

## Course guide

### 220224 - 220224 - Structures of Next Generation Materials

**Last modified:** 11/04/2025

**Unit in charge:** Terrassa School of Industrial, Aerospace and Audiovisual Engineering

**Teaching unit:** **Degree:** MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2013). (Optional subject).  
MASTER'S DEGREE IN AERONAUTICAL ENGINEERING (Syllabus 2014). (Optional subject).  
MASTER'S DEGREE IN SPACE AND AERONAUTICAL ENGINEERING (Syllabus 2016). (Optional subject).  
MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2025). (Optional subject).

**Academic year:** 2025    **ECTS Credits:** 3.0    **Languages:** English

#### LECTURER

**Coordinating lecturer:** Ernest Bernat Masó

**Others:** Drougkas, Anastasios  
Bernat Masó, Ernest

#### TEACHING METHODOLOGY

The course is organised in theoretical presentations of the topics conducted by the teaching staff together with students' teamworking. Students will select specific topics about the structural application of the new generation material presented by the teacher to perform an in-depth research that finish with the defense of a presentation and delivering a summarising document. List of topics is a sample list and it is definitely defined at the beginning of the course.

#### LEARNING OBJECTIVES OF THE SUBJECT

This course aims to:  
Provide students the knowledge, basic principles and tools to access, to order, to perform a critical analysis, to discuss and to present the scientific information related with the structures of new generation materials. At the end of the course students should be able to present the knowledge about the relationship between new generation materials and their structural applications for the presented topics, proposing creative alternative of application.

#### STUDY LOAD

Type	Hours	Percentage
Hours large group	27,0	36.00
Self study	48,0	64.00

**Total learning time:** 75 h

## CONTENTS

### Module 1: Introduction

**Description:**

Introduction to the course, organization and learning methodology. Presentation of the topics the course is about and the future potential application of the new generation materials introduced.

**Related activities:**

Theoretical sessions

**Full-or-part-time:** 5h

Theory classes: 2h

Self study : 3h

### Module 2: Self-healing concrete

**Description:**

Fundamental principles of MICP( Microbiologically Induced Calcite Precipitation), influential factors (type and concentration of bacteria and calcium source, temperature, mobility), evolution of the technology development, usefulness of its application to generate autohealing concrete, application for soil biostabilisation and future developments.

**Specific objectives:**

To know, to describe and to present the working principles of MICP

**Related activities:**

Group tasks:

Doing and defending a presentation about an specific point of the topic.

Writing a brief article about an specific point of the topic.

**Full-or-part-time:** 14h

Theory classes: 5h

Self study : 9h

### Module 3: FRCM

**Description:**

Structural response of FRCM (Fabric Reinforced Cementitious Matrix) system, influence of the components on the mechanical behaviour, application fields, existing codes (ACI & CNR), failure modes, historical development and future applications.

**Specific objectives:**

To know, to describe and to present the structural response of FRCM.

**Related activities:**

Group tasks:

Doing and defending a presentation about an specific point of the topic.

Writing a brief article about an specific point of the topic.

**Full-or-part-time:** 14h

Theory classes: 5h

Self study : 9h

#### Module 4: Electro-active polymers

**Description:**

Electromechanical response of electro-active polymers (EAPs), types of EAPs, production procedures and historical development, current and future applications,

**Specific objectives:**

To know, to describe and to present the working principles of electro-active polymers

**Related activities:**

Group tasks:

Doing and defending a presentation about an specific point of the topic.

Writing a brief article about an specific point of the topic.

**Full-or-part-time:** 14h

Theory classes: 5h

Self study : 9h

#### Module 5: Metamaterials

**Description:**

Working principles of metamaterials (from microstructure definition to global structural response), materials with negative stiffness, auxetic materials, pentamode materials and future applications.

**Specific objectives:**

To know, to describe and to present the working principles of metamaterials

**Related activities:**

Group tasks:

Doing and defending a presentation about an specific point of the topic.

Writing a brief article about an specific point of the topic.

**Full-or-part-time:** 14h

Theory classes: 5h

Self study : 9h

#### Module 6: Shape-memory alloys

**Description:**

Basics of the chemical structure of shape-memory alloys, NiTiNol case, superelasticity phenomena, research biomedical applications and research on mechanical and aerospace applications.

**Specific objectives:**

To know, to describe and to present the working principles of shape-memory alloys

**Related activities:**

Group tasks:

Doing and defending a presentation about an specific point of the topic.

Writing a brief article about an specific point of the topic.

**Full-or-part-time:** 14h

Theory classes: 5h

Self study : 9h



## GRADING SYSTEM

---

Presentations: 50% (10% per topic)

Deliverables (short articles): 50% (10% per topic)

## BIBLIOGRAPHY

---

### Basic:

- Pérez, M. A. Mechanics of composite materials. 2012.
- ACI 549.4R-13: guide to design and construction of externally bonded fabric-reinforced cementitious matrix (FRCM) systems for repair and strengthening concrete and masonry structures. American Concrete Institute, 2013. ISBN 9780870318528.
- Yamauchi, Kiyoshi [et al.]. Shape memory and superelastic alloys: technologies and applications. Philadelphia, PA: Woodhead Publishing, 2011. ISBN 9781845697075.
- Lim, Teik-Cheng. Mechanics of metamaterials with negative parameters [on line]. Singapore: Springer, 2020 [Consultation: 15/02/2023]. Available on: <https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=6272352>. ISBN 9811564469.
- Kim, Kwang J.; Tadokoro, Satoshi. Electroactive polymers for robotic applications: artificial muscles and sensors [on line]. London: Springer, 2007 [Consultation: 25/01/2023]. Available on: <https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-1-84628-372-7>. ISBN 9781846283710.
- Fisher, David J. Self-healing concrete [on line]. La Vergne: Materials Research Forum, 2021 [Consultation: 15/02/2023]. Available on: <https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=28485275>. ISBN 9781644901366.
- Carpi, Federico. Electromechanically active polymers: a concise reference [on line]. Cham: Springer, 2016 [Consultation: 25/01/2023]. Available on: <https://link-springer-com.recursos.biblioteca.upc.edu/referencework/10.1007/978-3-319-31530-0>. ISBN 9783319315300.