COURSE DESCRIPTION CARD - SYLLABUS

Course name

Computational methods in vehicle body design

Course

Field of study	Year/Semester
Construction and Exploitation of Means of Transport	1 / 2
Area of study (specialization)	**Profile of study**
Motor vehicles	general academic
Level of study	**Course offered in**
Second-cycle studies	polish
Form of study	**Requirements**
full-time	compulsory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
30	30	0
Tutorials	**Projects/seminars**	
0	0	

Number of credit points

4

Lecturers

Responsible for the course/lecturer:	Responsible for the course/lecturer:
Marek Maciejewski	Mikołaj Spadło

Prerequisites

Theoretical and practical knowledge of mechanical engineering, vehicle design, and fundamentals of the computer aided vehicle design. Knowledge of the principles of structural mechanics (statics, stability and dynamics) and flow issues. The ability to design car subassemblies and their elements in traditional engineering terms. Basic practice in handling computational systems based on the finite element method. The ability to independently formulate problems of mechanical analysis of a structure and to resolve related dilemmas. The ability to correctly plan and timely perform activities in the implementation of computational projects.

Course objective

Provide students with knowledge on: theoretical foundations and the implementation of numerical computational methods intended for modeling vehicle supporting systems and their static, stability, dynamic analysis in the linear and non-linear range, as well as the principles of inference regarding the strength and fatigue of structures, and in the scope of aerodynamic analysis of vehicles.

Course-related learning outcomes

Knowledge

1. He knows the theoretical basics and fundamentals of numerical computational methods for modeling vehicles and their subsystems. 2. Knows the finite element method and models used in the scope of structural mechanics. 3. Knows the basics and computer computational practice of static, stability and dynamic analysis in the linear and nonlinear range. 4. Knows computational problems in the range of vehicle aerodynamics.

Skills

1. Is able to use the finite element method for designing immediate and fatigue strength, stability, dynamics and aerodynamics of cars. 2. Is able to define the boundary and initial conditions and define the loads when using computer calculation methods in the design of vehicle systems. 3. Is able to carry out an engineering analysis and evaluation of the results obtained from computer simulations.

Social competences

1. Is aware of the importance of using computer methods for the optimization of vehicle design processes. 2. Understands the need for continuous updating of software supporting design processes.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Written exam on the lecture material, and credit based on the documentation of the computational analyzes of vehicle subassemblies or elements.

Programme content

The importance of using calculation methods in the design of bodies. Continuous and discrete issues. The transformation of a continuous problem into a discrete problem through discretization and approximation. Calculation methods: finite difference method (MRS), finite element method (FEM), boundary element method (MEB) and finite volume method (MOS).

Static calculations using FEM. Review of finite elements: volumetric, surface and linear. The course of static analysis. Methods for solving systems of linear equations: direct and iterative.

Stability calculations using FEM. The idea of bifurcation. Initial stability. Generalized eigenstability problem. The course of bifurcation analysis. Methods of solving one's own problem: iterative and direct.

Dynamic calculations using FEM. Equation of dynamics at the discrete level. The modal superposition method. Direct integration of equations of motion: explicit and implicit methods, and one-step and multi-step methods. Overview of selected methods. Assessment of integration methods. The damping problem.

Aerodynamic calculations using MOS. The Navier-Stokes equations for compressible and incompressible flow. Turbulence and methods of its parameterization. 2D and 3D simulations of flows around cars. Procedures for adaptation of computational grids. Simulation examples.

Teaching methods

1. Lecture: multimedia presentation. 2. Laboratory classes: carrying out computer simulations of vehicles or their components and processing the results.

Bibliography

Basic

1. Kleiber M., Wprowadzenie do metody elementów skończonych, Poznań, WPP 1984

2. Kleiber M., Numeryczna analiza statycznych i dynamicznych zagadnień stateczności konstrukcji, Poznań, WPP 1987

3. Łodygowski T., Kąkol W., Metoda elementów skończonych w wybranych zagadnieniach mechaniki konstrukcji inżynierskich, Poznań, WPP 1994

4. Drikakis D., Rider W., High-resolution methods for incompressible and low-speed flows, Berlin, Heidelberg, Springer-Verlag 2005

5. Jayanti S., Computational Fluid Dynamics for Engineers and Scientists, Springer Netherlands 2018

Additional

1. Pulliam T.H., Zingg D.W., Fundamental Algorithms in Computational Fluid Dynamics, Springer International Publishing 2014

Breakdown of average student's workload

	Hours	ECTS
Total workload	110	4,0
Classes requiring direct contact with the teacher	60	2,2
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	50	1,8

[1] delete or add other activities as appropriate