken before** |
| Structures 1/630G01019<br>Structures 2/630G01023<br>Structures 3/630G01028 |
| **Subjects that are recommended to be taken simultaneously** |
| Projects 6/630G01026<br>Urban Planning 4/630G01032<br>Construction 5/630G01033 |
| **Subjects that continue the syllabus** |
| Structures 5/630G01038 |
| **Other comments** |
| In order to<br>achieve better learning in the workshop, it is understood that it is necessary<br>to study simultaneously, and with due dedication, all the subjects that make up<br>the workshop. |

**(*)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.**