COURSE DESCRIPTION CARD - SYLLABUS

Course name
Computational methods in vehicle body design

Course

Field of study
Mechanical and Automotive Engineering

Area of study (specialization)
Motor vehicles

Level of study
Second-cycle studies

Form of study
part-time

Year/Semester
2/2

Profile of study
general academic

Course offered in
polish

Requirements
compulsory

Number of hours

Lecture
18

Laboratory classes
18

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points
4

Lecturers

Responsible for the course/lecturer:
Marek Maciejewski

Responsible for the course/lecturer:
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

Has extended knowledge of mathematics in the field of numerical methods used in optimization tasks, computer simulation, linear algebra, interpolation and approximation.

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.

Has extended knowledge of thermodynamics and fluid mechanics to the extent necessary to understand the principle of operation and calculations of thermodynamic and flow processes occurring in working machines such as heating, cooling, drying, thermal and pressure agglomeration, etc., pneumatic transport, energy conversion, etc.

Skills

Can plan and carry out experimental research of specific processes taking place in machines and routine tests of a working machine or a vehicle from a selected group of machines.

Can use a popular numerical system to program a simple system simulation task with a small number of degrees of freedom.

Is able to use the acquired knowledge in the field of thermodynamics and fluid mechanics to simulate thermodynamic processes in technological systems of machines, using specialized computer programs.

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.

It is ready to fulfill social obligations, inspire and organize activities for the benefit of the social environment.

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	60	4,0
Classes requiring direct contact with the teacher	36	2,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	24	2,0

[1] delete or add other activities as appropriate