UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

CONSIGLIO INTERCLASSE IN MATEMATICA

COURSE OF STUDY	**THREE-YEAR BACHELOR PROGRAMME IN MATHEMATICS**
ACADEMIC YEAR	**2023-2024**
ACADEMIC SUBJECT	**MATHEMATICAL ASPECTS OF QUANTUM MECHANICS**

General information	
Programme year	Third
Term	Second semester (February 26, 2024 – May 31, 2024)
European Credit Transfer and Accumulation System credits (ECTS)	7
SSD	MAT/07 – Mathematical Physics
Language	Italian
Mode of attendance	Not mandatory

Lecturer	
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Department and office	Department of Mathematics, room 13 second floor
Virtual meeting room	
Web page	https://www.dm.uniba.it/it/members/ligabo
Office hours	by appointment via email

Work schedule				
	Total	Lectures	Hands-on learning	Self-study
Hours	175	56		119
ECTS credits	7	7		

Learning objectives	
	Acquisition of the basic tools for the study of quantum mechanics: postulates, states, observables, dynamics.

Course prerequisites	
	The knowledge that is acquired in the first two years of a class L-35 degree. In particular: differential and integral calculus for functions of one or more variables, ordinary differential equations, linear algebra.

Syllabus	
Course contents	Fourier analysis: Fourier series, Hilbert space of summable squared functions, Fourier transform and related properties, Gaussian functions. Free particle: Free Schrodinger equation, Wave packets, Free evolution, Physical meaning of the wave function, Continuity equation. States and observables: Hilbert space of wave functions, Observables and linear operators, Expectation value of an observable, Commutator of x and p, Projection operators, Transition probability. Free particle in a bounded domain: Edge conditions, Impenetrable barrier and other edge conditions, Particle in a box. Eigenvalues and eigenfunctions, Particle on the circle. Linear operators on Hilbert spaces: Hamiltonian and dynamics, unitary operators, unitary evolution groups, symmetric and self-adjoint operators, Stone's theorem, translation group, canonical commutation relations, commutator and uncertainty relations, symmetries and conservation laws. Quantum harmonic oscillator: Definitions and properties, Spectrum and eigenfunctions.
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	
Repository	Microsoft Teams

Expected learning outcomes	
Knowledge and understanding	Acquisition of fundamental concepts and strategies for the study of Quantum Mechanics. Acquisition of the relative demonstration techniques.
Applying knowledge and understanding	The theoretical knowledge acquired is used in a large part of the differential equations of physics.

Soft skills	*DD3 Making judgments:* - Ability to evaluate the consistency of logical reasoning used in a proof. - Ability to identify the right mathematical tools and the right techniques to tackle complex problems.
	DD4 Communication skills: - Acquisition of advanced physical/mathematical language and formalism, necessary for consulting and understanding texts. - Exposure of the knowledge acquired through the description, analysis and resolution of problems.
	DD5 Learning skills: Acquisition of an adequate study method, supported by the consultation of texts and by the resolution of exercises and questions proposed periodically during the course.

Teaching methods	
	Frontal lessons

Assessment	
Assessment methods	The exam consists of a seminar on a topic agreed with the teachers from a list of advanced topics not introduced during the course. It is possible to work in groups of up to three students by appropriately adjusting the level of detail.
Evaluation criteria	*Knowledge and understanding:* acquisition and mastery of the definitions and theoretical results covered by the course. *Applied knowledge and understanding:* ability to apply the acquired theoretical knowledge to the study of partial differential equations; *Making judgments:* critical approach to concepts, ability to choose solution methods and ability to provide examples and counterexamples. *Communication skills:* mastery of language and quality of presentation. Ability to learn: ability to organize knowledge, critical reasoning and possible independent study.
Grading policy	The final mark is expressed out of thirty. The exam is passed if the final mark is greater than 17.

Further information	
	Attendance at lectures and tutorials is strongly recommended.