ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

43000390 - Advanced Analysis And Design Of Concrete Structure

DEGREE PROGRAMME

04AG - Master Universitario En Ingenieria De Caminos, Canales Y Puertos

ACADEMIC YEAR & SEMESTER

2025/26 - Semester 2

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Learning guide

1. Description

1.1. Subject details

Name of the subject	43000390 - Advanced Analysis And Design Of Concrete Structure
No of credits	4.5 ECTS
Type	Optional/elective
Academic year ot the programme	Second year
Semester of tuition	Semester 4
Tuition period	February-June
Tuition languages	English
Degree programme	04AG - Master Universitario en Ingenieria de Caminos, Canales y Puertos
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

CE22 - Conocimiento y capacidad para el análisis estructural mediante la aplicación de los métodos y programas de diseño y cálculo avanzado de estructuras, a partir del conocimiento y comprensión de las solicitaciones y su aplicación a las tipologías estructurales de la ingeniería civil. Capacidad para realizar evaluaciones de integridad estructural.

CE38 - Capacidad para integrar y aplicar los conocimientos técnicos en asesoría, análisis, diseño y modelización físico-matemática en ingeniería estructural.

CGP11 - Capacidad para el proyecto, ejecución e inspección de estructuras (puentes, edificaciones, etc.), de obras de cimentación y de obras subterráneas de uso civil (túneles, aparcamientos), y el diagnóstico sobre su integridad. Incorpora las competencias CB6, CB7 y CB8.

CT8 - Capacidad de diseñar, analizar e interpretar experimentos relevantes en ingeniería civil.

4.2. Learning outcomes

RA21 - Aplica y evalúa modelos avanzados de ingeniería estructural y geotécnica en proyecto y ejecución de obras.

RA77 - Knowledge of the nonlinear behaviour of concrete structures based on the interpretation of the experimental results available.

* 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	**1.1 Differences between behaviour, analysis and design criteria** Duration: 01:00 Lecture **1.2 Experimental results and available criteria** Duration: 01:00 Lecture **1.3 Constitutive equations. Moment-curvature diagrams** Duration: 01:00 Lecture			
2	**1.4 Non-linear analysis** Duration: 01:00 Lecture **3.1 Seismic Design: Introduction** Duration: 01:00 Lecture **3.2 Structural seismic behaviour** Duration: 01:00 Lecture			
3	**3.3 Ductility** Duration: 01:00 Lecture **3.4 Seismic Analysis and Design According to EN 1998-2** Duration: 01:00 Lecture **3.5 Seismic design of bridges** Duration: 01:00 Lecture			
4	**3.6 Seismic Design Worked Example** Duration: 01:00 Problem-solving class **3.7 Seismic Design Worked Example** Duration: 01:00 Problem-solving class **6.1Types of fibres and their application** Duration: 01:00 Lecture			

5	**6.2 Steel fibres: SLS and ULS** Duration: 01:00 Lecture **6.3 Worked example** Duration: 01:00 Problem-solving class **7.1 Strut&Tie Models: Introduction, Pile Caps and Footings** Duration: 01:00 Lecture			
6	**7.2 Concentrated loads, Brackets and Nodes** Duration: 01:00 Lecture			
7	**Visit to structures under construction in different plasces in Spain** Duration: 16:00 Practice field trip			
8	**Patial exam, consisting in a theoretical part and a practical part** Duration: 03:00 Additional activities			**Partial exam** Written test Progressive assessment Presential Duration: 03:00
9	**7.3 Bridge Diaphragms, Deviators** Duration: 01:00 Lecture **7.4 Worked examples** Duration: 01:00 Problem-solving class **2.1 Material and geometric nonlinearity. General concepts** Duration: 01:00 Lecture			
10	**2.2 Isolated columns** Duration: 01:00 Lecture **2.3 Frame columns** Duration: 01:00 Lecture **2.4 Slender bridge piers** Duration: 01:00 Lecture			
11	**2.5 Practical Example** Duration: 01:00 Problem-solving class			
12	**4.1 Rheological effects-Linear sectional and structural analysis** Duration: 01:00 Lecture **4.2 Imposed strains: nonlinear analysis** Duration: 01:00 Lecture			

13	**4.3 Integral structures** Duration: 01:00 Lecture **4.4 Example-Linear analysis** Duration: 01:00 Problem-solving class **4.5 Example-Integral structures** Duration: 01:00 Problem-solving class			
14	**8.1 Introduction to prestressing I** Duration: 01:00 Lecture **8.2 Introduction to prestressing II and prestressing layout** Duration: 01:00 Lecture **8.3 External prestressing** Duration: 01:00 Lecture			
15	**8.4 Prestressing in curved structures** Duration: 01:00 Lecture **8.5 Stays and cables** Duration: 01:00 Lecture **5.1 Introduction to fire curves** Duration: 01:00 Lecture			
16	**5.2 Material behaviour. Concrete and steel.** Duration: 01:00 Lecture **5.3 Sectional behaviour, Behavior of columns and Structures** Duration: 01:00 Lecture **5.4 Practical exercises on fire engineering** Duration: 01:00 Problem-solving class			
17	**Second parial exam and final 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 **Second Partial exam** Written test Progressive assessment Presential

				Duration: 02:00

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
8	Partial exam	Written test	Face-to-face	03:00	50%	5 / 10	CE38 CE22 CT8 CGP11
17	Second Partial exam	Written test	Face-to-face	02:00	50%	5 / 10	CE38 CE22 CT8 CGP11

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	CE22 CT8 CGP11 CE38

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	CE38 CE22 CT8 CGP11

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	