

Tárgytematika / Course Description **Systemic Engineering of Vehicle Design**

AJNB_JFTA025

Tárgyfelelős neve /

Teacher's name: dr. Feszty Dániel

Félév / Semester: 2025/26/1

Beszámolási forma /

Assesment: Folyamatos számonkérés

Tárgy heti óraszám /

Teaching hours(week): 2/3/4

Tárgy féléves óraszám /

Teaching hours(sem.):

OKTATÁS CÉLJA / AIM OF THE COURSE

The objective is to gain a comprehensive overview of the

- classification of road vehicles,
- structure of a passenger or race vehicle,
- drive train types,
- subsystems of road vehicles (e.g. drive system, undercarriage, steering system, brake system, communication and electronic system, safety systems),
- the materials used in road vehicles,
- design methodologies and principles and systemic approaches of vehicle design.

TANTÁRGY TARTALMA / DESCRIPTION

The course is held by two lecturers, Balázs Vehovszky and Ambrus Zelei.

* Total 112 hours, from which there is approximately $6 \cdot 8 = 48$ teaching hours frontal lecture (two times $4 \cdot 45$ mins block per week for a 6 weeks period).

* Furthermore, the students have compulsory projects

- 6 individual projects (one-week):

- 1) Wheel load transfer calculation & Ackermann steering geometry design & Car vibration simulation using quarter / half vehicle model (Matlab/Python)
- 2) Optimal path calculation based on traction budget and the point mass model of the vehicle
- 3) Vehicle path GPS measurement and postprocessing (velocity/acceleration analysis)
- 4) Whole vehicle center of gravity measurement
- 5) Go-kart frame torsional stiffness calculation (finite element method) and measurement (static & dynamic)
- 6) Literature review task on a chosen topic
 - Headlights
 - Carbon footprint calculation of cars
 - Safety tests
 - Special engineering materials in vehicles
 - Materials for the passenger compartment

Plastics in vehicles
Composites in vehicles
3D printing in car manufacturing
Heat insulation in vehicles
Aerodynamic "tricks" in vehicles
Ergonomy measures of passenger cars
Unique chassis design solutions
Painting technology of cars
Sound isolation/sound design of cars
Vibration absorbing solutions for car chasses
Glasses of cars
Special active safety assistants
Sensors for autonomous driving
Most practical passenger compartment solutions
Special HMI solutions
Worst car models, biggest failures
Special hybrid vehicles
Biggest safety issues, scandals
Biggest ergonomy mistakes
Chassis repair - possibilities and limitations
Recycling of vehicle parts
The most ... car - special vehicle records
Cheapest cars
Special urban cars
(Un)believable developments in the near future

- and additionally, 3-5-week long group project: project task is defined by the Arrabona Racing Team (ART, <https://www.arrabonaracing.hu/>). Weekly consultation (minimum once) with the ART members. 5-6 people per group. The project goal is to solve an actual problem related to the newest version of the ART formula student race car. Example topics:

E-cart electrification - gear pair sizing
Seat mount FEM simu
AIP FEM simu based on FS rules
Design a data acquisition system for the drivetrain
Compression tests of 3D printed materials

SZÁMONKÉRÉSI ÉS ÉRTÉKELÉSI RENDSZERE / ASSESMENT'S METHOD

A written report must be submitted for each project (6 individual reports, 1 group report)

Each project is finished oral presentation of the results in front of the class and the tutors:

- individual presentations for two freely chosen individual projects,
- the 3-weeks ART project ends with a presentation by the whole group.

There is a written exam on the lecture material + in case of failing of the written exam, oral retake exam can be done.

KÖTELEZŐ IRODALOM / OBLIGATORY MATERIAL

There are approximately 1000 PPT slides on the material. The outline:

- * Vehicle classification
- * Main vehicle parts (systemic view of a vehicle)
- * Main structural components of a vehicle (mechanical parts, electronics, software, communication)
- * Vehicle properties and their interaction (customer-oriented thinking and economic issues)
- * Evolution of cars (history and future perspectives, including the possible future of electric drive technology)
- * Modern material technologies (metals, polymers, ceramics, composites, others + costs)
- * Traditional manufacturing technologies
- * Modern trends in manufacturing & novel technologies
- * V-diagram used in vehicle design
- * Vehicle frame and chassis design (basic principles, types, manufacturing, and safety)
- * Suspension system (functionalities, design principles) + notion of degrees of freedom, mechanical joint types, springs and dampers, numerical simulation of simple mechanical and vibration systems
- * Suspension types, suspension kinematics and wheel alignment (e.g., caster, toe, and camber angle, roll center, KPI, scrub radius, anti-roll bar, effects on wheelbase and track)
- * Brake systems (classification and basic principles), slip, dynamics of braking
- * Tire and vehicle dynamics models, time-delay effect of tire contact, ideal curves on a track + resonance and fast Fourier transformation
- * Overview and application of simulation methods (multibody dynamics, finite element analysis, computational fluid dynamics, boundary element method for acoustics, IPG CarMaker)
- * Notion of verification and validation
- * Classical electronic components in a vehicle (battery, generator, starter motor, lights, dashboard)
- * Overview of electronic components in a modern vehicle (engine control, drive dynamics, safety, assistance, communication, entertainment)
- * Sensors and actuators in a vehicle (e.g., pressure, vibration, hydraulics, knock sensor, EGR valve, electronic actuators)
- * Bus systems & AUTOSAR (LIN, CAN, FlexRay, MOST): data transfer speed and safety issues

AJÁNLOTT IRODALOM / RECOMMENDED MATERIAL