Universidad de Navarra

Vehicle Systems Engineering (Ing.Gr.)
Guía docente 2026-27

PRESENTACIÓN

Brief description the course:

The aim of the course is the application of already acquired mechanical-engineering knowledge to study the dynamics associated to automotive and railway vehicles. It is a course oriented to students enrolled in the *Degree in Mechanical Engineering*.

Titulación (Módulo/Materia):

- Ingeniería Mecánica (Bloque Especializado Mecánica/Diseño de Máquinas y Vehículos)

Detalles:

- **ECTS**: 6 ECTS
- **Curso, semestre**: 4.º curso, 1.º semestre
- **Carácter**: Obligatorio
- **Idioma**: Inglés (6 ECTS)

Profesores de la asignatura:

- Alonso Pazos, Asier / Profesor invitado (asieralonso@external.unav.es)
- Medina Murua, Andoni / Invitado (amedina@external.unav.es)

Coordinador de la asignatura:

- Gil-Negrete Laborda, Nere / Profesora Catedrática
- Alonso Pazos, Asier / Profesor Invitado
- Medina Murua, Andoni / Profesor Invitado

RESULTADOS DE APRENDIZAJE (Competencias)

INGENIERÍA MECÁNICA

CG3 - Students will acquire knowledge in basic and technological subjects which enables them to learn new methods and theories, and give them the versatility to adapt to new situations.

CE20 - Students will acquire knowledge and skills for the calculation, design and testing of machines.

CONTENTS OF THE COURSE

The course is divided in two parts: RAILWAY & AUTOMOBILE.

THE RAILWAY

Unit 1. The Railway System

General description of railway system components. - Curve, cant and … - Railway signalling and transport capacity concepts.

Unit 2. Longitudinal Dynamics Concepts

Wheel-rail adhesion. - Running resistance. - Effect of rotational masses (wheelsets, traction drive …).

Unit 3. Traction System

General description and components (mechanical, electrical).- Specification of traction drive components (motors, gearboxes) for specific vehicles and operational conditions.

Unit 4. Braking System

General description and components (mechanical, pneumatic). - Specification of Braking system components (brake discs, brake cylinders …) for specific vehicles and operational conditions.

Unit 5. Suspension System

General description and components (mechanical, pneumatic, hydraulic).- Concepts of frequency behaviour of the vehicle and comfort.- Specification of suspension components (air springs, dampers …) for specific vehicles and operational conditions.

THE AUTOMOBILE

Unit 1. Tyres

Types and construction.- Longitudinal Forces (Slip Ratio).- Lateral Forces (Slip Angle).- Combined Forces (Friction Circle).- Autoaligning moment and Rolling Resistance.

Unit 2. Longitudinal Dynamics

Acting forces: traction/braking, aerodynamic force, rolling resistance, load.- *Acceleration*: Longitudinal load transfer and gear boxes design.- *Braking*: brake distribution.

Unit 3. Lateral Dynamics

Ackermann.- Bicycle model.- Understeering/Oversteering and Yaw gain.- Lateral Load transfer: Influence of roll centre and suspension stiffness.

ACTIVIDADES FORMATIVAS

6 ECTS: 150 - 180 working hours, are distributed in the following way:

- Theory classes: 20 hours
- Application classes: 40 hours
- Projects: 50 hours
- Tutorization: 3 hours
- Personal study time: 50 hours
- Evaluation: 5 hours

METODOLOGÍAS DOCENTES

- Theory and application classes in regular classroom
- Application classes in computer laboratory

- Individual or group projects and practical assignments
- Interviews with a professor
- Personal study, based on material from different sources
- Evaluation activities

The basic concepts of the syllabus will be highlighted in theory or application classes in regular classroom. The students will also attend classes in a computer laboratory in order to solve practical exercises using different software. Furthermore, the students will have to face and solve some assingments and projects either individually or working in groups, to be handed in, corrected and evaluated. Finally, they will have to pass a final exam to guarantee that they have acquired the basic concepts of railway and automotive dynamics.

EVALUACIÓN

ORDINARY ASSESSMENT

- **Intermediate or final exams:** 40%
- **Individual or group projects**: 60%

Comments:

- Both parts (Railway and Automobile) are independent. Each part has a weight of 50% in the final mark (5 points the Railway part and 5 points the Automobile part).
- **It is compulsory to get a minimum score of 50% in each part to pass the course** (2,5 points in Railway part; 2,5 points in Automobile part).
- The student will have to repeat failed parts in the extraordinary assesment.
- The evaluation of each part is briefly described below.

    1. Railway part: 50% individual projects (2,5 points) + 50% final exam (2,5 points).
    2. Automobile part: 50% group projects (2,5 points) + 50% final exam (2,5 points). **A minimum score of 50% (2,5 points) is required in the final exam to pass the Automobile part** (regardless of what is the score of the group projects).

EXTRAORDINARY ASSESSMENT

- **Intermediate or final exams:** 40%
- **Individual or group projects**: 60%

Comments:

- **It is compulsory to get a minimum score of 50% in each part to pass the course** (2,5 points in Railway part; 2,5 points in Automobile part).
- The student need to repeat only failed parts. *The mark of the passed part will be maintained*.
- The evaluation of each part is briefly described below.

    1. Railway part: 50% individual projects (2,5 points) + 50% final exam (2,5 points). *The marks of the individual projects will be maintained from the ordinary to the extraordinary assignment*.
    2. Automobile part: 50% group projects (2,5 points) + 50% final exam (2,5 points). **A minimum score of 50% (2,5 points) is required in the final exam to pass the Automobile part** (regardless of what is the score of the group projects). *The marks of the group projects will be maintained from the ordinary to the extraordinary assignment* .

HORARIOS DE ATENCIÓN

- Contact professors via e-mail to arrange an interview

BIBLIOGRAFÍA

Main references:

- "Race Car Vehicle Dynamics"; Milliken, W.F., Milliken, D.L.; *SAE International.* Localízalo en la biblioteca
- "Fudamentals of Vehicle Dynamics"; Gillespie, T.D.; *Society of Automotive Engineers, Inc.* Localízalo en la biblioteca (formato papel) Localízalo en la biblioteca (formato electrónico)
- "Railway Technical Web Pages – Rolling Stock" http://www.railway-technical.com/rstock.shtml

Other references:

- "Tecnología básica del automóvil: vehículos de gasolina, diesel y turbo" FASA-RENAULT
- "Tyres, suspension and handling"; John C. Dixon; *Cambridge University Press*
- "Dinámica vehicular basada en la técnica de Bond Graph"; Carlos Vera Älvarez , Jesús Félez Mindan Localízalo en la biblioteca
- "Vehicle handling dynamics"; J.R. Ellis; *MEP- London* Localízalo en la biblioteca
- "Introduction to Transportation Engineering and Planning"; Morlok, E.K. ; *McGraw-Hill* Localízalo en la biblioteca
- "Citröen XM"; Martínez, A., Sauzay, M.; *E.P.A. Editions* "Automotive Brake Systems, 1st Edition" BOSCH Localízalo en la biblioteca
- "Manual de Automóviles"; Arias-Paz, M.; *Editorial Dossat, S.A.* Localízalo en la biblioteca
- "The Automotive Chassis: Engineering Principles"; Reimpell, J., Stoll, H. Arnold Localízalo en la biblioteca (formato papel) Localízalo en la biblioteca (formato electrónico)
- "Theory of Ground Vehicles"; Wong, J.Y.; *John Wiley & Sons* Localízalo en la biblioteca (formato papel) Localízalo en la biblioteca (formato electrónico)
- "Steering and Suspension", 2nd Edition Remling, J.; *John Wiley & Sons* Localízalo en la biblioteca
- "Handbook of Railway Vehicle Dynamics" *Iwnicki S.D. (Editor) ,CRC Pres* Localízalo en la biblioteca
- "Transportes", *José Germán Giménez, Escuela Superior de Ingenieros Industriales, Universidad de Navarra*