GUÍA DOCENTE
2025 - 2026

FICHA TÉCNICA DE LA ASIGNATURA

Datos de la asignatura

Nombre completo	Diseño de Producto
Código	DIM-M2S-528
Título	Máster Universitario en Ingeniería Industrial por la Universidad Pontificia Comillas
Impartido en	Máster Universitario en Ingeniería Industrial [Primer Curso]
Cuatrimestre	Semestral
Créditos	4,5 ECTS
Carácter	Obligatoria
Departamento / Área	Departamento de Ingeniería Mecánica

Datos del profesorado

Profesor

Nombre	Silvia Fernández Villamarín
Departamento / Área	Departamento de Ingeniería Mecánica
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DATOS ESPECÍFICOS DE LA ASIGNATURA

Contextualización de la asignatura

Aportación al perfil profesional de la titulación

This subject concentrates on providing the fundamental theoretical and practical knowledge to understand the development cycle of a product, with special emphasis on advanced computer aided design and validation processes using computer aided engineering systems. An overview of product lifecycle stages and CAM systems will be provided while special focus will be put to mechanical and parametric design, surface modeling, behavior and optimization of models using simulation, and the scope and applications of reverse engineering processes.

Prerrequisitos

Knowledge of engineering drawings fundamentals and basic 3D modeling.

Competencias - Objetivos

Competencias

GENERALES

BA02	Saber aplicar e integrar sus conocimientos, la comprensión de estos, su fundamentación científica y sus capacidades de resolución de problemas en entornos nuevos y definidos de forma imprecisa, incluyendo contextos de carácter

	multidisciplinar tanto investigadores como profesionales altamente especializados.
BA03	Saber evaluar y seleccionar la teoría científica adecuada y la metodología precisa de sus campos de estudio para formular juicios a partir de información incompleta o limitada incluyendo, cuando sea preciso y pertinente, una reflexión sobre la responsabilidad social o ética ligada a la solución que se proponga en cada caso.
BA04	Ser capaces de predecir y controlar la evolución de situaciones complejas mediante el desarrollo de nuevas e innovadoras metodologías de trabajo adaptadas al ámbito científico/investigador, tecnológico o profesional concreto, en general multidisciplinar, en el que se desarrolle su actividad.
BA07	Ser capaces de asumir la responsabilidad de su propio desarrollo profesional y de su especialización en uno o más campos de estudio.
CG01	Tener conocimientos adecuados de los aspectos científicos y tecnológicos de: métodos matemáticos, analíticos y numéricos en la ingeniería, ingeniería eléctrica, ingeniería energética, ingeniería química, ingeniería mecánica, mecánica de medios continuos, electrónica industrial, automática, fabricación, materiales, métodos cuantitativos de gestión, informática industrial, urbanismo, infraestructuras, etc.
CG08	Aplicar los conocimientos adquiridos y resolver problemas en entornos nuevos o poco conocidos dentro de contextos más amplios y multidisciplinares.
CG10	Saber comunicar las conclusiones ¿y los conocimientos y razones últimas que las sustentan¿ a públicos especializados y no especializados de un modo claro y sin ambigüedades.
CG11	Poseer las habilidades de aprendizaje que permitan continuar estudiando de un modo autodirigido o autónomo.
ESPECÍFICAS	
CMI07	Conocimientos y capacidades para realizar certificaciones, auditorías, verificaciones, ensayos e informes
CMT03	Capacidad para el diseño y ensayo de máquinas

Resultados de Aprendizaje	
RA01	Interpretar y manejar información técnica y normativa referentes a elementos industriales
RA02	Conocer y representar de forma normalizada, piezas y elementos industriales. Preparar listas de materiales
RA03	Realizar el análisis funcional y determinar el diseño de elementos industriales partiendo de un plano
RA04	Diseñar (modelar en 3D) en el soporte adecuado, recogiendo la información técnica necesaria para su posterior fabricación o montaje
RA05	Redactar documentación relativa a la justificación técnica de utilización de un componente o conjunto industrial mediante procesos de validación (simulación)
RA06	Diseñar un componente en base a sus especificaciones, seleccionando el material, definiendo la geometría y dimensionándolo
	Participar en equipos de trabajo diferentes y en contextos disciplinares variados, asumiendo responsabilidades operativas

RA07	para con otros miembros del equipo, tomando decisiones de forma autónoma sobre las actividades a realizar y gestionando los recursos del equipo

BLOQUES TEMÁTICOS Y CONTENIDOS

Contenidos – Bloques Temáticos

Theory

Unit 1. Product lifecycle development and advanced Computer Aided Design (CAD).

Conception, design and implementation of products. Stages of a product lifecycle. Role of CADCAMCAE technologies. Types of data handled by design systems. Neutral formats. Parametric design and modeling criteria according to future changes and redesigns. Geometric patterns. Part lists and tables. Reports. Optimal design criteria. Design for Manufacturing (DFM). Design for Assembly (DFA). Render the appearance of a product.

Unit 2. Advanced design with complex surfaces

Mathematical concepts for curve and surface definition. Surface modeling: datum features and wireframe geometry, basic and advanced surfacing tools, operations on surfaces (joining, trimming, extending, checking connections…), creation and edition of solids using surfaces. Parametric model vs. direct modeling.

Unit 3. Analysis and optimization of parts and assemblies with Computer Aided Engineering software (CAE).

Finite Element Analysis (FEA) to validate functional performance: general stages of the process, solid and FEA models, materials definition, loading (loads, displacements constraints…), post-processing, results and verifications. Topology optimization.

Unit 4. Reverse Engineering

General methodology: point clouds, meshes (.stl), NURBS surface models and parametric CAD models. Digitizing methods and main technologies: applications and selection of reverse engineering systems. Hardware and software involved. Photogrammetry. Data alignment, point cloud cleaning up, mesh reconstruction and improvement. Surface models, history-based solid models and export to CAD software.

Unit 5. Computer Aided Manufacturing (CAM)

Introduction to CAD/CAM systems. Application areas. CAD/CAM integration and 3D modeling. Types of computer aided manufacturing processes. Production processes and CAM. Advantages and drawbacks. Fundamentals and general definitions of CAM systems. Input data. Hierarchy and structure of the system. Definition and generation of machining paths. High level programming languages. APT (automatically programmed tools) language for numerical control programming. Post processor: from CAM to NC. Configuration and statements of the post processor. Systems for virtual verification of trajectories. Definition and creation of the manufacturing simulated space. Implementing a CAM system.

Laboratory

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

1. 3D rendering of parts and assemblies.
2. Advanced parametric 3D design.

3. Surface modeling.
4. Optimization of parts and assemblies.
5. Use of 3D digitalization scanners.
6. Use of point clouds/meshes editing software.
7. Use of CAM software.

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 digital-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.

Lab session preparation.

Lab results analysis and report writing.

RESUMEN HORAS DE TRABAJO DEL ALUMNO

HORAS PRESENCIALES		
Clase magistral y presentaciones generales	Prácticas de laboratorio	
15.00	30.00	
HORAS NO PRESENCIALES		
Trabajos de carácter práctico individual	Estudio y resolución de problemas prácticos fuera del horario de clase por parte del alumno	Prácticas de laboratorio
25.00	15.00	35.00
CRÉDITOS ECTS: 4,5 (120,00 horas)		

EVALUACIÓN Y CRITERIOS DE CALIFICACIÓN

El uso de IA para crear trabajos completos o partes relevantes, sin citar la fuente o la herramienta o sin estar permitido expresamente en la descripción del trabajo, será considerado plagio y regulado conforme al Reglamento General de la Universidad.

Actividades de evaluación	Criterios de evaluación	Peso
Lab reports (including practical and theoretical sessions).	• Application of theoretical concepts to real problem-solving. • Ability to use and develop robotics software. • Written communication skills.	25
Homework: 10%	• Understanding of the theoretical concepts. • Application of these concepts to problem-solving. • Critical analysis of numerical exercises' results.	15
End-of-term exam (paper + computer): 60%	• Understanding of the theoretical concepts. • Application of these concepts to problem-solving. • Critical analysis of numerical exercises' results.	60

Calificaciones

Grading

Regular assessment

- Lab reports (including practical and theoretical sessions): 25%
- Homework: 15%
- End-of-term exam (paper + computer) (minimum score of 4.0): 60%

In order to pass the course, the weighted average mark must be greater or equal to 5 out of 10 points. In case of not exceeding the minimum score in the end-of-term exam, the final global mark will be the mark of said exam.

Retake

- Lab reports (including practical and theoretical sessions): 25%
- Retake exam (paper + computer) (minimum score of 4.0): 75%

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. In case of not exceeding the minimum score in the retake exam, the final global mark will be the mark of said exam.

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. Not complying with this requirement may have the following consequences:

  - Students who fail to attend more than 15% of the lectures may be denied the right to take the final exam during the regular assessment period.
- 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).

Guidelines for the Use of Artificial Intelligence

The use of AI is permitted in continuous assessment activities under the following conditions:

- AI may be used for pre-task activities such as brainstorming or initial research.
- AI may be used to assist in completing the task, including idea generation, drafting, or evaluating outcomes. Students must critically evaluate and modify AI-generated outputs to demonstrate their understanding.
- In all cases, the use of AI must be properly cited, and sources must be independently verified by the student.

In all other assessed activities, the use of AI is strictly prohibited.

PLAN DE TRABAJO Y CRONOGRAMA

Actividades	Fech reali
WORK PLAN AND SCHEDULE	

In and out-of-class activities	Date/Periodicity	Deadline
Final exam	After the lecture period	–
Lab sessions	Weeks 1 to 15	–
Review and self-study of the concepts covered in the lectures	After each lesson	–
Lab preparation	Before every lab session	–
Lab report writing	During every lab session	At the end of every lab session

- Final exam - After the lecture period.
- Lab sessions - Weeks 1 to 15.
- Review and self-study of the concepts covered in the lectures - After each lesson.
- Lab preparation - Before every lab session.
- Lab report writing - During every lab session - At the end of every lab session

BIBLIOGRAFÍA Y RECURSOS

Bibliografía Básica

- Slides prepared by the lecturer (available in Moodlerooms).
- K. T. Ulrich and S. D. Eppinger, *Product Design and Development*, 6th Ed., McGraw-Hill Education, 2015. ISBN-13: 978-0-078-02906-6.
- Chang, Wysk & Wang. *"Computer-Aided Manufacturing"*, 3rd Edition 2006. Pearson
- V. Raja and K. J. Fernandes (eds.), *Reverse Engineering. An Industrial Perspective*, 1st Ed., Springer-Verlag London, 2008. ISBN-13: 978-1-849-96660-3
- N. Hopkinson, R. J. M. Hague and P. M. Dickens (eds.), *Rapid Manufacturing: An Industrial Revolution for the Digital Age*, 1st Ed., John Wiley & Sons, 2005. ISBN-13: 978-0-470-01613-8

Bibliografía Complementaria

- K. Otto and K. Wood, *Product Design: Techniques in Reverse Engineering and New Product Development*, 1st Ed., Prentice Hall, 2000. ISBN-13: 978-0-130-21271-9
- Z. Zhou, S. Xie, and D. Chen, *Fundamentals of Digital Manufacturing Science*, 1st Ed., Springer-Verlag London, 2012. ISBN-13: 978-1-447-12714-7
- I. Gibson, D. W. Rosen, and B. Stucker, *Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing*. Springer-Verlag Boston, 2010. ISBN-13: 978-1-441-91119-3
- C. K. Chua, K. F. Leong, and C. S. Lim, *Rapid Prototyping: Principles and Applications*, 3rd Ed., World Scientific, 2010. ISBN-13: 978-9-812-77898-7