COMILLAS
UNIVERSIDAD PONTIFICIA
ICAI ICADE CIHS

GUÍA DOCENTE
2024 - 2025

FICHA TÉCNICA DE LA ASIGNATURA

Datos de la asignatura

Nombre completo	Vehicle Dynamics
Código	DIM-MMS-523
Impartido en	Máster Universitario en Ingeniería Industrial + Máster in Motorsport, Mobility and Safety [Primer Curso]
Créditos	3,0 ECTS
Carácter	Obligatoria
Departamento / Área	Departamento de Ingeniería Mecánica

Datos del profesorado

Profesor

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DATOS ESPECÍFICOS DE LA ASIGNATURA

Contextualización de la asignatura

Aportación al perfil profesional de la titulación

The course covers key topics such as suspension geometry, tire behavior and weight distribution, all essential for understanding how to achieve optimal stability, control, and speed. Students will learn to analyze forces acting on a vehicle and adjust systems for handling and traction. Practical applications and case studies will give students insights into real-world racing scenarios and innovations in automotive engineering.

Prerrequisitos

Course on Mechanics and basic knowledge of mechanical vibrations

Competencias - Objetivos

Competencias

Competences:

- **C1**: Develop the ability to analyze vehicle dynamics and propose improvements in vehicle performance critically.
- **C2**: Work collaboratively in multidisciplinary teams to solve complex vehicle dynamics problems, integrating knowledge from different areas.
- **C3**: Demonstrate autonomy in using simulation tools to investigate the dynamic behaviour of vehicles and suggest design modifications.
- **C4**: Engage in lifelong learning by staying updated on the latest technological advancements in vehicle dynamics and applying them to real-world problems.

- **C5**: Communicate technical findings effectively through reports, presentations, and discussions, adapting the communication style to different audiences.

Resultados de Aprendizaje

Knowledge:

- **K1**: Understand the fundamental principles of vehicle dynamics, including longitudinal, vertical, and lateral dynamics.
- **K2**: Familiarity with tyre models, braking systems, suspension systems, and steering geometry.
- **K3**: Knowledge of technologies such as ABS, ESP and regenerative braking and their role in vehicle stability and performance.
- **K4**: Understand the principles and techniques of vehicle dynamic simulations using specialized software (e.g., Dymola).
- **K5**: Familiarity with tyres' construction, materials, and grip mechanisms and their effect on vehicle dynamics.

Skills:

- **S1**: Apply tyre and load models to analyze vehicle dynamics in different conditions (longitudinal, vertical, and lateral).
- **S2**: Use vehicle simulation tools to model and predict vehicle behavior under various operating conditions.
- **S3**: Evaluate braking system performance, including energy balance, rolling resistance, and regenerative braking efficiency.
- **S4**: Design and adjust suspension systems to optimize vehicle stability, comfort, and handling.
- **S5**: Analyze the impact of different steering system technologies and geometries on vehicle manoeuvrability and safety.

BLOQUES TEMÁTICOS Y CONTENIDOS

Contenidos – Bloques Temáticos

1. Introduction to vehicle dynamics
    1.1 Purpose, contents & text references
    1.2 Introduction to a tire model
    1.3 Reference axis systems
2. Longitudinal dynamics
    2.1 Load model
    2.2 Tire technology review
        2.2.1 Grip mechanisms
        2.2.2 Construction & materials
        2.2.3 Coding.
    2.3 Tire longitudinal model
    2.4 Rolling resistance
    2.5 Braking systems technology review
    2.6 Braking systems energy & balance
    2.7 ABS - ESP technology review

2.8 Regenerative braking tech review

3. Vertical dynamics

3.1 Load model and dynamic response

3.2 Introduction to quarter car model

3.3 Elastic elements layouts

3.4 Damper element layouts

3.5 Damper characteristic definition and setup

3.6 Air springs and hydropneumatic suspension

3.7 Half car model: pitch & bounce

4. Lateral dynamics

4.1 Low speed turning model

4.2 Tire slip mechanism

4.3 High speed turning

4.3.1 Bicycle load model

4.3.2 Understeer gradient models

4.3.3 Roll moment distribution

4.3.4 Tractive forces effect

4.3.5 Other pseudo steer effects

4.4 Suspension and steering geometry

4.4.1 Static steer, camber and caster

4.4.2 Roll center and ride height

4.4.3 Suspension layout technical review

4.5 Steering systems tech review

4.5.1 Hydraulically assisted rack & pinion

4.5.2 Hydraulically assisted ball recirculating

4.5.3 Electric actuated systems

5 Simulation with Dymola

METODOLOGÍA DOCENTE

Aspectos metodológicos generales de la asignatura

In order to achieve the acquisition of the proposed competencies, the course will be developed with a focus on student activity as a priority factor. This means that both in-person and remote sessions will encourage the active involvement of students in learning activities

EVALUACIÓN Y CRITERIOS DE CALIFICACIÓN

- Multiple-choice exam at the end of the semester.
- Depending on the characteristics of the group, group work could be used as a grading criterion.

Calificaciones

- The grade will be based on the score obtained in the test or the group work, if applicable.
- A grade above 5 over 10 is required to pass the course.

BIBLIOGRAFÍA Y RECURSOS

Bibliografía Básica

- *Race Car Vehicle Dynamics* - William Milliken, Douglas Milliken ISBN 1-56091-526-3
- *Fundamentals of Vehicle Dynamics* - Thomas D. Gillespie - Society of Automotive Engineers (SAE) - ISBN 1-56091-199-9
- *Tire and Vehicle Dynamics* - Hans B. Pacejka - Butterworth-Heinemann - ISBN 1-48329-9708