COURSE OF STUDY *Physics (LM-17)*

ACADEMIC YEAR *2024-2025*

ACADEMIC SUBJECT *Probabilistic Methods of Physics*

General information	
Year of the course	1st
Academic calendar (starting and ending date)	2nd semester: March – May 2025
Credits (CFU/ECTS):	6
SSD	MAT/07
Language	English
Mode of attendance	Recommended, not compulsory

Professor/ Lecturer	
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Department and address	Department of Mathematics, office 22 second floor
Virtual room	https://www.dm.uniba.it/it/members/cunden
Office Hours (and modalities: e.g., by appointment, on line, etc.)	By appointment via email

Work schedule			
Hours			
Total	Lectures	Hands-on (laboratory, workshops, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
150	40	15	95
CFU/ECTS			
6	5	1	

Learning Objectives	Probability theory. Stochastic processes. Markov processes. Forward equations. Brownian motion. Stochastic differential equations.
Course prerequisites	Differential and integral calculus; Complex variables functions

Teaching strategies	In-class lectures (beamer and blackboard).
Expected learning outcomes in terms of	
Knowledge and understanding on:	• Understanding the scientific method, the nature, and the methods of research in Physics • Knowledge of mathematical and probabilistic methods for physics • Knowledge of advanced mathematical tools commonly used in basic and applied research fields • Knowledge of advanced computational techniques • Ability to understand and construct probabilistic models in order to interpret and model complex random, and time depending physical phenomena
Applying knowledge and understanding on:	• Ability to use analogy to apply known solutions to new problems (problem solving) • Ability to design and implement experimental or theoretical procedures to solve problems in academic and industrial research or to improve existing results

	● Ability to use analytical and numerical mathematical computation tools ● Ability to apply the stochastic calculus and the main analysis procedures for random signals
Soft skills	**Making informed judgments and choices:** o Ability to work with increasing levels of autonomy, including taking responsibility in project planning and managing facilities **Communicating knowledge and understanding:** o Competence in communication in Italian and English in advanced fields of Physics o Acquisition of communication proficiency in Italian and English o Ability to work in interdisciplinary teams, with a wording flexibility suitable to an intercultural environment **Capacities to continue learning:** o Acquisition of basic knowledge tools for continuous learning and knowledge updates o Acquisition of basic tools for a lifelong updating of personal learning o Ability to look at the bibliographies and databases available on the web
Syllabus	PROBABILITY 1. Probability spaces 2. Probability measures 3. Random variables 4. Limit theorems STOCHASTIC PROCESSES 5. Generalities 6. Sample trajectories 7. Markov processes 8. Elements of stochastic calculus 9. Dynamical theories of Brownian motion
Content knowledge	
Texts and readings	N. Cufaro Petroni: Probability and Stochastic Processes for Physicists (Springer 2020) W. Feller: An introduction to probability theory and applications (1968) R. Durrett: Probability: Theory and Examples (2019)
Notes, additional materials	
Repository	E-learning system at dm.uniba.it

Assessment	
Assessment methods	Oral exam that may include the resolution of exercises.
Assessment criteria	Knowledge and understanding: o The student must know the fundamentals of probability, the concepts of random variable and stochastic process, the main classical limit theorems . Applying knowledge and understanding: o The student must know and know how to use the process evolution equations in the form of both PDE's and SDE's, the stochastic differential calculus. The student must know the Brownian motion and the stochastic mechanics. Autonomy of judgment: o The student should be able to choose the right mathematical tool to tackle a problem in random processes. Communicating knowledge and understanding: o The student should be able to work in Italian and English in interdisciplinary teams, with a wording flexibility suitable to an intercultural environment.

	Capacities to continue learning: o The student should be able to update his personal learning, and to look at the bibliographies and databases available on the web.
Final exam and grading criteria	*The final mark is expressed out of thirty. The minimum mark to* pass the exam is 18/30.
Further information	
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