# Analysis and Design of Steel Structures (250472)

## General Information

| | |
|---|---|
| **School** | ETSECCPB |
| **Departments** | Departament d'Enginyeria Civil i Ambiental (DECA) |
| **Credits** | 5.0 ECTS |
| **Programs** | MÀSTER UNIVERSITARI EN ENGINYERIA DE CAMINS, CANALS I PORTS (pla 2012)<br>MÀSTER UNIVERSITARI EN ENGINYERIA DE CAMINS, CANALS I PORTS (pla 2012)<br>MÀSTER UNIVERSITARI EN ENGINYERIA ESTRUCTURAL I DE LA CONSTRUCCIÓ (pla 2015)<br>PARS: ENGINYER/A DE CAMINS, CANALS I PORTS (pla 2022) |
| **Course** | 2024/25 |

## Main teaching language at each group

- Group 10EN1 English (Q1)
- Group 10ES2 Spanish (Q2)

## Faculty

Responsible Faculty: Enrique Mirambell Arrizabalaga, Esther Real Saladrigas
Faculty: Itsaso Arrayago Luquin, Diego Cobo Del Arco, Enrique Mirambell Arrizabalaga, Esther Real Saladrigas

## Objectives of Education

Specialization subject in which knowledge on specific competences is intensified.

Knowledge and skills at specialization level that permit the development and application of techniques and methodologies at advanced level.

Contents of specialization at master level related to research or innovation in the field of engineering.

## Competencies

### Especific

Knowledge of all kinds of structures and materials and the ability to design, execute and maintain structures and buildings for civil works.
Knowledge of and competence in the application of advanced structural design and calculations for structural analysis, based on knowledge and understanding of forces and their application to civil engineering structures. The ability to assess structural integrity.

### Transversal

ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding the mechanisms on which scientific research is based, as well as the mechanisms and instruments for transferring results among socio-economic agents involved in research, development and innovation processes.
SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.

TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

# Total hours of student work

| | | Hours | Percentage |
|---|---|---|---|
| Supervised Learning | Large group | 25.5 h | 56.67 % |
| | Medium group | 9.75 h | 21.67 % |
| | Laboratory classes | 9.75 h | 21.67 % |
| | Guided Activities | 0.0 h | 0.00 % |
| Self Study | | 80.0 h | |

# Contents

## 1. Presentation

Course brief description

## 2. Basic knowledge. Notions of structural analysis

Resistance of the cross sections. Cross section classification. Class 4 cross sections. Internal forces interaction.
Cross-section resistance ELU
Column buckling theory. Beam-column behaviour. Effective lengths. Design rules of EAE and Eurocode.
ELU of element instability
Basic notions of structural analysis considering the geometrical and material non-linearities. Global plastic analysis: Plastic hinges theory. Collapse mechanisms.
Basic notions of structural analysis. Global plastic analysis

## 3. Brittle fracture

Fracture mechanics concepts. Fracture toughness. Resilience. Charpy test. Influence of temperature.
Design against brittle fracture. EN 1993-1-10, Spanish Code EAE.
Design of elements against brittle fracture.

## 4. Fatigue

Basic concepts of fatigue. Mechanism of fatigue failure. Fatigue design methods. Safety partial factors. SN curve method (EN 1993-1-9, EAE). Recommendations
Fatigue design methods

## Assessment 1

## 5. Fire

General considerations. Properties of materials in front of fire. Fire resistance. Calculation of temperatures in steel.
Fire

## 6. Cold-formed structures

Cold-formed sheets and profiles. Material properties. Resistances verifications and deflection calculations. CUFSM.
Cold-formed structures

## 7. Joints

Overview. Bolted joints. Category and check. Welded joints. Directional method.
Joint exercises

### 8. Structural analysis

Material nonlinearity. Geometric nonlinearity. Sway and non-sway frames. Consideration of second order effects.

### Assessment 2

### 9. Tutorial design software

Commercial steel frame design software will be used to consolidate the concepts explained during the course through a practical application.

## Activities

### Steel column

Design of a steel member of a building. Using Consteel

**Dedication**

3h

### Design of a steel beam subjected to fire

Design of a steel beam under fire

**Dedication**

3h

## Teaching Methodology

The course consists of 1,8 hours per week of classroom activity (large size group) and 0,8 hours weekly with half the students (medium size group).

The 1,8 hours in the large size groups are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.

The 0,8 hours in the medium size groups is devoted to solving practical problems with greater interaction with the students. The objective of these practical exercises is to consolidate the general and specific learning objectives.

The rest of weekly hours devoted to laboratory practice.

Support material in the form of a detailed teaching plan is provided using the virtual campus ATENEA: content, program of learning and assessment activities conducted and literature.

Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.

## Grading Rules

*(*) The evaluation calendar and grading rules will be approved before the start of the course.*

The mark of the course is obtained from the ratings of continuous assessment.

The first assessment is 50% and the second 50% of the total.

## Test Rules

Any exercice with conceptuals errors in determining the internal forces will be assessed with 0.

Failure to perform a laboratory or continuous assessment activity in the scheduled period will result in a mark of zero in that activity.

## Office Hours

To agree

## Bibliography

### Basic


- Comisión Permanente de Estructuras de Acero. EAE: instrucción de acero estructural: con comentarios de los miembros de la Comisión Permanente de Estructuras de Acero. Madrid: Ministerio de Fomento. Secretaría General Técnica, 2011. ISBN 978-84-498-0904-0.
- CEN. UNE-EN 1993-1-1:2008/AC: Eurocódigo 3: proyecto de estructuras de acero: Parte 1-1: Reglas generales y reglas para edificios. Madrid: AENOR, 2010.
- CEN. UNE-EN 1993-1-3:2009 Eurocódigo 3: Proyecto de estructuras de acero. Parte 1-3: Reglas generales. Reglas adicionales para perfiles y chapas de paredes delgadas conformadas en frío. AENOR, 2009.
- CEN. UNE-EN 1993-1-8:2011 Eurocódigo 3: Proyecto de estructuras de acero. Parte 1-8: Uniones. AENOR, 2011.
- Arnedo, A. Naves industriales con acero. Madrid: Asociación para la Promoción Técnica del Acero, 2009. ISBN 9788469222744.