STUDY MODULE DESCRIPTION FORM

Name of the module/subject		Code
Computational methods in vehicle body design		**1010615221010618720**
Field of study: **Mechanical Engineering**	Profile of study (general academic, practical): **(brak)**	Year /Semester: **1 / 2**
Elective path/specialty: **Motor Vehicles and Tractors**	Subject offered in: **Polish**	Course (compulsory, elective): **obligatory**
Cycle of study: **Second-cycle studies**	Form of study (full-time,part-time): **part-time**	

No. of hours				No. of credits
Lecture: **18**	Classes: **-**	Laboratory: **18**	Project/seminars: **-**	**4**

Status of the course in the study program (Basic, major, other)	(university-wide, from another field)
(brak)	**(brak)**

Education areas and fields of science and art	ECTS distribution (number and %)
technical sciences	**1 50%**
Technical sciences	**1 50%**

Responsible for subject / lecturer:

Mikołaj Spadło
email: mikolaj.spadlo@ put.poznan.pl
tel. 61 665 22 26
Wydział Inżynierii Transportu
ul. Piotrowo 3, 60-965 Poznań

Responsible for subject / lecturer:

Marek Maciejewski
email: marek.maciejewski@put.poznan.pl,
tel. 61 665 22 26
Wydział Inżynierii Transportu
ul. Piotrowo 3, 60-965 Poznań

Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	Theoretical and practical knowledge of mechanical engineering, building vehicles, and fundamentals of the computer aided vehicle design. Acquaintance with structural mechanics (statics, stability and dynamics) and fluid flow problems.
2	**Skills**	Competence in the vehicle assemblies design and its elements, in traditional engineering depiction. Basic practice in handling the computational software based on the finite element method.
3	**Social competencies**	Ability for independent problem formulation in the field of mechanical analysis of structures, and settling dilemma with this connected. Ability for correct computational task planning and their timely execution.

Assumptions and objectives of the course:

Transferring knowledge about: the theoretical basis and numerical computational methods designed for modelling the vehicle supporting systems and their static, buckling and dynamic analysis in the linear and nonlinear scope, and also inference rules about the strength and fatigue of structures and in the scope of vehicle aerodynamic analysis.

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. Knows theoretical basis and fundamentals of numerical computational methods for modelling the whole vehicles and their systems - [K2A_W01]

2. Knows the finite element method and the models used in scope of structural mechanics - [K2A_W06]

3. Knows basics and computational practice in scope of static, buckling and dynamic analyses in the linear and nonlinear range - [K2A_W11]

4. Knows computational problems in the range of vehicle aerodynamics - [K2A_W019]

Skills:

1. Is able to use the finite element method to determine the strength, fatigue, stability, dynamics and aerodynamics of vehicles - [K2A_U06]

2. Is able to define initial and boundary conditions, and also loads with the use of computational methods for designing the road vehicle systems - [-]

3. Is able to carry out an engineering analysis and to estimate obtained (from computer simulations) results - [-]

Social competencies:

1. Is aware of importance of the using the computer methods for optimization of vehicle design processes - [K2A_K04]

2. . Undestand the need of continuous updating the design aided software - [-]

Assessment methods of study outcomes

Written examination of lecture material, and credit classes on the basis of results of the personal computing tasks from the scope of computing the vehicle elements or subassemblies

Course description

The importance of using computational methods in body design. Continuous problems and discrete problems. Transformation of a continuous problem into a discrete one through discretization and approximation. Computational methods: finite difference method (FDM), finite element method (FEM), boundary element method (BEM) and finite volume method (FVM).

Static structural analysis using FEM. Overview of finite elements: volume, surface and linear elements. The course of static analysis. Direct and iterative methods for solving systems of linear equations.

Stability calculations using FEM. The idea of bifurcation. Initial stability. Generalized eigenproblem of stability. The course of bifurcation analysis. Direct and iterative methods for solving eigenproblem.

Dynamic structural analysis using FEM. Dynamics equation at the discrete level. The modal superposition method. Direct integration of the equations of motion: explicit and implicit methods, and one-step and multi-step methods. Discussion of selected methods. Evaluation of time integration methods. The problem of damping.

Aerodynamic calculations using FVM. The Navier-Stokes equations for compressible and incompressible flows. Turbulence and methods of its parameterization. Simulations of flows around cars in 2D and 3D space. Procedures for adaptation of computational meshes. Examples of simulations.

Basic bibliography:

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 bibliography:

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

Result of average student's workload

Activity	Time (working hours)
1. Participation in lectures	15
2. Lecture consultations	1
3. Preparation for the egzam	5
4. Admission to the egzamination	2
5. Preparation for the laboratory tests	5
6. Participation in laboratory classes	15
7. Laboratory consultations	1
8. Drawing up the report on laboratory tests	7

Student’s workload

Source of workload	hours	ECTS
Total workload	50	4
Contact hours	38	2
Practical activities	34	2