UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

CONSIGLIO INTERCLASSE IN MATEMATICA

General information	Academic year 2022-2023
Academic subject	**Mathematical aspects of quantum mechanics**
Degree programme	Mathematics
Programme year	Third
Term	Second semester (February 27, 2023 – May 26, 2023)
European Credit Transfer and Accumulation System credits (ECTS)	7
Language	Italian
Attendance	Not compulsory

Lecturers		
Name and surname	Marilena Ligabò (instructor of record)	Fabio Deelan Cunden
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Department and office	Department of Mathematics, room 13 second floor	Department of Mathematics, room 22 second floor
Virtual meeting room	Microsoft Teams code: riup7t7	
Web page	https://www.dm.uniba.it/members/ligabo	https://www.dm.uniba.it/members/cunden
Office hours	by appointment via email	

Syllabus	
Learning objectives	Acquiring the basic techniques for the study of the classical equations quantum mechanics: postulates, states, observables, dynamics.
Course prerequisites	Mathematical knowledge usually acquired during the first years of a degree of L-35 class. Especially: classical analysis of one and several variables, linear algebra, Hamiltonian mechanics.

Course contents	**Fourier Analysis:** Fourier Series of Complex-Valued Functions The Hilbert Space of Square-Integrable Functions The Fourier Transformation Basic Properties of the Fourier Transform Linear Operators Gaussian Functions **Free Particles:** The Free Schrodinger Equation Wave Packets The Free Time Evolution The Physical Meaning of a Wave Function Continuity Equation **States and Observables:** The Hilbert Space of Wave Functions Observables and Linear Operators Expectation Value of an Observable Other Observables The Commutator of x and p Projection Operators Transition Probability **Boundary Conditions:** Impenetrable Barrier and other Boundary Conditions Particle in a Box Eigenvalues and Eigenfunctions Particle on a Circle **Linear Operators in Hilbert Spaces:** Hamiltonian and Time Evolution Unitary Operators Unitary Time Evolution and Unitary Groups Symmetric Operators The Adjoint Operator Self-Adjointness and Stone's Theorem Translation Group Canonical Commutation Relations Commutator and Uncertainty Relation Symmetries and Conservation Laws **Harmonic Oscillator:** Basic Definitions and Properties Eigenfunctions and spectrum
Reference books	B. Thaller, Visual Quantum Mechanics: selected topics with computer-generated animations of quantum- mechanical phenomena, Springer, 2000. C. Hall, Quantum theory for mathematicians, Springer, 2013
Additional course materials	

Work schedule				
	Total	Lectures	Hands-on learning (exercises/laboratories)	Self-study
Hours	175	56		119
ECTS credits	7			

Teaching methods	

Expected learning outcomes	
Knowledge and understanding	Acquiring fundamental concepts and strategies for the Schrodinger equation. Acquiring basic mathematical proof techniques.
Applying knowledge and understanding	The acquired theoretical knowledge can be used in most of the differential equations of physics.
Making judgements	Ability to analyze the consistency of the logical arguments used in a proof. Problem solving skills should be supported by the capacity in evaluating the consistency of the found solution with the theoretical knowledge.
Communication skills	Students should acquire the physical and mathematical language necessary to read and comprehend textbooks, to explain the acquired knowledge, and to describe, analyze and solve problems.
Learning skills	Acquiring suitable learning methods, supported by text consultation and by solving the exercises and the questions periodically assigned in class.

Assessment and feedback	
Assessment methods	Oral exam
Evaluation criteria	- Ability to correctly state and prove theorems; - Ability to explain definitions, examples and counterexamples; - Calculation skills.
Grading policy	The final mark is expressed out of thirty. The exam is passed if the final mark is greater than 17.

Additional information	