



COMILLAS

UNIVERSIDAD PONTIFICIA

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Syllabus
2025 - 2026

GENERAL INFORMATION

Data of the subject	
Subject name	Advanced Materials & Joining
Subject code	DIM-MII-611
Main program	Official Master's Degree in Industrial Engineering
Involved programs	Máster Universitario en Ingeniería Industrial [Second year]
Quarter	Semestral
Credits	3,0 ECTS
Type	Obligatoria
Department	Department of Mechanical Engineering
Coordinator	Juan Carlos del Real Romero
Course overview	<p>This course will be an introduction to advanced materials and joining techniques. An overview of applications and manufacturing methods of new materials will be provided while special focus will be put to polymeric matrix composites. The whole life cycle from raw material to a quality-controlled assembly will be studied, including general properties of materials, testing methods and NDT evaluation. An introduction to bioinspired materials, smart materials, functional materials will be provided. In addition this course will cover the most recent advances in welding and joining technologies.</p>

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DESCRIPTION OF THE SUBJECT

Contextualization of the subject

Prerequisites

Knowledge of basic courses of materials science and strength of materials.

Course contents

Contents

Theory:

1. Introduction to composite materials: classifications, applications, terminology. Metallic, Ceramic and Polymeric Matrix Composites
2. Materials properties. Overview of different types of matrices, reinforcements, adhesives. Prepregs, fillers and other additives.
3. Micromechanical analysis of a lamina: prediction of mechanical properties of composites based on properties of fiber and matrix; volume and weight fractions. Longitudinal strength and stiffness. Coefficients of thermal and moisture expansion.
4. Basic characteristics of manufacturing processes for polymeric matrix composites.
5. Overview of ceramic and metallic matrix composites manufacturing methods
6. Mechanical Testing of Composites. Non destructive testing of composites. Applications.
7. Bioinspired materials, smart materials, functional materials.
8. Joining. Advanced welding methods. Friction Stir Welding, Laser welding, EB Welding, Ultrasonic.
9. Mechanical joining. Self-piercing rivets. Clinching. High speed joining.
10. Composites joining. Induction welding of thermoplastic composites. Co-curing of thermoset composites. Thermal assisted piercing of thermoplastic composites for mechanical fastening. Microwave welding of thermoplastic composites with dissimilar materials
11. Adhesive bonding.

Laboratory:

Each unit described previously has at least one associated lab practice (2 hours)

1. **Manufacturing a laminate composite.**
2. **Mechanical testing and fracture behavior of laminate composite**
3. **Mechanical testing of bonded joints**
4. **NDT inspection of composite**

EVALUATION AND CRITERIA

The use of AI to produce full assignments or substantial parts thereof, without proper citation of the source or tool used, or without explicit permission in the assignment instructions, will be considered plagiarism and therefore subject to the



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University's General Regulations.

BIBLIOGRAPHY AND RESOURCES

Basic References

- *Composite Materials. Science and Engineering*. 4th edition. K. Chawla. Springer (2019)
- *Composites Manufacturing. Materials, Product and Process Engineering*. S.K. Mazumdar. CRC Press (2001)
- *Fiber-Reinforced Composites: Materials, Manufacturing, and Design*, P. K. Mallick, 2nd edition, New York: Marcel Dekker, Inc. (1993).
- *Introduction to Composite Materials Design*, 2nd ed., Ever J. Barbero, CRC Press, (2011)
- *Advanced Welding Processes*. J. Norrish. Woodhead Publishing Limited (2006)
- *Handbook of Adhesion Technology*. L. F. M. da Silva, A. Öchsner, R.D. Adams, Springer Science & Business (2011)

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