COURSE OF STUDY THREE-YEAR BACHELOR PROGRAMME IN MATHEMATICS

ACADEMIC YEAR 2023-2024

ACADEMIC SUBJECT CALCULUS OF PROBABILITY AND STATISTICS

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/06 – Probability and Mathematical Statistics
Language	Italian
Mode of attendance	Not mandatory

Lecturers		
Name and surname	Yun Gang Lu (instructor of record)	Vitonofrio Crismale
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Department and office	Department of Mathematics, room 21, 2-nd floor	Department of Mathematics, room 18, 2-nd floor
Virtual meeting room	Microsoft Teams codice: dnuvlf1	Microsoft Teams codice: dnuvlf1
Web page	https://www.dm.uniba.it/it/members/lu	https://www.dm.uniba.it/it/members/crismale
Office hours	Monday and Wednesday 15:00-17:00	appointment via email

Work schedule			
	Total	Lectures	Hands-on learning (recitations)
Hours	175	40	30
ECTS credits	7	5	2

Learning objectives	
	Acquisition of the elements of probability calculation and mathematical statistics. Applying some mathematical models to analyze and solve problems in the presence of randomness.

Course prerequisites	
	Mathematical analysis in one or more variables, Elements of measure theory

Syllabus	
Course contents	1. Basic concepts and models of Probability theory: event, probability space and Kolmogorov's axiom; classical model; geometric model; conditional probability; the total—probability formula and the Bayes theorem; independence of events 2. Random variable; distribution and distribution function of a random variable; discrete distributions and discrete random variables, absolutely continuous

	distributions and random variables; independence of random variables; integration and important numerical characters of random variables such as expectation, moments, variance, co-variance. 3. The characteristic: Definition of the characteristic function for a finite measure on the Borel sigma- algebra and for a random variable; Important analytic properties of the characteristic function, including the continuity, differentiability and analyticity; the inverse formula and uniqueness theorem, which allow one to determine a measure based on its characteristic function; The weak convergence of probability measures and Levy's theorem, which relate the characteristic function to convergence of probability measures; Applications of the characteristic function to independence, the reproductive property and infinite divisibility 4. Four common used convergences of a sequence of random variables: the convergences of almost everywhere, in L^2, in probability, and in law; Markov's and Kolmogorov's inequalities; Relations among different types of convergence; The 0-1 law of Borel-Cantelli and Kolmogorov; The strong and weak laws of large numbers of Kolmogorov and Kinchin (some particular cases such as the law of large numbers of Borel, Chebyshov and Bernoulli); Central limit theorems of De Moivre-Laplace, Lindeberg, and Lyapunov; The Poisson type central limit theorem; The general formulation of central limit theorem and Feller's theorem; Applications of the 0-1 law, large number law, and central limit theorem to various problems in probability theory. 5. Elementary of statistics: samples, estimate and estimator; some properties of estimator, sample mean and sample variance estimators; maximum likelihood estimator—definition, properties and calculation; confidence interval; testing of hypothesis; the test Chi—square and the Pearson's theorem.
Reference books	– B.V. Gnedenko: Teoria della Probabilità (Editori Riuniti, 1987) – W. Feller: An Introduction to Probability Theory and Its Applications. (John Weley & Sons 1971) – A.N. Shiyayev: Probability (GTM, v. 95, Springer, 1996) – N. Cufaro Petroni: Lezioni di Calcolo delle Probabilità. (Edizioni dal Sud 1996) – P. Baldi: Calcolo delle Probabilità e Statistica, Mc Graw-Hill
Additional course materials	Lecture notes made available on the Microsoft Teams channel of the course
Repository	

Expected learning outcomes	
Knowledge and understanding	○ Fundamental knowledge of probability theory and statistics ○ Computation techniques
Applying knowledge and understanding	○ Computation of probability and conditional probability of some events ○ Computation of distribution of some random variables, their numerical characters ○ Understand and interpret various random phenomena by studying the limit behaviour of a sequence of random variables ○ Comprehension of elementary statistics
Soft skills	*Making judgements*: At the end of the course the student should be able to: ○ Understanding concepts, theorems and their proof ○ Resolving problems and exercises

	Communication skills: At the end of the course the student must be able to acquire the necessary probabilistic terminologies and formalism for: ○ Exposing acquired knowledge ○ Understanding and solving problem
	Learning skills: At the end of the course the student should be able to: ○ Acquire an adequate study method with a help of the consultation of texts ○ Solve exercises and questions

Teaching methods	
	Frontal teaching and guided problem solving during the exercise's sessions. The teaching course is not delivered in e-learning mode, unless modified due to the pandemic.

Assessment	
Assessment methods	Oral exam, during which the committee will evaluate the comprehension pf the theoretical topics presented in the lectures, and the capacity to solve problems arising in calculus of probabiilty and statistics by the candidate.
Evaluation criteria	*Knowledge and understanding*: Evaluation of the knowledge of probability theory and statistics, technical computation • *Applying knowledge and understanding*: statement and proof of some important results • *Making judgements*: Applicating main results to resolve some problems • *Communication skills*: Evaluation of the ability in exposing knowledge • *Learning skills*: Evaluation of autonomous studying
Grading policy	The final score is given out of thirty and the minimum score for passing the examination is 18/30. It derives from the evaluation criteria presented above. The evaluation will take into account the acquired knowledge as well as the transversal skills. To achieve a high evaluation, the student must have developed independent judgment and adequate capacity for argumentation and exposition.

Further information	