| MASTER IN COMPOSITE MATERIALS, 12º Edition 2022-2023 | | | |
|---|---|---|---|
| **Topics** | **ECTS** | **Coordinator** | **Teaching period** |
| **1st TERM (160 h)** | | | |
| Project management and quality control | 4 | Rebeca Calvo (Airbus Millitary) | 05/10/2022 20/10/2022 |
| Constituents Materials and Characterization | 8 | R. Avila (Airbus Ops) | 24/10/2022 17/11/2022 |
| Manufacturing processes for polymer matrix composites structures | 8 | I. J. Marquez (Airbus) | 21/11/2022 22/12/2022 |
| **2nd TERM ( 180 h)** | | | |
| Design of advanced composites structures | 5 | Joaquin Gallego (Airbus Defense) | 09/01/2023 24/01/2023 |
| Numerical simulation techniques | 4 | C. Gonzalez (UPM) | 30/01/2023 09/02/2023 |
| Analysis of advanced composites structures | 8 | J.C. Gomez (Airbus Ops) | 13/02/2023 09/03/2023 |
| Applications for Space structures | 2 | Alicia Ayuso (Airbus Space) | 13/03/2023 16/03/2023 |
| Certification of aircraft composites structures | 4 | J. M. Blanco (Airbus Ops) | 20/03/2023 30/03/2023 |
| SEMANA SANTA | | | 3-9 abril |
| **3RD TERM (160 h)** | | | |
| In service behaviour and repairs | 4 | Ivan Rodriguez (Airbus Ops) | 10/04/2023 20/04/2023 |
| Concurrent engineering | 2 | Francisco Escobar (Airbus Ops) | 24/04/2023 27/04/2023 |
| Smart composites | 4 | A.Güemes (UPM) | 03/05/2023 11/05/2023 |
| Concurrent engineering | 2 | Francisco Escobar (Airbus Ops) | 16/05/2023 18/05/2023 |
| Production management: Lean manufacturing | 4 | F.J. Paramio (Airbus AOSL) | 22/05/2023 01/06/2023 |
| Metal matrix composites (MMC), Ceramic matrix composites (CMC) | 2 | J. Llorca (IMDEA Materiales) | 05/06/2023 08/06/2023 |
| Nanocomposites and biocomposites. Recycling | 2 | A Ureña (URJC) | 12/06/2023 15/06/2023 |
| Environmental regulations. Health and safety | 2 | P. Fenoy (Airbus Military) | 19/06/2023 22/06/2023 |
| **PROYECTO FIN DE MASTER Master Thesis** | **26** | A.Güemes, A Fernandez (UPM) J. M. Blanco (Airbus) | 01/07/2023 20/12/2023 |
| **TOTAL** | **90** | | |

El curso comienzan el 3/10/2022, lunes, con la presentación y entrega de documentación, y finaliza el 20/12/23
El PFM debe ser entregado antes del 15/12/2023, para su calificación dentro del año 2023
En total son 720 h lectivas, de las que 270 h corresponden a tutoria individualizada sobre el TFM, 150 h son de actividades practicas de laboratorio, talleres interactivos o visitas a empresas, y 300 h a clases teóricas mas expositivas.
Este Programa puede sufrir cambios menores durante el curso por circunstancias imprevistas

Module 1: **CONSTITUENTS MATERIALS AND CHARACTERIZATION**

Coordinator: Rafael Avila (Airbus Operations)

Teaching staff: *J. Sanchez, R. Avila, A. Butragueño, J. Menendez Alberquilla, A. Espada, Ignacio Lopez, Tamara Blanco, Z. Martin Moreno, J. M. Menendez Martin, A. Fernandez, A. Güemes, J.M. Pintado, M.G. Prolongo, C. Arribas, A. R. Pozo Morales.*

Contents:

1.1 Polymer Matrix Composites. Types of resins and fibers.
1.2 Characterization of reinforcing fibers
1.3 Physico- Chemical Characterization of polymer matrix.
1.4 Interaction Fiber Matrix. Interfaces.
1.5 Physical properties of laminates, prepregs
1.6 Physical properties of sandwich structures, foams and honeycombs
1.7 Characterization lamina & laminates
1.8 Moisture absorption and Adhesives
1.9 Statistical Methods. Determination of allowables
1.10 NTD methods
1.11 Procurement of Composites
1.12 Laboratory: chemical tests (DSC, DMTA, FTIR)
1.13 Laboratory: mechanical testing (tensile, ILLS)
1.14 Laboratory:  impact tests and micrographies
1.16 Laboratory: non-destructive inspection equipments

Module 2. **MANUFACTURING PROCESSES FOR POLYMER MATRIX COMPOSITES STRUCTURES**

Coordinator: I. J. Marquez (Airbus)

Teaching staff: J*. Cuenca, P. Nogueroles, F. Rodriguez Lence, I. J. Marquez, J. M. Santos, Astorga, R. Avila, L. Rubio, J. Galiana, Isabel Martin, T. Busto, David Cano, Enrique Guinaldo, , J. M. Menendez Martin, A. Fernandez,*

Contents:

2.1 Process of hand molding.
2.2 Autoclave based processes (prepreg)
2.3 Equipments for manufacturing
2.4 Techniques for consolidation and curing of thermosetting resins
2.5 Liquid Molding RTM, RFI, SCRIMP
2.6 Out of autoclave Techniques
2.7 Principles of the processes with thermoplastic matrix
2.8 Tooling for Composites
2.9 Assembly
2.10 Cutting, Machining
2.11. Manufacturing costs. Economic model. Production Orders
2.12 Additive Manufacturing
2.13 Composite industrialization
2.14 Factories 4.0

Visit to production facilities (FIDAMC)

Module 3. **DESIGN OF COMPOSITE AIRCRAFT STRUCTURES**

Coordinator: Joaquín Gallego Pleite (Airbus Defense)

Teaching staff: Joaquín Gallego Pleite, Enrique Jiménez Gahete, Fernando Cano, David Navarro Martin

Contents:

3.0 introduction to the module: contents, education purpose and case study explanation
3.1 introduction to design of composite aircraft structures
3.2 characteristics of composites
3.3 manufacturing constrains and design drivers
3.4 design requirements and features
3.5 design rules, stacking sequence
3.6 union of layers
3.7 radii design
3.8 joggles design
3.9 sandwich design practices
3.10 tolerances in composite materials
3.11 reparability
3.12 corrosion protection design
3.13 abrasion, erosion and bird impact protection
3.14 design for electrical strikes
3.15 design for electrical bonding
3.16 fire design protection
3.17 general design for mechanical joints

Module 4. **NANOCOMPOSITES AND BIOCOMPOSITES. RECYCLING**

Coordinator: Alejandro Ureña Fernandez ( Univ Rey Juan Carlos I, Madrid)

Teaching staff: *A. Ureña, M. Sanchez Martinez, Silvia Gonzalez Prolongo, M. Gonzalez Prolongo*

Contents:

4.1 Nanotechnology and nanomaterials
4.2 Inorganic nanoparticles and other reinforcements
4.3 Carbon nanostructures
4.4 Thermoplastic nanocomposites
4.5 Thermosetting nanocomposites
4.6 Multiscale composites
4.7 Recycling of composite materials
4.8 Natural Composites

Module 5 **NUMERICAL SIMULATION TECHNIQUES**

Coordinator: Carlos González

Teaching staff: Sergio Sádaba, Javier Segurado, Diego Garijo, Carlos González

Contents

5.1 Multiscale Modelling of Composite Materials. Revision of Simulation Techniques
5.2 Introduction to the Finite Element Method (I). The Boundary Value Problem. Weak Formulation of Boundary Value Problem.
5.3 Introduction to the Finite Element Method (II). Spatial and Time Discretization. Implicit and Explicit Integration
5.4 Review of Constitutive Equations. Elasticity, Plasticity & Damage
5.5 Anisotropic Elasticity. Material Symmetry
5.6 Micro-Meso mechanics & RVE generation
5.7 Buckling analysis of composite structures.
5.8 Failure of composite materials. Failure Modes and Failure Criteria.
5.9 Continuum Damage Mechanics.
5.10 Cohesive Crack Models & Advanced Techniques (XFEM, DG, VCCT)
5,11 In Service Behaviour (I). Temperature & Humidity. Residual Stress
5.12 In Service Behaviour (II). Delamination Assesment
5.13 In Service Behaviour (III). Low velocity impacts. Debris impacts
5.14 In Service Behaviour (II). High velocity impacts. Bird & ice impacts
5.15 Processing Simulation.
5.16 Computer Lab. Introduction to Abaqus CAE&Standard. Getting Started
5.17 Computer Lab. Micromechanics and homogenization
5.18 Computer Lab. Stress analysis of the open hole specimen
5.19 Computer Lab. Analysis of the impact against composite plate

Module 6 **ANALYSIS OF COMPOSITE STRUCTURES**

Coordinator: José Carlos Gómez López

Teaching staff: *JC Gómez López, Fernando Mancebo Ordóñez, Francisco Fernández Sánchez, Juan Luis de la Gándara, Eduardo Oslé, Agustín González Díaz, Daniel Meizoso Latova, José Antonio Rodríguez Sánchez, Fernando Martín Prieto, Rubén Tejerina Hernanz, Jorge González Rubio, Maria del Carmen Rodriguez, Fernando de Nicolas.*

Contents:

6.1 Overview of structural analysis for composites
6.2 Design allowables
6.3 Environmental effects
6.4 Lamina and Laminates analysis
6.5 Damage tolerance
6.6 Strength Analysis
6.7 Hole Analysis
6.8 Bolted Joints
6.9 Bonded joints
6.10 Unfolding
6.11 Buckling
6.12 Post-buckling
6.13 Sandwich Structures
6.14 Global FEM Usage:
- Specific rules for modeling of composite estructures
- Global finite element models
- Detailed finite element models
- Non-linear finite element models

6.15 Detailed FEM Usage:
- Detailed finite element models
- Non-linear finite element models

6.16 Reparability
6.17 Production defects structural analysis
6.18 Structural testing
6.19 Practical case: Analysis of structural elements of a torsion box

Module 7 **CERTIFICATION OF AIRCRAFT COMPOSITE STRUCTURES**

*Coordinator:* Jose Maria Blanco (Airbus Operations).

Teaching staff: *J.M. Blanco, Adolfo Avila Gutierrez, Fernando Nicolas, Maria de la Paz Pastor*

- *Contents:*

7.1 Aircraft Certification General Overview
7.2 Structure Design Certification Requirements.
7.3 Composite Structure Design Certification & Manufacturing Interface.
7.4 Structure Design Certification & System Instalation Interaction
7.5 Proof Of The Structure Design
7.6 Structure Certification Test Program
7.7 Certification Documentation
7.8 Type Design Changes Certification (Modifications)
7.9 Continuous Airworthiness
7.10 Certification Of Manufacturing And Assembly Deviations (Concessions)

Modulo 8. **IN-SERVICE BEHAVIOUR AND REPAIR**

Coordinator Ivan Rodriguez ( Airbus Operations)

Teaching staff: *Ivan Rodriguez, J.L. Dominguez, A. Butragueño, V. Barcelo, L.P. Vicente, J.M. Vizarro, c. Fuentes, N. Fernandez, E. Abad*

8.1 Composite Repairs Of Aircraft In-Service
8.2 Fatigue & Damage Tolerance Evaluation Of Composite Structures.
8.3 Structural Repair Manual. SRM.
8.4 Protection Systems For Repairs Of CFRP Elements/Parts
8.5 Fatigue & Damage Tolerance Evaluation Of Composite Structures.
8.6 Service Bulletins.
8.7. Composite Repair Materials & Process In CFRP of In-Service A/C
8.8 Analysis Of Damages And Repairs For A/C In-Service

Module 9 **PROJECT AND QUALITY MANAGEMENT**

Coordinator: Rebeca Calvo Aguilar (Airbus Military)

Teaching staff: *Rebeca Calvo Aguilar, Ruben Elvira Herranz, Javier Yagüe Lopez*

9.1 Introduction to Project Management
9.2 Project product lifecycle phases
9.3 Project Management elements
9.4 Project initiating
9.5 to 9.7 Project planning
9.8 Project executing
9.9 to 9.11 Project monitoring and controlling
9.12 Project closing
9.13 Quality Management system. BMS awareness
9.14 Quality Management system
- Evolution of quality, QMS- UNE-EN-9100:2010
- Top Management aspects of the Standard
- Resources processes
- Planning of product realization, customer-related processes
- Continuous improvement processes
- Examples

9.15 Finance Concepts for Project managers

Modulo 10 **PRODUCTION MANAGEMENT: LEAN MANUFACTURING**

Coordinator : Francisco Jose Paramio

Teaching staff: *F. Paramio, Javier Sanchez, Victor Gonzalez*

10.1 Introduction to Lean
10.2 The 7 wastes & Kaizen.
10.3 Lean principles.
10.4 5S - Visual Management.
10.5 Andon & Jidoka
10.6 TPM ( Total Productive maintenance)
10.7 Yamzumi-Takt- Equilibrado
10.8 Standard Operation
10.9 Defect-free Systems Poka Yoke
10.10 SMED
10.11 Logic flow: kitting, kanban, milk run
10.12 Practical Problem Solving
10.13 Seven Quality Tools
10.14 VSM ( Value Stream Mapping)

Modulo 11 **NON CONVENTIONAL COMPOSITES (MMC, CMC)**

Coordinator : Javier Llorca (IMDEA Materiales)

Teaching staff: *J. Llorca, I. Savirov, N. Martin Piris, R. Guzman, J.J. Vilatela*

11.1 Introduction
11.2 Ceramic matrix composites
11.3 Processing and applications of CMC
11.4 Carbon/carbon composites
11.5 Metal matrix composites
11.6 Mechanical properties of MMC
11.7 Plastic deformation of MMC
11.8 Transport properties and environmental performances of MMC
11.9 Fracture and Fatigue of MMC
11.10 Nano arquitectures and Materials design: From nano to macro

Modulo 12 **SMART COMPOSITES**

Coordinator : Alfredo Güemes

Teaching staff: *A. Güemes, A. Fernandez Lopez, J.M. Menendez Martin, I. Gonzalez Requena, J.M. Pintado*

12.1 Smart materials & smart structures
12.2 Fibre optic sensors for smart structures
12.3 Fibre optic sensors for distributed sensing
12.4 Morphing Aircrafts. Actuators and shaper sensing
12.5 Smart processing
12.6 Smart structures. Issues related to the sensor integration in composites
12.7 Data driven SHM. Theory of PCA
12.8 Data driven SHM. Case Studies
12.9 Damage detection by Lamb waves
12.10 Design & usage of SHM Systems
    1. Probability of detection, decision and risk
    2. Methods for damage diagnosis
    3. Sensor self-diagnosis of piezoelectric transducers
    4. Aspects for design of SHM Systems
    5. Identification of unknown structural loads from dynamic measurements
12.11 Multifunctional composites
12.12 Self-healing materials

Modulo 13. **CONCURRENT ENGINEERING**

Coordinator : Francisco Escobar Benavides

Teaching staff: *F. Escobar, F. Nicolas Lopez*

13.1 Overview
Definitions& Principles
Customer focussed development
Design to cost
CE organization and Management
13.2 Concurrent engineering in composites
Overview
Certification &CE
Design to cost in composites
CE strategic vision in composites
F1 composite practice
13.3 CE case study: Airliner airframe

Modulo 14. **APPLICATIONS IN SPACE**

Coordinator : Alicia Ayuso

Teaching staff: *Alicia Ayuso, Victor Bautista Juzgado*

15.1 Composite materials role in space.
15.2 Composite materials in space applications. Space market
15.3 Space environment characteristics. Effects on composite materials
15.4 Material qualification for space
15.5 Examples of applications in space projects

- General overview of EADS Astrium CASA
- Satellites and payloads
- Launcher structures
- Satellite structures
- Antenna reflectors
- Engineering and CoC Composites
- Manufacturing and testing
- R&D, innovation

Modulo 15 **ENVIRONMENTAL REGULATIONS. HEALTH AND SAFETY**

Coordinator Pedro Fenoy ( Airbus Military)

Teaching staff: *P. Fenoy, Gema Maria Plaza Muñoz*

15.1 MA. Introduction, environmental aspects
15.2 MA. Environmental Management.
15.3 MA. Analysis of the product life cycle
15.4 MA. Environmental impacts. regulations
15.5 MA. Directives. Ecodesign
15.6 SL. General concepts
15.7 SL. Industrial Health
15.8 SL. Contaminants
15.9 SL. Ergonomics and Occupational Health
15.10 SL. Pathology at Job