UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

DIPARTIMENTO INTERUNIVERSITARIO DI FISICA

General information		
Academic subject	ISTITUZIONI DI FISICA TEORICA I	
Degree course	Fisica	
Academic Year	*2*	
European Credit Transfer and Accumulation System (ECTS)	6	
Language	Italian	
Academic calendar (starting and ending date)	March 2023-June 2023	
Attendance	Free willing	

Professor/ Lecturer	
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Virtual headquarters	
Tutoring (time and day)	On request. In presence or online

Syllabus	
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
Contents	• **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.
Books and bibliography	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*
Additional materials	None

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

Teaching strategy	Lectures/exercise classes in the classroom
Expected learning outcomes	
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

Assessment and feedback	

Methods of assessment	Written exams on exercises treated during the lectures. Oral exam on theoretical arguments treated during the lectures
Evaluation 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
Criteria for assessment and attribution of the final mark	Accuracy in the solution of the written problems. Clarity in the oral exposition of the physical concepts.
Additional information	