ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

43000441 - Advanced Analysis And Design Of Concrete Structures

DEGREE PROGRAMME

04AM - Master Universitario Ingenieria De Estructuras, Cimentaciones Y Materiales

ACADEMIC YEAR & SEMESTER

2025/26 - Semester 2

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	43000441 - Advanced Analysis And Design Of Concrete Structures
No of credits	4.5 ECTS
Type	Optional/elective
Academic year ot the programme	First year
Semester of tuition	Semester 2
Tuition period	February-June
Tuition languages	English
Degree programme	04AM - Master Universitario Ingenieria de Estructuras, Cimentaciones y Materiales
Centre	04 - E.T.S. De Ing. De Caminos Canales Y P.
Academic year	2025-26

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Manuel Alejandro Nicolas Pazo	Lab. de Estr.	manuelalejandro.nicolas@upm.es	Th - 17:00 - 20:00
Alejandro Rafael Perez Caldentey (Subject coordinator)	Lab. Estruct	alejandro.perezc@upm.es	Th - 17:00 - 20:00 F - 17:00 - 20:00

Borja Regulez Perez	Lab. Estruct	borja.regulez@upm.es	Th - 17:00 - 20:00

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

The subject - recommended (passed), are not defined.

3.2. Other recommended learning outcomes

- Structural analysis. Computer Science. Prestressed and reinforced concrete. Concrete and steel structures

4. Skills and learning outcomes *

4.1. Skills to be learned

CB10 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

CE12 - Capacidad para el ejercicio profesional de alta especialización o para la investigación predoctoral mediante la utilización de recursos de modelización predictiva en Análisis y diseño de estructuras de hormigón y de acero..

4.2. Learning outcomes

RA22 - Conoce las causas de no linealidad en estructuras originadas por las condiciones de sustentación y los métodos de cálculo estructural aplicables.

RA21 - Conoce las causas de no linealidad debida al material en estructuras, sus leyes constitutivas y los métodos de cálculo estructural aplicables.

RA20 - Conoce las causas de no linealidad geométrica en estructuras y los métodos de cálculo en los distintos niveles.

RA24 - Conoce los métodos numéricos para resolver los cálculos estructurales no lineales.

RA6 - Aplica normativa europea e internacional de ingeniería estructural, geotécnica y de materiales estructurales en proyecto, construcción, conservación y evaluación técnica

RA65 - Aplica la normativa de hormigón con fibras y distingue entre las tipologías existentes de fibras. Distingue el uso estructural del hormigón con fibras y conoce los criterios de selección y dosificación del material.

RA15 - Aplica normativa europea e internacional de ingeniería estructural, geotécnica y de materiales estructurales en proyecto, construcción, conservación y evaluación técnica Interioriza los principios de deontología profesional de ingeniería civil

RA23 - Conoce la influencia de las diversas causas de no linealidad en el análisis dinámico de estructuras y los métodos de cálculo aplicables.

RA25 - Conoce el formato de seguridad necesario para poder realizar comprobaciones estructurales mediante cálculos no lineales en estructuras reales.

RA33 - Conoce y sabe aplicar los fenómenos no lineales en cálculo de estrcuturas

RA27 - Aplica los métodos y modelos de cálculo de estructuras para el análisis del comportamiento de los puentes y para la comprobación de su seguridad

RA34 - Conoce y sabe aplicar la mecánica de medios continuos no lineal, incluyendo grandes rotaciones y deformaciones, y comportamiento no lineal de los materiales

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

Advanced analysis and design of concrete structures, including nonlinear behavior both at ULS and SLS, Strut-and-Tie Method as well as specific subjects such as prestressing, fire behavior, fibre reinforced concrete and seismic design.

5.2. Syllabus

1. Material nonlinear behaviour
    1.1. Differences between behaviour, analysis and design criteria
    1.2. Experimental results and available criteria
    1.3. Constitutive equations. Moment-curvature diagrams
    1.4. Nonlinear analysis
2. Behaviour of structures in seismic areas
    2.1. Seismic Design: Introduction
    2.2. Structural seismic behaviour
    2.3. Systems of One Degree of Freedom
    2.4. Ductility
    2.5. Shear design of Plastic Hinges Areas
    2.6. Seismic design of bridges
3. Slender elements
    3.1. Material and geometric nonlinearity. General concepts
    3.2. Isolated columns
    3.3. Frame columns
    3.4. Slender bridge piers
    3.5. Practical examples
    3.6. Seismic design Worked Example
4. SLS behaviour

4.1. Rheological effects-Linear sectional and structural analysis

4.2. Imposed strains: nonlinear analysis

4.3. Integral structures

4.4. Example-Linear analysis

4.5. Example-Integral structures

5. Behaviour of structures subjected to fire

5.1. Introduction to fire curves. Fire design codes

5.2. Material behaviour. Concrete and steel

5.3. Sectional behaviour

5.4. Behaviour of columns and Structures

6. Fibre reinforced concrete

6.1. Types of fibres and their application

6.2. Steel fibres: SLS and ULS

6.3. Textile fibres

7. Strut-and-tie method applied to structural elements

7.1. Introduction, Pile Caps and Footings

7.2. Concentrated loads, Brackets and Nodes

7.3. Bridge Diaphragms, Deviators

7.4. Worked example: Presstresed anchoring areas

8. Specific topics on prestressing

8.1. Introduction to prestressing

8.2. External prestress

8.3. Prestress? layouts in buildings and bridges

8.4. Prestress in curved structures

8.5. Stays and cables

6. Schedule

6.1. Subject schedule*

Week	Type 1 activities	Type 2 activities	Distant / On-line	Assessment activities
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				**There is no progressive evaluation. Just a final test.** Written test Progressive assessment Presential Duration: 00:00
17	**Consists of a single exam, which will last from 3 to 4 hours. This exam will be formed by several theoretical and practical exercises related to any part of the contents of the subject** Duration: 04:00 Additional activities			**Consists of a single exam, which will last from 3 to 4 hours. This exam will be formed by several theoretical and practical exercises related to any part of the contents of the subject** Written test Global examination Presential Duration: 04:00

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
16	There is no progressive evaluation. Just a final test.	Written test	Face-to-face	00:00	100%	5 / 10	CE12 CB10

7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Consists of a single exam, which will last from 3 to 4 hours. This exam will be formed by several theoretical and practical exercises related to any part of the contents of the subject	Written test	Face-to-face	04:00	100%	5 / 10	CE12 CB10

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Consists of a single exam, which will last from 3 to 4 hours. This exam will be formed by several theoretical and practical exercises related to any part of the contents of the subject.	Written test	Face-to-face	04:00	100%	5 / 10	CE12 CB10

7.2. Assessment criteria

Evaluation through "final exam only"

Description: Consists of a single exam, which will last from 3 to 4 hours. This exam will be formed by several theoretical and practical exercises related to any part of the contents of the subject.

Evaluation criteria: Each one of the exercises will be graded from 0 to 10 points. The final score will be the arithmetic mean of the scores obtained on each exercise.

Place and period: To be determined by the Head of Studies.

Result of the evaluation through"final exam only"

The final score will be the one obtained in the final exam.

The subject will be passed if the final score is equal or greater than 5.

Those students with a score less than 5 will not pass the subject.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
CEN European I for Standarization (2004). EN 1998-1. Eurocode 8: Design of structures for earthquake resistance Part 1: General rules, seismic actions and rules for buildings.	Bibliography	

Pérez, A et al (2012) Serviceability design of columns of long jointless strucutres. Engineering structures. Volumen 44, pages 359-371	Bibliography	
Calavera, J. (1984) Proyecto y cálculo de estructuras de hormigón para edificios. Editado por INTEMAC, Madrid.	Bibliography	
Leonhardt, F; Mönning, E (1985) Estructuras de Hormigón armado. Ed. El Ateneo, Buenos Aires	Bibliography	
Corres, H. (1980) Dimensionamiento de soportes esbeltos de sección constante de hormigón armado en estado límite de agotamiento o inestabilidad. Método de las curvaturas de referencia. Tesis Doctoral.	Bibliography	
León F. (1987) Comportamiento teórico y experimental en servicio y agotamiento de forjados unidireccionales de hormigón armado. Tesis Doctoral. ETSICCP UPM	Bibliography	
Pérez A. (1996) Comportamiento en servicio del hormigón estructural: Estudio Teórico y Experimental. Tesis Doctoral. ETSICCP UPM	Bibliography	
Ariñez F. (2016) Comportamiento y criterios de proyecto de soportes frente a la acción del fuego. Tesis Doctoral. ETSICCP UPM	Bibliography	