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: 737 - RMEE - Department of Strength of Materials and Structural Engineering.

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 strutural 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 definetely defined at the beginning of the course.

LEARNING OBJECTIVES OF THE SUBJECT

This course aims to:
Provide students the knowledgement, basic principles and tools to acces, 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 amterials 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, usefullness 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 structurals 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 aerospacial 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.