Syllabus

Course Description

Course Title	Fundamentals of Statistics
Course Code	42413
Course Title Additional	
Scientific-Disciplinary Sector	SECS-S/01
Language	English
Degree Course	Bachelor in Electronics and Cyber-Physical Systems Engineering
Other Degree Courses (Loaned)	
Lecturers	Prof. Emanuele Taufer, Emanuele.Taufer2@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/7405
Teaching Assistant	
Semester	First semester
Course Year/s	2
CP	9
Teaching Hours	54
Lab Hours	36
Individual Study Hours	135
Planned Office Hours	27
Contents Summary	The course covers fundamental topics of probability theory, descriptive statistics, statistical inference and statistical modelling. The theoretical aspects are complemented by labs where, among other things, the software R is used as a support to verify in practice theoretical concepts (for example convergences) or quickly implement and interpret statistical analyses (for example statistical tests, regression analysis).
Course 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
Keywords	Probability, Descriptive statistics, Statistical inference, Linear regression, Software R.
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
Propaedeutic Courses	
Teaching Format	In person lectures, exercises, lab sessions
Mandatory Attendance	Attendance is not compulsory, but highly recommended.
Specific Educational Objectives and Learning Outcomes	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.
Specific Educational Objectives and Learning Outcomes (additional info.)	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 2-hour written examination composed of • Exercises with pencil and paper or R • Theoretical questions Whenever feasible, the examination will be split in two modules: • Module 1: Probability and random variables – mid-term, 1.5 hours; • Module 2: Statistics - 2 hours.
Evaluation Criteria	• 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
Supplementary Readings	Provided by the lecturer during the course
Further Information	Subject Librarian: David Gebhardi, David.Gebhardi@unibz.it and Ilaria Miceli, Ilaria.Miceli@unibz.it Software used: R (https://cran.mirror.garr.it/CRAN/) The Rstudio IDE (https://posit.co/downloads/)
Sustainable Development	Quality education

Goals (SDGs)	