1. BASIC INFORMATION

Course	Structural Analysis
Degree program	Bachelor`s in the Fundamentals of Architecture
School	Architecture, Engineering and Design
Year	2
ECTS	6
Credit type	Basic
Language(s)	Spanish and English
Delivery mode	Face-to-face
Semester	Second semester
Academic year	2024-25
Coordinating professor	José Agulló Rueda

2. PRESENTATION

This subject is the second in Building Structures area and where the analysis of more complex structures and the beginning of their design is dealt with in more detail.

From the point of view of knowledge, it begins with the topic of Resistance is tackled, analysing in detail the mechanical properties of the sections of the structural elements and the stresses due to the different Axial, Shear and Bending moment stresses. And the subject of Rigidity, analysing in detail the deformations of beams and frames and finally understanding the concept of "dimensioning" a section as a valid choice to meet strength and rigidity.

The intermediate part of the course focuses on the analysis of hyperstatic structures by both elastic and plastic methods. And it is here where the computer calculation is introduced to make possible to understand complex structures that with the manual calculation would be unapproachable. Elastic analysis is linked to the previous part of deformations. The plastic analysis will be carried out both at the section level, linking with the previous dimensioning part, and at the structure level.

The final part is devoted to understanding the concept of structural modelling, applied mainly to one-way structures, although one-way slabs and singular structures will be dealt with in a simplified way and how to approach their calculation or with the help of computer software. This is where structures with large spans or heights or structures that resist due to their shape

are discussed. In this part of the course, the regulations on loads, safety coefficients and materials applied to building structures (CTE) are also studied.

From the practical point of view, Exercises and Workshops will be carried out with two different objectives. On the one hand, so that the student understands and practices the mathematical concepts so necessary in this subject and on the other hand so that he understands the processes of work in the design, analysis, dimensioning and documenting of the structures of building.

3. COMPETENCIES AND LEARNINGOUTCOMES

Core competencies:

- CB1: That students have demonstrated knowledge and understanding in a field of study that is based on general secondary education, at a level which, although supported by advanced textbooks, imply some knowledge of the vanguard of their field of study.
- CB2: That 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.
- CB3: That students have the ability to gather and interpret relevant data (usually within their field of study) to make judgements that include reflection on relevant social, scientific or ethical issues.
- CB4: That students can communicate information, ideas, problems and solutions to both the specialist and non-specialist.
- CB5: That students have developed the necessary learning skills to undertake further studies with a high level of autonomy.

General competencies:

- CG4: Understanding of the structural design, construction and engineering problems associated with building design
- CG5: Knowledge of physical problems and technologies and of the function of buildings so as to provide them with internal conditions of comfort and protection against climatic factors
- CG6: Knowledge of the industries, organisations, regulations and procedures involved in translating design concepts into buildings and integrating plans into overall planning

Cross-curricular competencies:

- CT1: Responsibility: aptitude or capacity to face responsibility that the profession of architect has in society, particularly when elaborating projects that take into consideration social and environmental factors.
- CT2: Self-confidence.
- CT4: Communication skills in the native language (both oral and written) and in the English language, in accordance with the principles the Universidad Europea de Madrid, any concept or specification for the development of the regulated profession of architect. This includes learning the specific vocabulary of the degree as well as the ability to manage information.
- CT5: Interpersonal skills.
- CT6: Flexibility
- CT7: Teamwork: Ability to work in teams of architects, or in interdisciplinary teams (with shared responsibility in many cases), managing and planning work groups that are necessary in the scheme of competences and tasks that are defined for projects of a certain scale, in which several disciplines come together. This ability includes skills for interpersonal relations and team leadership.
- CT9: Planning and time management: Ability to plan work in order to comply with delivery times and to respect the limits imposed by budgets and building codes.
- CT10: Innovation and creativity: Creativity, imagination and aesthetic sensitivity applied to the design in order to satisfy the both the aesthetic and technical demands. This competence includes critical reasoning and historical culture.

Specific competencies:

- CE13: Ability to apply technical and construction standards and regulations.
- CE17: Ability to conceive, calculate, design, integrate buildings and urban units and execute building structures.
- CE24: Adequate knowledge of solid, continuum and soil mechanics, as well as plastic and elastic qualities and strength of materials in heavy construction.

Learning outcomes:

- LO1: Choose the appropriate structural typology amongst available options.
- LO2: Determine and represent requests for simple isostatic and hyperstatic structures.

- LO3: Determine stresses in a section of the usual materials: steel, wood, reinforced concrete, masonry. Compare with the standards.
- LO4: Be capable of using professional computer programmes in English. Understanding the difference between real behavior and model, and interpreting the results within their field of validity.

The table below shows the relation between the competencies developed during the course and the envisaged learning outcomes:

Competencies	Learningoutcomes
CB1, CB2, CB4 CT1, CT2, CT4, CT9, CT10	LO1: Choose the appropriate structural typology amongst available options.
CB5 CE17, CE24	LO2: Determine and represent requests for simple isostatic and hyperstatic structures.
CB5 CE13, CE17, CE24	LO3: Determine stresses in a section of the usual materials: steel, wood, reinforced concrete, masonry. Compare withthestandards.
CB3 CT2, CT4, CT5, CT7 CE24	LO4: Be capable of using professional computer programmes in English. Understanding the difference between real behavior and model, and interpreting the results within their field of validity.

4. CONTENT

The subject is organized into SEVEN Learning Units (UAs), which are in turn divided into topics (depending on the LUs).

UA1 / Topic 1: Sizing by Resistance.

T1A: Mass Geometry. Mechanical properties of sections (simple, composite, tabulated)

T1B: Stresses in bars. Selection of sections by resistance.

UA2 / Topic 2: Sizing by Rigidity.

T2A: Deflections, concepts. Methods (virtual works, use of type cases + superposition)

T2B: Deflections. Application to beams (type cases + superposition)

UA3 / Topic 3: Hyperstatic structures, Elastic analysis methods

T3A: Hyperstatic structures. Concepts. (Elastic) cases using compatibility method

T3B: Hyperstatic structures. Compatibility method, application to continuous beams

UA4 / Topic 4: Hyperstatic structures, Plastic analysis methods

T4A: Plastic analysis. Concepts. Canonic cases (using lower bound method)

T4B: Plastic analysis. Static method, application to continuous beams

UA5 / Topic 5, 6 and 7: Structural regulations. Loads, Safety Coefficients and Materials. Models of one way/two way structures. Vertical and horizontal loads.

T5A Theory: Analytical model 1.Vertical loads in CTE. Tributary areas review. One way/two way design.

T5B: Model 2. Analytical model 2. Horizontal loads in CTE. Structural stability against horizontal loads.
T6: Frames, concepts. Behaviour according to type of connections between bars. Frames. Analysis with 2D software.
T7A: Analysis of one/two way floors
T7B: Analysis with software 2D.

UA6: Large span structures. Shape. Great heights.
T8: Unique structures by their shape. Behaviour of plate and sheet. Ideal shapes in tensión and compression.
UA7: Examples of works

5. TEACHING-LEARNING METHODOLOGIES

The types of teaching-learning methodologies used are indicated below:

- Master lectures/classes
- Guided studies, practical exercises, problem-solving
- Independent work
- Tutorials, follow-up and evaluations

6. LEARNING ACTIVITIES

Listed below are the types of learning activities and the number of hours the student will spend on each one:

Type of educationalactivity	Number of hours
Master lectures/classes	12,5 h
Guided studies, practical exercises, problem-solving	62,5 h
Presentation of projects	0 h
Work in group	0h
Independentwork	50 h
Tutorials, follow-up and evaluations	25 h
Labwork	0
Internships	0
TOTAL	**150 h**

7. ASSESSMENT

Listed below are the assessment systems used and the weight each one carries towards the final course grade:

ACTIVITIES GRADES	100%	
1.THEORY PART (Average>= 4'0)	60%	Extraordinary Call
EXAM 1	20%	Extraordinary Exam
EXAM 2	20%	Extraordinary Exam
EXAM 3	20%	Extraordinary Exam
2. PRACTICAL PART (Average>=4'0)	40%	
EXERCISES H+E	10%	<< Included in Extraordinary exam
LABORATORY (ACTIVITY AND REPORT)	5%	<< Included in Extraordinary exam
INITIAL WORK (W0)	5%	<< Included in Course Work
COURSE GROUP WORK (W)	20%	....Complete or do for Extraordinary call

When you access the course on the *Campus Virtual*, you'll find a description of the assessment activities you have to complete, as well as the delivery deadline and assessment procedure for each one.

1.1. First exam period

To pass the course in the first exam period you should obtain a grade greater than or equal to 5.0 out of 10.0 in the final grade (weighted average) of the course.
In addition, it will be necessary to have a minimum grade of 4 on average for the theoretical part of the course (exams) and also at least for the practical part (exercises, reports, coursework).

1.2. Second exam period

To pass the course in the second exam period you should obtain a grade greater than or equal to 5.0 out of 10.0 in the final grade (weighted average) of the subject.
In addition, it will be necessary to have a minimum grade of 4 on average for the theoretical part of the course (exams) and also at least for the practical part (exercises, reports, coursework). It will be obligatory to repeat in extraordinary summons the parts (theoretical, practical) in which the global qualification in ordinary has been inferior to 4.
The qualification of some activities (carried out in class and impossible to repeat in this call) will be included in others, see table at the beginning of this section. Exams will be included in one, which will add up the weight of both in the overall grade. The final W course work will be submitted again or completed if it has been started. This work can be done in a group (the same as in the ordinary call or different) or individually.

8. SCHEDULE

This table shows the delivery deadline for each assessable activity in the course. This schedule may be subject to changes for logistical reasons relating to the activities. The student will be notified of any change as and when appropriate.

9. BIBLIOGRAPHY

ARAUJO ARMERO, RAMÓN. *La arquitectura como técnica (1): superficies*. Madrid: A.T.C. Ediciones, 2007.

ARAUJO ARMERO, RAMÓN. *Construir en altura: sistemas, tipos y estructuras.* Madrid: Reverté, 2012.

CERVERA, MIGUEL y BLANCO, ELENA. *Mecánica de estructuras 2: Métodos de análisis.* Barcelona: Ediciones UPC, 2002.

CHARLESON, ANDREW. *Structure as architecture. A source book for architects and structural engineers*. New York: Architectural Press. 2005

CROXTON, P.C.L y MARTIN, L.H. *Solving problems in structures, vol. 2.* Essex: Longman Scientific and Technical, 1990

DALMAU M.R. y VILLARDELL, J. *Análisis plástico de estructuras. Introducción*. Barcelona: Edicions UPC, 2003

ENGEL, HEINO. *Structure System.* Berlin: Hatje Cantz Publishers, 1997

GARCÍA, DAVID. *La estructura y el proyecto.* Barcelona: COAC, 2005 (colección PapelesSert)

GORDON, J.E. *Structures: Or Why Things Don't Fall Down.* Boston: Da capo Press, 2003

HEYMAN, JACQUES. *The science of structural engineering.* London: Imperial College Press, 1999.

HEYMAN, JACQUES. *Basic Structural theory.* Cambridge: Cambridge University Press, 2008.

HEYMAN, JACQUES. *Beams and framed structures.* London: Pergamon Press, 1974.

HIBBELER, R.C. *Structural Analysis*. Boston: Prentice Hall 2012

MILLAIS, MACOLM. *Building structures.* Madrid: Celeste, 1997

ORTIZ, JESUS y HERNANDO, J. IGNACIO. *Estructuras de edificación: Análisis lineal y no lineal.* Barcelona: Ariel, 2002

SALVADORI, MARIO y HELLER, ROBERT. *Structure in Architecture.* Boston: Prentice Hall, 1986

TIMOSHENKO, S y YOUNG, D.H. *Theory of structures.* New York: Mc Graw Hill, 1965

TORROJA, EDUARDO. *Razón y ser de los tipos estructurales.* Madrid: Consejo Superior de Investigaciones Científicas, 2000.

VARIOS AUTORES. *Cuadernos de apoyo a la docencia.* Madrid: Instituto Juan de Herrera (Colección de cuadernos de temas diversos, muy numerosos los dedicados a estructuras)

10. DIVERSITY MANAGEMENT UNIT

Students with specific learning support needs:

Curricular adaptations and adjustments for students with specific learning support needs, in order to guarantee equal opportunities, will be overseen by the Diversity Management Unit (UAD: Unidad de Atención a la Diversidad).

It is compulsory for this Unit to issue a curricular adaptation/adjustment report, and therefore students with specific learning support needs should contact the Unit at unidad.diversidad@universidadeuropea.es at the beginning of each semester. From the Educational Guidance and Diversity Unit we offer support to our students throughout their university life to help them reach their academic achievements. Other main actions are the students inclusions with specific educational needs, universal accessibility on the different campuses of the university and equal opportunities.

From this unit we offer to our students:

1. Accompaniment and follow-up by means of counselling and personalized plans for students who need to improve their academic performance.
2. In terms of attention to diversity, non-significant curricular adjustments are made in terms of methodology and assessment for those students with specific educational needs, pursuing an equal opportunities for all students.
3. We offer students different extracurricular resources to develop different competences that will encourage their personal and professional development.
4. Vocational guidance through the provision of tools and counselling to students with vocational doubts or who believe they have made a mistake in their choice of degree.

Students in need of educational support can write to us at:
orientacioneducativa@universidadeuropea.es

11. ONLINE SURVEYS

Your opinion matters!

The Universidad Europea encourages you to participate in several surveys which help identify the strengths and areas we need to improve regarding professors, degree programs and the teaching-learning process.

The surveys will be made available in the “surveys” section in virtual campus or via e-mail.

Your assessment is necessary for us to improve.

Thank you very much for your participation.