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

2017/18 - Semester 2

Index

Learning guide

1. Description

1.1. Subjet details

Name of the subject	43000441 - Advanced analysis and design of concrete structures
No of credits	4.5 ECTS
Type	Optional
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	Escuela Tecnica Superior de Ingenieros de Caminos, Canales y Puertos
Academic year	2017-18

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Hugo Eduardo Corres Peiretti (Subject coordinator)	Lab Estructuras	hugoeduardo.corres@upm.es	F - 18:00 - 20:00
Fco.javier Leon Gonzalez	Lab Estructuras	franciscojavier.leon@upm.es	F - 16:00 - 20:00
Alejandro Perez Caldentey	Lab Estructuras	alejandro.perezc@upm.es	Th - 09:00 - 13:00

Jose Romo Martin	Lab Estructuras	jose.romo@upm.es	F - 18:00 - 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

El plan de estudios Master Universitario Ingenieria de Estructuras, Cimentaciones y Materiales no tiene definidas asignaturas previas recomendadas para esta asignatura.

3.2. Other recommended learning outcomes

- Structural analysis

- Computer Science

4. Skills and learning outcomes *

4.1. Skills to be learned

CB7 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio

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..

CG3 - Capacidad de diseñar, analizar e interpretar experimentos relevantes en Ingeniería Estructural, Geotécnica y de Materiales Estructurales.

4.2. Learning outcomes

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

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

* 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

This course covers the nonlinear behavior of concrete structures, considering the experimental information available and its influence in structural design. It also covers advanced topics of concrete analysis and design such as FRC, Strut and Tie Method, Fire behavior and special topics on prestressing.

Theoretical lessons:

The professor will present and explain the necessary concepts to understand the objectives of the course in order for the student to achieve the expected indicators. The professor will use appropriate practical examples and logical reasoning to develop the scientific and technical abilities of the student. The participation of students will be encouraged by means of discussions on the topics discussed.

Practical lessons:

Practical lessons will be aimed at the resolution of exercises and case-studies. Practical lessons are intended as a correlation between the content of theoretical lessons and engineering practice, in order for the students to achieve the ability of applying the acquired knowledge in their future career. The professor will first solve some exercises and case-studies to show the students how solve them on their own.

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. Slender elements
   2.1. Material and geometric nonlinearity. General concepts
   2.2. Isolated columns
   2.3. Frame columns
   2.4. Slender bridge piers
   2.5. Practical examples
3. Behaviour of structures in seismic areas
   3.1. Seismic Design: Introduction
   3.2. Structural seismic behaviour
   3.3. Systems of One Degree of Freedom
   3.4. Ductility
   3.5. Shear design of Plastic Hinges Areas
   3.6. Seismic design of bridges
   3.7. 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

5.5. Practical exercises on fire analysis

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.

7.5. Areas of introduction of prestress.

8. Specific topics on prestressing

8.1. Shear design in prestressed structures

8.2. External prestress

8.3. Prestress? layouts in buildings and bridges

8.4. Prestress in curved structures

6. Schedule

6.1. Subject schedule*

Week	Face-to-face classroom activities	Face-to-face laboratory activities	Other face-to-face activities	Assessment activities
1	**Theoretical lessons** Duration: 03:00 Lecture			
2	**Theoretical lessons** Duration: 03:00 Lecture			
3	**Theoretical lessons** Duration: 01:30 Lecture **Practice lessons** Duration: 01:30 Problem-solving class			
4	**Theoretical lessons** Duration: 03:00 Lecture			
5	**Theoretical lessons** Duration: 03:00 Lecture **Practical lessons** Duration: 02:00 Problem-solving class			
6	**Theoretical lessons** Duration: 03:00 Lecture			
7	**Theoretical lessons** Duration: 03:00 Lecture			**First test PE2** Written test Continuous assessment Duration: 03:30
8	**Theoretical lessons** Duration: 03:00 Lecture			
9	**Theoretical lessons** Duration: 03:00 Lecture			
10	**Theoretical lessons** Duration: 01:00 Lecture **Practical lessons** Duration: 02:00 Lecture			

11	**Theoretical lessons** Duration: 03:00 Lecture			
12	**Theoretical lessons** Duration: 03:00 Lecture			
13	**Theoretical lessons** Duration: 02:00 Lecture **Practical lessons** Duration: 01:00 Problem-solving class			
14	**Theoretical lessons** Duration: 01:30 Lecture **Practical lessons** Duration: 01:30 Problem-solving class			
15	**Theoretical lessons** Duration: 01:30 Lecture **Practical lessons** Duration: 01:30 Problem-solving class			
16				**Second test PE3** Written test Continuous assessment Duration: 03:30 **Final Test PE4** Written test Final examination Duration: 04:00

The independent study hours are training activities during which students should spend time on individual study or individual assignments.

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.

* The subject schedule is based on a previous theorical planning of the subject plan and might go to through experience some unexpected changes along throughout the academic year.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Continuous assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
7	First test PE2	Written test	Face-to-face	03:30	50%	5 / 10	CB7 CE12 CG3
16	Second test PE3	Written test	Face-to-face	03:30	50%	5 / 10	CB7 CE12 CG3

7.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
16	Final Test PE4	Written test	No Presential	04:00	100%	5 / 10	CG3 CB7 CE12

7.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

7.2. Assessment criteria

Evaluation through "continuous assessment"

PE1. Quizzes

Description: Four short in-class theoretical/practical quizzes (PE1.1 to PE1.4) that will be given after the theoretical classes.

Evaluation criteria: Two short quizzes (PE1.1 and PE1.2) will take place before the First exam (PE2) and the other two quizzes (PE1.3 and PE1.4) will take place before the Second exam (PE3). The short quizzes will be scored from 0 to 10 points. The arithmetic mean of PE1.1 and PE1.2 will be divided by 10 and will be used to increase the score of the First exam (PE2) only if the score of PE2 is greater than 4. The arithmetic mean of PE1.3 and PE1.4 will be divided by 10 and will be used to increase the score of the Second exam (PE3) only if the score of PE3 is greater than 4.

Place and period: After theoretical classes in non-previously announced dates.

PE2. First exam 50%

Description: Exam that consists of two theoretical questions and two practical exercises that correspond to the first part of the course.

Evaluation criteria: The exam score (on a 10 points scale) will be the arithmetic mean of the grades of the four parts (theoretical questions and practical exercises).

In order to approve this part of the course, the grade of the first exam must be equal or greater than 5.0 including, under circumstances explained above, the results of PE1.1 and PE1.2. In any case, the maximum grade will not be over 10.

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

PE3. Second exam 50%

Description: Exam that consists of two theoretical questions and two practical exercises that correspond to the second part of the course.

Evaluation criteria: The exam score (on a 10 points scale) will be the arithmetic mean of the grades of the four parts

(theoretical questions and practical exercises).

In order to approve this part of the course, the grade of the first exam must be equal or greater than 5.0 including, under circumstances explained above, the results of PE1.3 and PE1.4. In any case, the maximum grade will not be over 10.

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

The final score will be: The arithmetic mean of the scores in PE2 and PE3, in the case that the score of both PE2 and PE3 is equal or greater than 5.

Those students with a score less than 5 in any of the two exams (PE2 and PE3) will not pass the subject and will have another opportunity in the form of the ?final exam only? format.

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.

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
Moodle	Web resource	Webpage to download class presentations, exercises and overall course information