Card of Course: ***Modelling and Simulation of Selected Thermo-dynamic Problems in Automotive Vehicles (internal combustion engine, braking system).***

Description of course	
Code of course	
Name of course	***Modelling and Simulation of Selected Thermo-dynamic Problems in Automotive Vehicles (internal combustion engine, braking system)***
Version of course	*2024/2025*
A. ***Place of the course in system of studies***	
Level of education	*Intermediate*
Form and mode of studies	*Full-time studies*
Field of studies	*Transport*
Profile of studies	*General academic profile*
Specialization	*Main field*
Place of teaching of course	*Warsaw University of Technology, Faculty of Transport, Division for Construction and Operation of Transport Means*
Place of realization of course	*Not applicable*
Coordinator of course	*Andrzej Wolff, PhD, DSc., Division for Construction and Operation of Transport Means, Faculty of Transport, Warsaw University of Technology*
B. ***General characteristic of the course***	
Group/*Block of courses*	*Erasmus*
Level of course	*Intermediate*
Type of course	*Project*
Language of course	*English*
Location of the course in the study plan – nominal semester	
Location of the course in the academic year	*summer semester*
Preliminary requirements - formal	*Thermodynamics, Vehicle dynamics.*
Limit of students	*maximum 6 students (3 groups of 1-2 persons)*
C. ***Effects of education and manner of teaching***	
Purpose of course	*To familiarise the student with mathematical modelling and numerical simulation of selected thermodynamic and flow problems in automotive vehicles (internal combustion engine, braking system).*

Effects of education with reference to the learning outcomes for the area and field of study

No. effect	***Description of the effect***	***Reference to the characteristics of learning outcomes***	***Reference to the learning outcomes in the program***
Assumed learning outcomes in terms of knowledge			
W01	*The student has ordered and theoretically founded knowledge concerning thermodynamic and flow phenomena in automotive vehicles.*	*Tr1A_W08*	*T1A_W03*
W02	*The student knows the basic calculation methods of solving the fundamental physical processes taking place in automotive vehicles.*	*Tr1A_W01*	*T1A_W07*
W03	*The student has knowledge of the design and operation of some vehicle systems (internal combustion engine, braking system). He knows the basic methods of empirical testing of vehicle systems.*	*Tr1A_W09*	*T1A_W04*
Assumed learning outcomes in terms of skills			
U01	*The student has the ability to obtain information from the literature, integrate information and draw conclusions and opinions.*	*Tr1A_U01*	*T1A_U01*
U02	*The student is able to independently plan and conduct an experiment (physical, modelling, simulation) and interpret the results.*	*Tr1A_U09*	*T1A_U08*

U03	*The student can make a critical analysis of the functioning of the existing technical solutions (range of skills and references depends on the subject of the project).*	*Tr1A_U17*	*T1A_U13*
U04	*The student can design a device / object / system / process / typical for the specialization being studied.*	*Tr1A_U23*	*T1A_U16*
Assumed learning outcomes in the field of social competences			
KS01	–	–	–

Form of didactic studies and number of hours	*Lecture*	*Exercise*	*Laboratory*	*Project*	*Other*
On a weekly plan	0	0	0	**1**	0
Throughout the semester	0	0	0	**15**	0

Contents of education - separately for each form of didactic studies	1. *Mathematical modelling and simulation investigations of selected thermodynamic and flow problems in automotive vehicles. Individual projects (student groups of 1-2 persons) of the following subjects:* 2. *Numerical simulation of heat transfer process in automotive brakes;* 3. *Numerical simulation of a gas flow through the labyrinth seal of a piston ring pack;* 4. *Numerical simulation of hydrodynamic lubrication of piston rings of an internal combustion engine;* 5. *Numerical simulation of the working cycle of an internal combustion engine.*
Teaching methods	*Consultations with the person responsible for the semester project.*

Methods of verification of effects of education	
No. effect	***Methods of verification***
Assumed learning outcomes in terms of knowledge	
W01	*Checking of the performed project (description and results), and oral interview (defence of the project).*
W02	*Checking of the performed project (description and results), and oral interview (defence of the project).*
W03	*Checking of the performed project (description and results), and oral interview (defence of the project).*
Assumed learning outcomes in terms of skills	
U01	*Checking of the performed project (description and results), and oral interview (defence of the project).*
U02	*Checking of the performed project (description and results), and oral interview (defence of the project).*
U03	*Checking of the performed project (description and results), and oral interview (defence of the project).*
U04	*Checking of the performed project (description and results), and oral interview (defence of the project).*
Assumed learning outcomes in the field of social competences	
KS01	–

Methods of evaluation	*Computational project – checking of simulation results and a report in a written form.*
Exam	*No*
Literature	***Basic literature*****:** *[1] Incropera F. P., DeWitt D. P., Bergman T. L, Lavine A. S., Introduction to Heat Transfer, John Willey & Sons, 2006.* *[2] Heywood J. B., Internal Combustion Engine Fundamentals, McGraw Hill Science Engineering, 1988;* *[3] Sonntag R.E., Borgnakke C., Van Wylen G.J., Fundamentals of Thermodynamics, John Willey & Sons, 2002;* *[4] Taylor C.F., Internal Combustion Engine in Theory and Practice, MIT Press, 1985.* ***Supplementary literature*****:** *[1] Gillespie T. D., Fundamentals of vehicle dynamics, SAE, Inc. Warrendale 1994;* *[2] John J., Gas Dynamics, Prentice Hall, 2006.*
Website of the course	–

D. ***Student's activity***	
Number of ECTS credits	***3***
Number of hours of student's work to achieve effects of education	***75 hours****, including: work with academic teacher 10 hours, studying the literature 15 hours, familiarising with software 18 hours, independently performing of the project 30 hours, defence of the project 2 hours.*
Number of ECTS credits on the course with direct participation of academic teacher	***0,5 ECTS points*** *(work with academic teacher 10 hours).*
Number of ECTS credits on practical activities on the course	***3 ECTS points*** *(75 hours, including: work with teacher 10 hours, studying the literature 15 hours, familiarising with software 18 hours, independently performing of the project 30 hours, defence of the project 2 hours).*
E. ***Additional information***	
Notes	*As long as it does not cause changes in the relationship of a given subject with the directional effects in the content of education, changes may be introduced on an ongoing basis, taking into account the latest scientific achievements.*
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