ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

43000442 - Analysis And Design Of Mixed Steel-concrete Structures

DEGREE PROGRAMME

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

ACADEMIC YEAR & SEMESTER

2022/23 - Semester 2

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	43000442 - Analysis And Design Of Mixed Steel-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	04 - Escuela Tecnica Superior De Ingenieros De Caminos, Canales Y Puertos
Academic year	2022-23

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Javier Pascual Santos (Subject coordinator)	L Estructuras	javier.pascual@upm.es	Tu - 16:30 - 18:30
Luis Matute Rubio	L. estructuras	luis.matute@upm.es	Tu - 14:00 - 15:00 Th - 14:00 - 15:00

Miguel Ortega Cornejo	L. estructuras	miguel.ortega@upm.es	Tu - 17:30 - 18:30 W - 17:30 - 18:30

* 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

- Mechanics of Materials

- Structural Analysis

- Concrete Structures

- 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.

CB6 - Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación

CE11 - 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 puentes.

4.2. Learning outcomes

RA30 - Plantea el método de construcción de un puente

RA1 - Utiliza con eficacia, autonomía y polivalencia recursos de modelización predictiva en la temática de la materia

RA12 - Realiza individualmente un proyecto o una preinvestigación originales de Ingeniería estructural, geotécnica o de materiales estructurales

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

RA16 - conocer los modelos teóricos de comportamiento mecánico en rotura de mayor interés aplicables a los materiales estructurales

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

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

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

RA18 - saber aplicar los conocimientos anteriores en diseño, construcción y mantenimiento de estructuras

RA10 - Interioriza los principios y técnicas de organización y dirección de equipos

RA11 - Realiza una exploración bibliográfica y un plan de trabajo justificado del TFM haciendo uso en particular del conocimiento adquirido sobre normativa europea e internacional de ingeniería estructural, geotécnica y de materiales estructurales para proyecto, construcción, conservación y evaluación técnica Interioriza los principios y técnicas de organización y dirección de equipos Interioriza los principios de deontología profesional de ingeniería civil

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

RA28 - Plantea el método de construcción de un puentePlantea el método de construcción de un puente

RA2 - Presenta comunicaciones orales, escritas y gráficas, estructurada y argumentadamente, en lengua española

e inglesa

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

* 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

A medium level course in steel concrete composite structures is shown.

No previous knowledge in this kind of structures is required. Lessons are introduced from the simple basic ideas to more complex concepts, so as to provide the student with wide enough tools for the analysis of steel concrete composite structures at the end of the course.

5.2. Syllabus

1. BASIS
   1.1. Bibliographical sources
   1.2. Brief Historical introduction
2. COMPOSITE STRUCTURES BEHAVIOUR FUNDAMENTALS
   2.1. Composite sections definition. Composite Structural systems. Hybrid Structural Systems
   2.2. Composite structural systems. Components and fundamentals. The connection
   2.3. Features of the Composite Construction
   2.4. Composite structures application to the buildings and bridges field
3. ELASTIC ANALYSIS OF COMPOSITE SECTIONS. IDEAL SECTION METHOD
   3.1. Reduced ideal section analysis method. Equivalence Coefficient. Reduced effective widths
   3.2. Simplified method for long term concrete effects treatment
   3.3. Sectional forces elastic analysis at short and long term
   3.4. Sectional forces elastic analysis under imposed deformations. Temperature and shrinkage

3.5. Cracked composite section analysis

3.6. SLS verification in steel-concrete composite structures

3.6.1. Stress verification

3.6.2. Cracking control

3.6.3. Deformations

4. PLASTIC ANALYSIS OF COMPOSITE SECTIONS UNDER NORMAL AND SHEAR STRESSES

4.1. Limits of application of the methods of elastic analysis to composite sections.

4.2. Plastic bending moment of a composite section

4.3. Rigid plastic interaction Bending-Shear

4.4. Class of cross sections

4.5. ULS verification in steel-concrete composite structures

5. STUDY OF COMPOSITE STRUCTURES CONNECTION

5.1. Introduction. General Concepts

5.2. Types of connectors

5.3. Horizontal shear forces analysis under elastic and elasto-plastic behaviour

5.4. Elastic analysis of the connection

5.5. Non elastic analysis of the connection

5.6. Horizontal shear reinforcement analysis on the concrete slab

6. HISTORY, EVOLUTION AND TYPOLOGIES IN STEEL-CONCRETE COMPOSITE BRIDGES

6.1. Steel bridges in XIX century

6.2. Steel bridges in XX century

6.3. Current trends in steel-concrete composite bridges

7. REDISTRIBUTION OF FORCES IN STEEL CONCRETE COMPOSITE STRUCTURES

7.1. Rheological effects in concrete under variable stress level

7.2. Introduction to redistribution of forces in steel-concrete composite structures

7.3. Redistribution of forces due to cracking, creep, shrinkage and settlements

7.4. Redistributions in evolutive built cross sections

7.5. Redistribution of forces in evolutive built structures

6. Schedule

6.1. Subject schedule*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	**T1** Duration: 01:00 Lecture **T2** Duration: 02:00 Lecture			
2	**T3** Duration: 03:00 Lecture			
3	**Proyecto tutelado** Duration: 01:00 Additional activities **T3** Duration: 02:00 Lecture			**Practical exercises** Individual work Continuous assessment Not Presential Duration: 06:00
4	**T3** Duration: 03:00 Lecture			
5	**Proyecto tutelado** Duration: 01:00 Additional activities **T4** Duration: 02:00 Lecture			**Practical exercises** Individual work Continuous assessment Not Presential Duration: 06:00
6	**T4** Duration: 03:00 Lecture			
7	**Proyecto tutelado** Duration: 02:00 Additional activities **T5** Duration: 01:00 Lecture			**Practical exercises** Individual work Continuous assessment Not Presential Duration: 06:00
8	**P1** Duration: 03:00 Problem-solving class			
9	**Proyecto tutelado** Duration: 02:00 Additional activities **T5** Duration: 01:00 Lecture			**Practical exercises** Individual work Continuous assessment Not Presential Duration: 06:00

10	**T5** Duration: 02:00 Lecture **T6** Duration: 01:00 Lecture			
11	**T6** Duration: 02:00 Lecture **T7** Duration: 01:00 Lecture			
12	**Proyecto tutelado** Duration: 01:00 Additional activities **T7** Duration: 02:00 Lecture			**Practical exercises** Individual work Continuous assessment Not Presential Duration: 06:00
13	**P2** Duration: 03:00 Problem-solving class			
14	**T7** Duration: 03:00 Lecture			
15	**T7** Duration: 03:00 Lecture			
16				**Theoretical and practical exercises** Written test Continuous assessment Presential Duration: 02:00
17				**Theoretical and prectical exercises** Written test Final examination Not Presential Duration: 03:00

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.

* The schedule is based on an a priori planning of the subject; it might be modified during the academic year, especially considering the COVID19 evolution.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
3	Practical exercises	Individual work	No Presential	06:00	10%	5 / 10	CB6 CE11
5	Practical exercises	Individual work	No Presential	06:00	10%	5 / 10	CB6 CE11
7	Practical exercises	Individual work	No Presential	06:00	10%	5 / 10	CB6 CE11
9	Practical exercises	Individual work	No Presential	06:00	10%	5 / 10	CB6 CE11
12	Practical exercises	Individual work	No Presential	06:00	10%	5 / 10	CB6 CE11
16	Theoretical and practical exercises	Written test	Face-to-face	02:00	50%	5 / 10	CB6 CB10 CE11

7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Theoretical and prectical exercises	Written test	No Presential	03:00	100%	5 / 10	CB6 CB10 CE11

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Additional work	Individual work	Face-to-face	02:00	100%	5 / 10	CB6 CB10 CE11

7.2. Assessment criteria

EVALUACIÓN CONTINUA: Practical exercises during the course 50%, and 50% for the final exam.

SOLO EXAMEN FINAL: 100% for the final exam.

Pruebas de evaluación y sus criterios de calificación adaptadas al formato no presencial

No cambia la estructura de las Pruebas de Evaluación ni los criterios de calificación de las mismas y de Evaluación de la Asignatura.

Los detalles técnicos de los procedimientos de realización no presencial de las pruebas se detallarán en las correspondientes convocatorias.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
LECTURES	Bibliography	MILLANES,F. Estructuras Mixtas. E.T.S. Ingenieros de Caminos, C. y P. Madrid
BOOKS-1	Bibliography	MARTÍNEZ CALZÓN,J. ORTIZ HERRERA,J. Construcción mixta hormigón acero. Ed Rueda (1978) VIÑUELA RUEDA,L. MARTÍNEZ SALCEDO,J. Proyecto y Construcción de Puentes metálicos y mixtos. APTA (2009)
BOOKS-2	Bibliography	JOHNSON,R.P. Composite Structures of Steel and Concrete. Vol.-1 Beams, Columns, Frames and applications in Building. Collins(1975) JOHNSON,R.P., BUCKBY,R.J. Composite

		Structures of Steel and Concrete. Vol.-2 Bridges. Collins (1986)
BOOKS-3	Bibliography	LEBET,J.P., HIRT,M. Ponts en Acier. Presses Polytechniques et Universitaires Romandes. (2009)
HANDBOOKS	Bibliography	MANUAL DE PROYECTO COMBRI. Puentes Competitivos de Acero y Hormigón.(2008) ACHE. Comprobación de un Tablero Mixto. Monografía M-10
Slides for sessions	Web resource	Ppt slides of the sessions in Moodle
Solved exercises	Web resource	Solved exercises in Moodle