



Course guide

2400220 - 240MEI73 - Mixed Metal Structures

Last modified: 08/04/2026

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 737 - RMEE - Department of Strength of Materials and Structural Engineering.
Degree: MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2025). (Optional subject).
Academic year: 2026 **ECTS Credits:** 5.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: Miquel Casafont Ribera
Others: Manuel Gonzalez Puig

PRIOR SKILLS

They are not needed

REQUIREMENTS

They are not needed

TEACHING METHODOLOGY

Lectures
Problems
Case studies

LEARNING OBJECTIVES OF THE SUBJECT

Introduction to the design of steel and composite structures, covering the following aspects: structural typologies, standards, limit states, joints, resistance, instabilities, fatigue, and fire resistance.

STUDY LOAD

Type	Hours	Percentage
Hours large group	22,5	50.00
Hours small group	22,5	50.00

Total learning time: 45 h

CONTENTS

Introduction

Description:

Typologies used in steel structures. Standards: Eurocode 3 EN 1993-1-1 and Spanish Structural Code. Materials. Global analysis. Global imperfections. Ultimate Limit State (ULS); partial safety factors. Serviceability Limit State (SLS); deflections and vibrations in steel structures.

Full-or-part-time: 5h

Theory classes: 5h

Connections

Description:

Bolted connections under shear. Bolted connections in friction and tension. Welded connections. General formula. Combined welds.

Full-or-part-time: 5h

Theory classes: 5h

Joints

Description:

Design and calculation of joints; the component method. Flexible (nominally pinned) joints. Semi-rigid and rigid connections. Derivation of the moment-rotation curve. Column base joints. Connections of hollow profiles.

Full-or-part-time: 5h

Theory classes: 5h

Cross-section resistance

Description:

Cross-section resistance. Plastic bending. Cross-section classification. N-V-M interaction.

Full-or-part-time: 5h

Theory classes: 5h

Local buckling

Description:

Plate buckling. Class 4 cross-sections. Calculation of the effective cross-section.

Full-or-part-time: 5h

Theory classes: 5h



Flexural buckling

Description:

Flexural buckling of perfect columns. Buckling length.. Elastic buckling load of a structure. Wood diagrams. Imperfections in columns. European buckling curves. Built-up members.

Full-or-part-time: 5h

Theory classes: 5h

Buckling phenomena with torsion

Description:

Lateral buckling of beams. Torsional and flexural-torsional buckling of columns. General interaction equations for beam-columns.

Full-or-part-time: 5h

Theory classes: 5h

Steel-concrete composite structures.

Description:

Steel-concrete composite structures. Behaviour of connectors. Composite beams. Composite slabs combining cold-formed steel trapezoidal sheeting and concrete. Composite columns.

Full-or-part-time: 5h

Theory classes: 5h

Fatigue

Description:

Fatigue. Brittle fracture at low temperature.

Full-or-part-time: 5h

Theory classes: 5h

Fire resistance

Description:

Fire resistance of steel and composite structures. The thermal problem. The structural problem. Simplified member verification.

Full-or-part-time: 5h

Theory classes: 5h

GRADING SYSTEM

Case study I: 25 %

Case study II: 25 %

Final exam: 50 %

Only the final exam is subject to re-evaluation



EXAMINATION RULES.

Examen final:

1. Theory: closed book exam.
2. Problem 1: open book exam, with access to the subject webpage allowed.
3. Problem 2: open book exam, with access to the subject webpage allowed.

BIBLIOGRAPHY

Basic:

- Eurocodi 1: EN1991 (2002-2006): Accions sobre estructures [on line]. [Consultation: 17/11/2025]. Available on: https://cdn.mitma.gob.es/portal-web-drupal/carreteras/normativa/AN_UNE-EN_1991-1-1.pdf.
- Eurocodi 3: EN1993-1-1 (2005): Disseny d'estructures d'acer – Bases generals i regles per a edificis [on line]. [Consultation: 10/04/2026]. Available on: https://cdn.mitma.gob.es/portal-web-drupal/carreteras/normativa/AN_UNE-EN%201993-1-1.pdf.
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- Eurocodi 3: EN1993-1-5 (2006): Disseny d'estructures d'acer – Plaques sotmeses a càrregues en el seu pla [on line]. 2006 [Consultation: 10/04/2026]. Available on: <https://www.phd.eng.br/wp-content/uploads/2015/12/en.1993.1.5.2006.pdf>.
- Nou Codi Estructural d'Espanya (2021) [on line]. [Consultation: 10/04/2026]. Available on: <https://www.boe.es/buscar/doc.php?id=BOE-A-2021-13105>.
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- Codi Tècnic de l'Edificació DB-SE AE (2009): Accions en l'edificació [on line]. 2009 [Consultation: 10/04/2026]. Available on: <https://www.codigotecnico.org/pdf/Documentos/SE/DBSE-AE.pdf>.
- Cudós Samblancat, Vicente. Cálculo de Estructuras de Acero. Madrid: Editorial Blume, 1979. ISBN 8472141284.
- Ramón Argüelles Álvarez [et al.]. Estructuras de acero. 3a ed ampl.. Madrid: Bellisco, 2013. ISBN 9788492970520.
- Hirt, Manfred A.. Construction métallique: notions fondamentales et méthodes de dimensionnement. 2e ed. Lausanne: Presses Polytechniques et Universitaires Romandes, 2015. ISBN 9782880746469.
- Hirt, Manfred A. Charpentes métalliques : conception et dimensionnement des halles et bâtiments. 9a ed. EPFL, 2022. ISBN 2880746299.
- Eurocodi 3: EN1993-1-2 (2005): Disseny d'estructures d'acer - Projecte d'estructures sotmeses a foc.
- Eurocodi 3: EN1993-1-3 (2006): Disseny d'estructures d'acer - Regles addicionals per a perfils i xapes de parets primes conformades en fred [on line]. 2006 [Consultation: 10/04/2026]. Available on: <https://www.phd.eng.br/wp-content/uploads/2015/12/en.1993.1.3.2006.pdf>.
- Eurocodi 4: EN1994-1-1 (2004): Disseny d'estructures mixtes acer i formigó [on line]. 2004 [Consultation: 10/04/2026]. Available on: https://cdn.transportes.gob.es/portal-web-transportes/carreteras/normativa_tecnica/21_eurocodigos/AN_UNE-EN-1994-1-1.pdf.

RESOURCES

Other resources:

1. ATENEA ETSEIB Digital Campus: course notes, solved example problems, and final exam solutions.
2. PowerCollege software package: DIAMONDS – PowerFrame and PowerConnect, TEKLA Viewer, LTBeam, EBPlate, and others.
3. Useful websites:
<https://belliscovirtual.com/4010-libros-y-programas-del-profesor-d-ramon-argueelles-alvarez/>
><https://www.buildsoft.eu/es/product/diamonds> /><https://www.buildsoft.eu/es/product/powerconnect>
><https://www.ideastatica.com/>