GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Modern physics, PG_00031943						
Field of study	Technical Physics						
Date of commencement of studies	February 2024		Academic year of realisation of subject		2023/2024		
Education level	second-cycle studies		Subject group		Optional subject group Subject group related to scientific research in the field of study		
Mode of study	Full-time studies		Mode of delivery		e-learning		
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	Department of Theoretical Physics and Quantum Information -> Faculty of Applied Physics and Mathematics						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. arch. Jan Kozicki				
	Teachers		dr hab. inż. arch. Jan Kozicki				
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	30.0	0.0	0.0	0.0	60
	E-learning hours included: 60.0						
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	60		8.0	32.0		100
Subject objectives	Introduce students to the following: 1. Elements of the theory of relativity - reference systems, the speed of light, Einstein's postulates, Lorentz transformation and its consequences; 2. Elements of quantum mechanics - the postulates of quantum theory, Heisenberg's uncertainty principle, the Schrödinger wave function, Hamiltonian, unit systems SI, natural and atomic; 3. Elements of quantum field theory - free fields for spin 0, spin 1/2, spin 1, Dirac, Klein-Gordon & Proca equation.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W01] Has extended and systematized knowledge of the basics of physics.	The student has an knowledge of the fundamental elements of special relativity and fundamental elements of quantum mechanics and fundamental elements of quantum field theory.	[SW1] Assessment of factual knowledge
[K7_W03] Has general knowledge of current development paths and discoveries in the scope of physics and related fields of science and technology.	The student knows the current developments and trends in physics.	[SW1] Assessment of factual knowledge

Subject contents	Elements of the theory of relativity - reference systems, the speed of light, Einstein's postulates, Lorentz transformation and its consequences. Elements of quantum mechanics - the postulates of quantum theory, Heisenberg's uncertainty principle, the Schrödinger wave function, quantum numbers, Hamiltonian; Elements of quantum field theory - free fields for spin 0, spin 1/2, spin 1, Dirac, Klein-Gordon & Proca equations.
Prerequisites and co-requisites	Fundamentals of classical mechanics Fundamentals of classical electrodynamics

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
final exam	50.0%	50.0%
test	50.0%	50.0%

Recommended reading	Basic literature	Robert D. Klauber, Student Friendly Quantum Field Theory, Sandtrove Press, 2015 R. Shankar, Principles of Quantum Mechanics, Springer, 1994
	Supplementary literature	H. Haken, H. C. Wolf, The Physics of Atoms and Quanta, Springer, 2005
	eResources addresses	Adresy na platformie eNauczanie: Fizyka współczesna 2023/2024 - Moodle ID: 35621 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=35621
Example issues/ example questions/ tasks being completed	1. Draw a Feynman diagram for a muon and anti-muon annihilating each other to produce a virtual photon, which then produces an electron and a positron. Using simplified symbols to represent more complex mathematical quantities, show how the probability of this interaction would be calculated. 2. Construct a chart showing how non-relativistic theories, relativistic theories, particles, fields, classical theory and quantum theory are interrelated. 3. Calculate d'Alembertian of square of interval x_μ, using tensor notation. 4. Why are the Hamiltonian and the Hamiltonian density not Lorentz scalars? If they are to represent energy and energy density, respectively, does this make sense? (Does the energy of an object or system have the same value for all observers? Do you measure the same kinetic energy for the plane passing overhead as someone on board of the plane would?) Energy is the zeroth component of the four-momentum p_μ. Does one component of a four vector have the same value for everyone? 5. Derive the commutators for the continuous solutions to the Klein-Gordon field equation from the second postulate of the 2nd canonical quantization. 6. Find the transition amplitude operating on the vacuum when a virtual anti-particle is propagated as shown on Fig 3-3b (page.71). Use symbols for numeric factors resulting from creation and destruction operators acting on the vacuum and other states. 7. Derive the adjoint Dirac equation (4-31) page.91	
Work placement	Not applicable	