



Subject card

Subject name and code		Relativistic quantum mechanics, PG_00064607						
Field of study		Technical Physics						
Date of commencement of studies		February 2027	Academic year of realisation of subject			2026/2027		
Education level		second-cycle studies	Subject group			Obligatory subject group in the field of study Subject group related to scientific research in the field of study		
Mode of study		Full-time studies	Mode of delivery			at the university		
Year of study		1	Language of instruction			Polish		
Semester of study		1	ECTS credits			4.0		
Learning profile		general academic profile	Assessment form			exam		
Conducting unit		Division of Electron Collisions Physics -> Institute of Physics and Applied Computer Science -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)		Subject supervisor		dr hab. Paweł Możejko				
		Teachers						
Lesson types		Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
		Number of study hours	30.0	15.0	0.0	0.0	0.0	45
		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	45	5.0	50.0	100		
Subject objectives		Students become acquainted with selected topics and methods in relativistic quantum mechanics.						
Learning outcomes		Course outcome	Subject outcome			Method of verification		
		[K7_W01] demonstrates advanced knowledge of key branches of physics, including quantum mechanics and molecular electronics.	The student has in-depth knowledge of quantum mechanics, including relativistic concepts. Can explain the form of the Klein-Gordon and Dirac equations and interpret their solutions. Can identify and explain the key steps in the quantization of the electromagnetic field. Understands the fundamentals of describing the interaction of physical systems with light.			[SW1] Assessment of factual knowledge		
		[K7_W02] possesses advanced, theoretically grounded knowledge in physics and, to an extent appropriate to professional needs, in related scientific or technical disciplines, including applied computer science, applied physics and photovoltaics.	A student is familiar with selected topics in advanced quantum mechanics. He can prove the relativistic invariance of the Dirac equation. Knows the formulation of time-dependent perturbation theory in quantum mechanics.			[SW1] Assessment of factual knowledge		
		[K7_U04] is able to formulate and test research hypotheses.	A student has practical skills in advanced quantum mechanics. A student can solve the Klein-Gordon and Dirac equations for selected physical systems. A student can correctly interpret the solutions to the Klein-Gordon and Dirac equations. Can describe the interaction of a two-level atom with light.			[SU3] Assessment of ability to use knowledge gained from the subject [SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools		

Subject contents	Course content – lecture		
	<ol style="list-style-type: none"> 1. A concise overview of non-relativistic quantum mechanics and elements of special relativity theory 2. Klein-Gordon equation 3. The pi-meson atom problem with the Zeeman effect - solution of the Klein-Gordon equation 4. Dirac equation 5. Relativistic invariance of the Dirac equation 6. Solution of the Dirac equation for free particles 7. Solution of the Dirac equation for the hydrogen atom 8. Time dependent perturbation theory 9. Quantization of the electromagnetic field 10. Interaction of light with atomic systems 		
	Course content – exercises		
	<ol style="list-style-type: none"> 1. Solution of the Klein-Gordon equation for a pi-meson atom. 2. Solution of the Klein-Gordon equation for a pi-meson atom placed in a constant weak magnetic field 3. Solution of the Dirac equation for a hydrogen atom - performing calculations omitted from the lecture 4. Solution of simple perturbation problems with time-dependent perturbation 5. Solution of the problem of the interaction of a two-level atom with light 		
Prerequisites and co-requisites			
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Exam mark	50.0%	100.0%
Recommended reading	Basic literature	<ol style="list-style-type: none"> 1. A.S. Davydov "Quantum Mechanics" Pergamon Press, Oxford, 1965 2. J. D. Bjorken, S. D. Drell "Relativistic Quantum Mechanics" McGraw-Hill, New York, 1964 3. W. Greiner "Relativistic Quantum Mechanics" Springer, Berlin, 1994 4. V. Berestetski, E. Lifchitz, L. Pitayevski "Relativistic quantum theory" MIR, Moscow 1967 	
	Supplementary literature	<ol style="list-style-type: none"> 1. Pauling, L: Introduction to Quantum Mechanics: With Applications to Chemistry (Dover) 2. S. Kryszewski "Mechanika kwantowa" Wyd. UG 3. L. Grave de Peralta, M.F. Lozada, H. Farooq, G. Eichman, A. Singh, G. Prime "Relativistic and Non-relativistic Quantum Mechanics. Both at Once" Springer 2023 4. My colorful lecture notes - quantum mechanics - available in the course on the eNauczanie website. 	
	eResources addresses		
Example issues/ example questions/ tasks being completed	<ul style="list-style-type: none"> • Give the form of the Klein-Gordon equation along with its physical justification. • Solve the Klein-Gordon equation for the motion of a free particle. • Solve the Dirac equation describing a bound electron-proton system. • Discuss and justify the key steps in quantization of the electromagnetic field. 		
Practical activities within the subject	Not applicable		

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