COURSE OF STUDY FISICA

ACADEMIC YEAR 2023/24

ACADEMIC SUBJECT ISTITUZIONI DI FISICA TEORICA I

General information	
Year of the course	II Year
Academic calendar (starting and ending date)	March 2023-June 2023
Credits (CFU/ETCS):	6
SSD	FIS/02
Language	Italian
Mode of attendance	Free willing

Professor/ Lecturer	
Name and Surname	Alessandro Mirizzi
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Telephone	
Department and address	Dipartimento Interateneo di Fisica, Via Amendola 173
Virtual room	
Office Hours (and modalities: e.g., by appointment, on line, etc.)	On request. In presence or online

Work schedule			
Hours			
Total	Lectures	Hands-on (laboratory, workshops, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
150	32	30	88
CFU/ETCS			
6	4	2	

Learning Objectives	Knowledge of mathematical and physical foundation of elementary quantum mechanics
Course prerequisites	Concepts and techniques of Calculus, Linear Algebra, Analytical and Classical Mechanics

Teaching strategie	Lectures/exercise classes in the classroom
Expected learning outcomes in terms of	
Knowledge and understanding on:	○ Comprehension of the theoretical formulation of Quantum Mechanics. ○
Applying knowledge and understanding on:	○ The students will acquire the ability to apply the principles of Quantum Mechanics to simple one-dimensional systems and to generalize them to more complex systems. ○
Soft skills	• *Making informed judgments and choices* ○ Relation between experimental and theoretical physics. Use of the analogy in the development of the scientific knowledge

	• *Communicating knowledge and understanding*
	  ○ Development of adequate skill in communicating the learnt topics
	• *Capacities to continue learning*
	  ○ Ability is searching bibliographical references, in using (online) databases, and online material

Syllabus	
Content knowledge	• **Physical Prelude.** Crisis of classical mechanics. Black-body. Compton scattering. De Broglie waves. Schrödinger equation. Physical foundations of quantum mechanics. Quantum mechanical interpretation of double-slit experiments with electrons. • **Mathematical prelude.** Vectorial spaces and Hilbert spaces. Ortonormal basis. Dual space. Linear operators. Commutators. Inverse, adjoint, self-adjoint, unitary operators. Eigenvalue equation. Degeneracy. Eigenvalues and eigenvectors of self-adjoint and unitary operators. • **Postulates of quantum mechanics.** Principle of superposition. Physical observables and state vector. Measurement process. Reduction of state vector. Average value. Compatible observables. Position operator. Compatibility of coordinates. Representations. Wave functions and matrices. Unitary transformations. Hamiltonian. Temporal evolution of Schroedinger equation. Propagator. Heisenberg scheme. Conservation laws. Stationary states and time-independent Schoredinger. Momentum: eigenvalue equation, generators of translator. Indeterminacy relations. Wave packet. Excercises. • **Quantum systems.** Two-level systems. Postulate of the Hamiltonian. Free particle. Propagator. Broadening of the wave packet. Probability current. Square potentials: wall, well, direc-delta. General properties of Schroedinger equation. Harmonic oscillators. Periodic excercises. **Angular momentum.** Generator of the rotations. Commutations rules. Eigenvalue equation for J^2 and J_z with operatioral method and in coordinate representation. Sum of angular momenta. Clebsh-Gordon coefficients. Parity. Spin as generator of rotations. Electron spin. Schroedinger equation in a magnetic field. Bohm-Arhanov effect. Excercises.
Texts and readings	1. G. Nardulli, *Meccanica Quantistica I, Principi*, Franco Angeli, Milano 2001. 2. *L. Angelini, Meccanica Quantistica: problemi scelti, II edizione, Springer-Verlag Italia, Milano 2018*
Notes, additional materials	None
Repository	

Assessment	
Assessment methods	Written exams on exercises treated during the lectures. Oral exam on theoretical arguments treated during the lectures

Assessment criteria	• *Knowledge and understanding*
	  ○ Knowledge of theoretical foundation of quantum mechanics
	• *Applying knowledge and understanding*
	  ○ Use the acquired knowledge to solve problems of elementary quantum mechanics
	• *Autonomy of judgment*
	  ○ Developing physical and mathematical tools to properly model physical problems relative to simple quantum systems
	• *Communicating knowledge and understanding*
	  ○ Express in a proper way physical and mathematical concepts characterizing elementary quantum mechanics
	• *Communication skills*
	  ○ Acquire an appropriate rigorous language to communicate science
	• *Capacities to continue learning*
	  ○ Develop mathematical and physical tool to model physical problems

Final exam and grading criteria	Accuracy in the solution of the written problems. Clarity in the oral exposition of the physical concepts.
Further information	
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