

## Course guide

### 240246 - 240AU113 - Computer-Aided Engineering

**Last modified:** 03/06/2025

**Unit in charge:** Barcelona School of Industrial Engineering  
**Teaching unit:** 737 - RMEE - Department of Strength of Materials and Structural Engineering.

**Degree:** MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Optional subject).  
MASTER'S DEGREE IN AUTOMOTIVE ENGINEERING (Syllabus 2019). (Optional subject).

**Academic year:** 2025    **ECTS Credits:** 4.5    **Languages:** Spanish

#### LECTURER

---

**Coordinating lecturer:**

Ávila Díaz, Julián Arnaldo

**Others:** Bové Tous, Oriol

#### PRIOR SKILLS

---

Prior Skills: Knowledge of Continuous Media Mechanics, Strength of Material , Mechanics, Graphic Expression, and Manufacturing Technologies at the grade-level

#### REQUIREMENTS

---

Minimum level of knowledge of Spanish: B2

#### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

---

**Specific:**

CEAU 1. (ENG) Realitzar models d'enginyeria, aplicar mètodes innovadors en la resolució de problemes i aplicacions informàtiques adequades, per al disseny, simulació, optimització i control de processos i sistemes.

CEAU 5. (ENG) Dirigir i organitzar empreses, així com sistemes de producció i serveis, aplicant coneixements i capacitats d'organització industrial, planificació i logística, legislació, comptabilitat financiera i de costos.

CEAU11. (ENG) Planificar, portar un seguiment i controlar el desenvolupament de productes, aplicant coneixements d'electricitat, electrònica i els sistemes d'emmagatzematge d'energia.

CEAU14. (ENG) Seleccionar i utilitzar les eines adequades per dissenyar elements d'automoció en resposta a les especificacions tècniques donades.

**Generical:**

CGAU 4. Be able to conduct research, development and innovation in relation to automotive technology.

## TEACHING METHODOLOGY

Teaching methodologies:

a) 40.5 hours of face-to-face sessions, which will consist of lectures, problems and 5 practical sessions of simple case resolution (in a working group).

b) Short exercises solved outside the classroom (individually)

c) Resolution of a practical case chosen by the students themselves (in work group)

The working groups to carry out activities a) and c) will be made up of between three to five students, will be defined at the beginning of the course and will remain until their completion.

## LEARNING OBJECTIVES OF THE SUBJECT

To present the possibilities offered by the virtual development of new products and processes in the automotive sector, as well as the new technologies associated with Industry 4.0 in the production field. Additionally, the knowledge of structural analysis will be extended with its most advanced topics: multisolid analysis, advanced structural analysis and optimization.

The different technologies will be presented in the context of each of the following phases of the industrial process:

1- Conceptual design phase.

2- Product engineering and manufacturing development phase.

3- In-plant manufacturing phase.

## STUDY LOAD

Type	Hours	Percentage
Self study	72,0	64.00
Hours large group	27,0	24.00
Hours small group	13,5	12.00

**Total learning time:** 112.5 h

## CONTENTS

### 0. Virtual development in automotive engineering.

#### Description:

Presentation of the role of new digital technologies in the design and development of a new vehicle (inaugural conference).

#### Specific objectives:

To introduce the various applications of virtual automotive development, from the perspective of a large manufacturer.

Introduction of the subject

#### Related activities:

Synthesis and search for additional information.

**Full-or-part-time:** 2h 30m

Theory classes: 1h 30m

Self study : 1h

## 1. The conceptual design stage

### Description:

There will be an introduction to design software (CAD) and the creation of digital models (Digital Mockup). Linked with this, virtual reality and augmented reality applications will be presented to the design and verification of new products. Finally, the PLM systems for the management of products throughout their life cycle will be presented, along with the new digital Twin approach.

Temary:

- 1.1. Design assisted by computer. Digital models.
- 1.2. Virtual and augmented reality.
- 1.3. PLM systems and digital twins

### Specific objectives:

Establish a solid base of knowledge of the technologies that the automotive sector applies in this phase.

### Related activities:

Practice on virtual models and VR&AR applications.

### Full-or-part-time: 15h

Theory classes: 4h 30m

Practical classes: 1h 30m

Self study : 9h

## 2. The development stage (I): Computational mechanics of solids.

### Description:

The various technologies that are applied to the simulation of products and processes, their conceptual bases, existing tools, fields of application and interrelationships between them will be presented.

Temary:

- 2.1. Multisolid simulation of mechanical systems.
- 2.2. Linear dynamic structural analysis.
- 2.3. Nonlinear structural analysis.

### Specific objectives:

Know the technologies of computational mechanics of solids and their applications.

### Related activities:

Practical session of multisolid analysis and practical session of advanced structural analysis.

### Full-or-part-time: 43h 30m

Theory classes: 13h 30m

Practical classes: 3h

Self study : 27h

### 3. The development stage (II): Optimization, stochastic simulation and correlation.

**Description:**

Description: Various technologies that complement and enhance simulation techniques in computational mechanics will be presented.

Temary:

- 3.1. Parametric optimization
- 3.2. Topological and topographic optimization
- 3.3. Stochastic simulation, concepts and applications.
- 3.4. Correlation between physical tests and numerical simulations.

**Specific objectives:**

Increase the analysis capabilities of conventional simulation systems.

**Related activities:**

Topological optimization practice session

**Full-or-part-time:** 18h

Theory classes: 4h 30m

Practical classes: 1h 30m

Self study : 12h

### 4. The manufacturing stage (I): Additive manufacturing

**Description:**

Description: The different existing technologies for additive manufacturing and their applications to the automotive sector will be presented.

Temary:

- 4.1. Technologies available for various types of materials
- 4.2. Design criteria and technology limitations
- 4.3. Applications to rapid prototyping
- 4.4. Applications to manufacturing tools
- 4.5. Applications to parts and components. Optimization.

**Specific objectives:**

Specific objectives: To publicize the different existing technologies for additive manufacturing, both metallic and non-metallic materials. Present its advantages, especially in terms of topological optimization, the limitations existing in its industrial application, as well as various application examples.

**Related activities:**

Practical session at the CIM Foundation facilities

**Full-or-part-time:** 15h

Theory classes: 4h 30m

Practical classes: 1h 30m

Self study : 9h

## 5. The manufacturing stage (II): the digitization of the factory

### Description:

Se presentarán las distintas tecnologías asociadas a las actividades de industrialización y fabricación.

Temario:

- 5.1 La fábrica virtual
- 5.2. Simulaciones logísticas y ergonómicas.
- 5.3. Concepto de sistema integrado de fabricación.
- 5.4. Sistemas digitales para la gestión de la producción (SCADA,MES,ERP)

### Specific objectives:

Complete knowledge on digital systems applied to industrialization and manufacturing

### Related activities:

Solving application exercises

**Full-or-part-time:** 13h 30m

Theory classes: 4h 30m

Self study : 9h

## GRADING SYSTEM

There are two types of evaluation: (1) continuous and (2) special.

Continuous evaluation:

Continuous assessment is intended for students who can follow the course on a regular basis. The teaching methodology has been designed for this modality.

The elements that are taken into account for the evaluation are: (1) partial test, (2) presentations of exercises and practices, (3) final presentation of the course work. (4) final test.

With the 4 previous elements, 4 notes are built: (NEP) partial test, (NEC) continuous assessment note that incorporates the delivered exercises and practices, (NEF) final test, and (NTC) grade of the course work and presentation of the same. The final grade (NF) is obtained by weighing the four previous elements as follows:

Qualification system:  $NF = 0.2 * NEP + 0.2 * NEF + 0.2 * NEC + 0.4 * NTC$

If the subject is suspended, a reevaluation exam may be taken.

In this case, the grade for the reevaluation exam (NER) will replace the grades for the final exam (NEF) and part exam (NEP) in the calculation of the final grade:

Qualification system:  $NF = 0.4 * NER + 0.4 * NTC + 0.2 * NEC$

Special evaluation:

The special assessment is designed for students who, due to the circumstances, cannot usually attend class. This modality excludes the previous one, and mixed approaches are not possible. To adhere to it, you must communicate in writing at the beginning of the course.

NOTE: The automotive master is face-to-face, so remote support will not be available for the non-face-to-face development of the subject.

Students in this situation must sit the partial (NEP) and final (NEF) exams, perform and deliver all the work and exercises proposed during the course, including the 2 finite element practices that will be carried out autonomously by the student ( NEC), and carry out and deliver the course work individually (NTC) although it may have a lesser scope, which must be previously approved by the coordinator of the course.

The reevaluation process will be identical to the continuous evaluation.

## EXAMINATION RULES.

---

Testing standards:

a) Partial exam: This is a conceptual written exam, the objective of which is to ensure that the theoretical concepts underlying the practical part of the course have been assimilated. To carry it out, the use of a form (a DIN A4 sheet) will be allowed. The corresponding grade (NEP) will include the assessment of the case study proposal presented for the course work, which will have a weight of 30% of the total NEP grade.

b) Final Exam: This is a conceptual written exam, the objective of which is to ensure that the theoretical concepts underlying the practical part of the course have been assimilated, excluding what has already been examined in the part. To carry it out, the use of a form (a DIN A4 sheet) will be allowed

c) Continuous Evaluation: throughout the course, three deliverable exercises will be proposed to be solved as a team outside the classroom. Likewise, five practices (Virtual mockups and VR&AR applications, multi-solid simulation, advanced structural analysis using finite elements, optimization, additive manufacturing) will also be carried out in teams. Each practice must be accompanied by the delivery of the corresponding report.

d) Course work: Each work group will have to identify and solve a case study throughout the course. A first installment will be made with the case definition report, which will be assessed along with the partial exam, and a second installment with the full work report, which will be presented orally to be evaluated during the last session of the course.

e) Reevaluation Exam: It will be equivalent to the exams that it substitutes.

## BIBLIOGRAPHY

---

### Basic:

- French, Michael J. Conceptual design for engineers [on line]. 3rd ed. London: Springer, 2010 [Consultation: 31/01/2025]. Available on : <https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=3073885>. ISBN 9781849968539.
- Hirz, Mario [et al.]. Integrated computer-aided design in automotive development [on line]. 1. Berlin: Springer, 2013 [Consultation: 08/11/2023]. Available on: <https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-3-642-11940-8>. ISBN 9783642119392.
- Kanta, Surjya Kanta Pal [et al.]. Digital twin-fundamental concepts to applications in advanced manufacturing [on line]. 1. Cham, Switzerland: Springer, 2022 [Consultation: 08/11/2023]. Available on: <https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-3-030-81815-9>. ISBN 3030818152.
- Haug, Edward J. Computer aided kinematics and dynamics of mechanical systems. Boston [etc.]: Allyn and Bacon, 1989-. ISBN 0205120970.

### Complementary:

- Félez, Jesús; Martínez, Ma. Luisa. Ingeniería gráfica y diseño. Madrid: Síntesis, 2008. ISBN 9788497564991.
- Bhise, Vivek D. Ergonomics in the automotive design process [on line]. Boca Raton [etc.]: CRC Press, cop. 2012 [Consultation: 27/11/2025]. Available on : <https://www-taylorfrancis-com.recursos.biblioteca.upc.edu/books/mono/10.1201/b11237/ergonomics-automotive-design-process-vivek-bhise>. ISBN 9781439842102.
- Agulló i Batlle, Joaquim. Mecànica de la partícula i del sòlid rígid : amb 676 figures, 315 qüestions amb solucions, 105 problemes amb resultats i 94 exemples d'aplicació. Barcelona: Publicacions OK Punt, 1995. ISBN 8492085002.
- Agulló i Batlle, Joaquim. Mecánica de la partícula y del sólido rígido. Barcelona: OK Punt, 2000. ISBN 8492085053.
- Cardona Foix, Salvador ; Clos Costa ,Daniel. Teoria de màquines [on line]. 2a ed. Barcelona: Edicions UPC, 2008 [Consultation: 08/09/2025]. Available on: <https://upcommons.upc.edu/entities/publication/2eea93fe-5c5b-4051-9380-da1548a4dae2>. ISBN 9788483019634.
- Argüelles Álvarez, Ramón. Cálculo de estructuras. Madrid: Escuela Técnica Superior de Ingenieros de Montes, 1981-1986. ISBN 8460024105.