COURSE DESCRIPTION CARD - SYLLABUS

Course name
Design of car bodies [S2MiBP1-PS>PNS]

Course

Field of study
Mechanical and Automotive Engineering

Year/Semester
1/1

Area of study (specialization)
Motor Vehicles

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
30

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

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Lecturers

Prerequisites

Basic knowledge of technical drawing, machine construction, materials science, car construction and car dynamics. Knowledge of the basic principles of designing and conducting strength and fatigue analyzes. The ability to adapt the design process to the task being performed, the choice of design solutions depending on the requirements and results of strength analyzes, and the basic ability to use design support software. Defining the hierarchy and schedule of project tasks. Ability to identify construction problems. Independence.

Course objective

Providing students with knowledge about the requirements for a car body in terms of applicable regulations and technical requirements. Overview of the basic elements of the design process: spatial layout of the vehicle, styling, statics, body stability and dynamics, crash resistance, weight minimization, aerodynamics.

Course-related learning outcomes

Knowledge:
Has a basic knowledge of the mechanics of solids and discrete systems with many degrees of freedom, mathematical modeling of physical and mechanical systems based on d"Alembert"s principle and

Lagrange"s equations, mathematical description of materials using constitutive equations.
He knows the modern engineering methods of computer graphics and the theoretical basis of engineering calculations using the finite element method.
Has extensive knowledge of selected departments of technical mechanics related to the selected specialization.

Skills:
He can correctly select the optimal material and its processing technology for typical parts of working machines, taking into account the latest achievements in material engineering.
He can develop a technical description, offer and design documentation for a complex machine from a selected group of machines.
Can perform a medium complex design of a working machine or its assembly using modern CAD tools, including tools for spatial modeling of machines and calculations using the finite element method.

Social competences:
He is ready to critically assess his knowledge and received content.
Is ready to recognize the importance of knowledge in solving cognitive and practical problems and to consult experts in case of difficulties in solving the problem on its own.
Is ready to fulfill professional roles responsibly, taking into account the changing social needs, including:

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Written exam on the lecture material, completion of laboratory classes based on the documentation of the tasks performed.

Programme content

The scope of the lecture includes the following topics:
- body design process,
- overview of materials and technologies used in bodies,
- virtual strength analyses,
- experiments on physical models and prototypes,
- aerodynamic interactions.

Course topics

The process of designing a car, and separating the process of designing the body from it. The main challenge: reducing fuel consumption and emissions by reducing vehicle weight. Stages of the body design process. Defining the functional features of the car and body. Choice of body concept.
Principles of styling and arrangement of the car interior - evaluation of solutions and selection criteria. Creation of virtual (digital) body designs.
Diagram of the body design process with an overview of the most important components. Overview of materials and technologies used in the manufacture of bodies. Discussion of issues: shaping material properties, methods of forming semi-finished products, techniques of joining materials, taking into account recycling. A study of weight reduction and a combination of functional and design requirements.
Conducting virtual strength analyzes (simulations) in the field of statics, stability and dynamics of the car body. Verification of the structure with regard to: torsion and bending stiffness of the body, and determination of the frequency and eigenmodes of the body. Carrying out simulations of vehicle collisions and assessment of passive safety.
Making a prototype. Materials, manufacturing techniques and joining methods used in prototyping. Methods of assembly and evaluation of the correctness of the prototype production. Conducting experiments on physical models and prototypes in terms of stiffness, natural vibrations and crash tests. Criteria for evaluating the results of experimental research.
Body aerodynamics and its importance in meeting the challenges posed by the vehicle design. Basic knowledge of aerodynamic effects (convection and diffusion) and flows (steady and transient). Explaining the importance of turbulence. Discussion of drag and aerodynamic downforce. Car drag and lift coefficients.

Considerations on passenger car aerodynamics. Influence of various body parameters on aerodynamic drag. Truck aerodynamics. Solutions reducing aerodynamic drag. Aerodynamics of the tanker, bus and vans.
Sports car aerodynamics. The importance of aerodynamic downforce and ways to increase it. Application of wings, diffusers and vortex generators. Aerodynamic solutions for FORMULA STUDENT vehicles. Racing car aerodynamics (with exposed and covered wheels). Optimization of the pressure distribution on the wheels and the pressure center.

Teaching methods

1. Lecture: multimedia presentation. 2. Laboratory classes: creating virtual models of vehicle bodies and their documentation.

Bibliography

Basic
1. Zieliński A.: Konstrukcja nadwozi samochodów osobowych i pochodnych, WKiŁ, 2008
2. Morello L., Rossini L. R., Pia G., Tonoli A.: The Automotive Body, Volume I: Components Design, Springer 2011
3. Morello L., Rossini L. R., Pia G., Tonoli A.: The Automotive Body, Volume II: System Design, Springer 2011
4. P.Geck, Automotive Lightweighting Using Advanced High-Strength Steels, SAE International 2014
5. J.Piechna, Podstawy aerodynamiki pojazdów, WKiŁ 2000
Additional
1. R.H.Barnard, Road vehicle aerodynamic design, MechAero 2010
2. W.-H.Hucho, Aerodynamika samochodu, Od mechaniki przepływu do budowy pojazdu, WKiŁ 1988
3. J.Katz, Automotive aerodynamics, John Wiley & Sons 2016
4. T.Ch.Schuetz, Aerodynamics of road vehicles, SAE International 2016
5. J.Happian-Smith (ed.), An Introduction to Modern Vehicle Design, Butterworth-Heinemann 2002

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	60	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	40	2,00