General information	
Academic subject	Istituzioni di Fisica Teorica II (Modulo A: Meccanica Quantistica)
Degree course	Fisica (L-30)
Academic Year	3rd
European Credit Transfer and Accumulation System (ECTS)	5
Language	Italian
Academic calendar (starting and ending date)	1st semester: Last week of September – Third week of December
Attendance	Free

Professor/ Lecturer	
Name and Surname	Prof. Paolo Facchi
E-mail	paolo.facchi@uniba.it
Telephone	080 544 3222
Department and address	*Dipartimento Interateneo di Fisica, office 182*
Virtual headquarters (Microsoft Teams code)	
Tutoring (time and day)	Students are invited to send an e-mail to arrange individual or group meetings

Syllabus	
Learning Objectives	In-depth knowledge of the theoretical foundations of Quantum Mechanics and ability to apply them to realistic physical models, also using approximation methods.
Course prerequisites	Postulates of Quantum Mechanics. Complex annalysis. Differential and operator calculus. One-dimensional quantum systems. Quantum dynamics.
Contents	***Angular momentum.*** Rotations and commutation relations. Spin and orbital angular momentum. Composition of Angular Momenta. Clebsch-Gordan coefficients. Examples. Schwinger model. Exercises. ***Symmetries.*** Symmetries, conservation laws and degeneracies. Discrete symmetries, spatial inversion and parity operator. Parity of the orbital angular momentum eigenstates. Exercises. ***Central potentials.*** Hamiltonian in spherical coordinates. Radial equation. Behavior of the radial function at the origin. Solution of the radial equation for the free particle, particle in a sphere, and particle in a potential well. Expansion of plane waves into spherical waves. Hydrogen atom. Exercises. ***Identical particles.*** Permutation symmetry. Indistinguishability principle. Bosons and Fermions. Two-electron system. Helium atom. Exercises. ***Perturbation theory.*** Time-independent perturbation theory: nondegenerate and degenerate case. The Stark effect. Fine structure. Time-dependent perturbation theory. Instant perturbation. Periodic perturbation. Fermi's Golden Rule. Exercises. ***Quantum dynamics.*** Time evolution and Schroedinger equation. Interaction picture and Dyson series. Propagator. Feynman path integrals. Semiclassical limit.
Books and bibliography	- J.J. Sakurai, J. Napolitano, Modern Quantum Mechanics, Cambridge University Press, Cambridge 2020; - L. Angelini, Meccanica Quantistica: problemi scelti, Springer-Verlag Italia, Milano 2018. - Lecture notes
Additional materials	*Additional books:* - L.D. Landau, E.M. Lifshitz, Quantum Mechanics, Pergamon Press, Oxford 1962; - A. Messiah, Mecanique Quantique, Dunod, Paris 1962, volume I; - J. Schwinger, Quantum Mechanics, Springer, Berlin 2001; - A. Peres, Quantum Theory: Concepts and Methods, Kluwer, Dordrecht 1995. - *Lecture notes available online at* http://www.ba.infn.it/~facchi/Sito/Lectures.html

Work schedule			
Total	Lectures	Hands on (Laboratory, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
Hours			
150	24	30	96
ECTS			
5	3	2	

Teaching strategy	
	Lectures and exercise sessions

Expected learning outcomes	
Knowledge and understanding on:	Composite systems. Total angular momentum. Spin. Symmetries. identical particles. Quantum dynamics.
Applying knowledge and understanding on:	Analytical and approximation techniques for understanding quantum phenomena and solving problems in quantum mechanics.
Soft skills	• **Making informed judgments and choices** Relationship between Experimental Physics and Theoretical Physics. The use of analogy in the development of scientific knowledge. • **Communicating knowledge and understanding** The student will acquire mastery of the lexicon of quantum physics. • **Capacities to continue learning** Ability to resolve quantum mechanical problems. Ability to consult bibliographic material and material on the web

Assessment and feedback	
Methods of assessment	Written exam; oral exam
Evaluation criteria	• **Knowledge and understanding** ○ Knowledge of the theoretical fundamentals of quantum mechanics • **Applying knowledge and understanding** ○ Using the acquired knowledge to solve problems in quantum mechanics • **Autonomy of judgement** ○ Developing physical and mathematical tools to properly model simple quantum systems • **Communicating knowledge and understanding** ○ Expressing the physical and mathematical concepts of quantum mechanicas • ***Capacities to continue learning*** Developing mathematical and physical tools to model simple nonrelativistic quantum systems.
Criteria for assessment and attribution of the final mark	Written exam (50%). Oral exam (50%)
Additional information	