



# Course guide

## 330534 - DV - Vehicle Dynamics

**Last modified:** 04/05/2023

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

**Degree:** BACHELOR'S DEGREE IN AUTOMOTIVE ENGINEERING (Syllabus 2017). (Compulsory subject).

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

### LECTURER

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**Coordinating lecturer:** Català Calderón, Pau

**Others:** Peña Pitarch, Esteban

### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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**Specific:**

1. Vehicle kinematics. Dynamics of conventional wheels. Vehicle dynamics without suspensions. Steering system. Suspension system. Braking system. Vibration analysis.

**Generical:**

CG11. Ability to write and develop projects for vehicles and/or their components.

**Transversal:**

2. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.  
04 COE N3. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.  
05 TEQ N3. TEAMWORK - Level 3. Managing and making work groups effective. Resolving possible conflicts, valuing working with others, assessing the effectiveness of a team and presenting the final results.

### TEACHING METHODOLOGY

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- Master class or conference.
- Problem solving and case study.
- Project, activity or work of reduced scope.
- Project or work of wide scope.
- Evaluation activities.

### LEARNING OBJECTIVES OF THE SUBJECT

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At the end of the course, students must be able to:

- To apply correctly the fundamental concepts of the statics, kinematics and dynamics of the rigid solid and to be able to apply them to practical cases of automotive engineering.
- Know the different auxiliary mechanisms of a vehicle, as well as be able to carry out its design.
- Apply the basic concepts of the kinematics and dynamics of a vehicle and be able to apply them to practical cases in automotive engineering.

## STUDY LOAD

Type	Hours	Percentage
Hours small group	30,0	20.00
Self study	90,0	60.00
Hours large group	30,0	20.00

**Total learning time:** 150 h

## CONTENTS

### 1. Introduction to vehicle dynamics

**Description:**

General characteristics of a motor vehicle. Classification of motor vehicles. Vehicle dynamics specific terminology. Introduction to vehicle dynamics.

**Related activities:**

PROB, SIM, PAR, EP1, EFINAL

**Full-or-part-time:** 20h

Theory classes: 4h

Practical classes: 4h

Self study : 12h

### 2. Wheel dynamics. Tires

**Description:**

Wheels. Tires. Covers or tires. Dynamic tire behavior. Efforts in the footprint. Properties of the tire in the turn. Numerical models of ground tire interaction.

**Related activities:**

PROB, SIM, PAR, EP1, EFINAL

**Full-or-part-time:** 10h

Theory classes: 2h

Practical classes: 2h

Self study : 6h

### 3. Longitudinal dynamics

**Description:**

Maximum acceleration. Engine power. Maximum acceleration. Tractor capacity driving wheels.

**Related activities:**

PROB, SIM, PAR, EP1, EFINAL

**Full-or-part-time:** 40h

Theory classes: 8h

Practical classes: 8h

Self study : 24h

#### 4. Braking performance

**Description:**

Fundamental braking equation. Analysis of braking performance. Braking performance. Brake load transfer. Anti-lock braking systems (ABS).

**Related activities:**

PROB, SIM, PAR, EP2, EFINAL

**Full-or-part-time:** 20h

Theory classes: 4h

Practical classes: 4h

Self study : 12h

#### 5. The steering system

**Description:**

Kinematics of direction. Four-wheel steering system. Vehicle with trailer. Vehicles with more than two axles. Mechanisms for steering systems. High speed turns.

**Related activities:**

PROB, SIM, PAR, EP2, EFINAL

**Full-or-part-time:** 32h

Theory classes: 6h

Practical classes: 6h

Self study : 20h

#### 6. Suspension system

**Description:**

Suspension system. Roll Centers and roll axis. Study of the rolling motion of a vehicle.

**Related activities:**

PROB, SIM, PAR, EP2, EFINAL

**Full-or-part-time:** 20h

Theory classes: 4h

Practical classes: 4h

Self study : 12h

#### 7. Vibration analysis

**Description:**

Introduction to vibrations. Vehicle response properties in a vertical motion. Perception of ride.

**Full-or-part-time:** 8h

Theory classes: 2h

Practical classes: 2h

Self study : 4h



## ACTIVITIES

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### Partial Exam 1

**Description:**

Assessment of acquired knowledge

**Delivery:**

Delivered exam

**Full-or-part-time:** 44h

Theory classes: 2h

Self study: 42h

### Partial Exam 2

**Description:**

Assessment of acquired knowledge

**Delivery:**

Delivered exam.

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

Theory classes: 2h

Self study: 48h

### Final Exam

**Description:**

Assessment of acquired knowledge.

**Delivery:**

Delivered exam.

**Full-or-part-time:** 93h

Theory classes: 3h

Self study: 90h

### Problems delivery

**Description:**

Delivery of technical reports explaining the resolution of problems related to real cars.

**Delivery:**

Technical report.

**Full-or-part-time:** 16h

Guided activities: 16h



### Simulation Report

**Description:**

Delivery of a technical report explaining the results obtained by using an MBD simulation software of a complete vehicle and some of its mechanical subsystems. These simulated results must be contrasted with analytical values obtained through the theoretical content presented in the subject.

**Delivery:**

Technical report and simulation files.

**Full-or-part-time:** 26h

Practical classes: 10h

Self study: 16h

### Class participation

**Description:**

attendance and participation in class and laboratories. Online tests can be proposed to be solved by the students of the content explained in class.

**Delivery:**

Class participation and tests

**Full-or-part-time:** 1h

Theory classes: 1h

## GRADING SYSTEM

- PROB: Delivery of proposed problems (10%).
- SIM: Simulation report (15%).
- PAR: Class attendance and participation (5%).
- EP1: Partial exam 1 (35%).
- EP2: Partial exam 2 (35%).
- FINAL: Recovery exam (70%).

The final grade (NFINAL), rounded to the tenth, will be the next weighted average.

$$NFINAL = \max(70\% \cdot EFINAL, 35\% \cdot EP1 + 35\% \cdot EP2) + 10\% \cdot PROB + 15\% \cdot SIM + 5\% \cdot PAR.$$

Students who fail to pass the subject in part (EP1, EP2) or those who want to improve their qualification, they will have a second chance with a new final test (EFINAL).

## EXAMINATION RULES.

- Late deliveries will not be accepted (SIM, PROB). Deliveries must be made via the ATENEA campus.
- In the delivery any total or partial copy of solutions will suppose the suspension of the activity. The student must ensure the privacy and security of their data.
- The structure and rules of the exams of the subject (EP1, EP2, EFINAL) are the following:  
Duration: 2 h - 3 h  
Part of theory (3 points). Test questions and open-ended questions. No form or notes.  
Part of problems (7 points). Between one and three problems. With form and / or notes.



## BIBLIOGRAPHY

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### Basic:

- Jazar, Reza N. Vehicle dynamics : theory and applications [on line]. 2n edition. New York: Springer, 2017 [Consultation: 19/11/2020]. Available on: <http://dx.doi.org/10.1007/978-1-4614-8544-5>. ISBN 9780387742434.
- Gillespie, T. D. Fundamentals of vehicle dynamics [on line]. 4th ed. Warrendale, PA: Society of Automotive Engineers, cop. 1992 [Consultation: 28/07/2022]. Available on: [https://search-ebSCOhost-com.recursos.biblioteca.upc.edu/login.aspx?direct=true&AuthType=ip,uid&db=nlebk&AN=3040054&site=ehost-live&ebv=EB&ppid=pp\\_Cover](https://search-ebSCOhost-com.recursos.biblioteca.upc.edu/login.aspx?direct=true&AuthType=ip,uid&db=nlebk&AN=3040054&site=ehost-live&ebv=EB&ppid=pp_Cover). ISBN 1560911999.
- Font Mezquita, J.; Dols, J. F. Tratado sobre automóviles. Tomo I y II, Tecnología del automóvil. València: Universitat Politècnica de Valencia, 2004. ISBN 9788477215011.
- Font Mezquita, J.; Dols, J. F. Tratado sobre automóviles. Tomo III, el entorno del automóvil. Valencia: Universidad Politècnica de Valencia, 1997-2006. ISBN 8477215014.
- Luque, P.; Álvarez, D.; Vera, C. Ingeniería del automóvil: sistemas y comportamiento dinámico. Madrid: Paraninfo, 2004. ISBN 9788497322829.
- Font Mezquita, J.; Dols, J. F. Tratado sobre automóviles. Tomo IV, La dinámica del automóvil. València: Universitat Politècnica de Valencia, 2006. ISBN 8483630206.

## RESOURCES

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### Other resources:

Class presentations and MBD simulation software with specific toolkits for vehicle dynamics.