UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Scienze Economiche, Aziendali e Statistiche
ACADEMIC YEAR	2022/2023
MASTER'S DEGREE (MSC)	STATISTICS AND DATA SCIENCE
SUBJECT	STOCHASTIC PROCESSES
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50606-Statistico
CODE	16439
SCIENTIFIC SECTOR(S)	SECS-S/01
HEAD PROFESSOR(S)	ADELFIO GIADA Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	108
COURSE ACTIVITY (Hrs)	42
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	1
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**ADELFIO GIADA** Tuesday 11:00 13:00 ex DSSM secondo piano Thursday 11:00 13:00 ex DSSM secondo piano

DOCENTE: Prof.ssa GIADA ADELFIO

PREREQUISITES	Knowledge of Inference and Probability
LEARNING OUTCOMES	Knowledge and understanding At the end of the course, students should show knowledge and comprehension of the main topics of the course. In particular they should learn the specific language of probability theory and fundamentals of stochastic processes Applying knowledge and understanding Students should become able to apply their knowledge and comprehension to tackle problems of uncertainty by means of suitable stochastic models. Specifically, students should be capable to: -classify a stochastic process; -interpret different forms of stochastic dependencies; -describe a time and space dependent random pattern with a suitable stochastic process; For this point the practice lessons will be fundamental. Making judgments Students should become able to recognize with criticism the significant elements of a problem of uncertainty, thereby assessing the probabilistic tools used to tackle the problem. Students will take these elements during the lessons and practice, aimed at the stimulation of personal judgments . Communication skills Ability to explain the characteristics of probabilistic tools, highlighting the usefulness of their application. Classes aim also to stimulate and promote debate in the classroom, in order to provide the fluency of terminology and concepts, sometimes complex, also at conversational level . Learning skills Ability to read the national and international basic literature, and increase the acquired knowledge in attending higher level courses
ASSESSMENT METHODS	Learning assessment: The exam is done through an oral interview. The Selection Committee will be led by the lecturer of the teaching and at least one professor or assistant professor of the same or similar subject area. The ongoing evaluation will not be introduced since in the first part of the course the basic elements of the theory of stochastic processes will not be introduced. ORAL EXAM The oral test, in English, aims to deepen learning assessment of students. This will consist in at least two questions aimed to graduate the evaluation of knowledge, skills, abilities and transversality with arguments of the courses taken previously owned by the student as well as the ability to provide this knowledge with a suitable language of probability and stochastic processes theories. The test could also consist in the performance of a practical example. The threshold of sufficiency of the oral test will be reached when the student shows knowledge and understanding of the subjects at least in the general lines (definition of concepts) and has minimal application skills, consisting of the examples of simple concrete cases. The more the student will show his/her argumentative and expository ability, as well as the property of language, also in English, the more the evaluation will be positive. The final evaluation of the exam will take in consideration three main aspects: i) the mastery of the subjects; ii) the ability in applying the knowledge iii) the property of language. The teacher will take into account also some examination contextual factors (such as active participation in class and exercises, or the presence of some disability) and the English-language performance (extent of vocabulary, knowledge of statistical terms, pronunciation). If the student does not pass the exam, can participate in the following
EDUCATIONAL OBJECTIVES	The course aims to provide a basic probabilistic preparation with the introduction of some useful concepts for the advanced use of probability theory and stochastic processes (SP) in discrete and continuous parameter, focusing on

	some of the most frequently exploited models in applied sciences. Therefore, at the end of the course, students should be able to apply the fundamental laws of the probability theory and to link them to the theory of SP. Moreover, students should be able to correctly define a SP, to distinguish between the different nature of a SP (discrete or continuous) and to understand their peculiarities and their possible applications. In particular they have to be able to get the main issues related to SPs (such as distributional properties, estimation, interpretation) and to understand also possible links among different processe
TEACHING METHODS	The course will be in English and will be organized in frontal and practice classes.
SUGGESTED BIBLIOGRAPHY	S. Ross (2008) Introduction to probability models, Academic Press. (capitoli da 1 a 6 e capitolo 10) G. R. Grimmett, D. R. Stirzaker (2001). Probability and Random Processes (Third Edition). Oxford University Press. (capitoli 3, 4 e 6 - paragrafi 6.1-6.4, 6.7-6.9, capitoli 7, 8, 11- paragrafi 11.1 e 11.2, capitolo 12- paragrafi 12.1 e 12.4) Dispense fornite dal docente.

SYLLABUS

Hrs	Frontal teaching
2	Probability measure and basic rules - Conditional Probability Bayes-theorem
2	Random variable - Independent Random variable - Probability density function – Joint distribution - Joint and marginal densities -Moment of a random variable - Covariance and correlation - Random vectors Discrete distribution Continuous distributions
2	Conditional expectation - Conditional distribution - Properties of Conditional expectation
2	Expectation of random number of r.v.'s . Inequalities Asymptotic theory: Convergences Examples of convergence in probability and a.s. Law of large numbers Central limit theorem
2	Predictable stochastic processes - Stationary Processes Discrete time processes. Definition of Markovian process, and discrete time Markov chain (DTMC). Stochastic Transition matrix and its properties. Chapman-Kolmogorov equation.
2	State classification, class properties and irreducibility, Absorbing Markov chain Canonical Form Fundamental Matrix
2	Martingales introduction and Fair game Doob decomposition of an adapted process . Stopping times Theorem of convergence of martingales
2	Gambler's ruin problem Applications Risk insurance business, Random walk hitting probabilities
2	Continuous-time stochastic processes -Markov processes Birth-death process Queue model - Time Homogeneity (Embedded Markov Chains) The Transition Probability Function , Backward and Forward Equations , The Infinitesimal Generator, Stationary Distributions for CTMC
2	Gaussian noise The Wiener process / Brownian motion - Markov property of Brownian motion . Brownian motion drift and scaling
2	Renewal process, Point process (PP) in space and time; Moments of PP- K function
2	Conditional intensity functions(CIF), Papangelou CIF , Homogeneous Poisson PP -Operations on PP (thinning, superposition,..) More general Processes - Marked PP, ETAS, ML estimation

Hrs	Practice
4	Probability measure and basic rules - Conditional Probability Bayes-theorem
4	Moments of a random variable - Conditional expectation - Conditional distribution -
6	Markov chains and State classification of Markov Chains
2	Martingales and Fair game
2	Renewal process, Point processes