Course guide
295761 - 295EM121 - Composite Technology

Last modified: 27/05/2024

Unit in charge: Barcelona East School of Engineering
Teaching unit: 702 - CEM - Department of Materials Science and Engineering.

Degree: ERASMUS MUNDUS MASTER'S DEGREE IN ADVANCED MATERIALS SCIENCE AND ENGINEERING (Syllabus 2014). (Optional subject).
MASTER'S DEGREE IN MATERIALS SCIENCE AND ADVANCED MATERIALS ENGINEERING (Syllabus 2019). (Optional subject).
ERASMUS MUNDUS MASTER'S DEGREE IN ADVANCED MATERIALS SCIENCE AND ENGINEERING (Syllabus 2021). (Optional subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: M Lluisa Maspoch

Others:

PRIOR SKILLS

To have knowledge about plastic materials at the level of the subjects Fundamentals of Polymers and Plastics materials and composites (Degree in Materials Engineering.)
For non-graduates of degrees related to Science and Materials Engineering: having completed the subject 240EM013 - Structure and Properties of Polymers.

REQUIREMENTS

Have knowledge about plastic, ceramics and metals materials

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEMCEAM-02. (ENG) Aplicar métodos innovadores para el diseño, simulación, optimización y control de procesos de producción y transformación de materiales

Transversal:
06 URI. EFFECTIVE USE OF INFORMATION RESOURCES. Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.

TEACHING METHODOLOGY

LEARNING OBJECTIVES OF THE SUBJECT

1. Know the main types of organic matrices, of second phases.
2. Know the properties of the interface and how it can be modified
3. Know the main processing processes of composite materials with fibers.
4. Learn how to design a laminated composite material in order to optimize its useful life in real service conditions.
5. Know the main compounds of inorganic matrix, particularly their phases and properties, in view of their optimal microstructural design according to the requirements of the application.

STUDY LOAD

Type	Hours	Percentage
Hours small group	14,0	9.33
Hours large group	28,0	18.67
Self study	108,0	72.00

Total learning time: 150 h

CONTENTS

Subject 1. Introduction

Description:
Definition
Classification
Examples of applications
Natural compounds
The wood

Full-or-part-time: 6h
Theory classes: 3h
Self study : 3h

Subject 2. Composites with fibers.

Description:
Types of fibers.
Types of polymeric matrix.
Matrix fiber interfaces.
Key factors that determine the properties of a compound.

Related activities:
Laboratory work.

Full-or-part-time: 21h
Theory classes: 7h 30m
Practical classes: 1h 30m
Self study : 12h

Subject 3. Compounds with particles.

Description:
Rigid particles: types of particles, function of each type of particle, effects on mechanical properties and on fracture behavior and crack propagation. Incorporation.
Elastomeric particles: preparation of these compsites, examples and applications. Effect on mechanical properties and on tenacity

Full-or-part-time: 8h 30m
Theory classes: 3h
Self study : 5h 30m

Tema 4. Foams

Description:
Definitions by cell type and size.
Preparation methods.
Examples and applications.
Properties and function of the size of the cells.

Full-or-part-time: 4h 30m
Theory classes: 1h 30m
Self study : 3h

Subject 5. Nanocomposites.

Description:
Classification and types of nanofillers in polymer matrix.
Methods of preparation of organic matrix nanocomposites.
Relationship structure and properties.
Examples of applications

Full-or-part-time: 4h 30m
Theory classes: 1h 30m
Self study : 3h

Subject 6. Processing of composites

Description:
Manual and projection molding.
SMC and BMC.
Compression molding
Vacuum bag, infusion and RTM.
Autoclave.
Pultrusion and winding of filaments.
RIM, RRIM and SRIM

Related activities:
Guided work.

Full-or-part-time: 11h
Guided activities: 3h
Self study : 8h

Subject7. Micro and macromechanics of composite materials with long fibers

Description:
Unidirectional mechanical properties of composite materials with long fibers from known properties of fiber and matrix.
Mechanical properties in laminates: estimation of elastic constants in the medium plane.
Mechanical design of laminates.

Related activities:
Group activities

Full-or-part-time: 36h
Theory classes: 6h
Guided activities: 6h
Self study : 24h

Subject 9. Failure analysis in laminates.

Description:
Failure models.
The "Ply discount" model.
Prediction of useful life of laminates.

Full-or-part-time: 13h 30m
Theory classes: 1h 30m
Guided activities: 3h
Self study : 9h

Inorganic Matrix Composites

Description:
Definition. Types of metal- and ceramic- matrix composites, and microstructural features. Matrix and reinforcement materials. Fabrication processes. Load transfer concept. Interfacial bonding strength. Micromechanics, thermal and physical properties. Case study: Hard and superhard materials - cemented carbides, diamond composites and polycrystalline cubic boron nitrides.

Specific objectives:
To become familiar with inorganic-matrix (metal- and ceramic-) composites regarding structural
and functional applications. Fundamental structure-property relationships underlying mechanical, thermal and energy related parameters. Case Studies in design and performance of advanced ceramic-matrix composites.

Related activities:
Laboratory work.

Full-or-part-time: 26h 10m
Theory classes: 9h
Laboratory classes: 1h 30m
Guided activities: 1h 30m
Self study : 14h 10m

GRADING SYSTEM

BIBLIOGRAPHY

Basic:
- Friedrich, Klaus; Fakirov, Stoyko; Zhang, Zhong. Polymer composites : from nano-to-macro-scale. New York: Springer, 2005. ISBN 0387241760.
- Composite materials technology : processes and properties. Munich [etc.]: Hanser, cop. 1990. ISBN 3446156844.
- Tecnología de los composites/plásticos reforzados. Barcelona: Hanser, DL 1992. ISBN 8487454046.
- Hull, Derek. Materiales compuestos. Barcelona [etc.]: Reverté, cop. 1987. ISBN 8429148396.
- Barsoum, Michel W. Fundamentals of ceramics. New York: Taylor & Francis, cop. 2003. ISBN 9780750309028.
- Chawla, Nikhilesh; Chawla, Krishan K. Metal Matrix Composites. New York: Springer, 2006. ISBN 9786610459636.
- Wachtman, J. B.; Cannon, W.; Matthewson, M. Mechanical properties of ceramics. 2nd ed. Hoboken, NJ: John Wiley & Sons, cop. 2009. ISBN 9780471735816.

Complementary:
- Gibson, Lorna J.; Ashby, Michael F. Cellular solids : structure and properties. 2nd ed. Cambridge: Cambridge University Press, 2001. ISBN 0521499119.
- Kinloch, A. J.; Young, R. J. Fracture behaviour of polymers. London [etc.]: Chapman & Hall, 1995. ISBN 0412540703.
- Composites science and technology [on line]. New York, NY: Elsevier Science Pub Co, [1999?]- [Consultation: 20/05/2020]. Available on: https://www.sciencedirect.com/science/journal/02663538.- editor-in-chief, Vinod K. Sarin ; edited by Daniele Marie,

Luis Llanes. Comprehensive hard materials. Amsterdam: Elsevier, 2014. ISBN 9780080965284.