GUÍA DOCENTE
2021 - 2022

# FICHA TÉCNICA DE LA ASIGNATURA

## Datos de la asignatura

| | |
|---|---|
| **Nombre completo** | Fabricación Aditiva/ Additive Manufacturing |
| **Código** | DIM-M2S-529 |
| **Impartido en** | Máster Universitario en Ingeniería Industrial + Máster en Ingeniería para la Movilidad y Seguridad [Primer Curso] |
| **Cuatrimestre** | Semestral |
| **Créditos** | 1,5 ECTS |
| **Carácter** | Obligatoria |
| **Departamento / Área** | Departamento de Ingeniería Mecánica |
| **Responsable** | Silvia Fernández Villamarín |
| **Horario de tutorías** | Arrange an appointment through email. |

## Datos del profesorado

# DATOS ESPECÍFICOS DE LA ASIGNATURA

## Contextualización de la asignatura

### Aportación al perfil profesional de la titulación

This subject has been designed to take students through the additive manufacturing (AM) concept defined by a range of technologies that are capable of joining materials to make objects from 3D model data, usually layer upon layer, in a quick and easy process. The additive, freeform nature of the technology, coupled with improvements in materials, processing speed, accuracy and surface finish, open up an array of manufacturing options that before were impossible with conventional technologies.

At the end of the season, the students will be able to understand the concept of AM, implement the process, main applications and materials, design criteria for AM and post-processing techniques. In addition, students will gain hands-on experience in AM parts design rules.

### Prerequisitos

Fundamentals of engineering drawing and basic 3D modeling.

## Competencias - Objetivos

### Competencias

**GENERAL COMPETENCES:**

CG1. Have acquired advanced knowledge and demonstrated, in a research and technological or highly specialized context, a detailed and well-founded understanding of the theoretical and practical aspects, as well as of the work methodology in one or more fields of study.

CG2. Know how to apply and integrate their knowledge, understanding, scientific rationale, and problem-solving skills to new and

imprecisely defined environments, including highly specialized multidisciplinary research and professional contexts.

CG5. Be able to transmit in a clear and unambiguous manner, to specialist and non-specialist audiences, results from scientific and technological research or state-of-the-art innovation, as well as the most relevant foundations that support them.

CG6. Have developed sufficient autonomy to participate in research projects and scientific or technological collaborations within their thematic area, in interdisciplinary contexts and, where appropriate, with a high knowledge transfer component.

CG7. Being able to take responsibility for their own professional development and their specialization in one or more fields of study.

**SPECIFIC COMPETENCES:**

CE7. Know the new manufacturing technologies, as well as its potential industrial application.

(Competences in English are a free translation of the official Spanish version).

## BLOQUES TEMÁTICOS Y CONTENIDOS

### Contenidos – Bloques Temáticos

**THEORY:**

1. Additive Manufacturing. General methodology, stages, and components of the process. Main technologies, principles, and applications. Strengths, weaknesses, challenges, and limitations of AM technologies. Main brands and suppliers available. Materials (polymers, metals, composites, and biomaterials). Characterization techniques. Tolerances. Mechanical evaluation of AM functional parts. Techniques for post-processing. Production economics of AM. Current status and future tendency of additive manufacturing.

2. CAD and Additive Manufacturing. Design for Additive Manufacturing (DFAM): minimum feature size or wall thickness, lattice structures, free-form geometries, integrated parts/functions, customization, bounding box size... Design for functionality and 3D printability. Modeling best practices: holes, fine details, thin walls, strength, moving parts, and assemblies. Planning and slicing AM software.

3. Topology optimization in Additive Manufacturing. Reduction of material usage. Simulation of structures with complex shapes which exactly meet the mechanical constraints while requiring as little material as possible.

**LABORATORY:**

Each unit described previously has at least one associated lab practice (2 hours).
1. Preparation of 3D CAD models and use of planning/slicing AM software.
2. Use of FDM, SLA, DLP, and SLS machines to produce 3D physical models.
3. Primary designs and AM redesigns reflecting the distinctive features and freedom that the AM technology has to offer but within the capacity of the AM machines. Test and evaluation of the AM part against the requirements (geometry, dimensions, tolerances, mass, surface finish, functionality, and mechanical properties).

## METODOLOGÍA DOCENTE

### Aspectos metodológicos generales de la asignatura

Inspired by the "learn by doing" paradigm, this course is designed to provide students with the tools they require to develop additive manufacturing process by the end of the term. In every unit, after the initial explanation of each concept, the instructor will propose individual or group activities (some of which will be graded) to test students' understanding.

## Metodología Presencial: Actividades

Lectures: The lecturer will introduce the fundamental concepts of each unit, along with some practical recommendations, and will go through worked examples to support the explanation.

Lab sessions: Under the instructor's supervision, students will apply the concepts and techniques covered in the lectures using computer software, machines and equipment. Students will later analyze and report lab results.

Tutoring for groups or individual students will be organized upon request.

## Metodología No presencial: Actividades

Personal study of the course material and resolution of the proposed exercises.

Final project.

Lab session preparation.

Lab results analysis and report writing.

## RESUMEN HORAS DE TRABAJO DEL ALUMNO

| STUDENT WORK-TIME SUMMARY | | | |
|---|---|---|---|
| IN-CLASS HOURS | | | |
| Lectures | | Lab sessions and problems solving | |
| 5 | | 10 | |
| OUT-OF-CLASS HOURS | | | |
| Self-study | Lab preparation | Homework | Final project |
| 12.5 | 2.5 | 7.5 | 7.5 |
| | | ECTS credits: | 1.5 (45 hours) |

## EVALUACIÓN Y CRITERIOS DE CALIFICACIÓN

## Calificaciones

**REGULAR ASSESSMENT:**

Class Presentation: 30%
Homework: 30%
Final project: 40%
In order to pass the course, the weighted average mark must be greater or equal to 5 out of 10 points.

**RETAKE:**

Class Presentation: 15%
Homework: 15%
Final project: 20%
Retake exam (paper + computer): 50%
As in the regular assessment period, in order to pass the course, the weighted average mark must be greater or equal to 5 out of 10 points.

**COURSE RULES:**

Class attendance is mandatory according to Article 93 of the General Regulations (Reglamento General) of Comillas Pontifical University and Article 6 of the Academic Rules (Normas Académicas) of the ICAI School of Engineering.

Students who commit an irregularity in any graded activity will receive a mark of zero in the activity and disciplinary procedure will follow (cf. Article 168 of the General Regulations (Reglamento General) of Comillas Pontifical University).

## PLAN DE TRABAJO Y CRONOGRAMA

| Actividades | Fecha de realización | Fecha de entrega |
|---|---|---|
| SESSION 1. Additive Manufacturing Technologies. | | |
| SESSION 2. Additive Manufacturing & CAD. | | |
| SESSION 3. Design for Additive Manufacturing (DFAM). Final Project. | | |
| SESSION 4. Materials, Postprocessing and Finishing, 3D Printing Cost, Slicing & Planning Software, AM Lab. | | |
| SESSION 5. Topology Optimization. | | |

## BIBLIOGRAFÍA Y RECURSOS

### Bibliografía Básica

Slides prepared by the lecturer (available in Moodlerooms).

Fundamentals of Digital Manufacturing Science. Z. Zhou, S. Xie, D. Chen. Springer.
Rapid Manufacturing. An Industrial Revolution for the Digital Age. N. Hopkinson, R.J.M. Hague, P.M. Dickens. John Wiley & Sons.
Additive Manufacturing Technologies. I. Gibson, D.W. Rosen, B. Stucker. Springer.
Rapid Prototyping: Principles and Applications. C.K. Chua, K.F. Leong, C.S. Lim. World Scientific.