COURSE DESCRIPTION – ACADEMIC YEAR 2024/2025

Course title	**Fundamentals of Statistics**
Course code	42413
Scientific sector	SECS-S/01
Degree	Bachelor in Electronics and Cyberphysical Systems (L-8)
Semester	1
Year	2
Credits	9
Modular	No

Total lecturing hours	54
Total lab hours	36
Attendance	Attendance is not compulsory, but highly recommended.
Prerequisites	The course requires the concepts of elementary calculus and linear algebra, in particular: • Set theory • Limits of functions • Convergence of sequences and series • Derivatives and partial derivatives • Integrals • Matrix algebra
Course page	Teams

Specific educational objectives	The course belongs to the type "Attività formativa affine o integrativa nell'ambito della Statistica" The course covers the fundamental aspects of probability theory, and the principles of statistical inference and statistical modelling. The theoretical aspects are complemented by the use of dynamic documents and reproducible modern data analysis with R. The main objectives are to endow the student with the fundamental skills to solve real problems by using probability theory, and to perform a rigorous data analysis by using appropriate statistical methods.

Lecturer	Emanuele Taufer
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Scientific sector of lecturer	STATISTICA - SECS-S/01
Teaching language	English
Office hours	tbd
Lecturing assistant (if any)	
Contact LA	
Office hours LA	
List of topics	**Probability Theory** • Fundamentals of probability: events and sample space. Definition of probability. • Kolmogorov's axioms and probability spaces.

	• Combinatorics and counting. • Conditional probability and independence. • Law of total probabilities and Bayes' theorem. • Random variables and probability distributions. • Expected value and variance. Moments of a random variable. Quantiles and percentiles. • Common random variables: discrete random variables. • Common random variables: continuous random variables. • Functions of a random variable. • Bivariate random variables: joint and marginal distributions. • Bivariate random variables: conditional distributions and independence. Covariance and correlation. • Convergence of sequences of random variable and limit theorems. **Statistical Inference** • Descriptive statistics. • Populations and their parameters. • Random sampling. Statistics and Sampling distributions . • Fundamentals of point estimation. Properties of point estimators. • Point estimation of the mean and the variance. • Interval estimation: introduction. • Confidence interval for the mean and the variance. • Hypothesis testing: introduction. • Hypothesis testing: the p-value, type I and II errors. Power and size. • Hypothesis testing for the mean. • Hypothesis testing for the difference of two means. • Chi-squared type tests for contingency tables. • Estimation methods: method of moments; Maximum likelihood; Least squares. **The linear regression model** • Introduction and assumptions • Parameter estimation. • Hypothesis testing and confidence intervals for the parameters of the model. • Model selection and goodness of fit. • Residuals analysis and diagnostics. • Violation of the assumptions and some extensions. **Laboratory** • Introduction to R • Probability and statistics with R • Dynamic documents and reproducible data analysis with Rmarkdown and knitr
Teaching format	In person lectures, exercises, lab sessions

Learning outcomes	Upon successful completion of this course, the students are expecte d to acquire the following

	Knowledge and understanding • basic descriptive statistics; • fundamental notions of probability theory; • fundamentals of statistical learning; • fundamentals of statistical modelling; • statistical lexicon; • formalize problems that involve randomness and uncertainty in terms of probability and statistics; • basics of statistical software; **Applications** • manipulate and summarize data; • visualize and understand relationships inside data; • apply the appropriate tools of inferential statistics and statistical modelling to extract useful information from data, test hypotheses and make predictions; • use R, knitr and Rmarkdown to perform a modern and reproducible data analysis. **Interpretation and communication** • use and interpret the results from a statistical analysis to take informed decisions • communicate appropriately and with rigour the results of a statistical analysis

Assessment	A 3-hour written examination composed of • Exercises • Theoretical questions Whenever feasible, the examination will be split in two modules: • Module 1: Probability – mid-term, 1.5 hours; • Module 2: Statistics - 2 hours. The oral examination is optional: students that pass the exam (mark $\geq$ 18) can decide to take it to improve their final mark.
Assessment language	English
Assessment Typology	Monocratic
Evaluation criteria and criteria for awarding marks	• Correctness of the answers • Mastery of the technical language

Required readings	Ross, S. Introduction to Probability and Statistics for Engineers and Scientists. 6th Ed. 2020, Academic press, **ISBN:** 9780128243466. Subject Librarian: David Gebhardi, David.Gebhardi@unibz.it and Ilaria Miceli, Ilaria.Miceli@unibz.it
Supplementary readings	• Provided by the lecturer during the course
Software used	• R (https://cran.mirror.garr.it/CRAN/) • The Rstudio IDE (https://posit.co/downloads/)