Course guide
340707 - FORM2 - Formula Student 2

Last modified: 09/01/2025

Unit in charge: Vilanova i la Geltrú School of Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control.

Degree: BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL DESIGN AND PRODUCT DEVELOPMENT ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN INFORMATICS ENGINEERING (Syllabus 2018). (Optional subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: De Pinto, Stefano

Others: De Pinto, Stefano

PRIOR SKILLS

Knowledge in Physics and Mathematics: A good understanding of physical concepts such as forces, energy, and motion, as well as mathematical skills, is fundamental for the design and analysis of mechanical and electrical systems.

Knowledge in Mechanics: Students should be familiar with principles of mechanics, such as statics, fluids, and dynamics. This will help students in the development of the vehicle, understanding aspects of vehicle dynamics, aerodynamics, engine behavior, and tires.

Knowledge of Applied Mechanics: Static and dynamic equilibrium, calculation of forces and moments for a rigid body, fluid dynamics for the aerodynamics section, and basic knowledge of propulsion systems.
Having completed the Formula Student 1 course is foundational for understanding the topics that will be covered.
Skills in Matlab to model and simulate mechanical and electrical components is valuable.

Interest in Innovation and Sustainability: Students should be motivated to explore creative and sustainable solutions in the design of competition vehicles.

Strong Teamwork Skills.

THESE SKILLS WILL BE EXPANDED AND ENHANCED DURING THE COURSE, THEREFORE, PRIOR KNOWLEDGE IS RECOMMENDED.

TEACHING METHODOLOGY

The course is structured as an engineering project where students are challenged to design and build a competition car for the annual international Formula Student event, scheduled to take place in August and September. The project is divided into two phases:

Virtual Phase (Formula Student 1)
This phase focuses on defining the vehicle targets and establishing the groundwork for design decisions.

Practical Phase (Formula Student 2)
This phase involves constructing, modifying, and testing the vehicle.

The project spans multiple applied engineering fields, including mechanical, electrical, electronics, computer science, product design, and project management. This interdisciplinary approach provides students with a comprehensive understanding of all vehicle components, enabling them to grasp how these elements function together. The course bridges theoretical knowledge with practical, real-world applications.

Formula Student 1 is essential for developing a strong foundation in vehicle design, addressing the core concepts and assumptions critical to the project.

Formula Student 2 builds on this foundation and covers advanced topics, related to the world of Race cars, including:

-Advanced lateral dynamics modeling
-Suspension systems
Springs, dampers, and anti-roll bars
-Race car balancing
-Front wheel assembly and steering
-Brakes: fundamentals and design
-Telemetry analysis

LEARNING OBJECTIVES OF THE SUBJECT

The objective of this course is to provide all the key tools for analyzing the performance of a competition vehicle. These concepts are essential for developing complex projects such as Formula Student and other competition vehicles. Through lectures, group projects, and the use of dedicated software, students will understand all aspects related to vehicle design and analyze its performance.

STUDY LOAD

Type	Hours	Percentage
Guided activities	10,0	6.67
Hours large group	30,0	20.00
Self study	110,0	73.33

Total learning time: 150 h

CONTENTS

Advanced lateral dynamics modeling

Description:
Following the analysis carried out in FS1, the student will lear more about advanced vehicle dynamics model, a.k.a. two-track model, understanding the influence of the lateral load transfer

Full-or-part-time: 6h
Theory classes: 6h

Springs, dampers, and anti-roll bars

Description:
Analysis of the types of spring/damper arrangement used on racing cars, knowing in detail how to
- specify the length and stiffness of suspension springs
- the basic types of racing damper and how to define the optimum characteristics
- design an appropriate anti-roll system

Full-or-part-time: 2h
Theory classes: 2h

Suspension system

Description:
During this part of the course
-You will know what is required from a racing car suspension in order to optimise performance
-You will know how to design a double wishbone suspension and understand how geometry changes
affect the ability to control wheel camber and other important characteristics
-You will learn how suspension geometry can be used to control the pitching of a car during acceleration and braking – so called anti-squat and anti-dive
-You will be able to calculate loads in the suspension and select suitable structural members
-You will be aware of why particular wishbone geometries have been adopted in a range of different cars

Full-or-part-time: 4h
Theory classes: 4h

Race car balancing

Description:
At the end of this part of the course:

-You will be aware of the basic types of racing tyre
-You will understand the important concept of tyre slip angle and how this influences understeer and oversteer during cornering
-You will learn the significance of tyre drag force and camber thrust
-You will be able to calculate individual wheel lateral load transfer during cornering and appreciate how this changes with front and rear suspension roll stiffness
-You will understand the factors that contribute to understeer/oversteer balance and be able to perform the necessary calculations to produce a desired handling curve
-You will be able to estimate the actual amount of jacking that occurs during cornering

Full-or-part-time: 6h
Theory classes: 6h

Front wheel assembly and steering

Description:
At the end of this chapter:
-You will know which components are involved in the front wheel assembly and how they are packaged
-You will understand that it is important to minimise the unsprung mass
-You will be able to define various aspects of front wheel geometry
-You will understand racing car steering systems and how to avoid problems such as bump steer
-You will be able to specify wheel bearings
-You will learn how to evaluate the loads on wheel uprights to facilitate effective cornering and braking

Full-or-part-time: 2h
Theory classes: 2h

Brakes- fundamentals and design

Description:
At the end of this chapter:
-You will know the elements of a car braking system
-You will understand the key objectives in brake system design
-You will understand the importance of brake balance and how it is achieved
-You will know how to size and specify the various brake components
-You will learn how to evaluate the loads on the brake pedal and its assembly, and to ensure adequate robustness

Full-or-part-time: 4h
Theory classes: 4h

Telemetry analysis

Description:
content english

Full-or-part-time: 2h
Theory classes: 2h

Tutorials

Description:
content english

Full-or-part-time: 4h
Theory classes: 4h

GRADING SYSTEM

The evaluation will be based on each student's participation in the project according to the following criteria:

Two partial exams (one mid-term and one at the end of the course) with a final oral interview (60%)
Development of a group project dedicated to one of the vehicle areas (Dynamics, Ergonomics, Chassis, Powertrain, Electrical, Aerodynamics) (40%)