



POLITÉCNICA

INTERNATIONAL
CAMPUS OF
EXCELLENCE

COORDINATION PROCESS OF
LEARNING ACTIVITIES
PR/CL/001



E.T.S. de Ingenieros de
Caminos, Canales y Puertos

ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

43000442 - Analysis And Design Of Steel And Concrete Composite Bridges And Structures

DEGREE PROGRAMME

04AM - Master Universitario Ingenieria de Estructuras, Cimentaciones y Materiales

ACADEMIC YEAR & SEMESTER

2020/21 - Semester 2

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Learning guide

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1. Description

1.1. Subject details

| | |
|---------------------------------------|---|
| Name of the subject | 43000442 - Analysis And Design Of Steel And Concrete Composite Bridges And Structures |
| No of credits | 4.5 ECTS |
| Type | Optional |
| Academic year of 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 | 2020-21 |

2. Faculty

2.1. Faculty members with subject teaching role

| Name and surname | Office/Room | Email | Tutoring hours * |
|---|--------------------|----------------------------|---|
| Javier Pascual Santos | L Estructuras | javier.pascual@upm.es | M - 12:00 - 14:00 |
| Antonio Aureo Martinez Cutillas (Subject coordinator) | 9-1 | a.martinez.cutillas@upm.es | Th - 16:00 - 19:00 F - 16:00 - 19:00 |

| | | | |
|-------------------|----------------|--------------------|-------------------|
| Luis Matute Rubio | L. estructuras | luis.matute@upm.es | M - 11:00 - 13:00 |
|-------------------|----------------|--------------------|-------------------|

* 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

- 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 puente Plantea 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

5.2. Syllabus

1. 0. BASIS

1.1. 0.1. Bibliographical sources

1.2. 0.2. Brief Historical introduction

2. 1. COMPOSITE STRUCTURES BEHAVIOUR FUNDAMENTALS

2.1. 1.1. Composite sections definition. Composite Structural systems. Hybrid Structural Systems

2.2. 1.2. Composite structural systems. Components and fundamentals. The connection

2.3. 1.3. Features of the Composite Construction

2.4. 1.4. Composite structures application to the buildings and bridges field

3. 2. ELASTIC ANALYSIS OF COMPOSITE SECTIONS. IDEAL SECTION METHOD

3.1. 2.1. Reduced ideal section analysis method. Equivalence Coefficient. Reduced effective widths

3.2. 2.2. Simplified method for long term concrete effects treatment

3.3. 2.3. Sectional forces elastic analysis at short and long term

3.4. 2.4. Sectional forces elastic analysis under imposed deformations. Temperature and shrinkage

3.5. 2.5. Cracked composite section analysis

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

4.1. 3.1. Limits of application of the methods of elastic analysis to composite sections.

4.2. 3.2. Plastic bending moment of a composite section

4.3. 3.3. Rigid plastic interaction Bending-Shear

4.4. 3.4. Composite sections clasification

5. 4. STUDY OF COMPOSITE STRUCTURES CONNECTION

5.1. 4.1. Introduction. General Concepts

5.2. 4.2. Types of connectors

5.3. 4.3. Horizontal shear forces analysis under elastic and elasto-plastic behaviour

5.4. 4.4. Elastic analysis of the connection

5.5. 4.5. Non elastic analysis of the connection

5.6. 4.6. Horizontal shear reinforcement analysis on the concrete slab

6. 5.- LONG TERM ANALYSIS OF COMPOSITE STRUCTURES

6.1. 5.1.-Rheological properties of concrete: creep and shrinkage

6.2. 5.2.- Methods of analysis of long term effects in concrete structures

6.2.1. 5.2.1.- Step by step methods

6.2.2. 5.2.2.-Simplified methods

6.3. 5.3.- Creep analysis of composite structures at sectional level

6.3.1. 5.3.1.-Step by step methods

6.3.2. 5.3.2.-Simplified Methods

6.4. 5.4.-Shrinkage analysis at sectional level

6.5. 5.5.-Long term effects due to prestress loads

6.6. 5.6.-Lon term analysis at structural level

7. 6.- SERVICE LIMIT STATE VERIFICATION OF COMPOSITE STRUCTURES

7.1. 6.1.-Stress verification

7.2. 6.2.-Cracking control in composite structures

7.2.1. 6.2.1.-Reinforcing steel stress control

7.2.2. 6.2.2.-Reinforcing steel layout

7.2.3. 6.2.3.-Sectional forces redistribution due to cracking

7.3. 6.3.-Displacement and vibration control

8. 7.- ULTIMATE LIMIT STATE VERIFICATION OF COMPOSITE STRUCTURES

8.1. 7.1.-Cross section classification

8.2. 7.2.-Cross section resistance due to normal and shear stresses

8.2.1. 7.2.1.-Class 1,2 and 3 cross section resistance

8.2.2. 7.2.2.-Class 4 cross section resistance

6. Schedule

6.1. Subject schedule*

| Week | Face-to-face classroom activities | Face-to-face laboratory activities | Distant / On-line | Assessment activities |
|------|-----------------------------------|------------------------------------|-------------------|---|
| 1 | T0 Duration: 01:00 Lecture | | | |
| 2 | | | | |
| 3 | | | | Practical exercises Individual work Continuous assessment Presential Duration: 06:00 |
| 4 | | | | |
| 5 | | | | Practical exercises Individual work Continuous assessment Presential Duration: 06:00 |
| 6 | | | | |
| 7 | | | | Practical exercises Individual work Continuous assessment Presential Duration: 06:00 |
| 8 | | | | |
| 9 | | | | Practical exercises Individual work Continuous assessment Presential Duration: 06:00 |
| 10 | | | | |
| 11 | | | | |
| 12 | | | | Practical exercises Individual work Continuous assessment Presential Duration: 06:00 |
| 13 | | | | |
| 14 | | | | |
| 15 | | | | |
| 16 | | | | |
| 17 | | | | |

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. Continuous assessment

| Week | Description | Modality | Type | Duration | Weight | Minimum grade | Evaluated skills |
|------|---------------------|-----------------|--------------|----------|--------|---------------|------------------|
| 3 | Practical exercises | Individual work | Face-to-face | 06:00 | 1% | 5 / 10 | CB6 CE11 |
| 5 | Practical exercises | Individual work | Face-to-face | 06:00 | 1% | 5 / 10 | CE11 CB6 |
| 7 | Practical exercises | Individual work | Face-to-face | 06:00 | 1% | 5 / 10 | CE11 CB6 |
| 9 | Practical exercises | Individual work | Face-to-face | 06:00 | 1% | 5 / 10 | CE11 CB6 |
| 12 | Practical exercises | Individual work | Face-to-face | 06:00 | 1% | 5 / 10 | CE11 CB6 |

7.1.2. Final examination

No se ha definido la evaluación sólo por prueba final.

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 | 80% | 5 / 10 | CB10 CE11 CB6 |

7.2. Assessment criteria

EVALUACIÓN CONTINUA 10%

EVALUACIÓN CONTINUA 90%

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 |