

Subject card

Subject name and code	Classical Mechanics, PG_00211025						
Field of study	Physics						
Date of commencement of studies	October 2026		Academic year of realisation of subject		2027/2028		
Education level	Bachelor's studies		Subject group		Obligatory subject group in the field of study		
Mode of study	full-time studies		Mode of delivery		at the university		
Year of study	2		Language of instruction		Polish Classes may be conducted in English in the following cases: - classes taught by an English-speaking lecturer; -the presence in the group of a foreign student who does not speak Polish; - classes conducted by an invited external expert; -at the request of the students in the given group.		
Semester of study	3		ECTS credits		7.0		
Learning profile	academic		Assessment form		exam		
Conducting unit							
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. Michał Studziński				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	45.0	30.0	15.0	0.0	0.0	90
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan		Participation in consultation hours		Self-study	SUM
	Number of study hours	90		0.0		85.0	175
Subject objectives	Understanding of the theoretical foundations of classical physics. In particular, the aim of the lecture is to go beyond Newtonian formalism and to introduce other methods for describing mechanical systems, such as the Lagrangian, Hamiltonian, and related formalisms.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[FIZL3_W05] understands, on the advanced level, astrophysical phenomena and the laws governing them, knows advanced physical processes taking place in the Universe	The student knows and understands the basic laws of classical mechanics and can explain their role in the description of the motion of particles, many-body systems, and simple astrophysical systems, in particular motion in a gravitational field and orbital motion.	[SW4] test/exam - oral or written [SW1] oral statement/conversation/discussion
	[FIZL3_U09] can extrapolate the results obtained in the terrestrial laboratory to describe phenomena in the Universe	The student is able to use the laws of classical mechanics established for laboratory systems to model and interpret phenomena occurring on astronomical scales, in particular the motion of planets, satellites, binary systems, and motion in a central force field.	[SU1] oral statement/conversation/discussion [SU4] test/exam - oral or written [SU8] observation of student's independent or team work
	[FIZL3_U03] can apply the formalism of classical physics to describe phenomena at the macroscopic level	The student is able to apply the formalism of classical mechanics, in particular the Lagrangian, Hamiltonian, and Jacobi formalisms, including selected relativistic elements, to describe and analyze phenomena and processes occurring in macroscopic systems.	[SU1] oral statement/conversation/discussion [SU4] test/exam - oral or written [SU5] implementation of a problem task [SU8] observation of student's independent or team work
	[FIZL3_U04] can apply the formalism of phenomenological thermodynamics and statistical physics to describe complex systems	The student is able to apply the formalism of classical mechanics, in particular Newton's laws, conservation laws, Lagrange equations, and basic elements of Hamiltonian formalism, to describe complex systems, including systems with many degrees of freedom and systems with constraints.	[SU1] oral statement/conversation/discussion [SU4] test/exam - oral or written
	[FIZL3_U08] can use numerical methods or software for symbolic calculations and simulations to describe and model physical phenomena and processes	The student is able to apply numerical methods or computer algebra software to model the motion of mechanical systems described in the Lagrangian and Hamiltonian formalisms and to analyze selected phenomena of classical mechanics.	[SU1] oral statement/conversation/discussion [SU4] test/exam - oral or written [SU5] implementation of a problem task [SU8] observation of student's independent or team work
	[FIZL3_W01] has advanced knowledge of physical concepts, principles and theories, understands their historical development and significance not only for physics, but also for other exact and natural sciences and cognition of the world; knows and understands fundamental dilemmas of the civilization	The student knows and understands advanced concepts, principles, and theories of classical mechanics, including the Lagrangian, Hamiltonian, and Jacobi formalisms; understands their historical development and their significance for physics and other natural sciences; and is also aware of the limitations of these theories in the context of modern physics, particularly in the areas of relativistic and quantum phenomena.	[SW4] test/exam - oral or written [SW1] oral statement/conversation/discussion [SW5] implementation of a problem task
	[FIZL3_W06] knows and understands, on the advanced level, the principles of non-relativistic or relativistic mechanics	The student knows and understands the fundamental principles of classical non-relativistic mechanics and selected topics in relativistic mechanics, including the Lagrangian, Hamiltonian, and Jacobi formalisms used to describe macroscopic systems.	[SW4] test/exam - oral or written [SW1] oral statement/conversation/discussion [SW5] implementation of a problem task

Subject contents	-Constraints and their classification. Configuration space. Lagranges equations of the first kind and DAlemberts principle. -Lagrangian dynamics (including Lagranges equations of the second kind and the Lagrange equations for a charged particle). -Hamiltons variational principle. -Noethers theorem: conservation laws and symmetries of the Lagrangian function; Noethers theorem and conservation of energy; Noethers theorem and conservation of momentum. -Kinematics and dynamics of a rigid body (including: inertia tensor of a rigid body, principal axes of the inertia tensor, description of rigid-body motion, Eulers equations, Euler angles, precession). -Small oscillations. Harmonic oscillator. Small oscillations in systems with many degrees of freedom. Normal modes. -Hamiltonian dynamics. -Canonical transformations. -HamiltonJacobi theory (selected topics). -Perturbation theory in the Hamiltonian formalism (selected topics).		
Prerequisites and co-requisites	Knowledge of the fundamentals of Newtonian mechanics together with the basics of algebra, vector analysis, and mathematical analysis at the level of an undergraduate physics course.		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	in-class written test (tutorials)	51.0%	35.0%
	in-class practical test (laboratory)	51.0%	20.0%
	written exam (wykład)	51.0%	45.0%
Recommended reading	Basic literature	- N. A. Lemos, <i>Analytical Mechanics</i>, Cambridge University Press - G. L. Kotkin and V. G. Serbo, <i>Exploring Clasical Mechanics</i>, Oxford University Press - P. Hamill, <i>A Student's Guide to Lagrangians and Hamiltonians</i>, Cambridge University Press	
	Supplementary literature	- Feynman, R. P., Leighton, R. B., & Sands, M. <i>The Feynman Lectures on Physics, Volume I: Mainly Mechanics, Radiation, and Heat</i>. Reading, Massachusetts: Addison-Wesley, 1964 (New Millennium Edition: Basic Books, 2015). - W. Greiner, <i>Classical Mechanics, Point Particles and Relativity</i>, Springer - H. Goldstein, Ch. Poole, J. Safko, <i>Classical Mechanics</i>, Addison Wesley	
	eResources addresses		

Example issues/ example questions/ tasks being completed	-Lagranges equations of the first and second kind derivation and applications. -Using Noethers theorem, demonstrate the relationship between translational symmetry and conservation of momentum. -Implement a simulation of small oscillations in a system with many degrees of freedom and identify the normal modes. -Discuss the significance of Eulers equations in describing the motion of a rigid body.
Work placement	Not applicable

Document generated electronically. Does not require a seal or signature.