Description of course		
Code		
Name	**Analytical Dynamics**	
Version	2025/26	
A. Place of the course in system of studies		
Level of education	second cycle programme	
Form and mode of studies	full-time study	
Field of studies	Transport	
Profile	General academic profile	
Specialisation	Main field	
Place of teaching of course		
Place of realization of course	Warsaw University of Technology, Faculty of Transport	
Coordinator	Dr hab. inż. Michał Opala	
B. General characteristic of the course		
Block of courses	nd	
Group of courses		
Level of course	Intermediate	
Language of course	English	
Nominal semester		
Preliminary requirements	Mathematics in the field of differential and integral calculus.	
Limit of students	–	
C. Effects of education and manner of teaching		
Purpose of course	The objective of this course is to familiarize students with the fundamentals of analytical mechanics and methods for modelling and analysing dynamic systems, particularly those used in vehicles and transport systems. Students will acquire the ability to solve problems related to mechanical vibrations (including suspension, body, and powertrain vibrations), rigid body motion within the context of vehicle kinematics and dynamics, and analysis of forces acting on structural elements of transport means. Additionally, the course introduces students to collision modeling and demonstrates examples of utilizing selected computational methods in dynamic analysis.	
Effects of education	See Table 1	
Form of didactic studies and number of hours per week	Lecture	1h per week / total 15.00h
	Exercise type of course	1h per week / total 15.00h
	Laboratory	–
	Project type of course	
Contents of education	Lectures - basic concepts of classical mechanics, principles of conservation and changeability, dynamics of a rigid body in space. Elements of the impact theory. Introduction to analytical mechanics. Generalized constraints and coordinates, virtual work, d'Alembert's principle, Lagrange's equations of the first and second kind. Mechanical vibrations. Linear vibrations of systems with one or more degrees of freedom. Nonlinear vibrations - examples of systems with one degree of freedom. Methods of analysis of vibrating systems. Methods of synthesis of vibrating systems. Modelling of mechanical systems. Examples of applications of theoretical mechanics in computer aided engineering (CAE). Problem-solving exercises and tutorials - development of models of simple mechanical systems, selection of appropriate principles and methods of mechanics and making calculations.	
Methods of education	Lectures - conventional lecture (content conveyed directly in finished form) and problem lecture (presentation of selected scientific and practical problems). Use of multimedia presentations. Problem-solving exercises and tutorials - conventional and conversational auditorium exercises. Use of multimedia materials.	
Methods of evaluation	Passing the classes is based on the test carried out at the end of semester. The exact date of the test is set at the beginning of the semester. The test consists of a practical part (2-3	

	calculation tasks) and a theoretical part (2-3 open theoretical questions on the material presented in the lecture). A minimum of 50% correct answers is required. The condition for passing the course is to obtain a grade not lower than 3 in the test. The correction test is scheduled for the last class.
Methods of verification of effects of education	Written test or an alternative form of verification which involves team preparation of a report on the assigned tasks and presentation. The tasks involve modelling mechanical systems.
Exam	No.
Literature:	Morin D., Introduction to Classical Mechanics With Problems and Solutions, CUP, 2008. J. L. Meriam, L. G. Kraige, Engineering Mechanics, Volume 2, Dynamics, John Wiley & Sons, Inc. Beer F.P., Johnston E.R.: Vector Mechanics for Engineers. Statics and Dynamics. McGraw Hill, 2019. Hibbeler R. C.: Engineering Mechanics: Dynamics, 13th Edition, Prentice Hall, 2013. Ginsberg J., Engineering dynamics, CUP, 2008. G. Housner, D. Hudson, Applied Mechanics – Dynamics, 2nd ed., Caltech, 1980. (https://core.ac.uk/download/pdf/216148055.pdf), Logan D.L., A First Course in The Finite Element Method, Fifth edition, Cengage Learning, 2012. Pidaparti R.M., Engineering Finite Element Analysis, Morgan & Claypool, 2017
www	–
D. Student's activity	
Number of ECTS points	3
Number of hours of student's job for achievement of education's effect (description):	43h (Preparation for exercises 10h. Preparation for the test from the lecture part 10h. Preparation for the test from exercises, alternatively team report and presentation 15h. Studying literature 8h.)
Number of credits ECTS on the course with direct participation of academic teacher	1.28 (Hours related to participation in classes 30h. Consultation 2h)
Number of credits ECTS on practical activities on the course	15h
E. Additional information	
Notes	As long as it does not cause changes in the scope of linking a given module of classes with major learning outcomes, changes in the content of education may be introduced on an ongoing basis, taking into account the latest scientific achievements.
Date of last edition	17.06.2025

Table 1. General academic profile

Effect:	Field effects	Verification:	Area effect
Knowledge			
Knows the basic concepts and equations of analytical mechanics.	W01	The written test consists of two or three open theoretical questions.	Tr2A_W03
Knows the problems of analysis and synthesis of mechanical systems.	W02	The written test consists of two or three open theoretical questions.	Tr2A_W03
Knows the methods of modeling mechanical systems and the structure of vibrating linear and nonlinear systems.	W03	The written test consists of two or three open theoretical questions.	Tr2A_W03, Tr2A_W10

Knows the methods of analysis of mechanical systems limited by constraints.	W04	The written test consists of two or three open theoretical questions.	Tr2A_W03, Tr2A_W10
Skills			
Is able to solve tasks related to the dynamics of vibrating systems.	U01	The written test includes calculation tasks related to finding equations of motion and natural frequencies. An alternative form of verification involves team preparation of a report on the assigned tasks. The tasks involve modelling a mechanical system.	Tr2A_U12
Can solve problems containing models of colliding simple mechanical systems.	U02	The written test includes calculation tasks related to finding velocities of the bodies after the collision. An alternative form of verification involves team preparation of a report on the assigned tasks. The tasks involve modelling a mechanical system.	Tr2A_U12
Can model mechanical systems.	U03	The written test includes calculation tasks related to finding constraints equations and equilibrium positions. An alternative form of verification involves team preparation of a report on the assigned tasks. The tasks involve modelling a mechanical system.	Tr2A_U12
Social competences			
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