

## Course guide

# 240244 - 240AU111 - Steering, Suspension and Braking Systems

Last modified: 10/07/2023

**Unit in charge:** Barcelona School of Industrial Engineering  
**Teaching unit:** 712 - EM - Department of Mechanical Engineering.

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

**Academic year:** 2023    **ECTS Credits:** 6.0    **Languages:** Spanish

## LECTURER

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**Coordinating lecturer:** ENRIQUE ERNESTO ZAYAS FIGUERAS

**Others:** Carlos-Alberto Sánchez Martín  
Raúl Fuentes Sainz de la Maza

## PRIOR SKILLS

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Knowledge of Mechanics and Machine Theory. Knowledge of Endurance of Materials and Materials Science. Knowledge of Machine Elements Technology.

## REQUIREMENTS

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Have taken the Q1 course: Vehicle Dynamics.

## DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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### Specific:

CEAU 3. (ENG) Explicar l'arquitectura d'un vehicle d'automoció, el seu comportament, les seves parts i els sistemes que l'integren.

CEAU13. (ENG) Avaluar el comportament d'un vehicle mitjançant l'aplicació de sistemes motrius i de transmissió i establir solucions viables econòmicament en el sector de l'automoció (competència específica de l'especialitat Motors i Mecànica).

### Generical:

CGAU 1. Ability to apply appropriate knowledge of mathematical aspects, analytical, scientific, instrumental, technological and management, the resolution of the problems of the automotive

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

CGAU11. Develop independent learning skills to maintain and enhance the powers of Automotive Engineering, to allow the continued development of the profession.

## TEACHING METHODOLOGY

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The teaching methodology is based on two types of activities: i) class sessions in which the lecturer provides concepts and knowledge and, using practical exercises, shows how to apply them to solve real problems and situations. In several of these sessions, exercises are set out and students have to resolve them in class with the professor's guidance; ii) practical laboratory sessions in small groups where students carry out activities under the Professor's supervision. In these practical sessions, students learn the use of pre-design and system development support tools as well as testing, measurement and data analysis techniques.

## LEARNING OBJECTIVES OF THE SUBJECT

- Theoretical and practical understanding of steering, suspension and braking systems, as well as their influence on the vehicle dynamic performance.
- Knowledge of the different types of designs and components used in steering, suspension and braking systems, and ability to assess their advantages and disadvantages.
- Competence in the preliminary design of steering, suspension and braking systems. Ability to apply design criteria and assess the results of calculations and simulations.
- Competence in the testing of steering, suspension and braking systems. Knowledge of the instrumentation and equipment required for testing, and ability to programme tests and to analyse and assess the test results.

## STUDY LOAD

Type	Hours	Percentage
Hours medium group	36,0	24.00
Self study	96,0	64.00
Hours small group	18,0	12.00

**Total learning time:** 150 h

## CONTENTS

### 1: Steering Systems

#### Description:

Types and components of steering systems. Geometry of a steering system: Ackerman condition and specific dimensions and angles. Maneuverability at very low speed. Power steering systems.

#### Specific objectives:

Knowledge of the different types of steering systems: their advantages, disadvantages and areas of application. Ability to characterise geometrically a steering system and how the different steering parameters affect vehicle dynamics. Ability to define the steering mechanism through simulation tools.

#### Related activities:

Carrying out exercises regarding to steering system geometry. Simulation of the performance of a steering system by means of multibody simulation software.

#### Full-or-part-time: 41h

Practical classes: 9h

Laboratory classes: 6h

Self study : 26h

## 2: Suspension Systems

### Description:

Types of suspension systems and their description. Components of a suspension system. Performance of a suspension system. Dimensioning of the spring and the shock absorber: dynamic model of 1/4 vehicle. Shock absorber tuning: dynamic model of 1/2 vehicle.

### Specific objectives:

Knowledge of the purpose of a suspension system. Identification of the different types of suspension systems, their components and areas of application. Ability to characterise the geometry of a suspension system and determine its main elements following stability and comfort criteria.

### Related activities:

Carrying out design and dimensioning exercises of a suspension system: calculation of the stiffness and damping ratio. Characterisation of 1 and 2 degrees of freedom systems in the frequency domain.

### Full-or-part-time: 59h

Practical classes: 15h

Laboratory classes: 6h

Self study : 38h

## 3: Braking Systems

### Description:

Braking system types and characteristics. Braking system hydraulic circuits. Power-assisted brake. Braking system dynamics. Optimal balance of the braking loads. Introduction to active safety systems: ABS, ESP, etc.

### Specific objectives:

Knowledge of the different types of braking systems: their characteristics and areas of application. Ability to make brake-system design calculations. Knowledge of the different systems of power-assisted brakes and main concepts of the electronics involved in active safety systems related to braking: ABS, ESP, etc.

### Related activities:

Carrying out braking system dimensioning exercises.

### Full-or-part-time: 50h

Practical classes: 12h

Laboratory classes: 6h

Self study : 32h

## GRADING SYSTEM

Assessment is based on three types of evaluation activities: a mid-term, partial test; a final exam; and an evaluation of the practices. Both the partial test and the final exam, assess the theoretical and practical aspects of the course. Practices are assessed on the basis of the report that every student must write and deliver to the Professor at the end of each practical session. The assessment criteria for practices is the degree of understanding of the work carried out during the practical session and the clarity when writing and presenting the report.

The algorithm to calculate the final mark is:  $N_{\text{final}} = 0.2 \cdot \text{NEP} + 0.8 \cdot \text{Max}[\text{NEF}; 0.7 \cdot \text{NEF} + 0.3 \cdot \text{NPP}]$

Where: NEP= mark of the practices, NEF = final exam mark, and NPP = partial test mark.

A special exam will be offered in July to those students that have not passed the subject. The mark obtained with this exam, NREAV, replaces the final exam mark, NEF.



## EXAMINATION RULES.

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Personal notes and reference material can be used during the practical exercises in both the partial test and the final exam. No documentation may be consulted during the theory part.

## BIBLIOGRAPHY

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### Basic:

- Post, Wulf [et al.]. Sistemas de freno convencionales y electrónicos. 3a ed. Plochingen: Robert Bosch GmbH, 2003. ISBN 9783934584617.
- Alonso Pérez, J. M.. Técnicas del automóvil : Chasis. 8ª ed. Madrid: Paraninfo, 2008. ISBN 9788497326612.
- Luque, P. ; Álvarez, D. ; Vera, C.. Ingeniería del automóvil : sistemas y comportamiento dinámico. Madrid: Thomson Paraninfo, 2004. ISBN 9788497322829.

### Complementary:

- Dixon, John C.. Suspension geometry and computation. Chichester: John Wiley & Sons, 2009. ISBN 9780470510216.
- Wong, J.Y.. Theory of ground vehicles. 4th ed. New York: John Wiley & Sons, 2008. ISBN 9780470170380.
- Gillespie, T. D. Fundamentals of vehicle dynamics [on line]. Warrendale, PA: Society of Automotive Engineers, 1992 [Consultation: 03/02/2022]. Available on : <https://web-p-ebshost-com.recursos/ehost/ebookviewer/ebook?sid=f907c84d-9c9e-4b3a-abec-23d9a9255c94%40redis&vid=0&format=EB>. ISBN 1560911999.
- Genta, Giancarlo. L'Autotelaio 1: Progetto dei componenti. Torino: Libreria Editrice Universitaria Levrotto & Bella, 2007. ISBN 9788882181413.

## RESOURCES

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### Audiovisual material:

- Transparències de classe. Audiovisual material prepared by the teaching team. This material is accessible through the Atenea Campus.