òGeneral information		
Academic subject	Mathematics and Elements of Statistics	
Degree course	Natural Sciences (I level)	
Academic Year	First year	
European Credit Transfer and Accumulation System (ECTS)		9
Language	Italian	
Academic calendar (starting and ending date)	October 2021-January 2022	
Attendance	*Yes*	

Professor/ Lecturer	
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Virtual headquarters	Mycrosoft Teams Platform (course code tjfzept)
Tutoring (time and day)	By appointment to be requested by e-mail

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Syllabus	
Learning Objectives	The course aims to provide the mathematical tools concerning elementary functions, differential and integral calculus, and the basic notions about descriptive and inferential Statistics, with elements of Probability. The use of the mathematical language will be enhanced, the aspects of mathematical analysis involved in the modelization of natural phenomena will be studied and the course will provide the theoretical knowledge for the solutions of problems in data interpretation. The students will be trained, by means of numerical exercises and problems during the classes, to use the learned theoretical tools in applied frameworks.
Course prerequisites	Knowledge of the basic notions of algebra and calculus, basic notions of analytic geometry in the plane
Contents	**Lectures** Basic notions of set theory Set operations: union, intersection, Cartesian product. The notion of function and related properties. Composition of functions. Injective, surjective, bijective functions; inverse function. Numerical sets The set of rational numbers Q. Existence of non rational numbers. The set R of real numbers. The real line. Intervals, open and closed, limited and unlimited intervals. Scientific notation. Approximation with a fixed number of digits. Approximation errors: absolute, relative, percentage error. Propagation of the error in the operations. Analytic Geometry review The Cartesian plane; distance between two points; equation of the line,

	equation of the circle, equation of the parabola. Real variable functions The graph of a function. The algebra of functions. Transformation of graphs. Qualitative properties of real functions: symmetries, monotonicity, local and global extrema, boundedness, convexity. Elementary functions: polynomial functions, rational functions, irrational functions, exponential functions, logarithmic functions. Algebraic properties of logarithms. Principal basis of logarithms. The Gaussian function. Trigonometric functions and their inverses. Equations and inequalities involving elementary functions. Limits and Continuity Definition of limit of functions. Limits of some elementary functions. Algebra of limits. Limit theorems. Limits at infinity and infinite limits. Indeterminate forms. Definition of continuity at a point and on an interval. Algebra of continuous functions. Continuity of elementary functions. Weierstrass Theorem, Bolzano's Theorem, The Intermediate Value Theorem. Differential calculus Notion of derivative. Differentiability implies continuity. Tangent line and the geometric meaning of derivative. Derivatives of elementary functions. Rules of differentiation. Higher order derivatives. Theorems of differential calculus: Rolle's Theorem, Lagrange's Theorem. Monotonicity criterium. Convexity criterium. Finding local maxima and minima. De l'Hopital Theorem. Study of the graph of a function. Integral Calculus The Riemann integrability. The Riemann integral. Integrability of continuous functions. Geometric interpretation of the Riemann integral. Properties of the Riemann integral. The Integral Mean Theorem. Primitives. Fundamental Theorem of Integral Calculus. Fundamental Formula of Integral Calculus. Indefinite integrals. Rules for integration. Integration of rational functions. Integration by substitution. Integration by parts. Introduction to improper integrals. Elements of Combinatorics Dispositions: simple and with repetitions. Permutations. Combinations. Elements of Probability Sample space and random events. Definitions of probability. Axioms of probability. Conditional probability. Independent events. Discrete and continuous random variables. Probability density function. Distribution function. Mean value, variance and standard deviation of a random variable. Bernoulli's random variable. The Normal distribution. The Central Limit Theorem. Elements of Statistics

	Qualitative and quantitative variables. Graphic representation of statistical data. Measures of location: mean, median, mode. Quantiles, percentiles. Indices of dispersion: variance, standard deviation, range, interquartile range. Approximately normal data. Bivariate data. Dispersion diagram. Least square method. Linear regression. Coefficient of linear correlation. Statistical inference. Pointwise estimate of parameters. Confidence interval for the mean. Introduction to the hypothesis statistical tests. **Workshop hours** The workshop hours will be devoted to carry out exercises on the different arguments of the course. Precisely, the exercise sessions will concern the following topics: - The basic tools of mathematical language - Equations and inequalities - Determination of the domain, zeroes and sign of a function; qualitative properties of functions; transformation of graphs - Limits - Calculus and applications of the derivative - The complete study of functions - The integral calculus and its applications - Descriptive Statistics and linear regression - Elementary probability, normal distribution and the use of tables of standard normal distribution
Books and bibliography	**Theory books** • Marcellini-Sbordone, "Elementi di Calcolo", Liguori Editore. • D. Benedetto- M. Degli Esposti- C. Maffei, Matematica per le Scienze della Vita, Casa Editrice Ambrosiana. • S. Ross, Introduzione alla Statistica, Apogeo Education, Maggioli Editore. **Exercise books** • Marcellini-Sbordone, Esercitazioni di Matematica, Vol 1, part I and II, Liguori Editore. • Exercise sheets available on the course website. The suggested books can be consulted in the library of the Department of Mathematics.
Additional materials	In addition to recommended books, a set of sheets of exercises and some slides on Statistics will be made available by the course teacher on the webpage of the course at the following link: https://www.dm.uniba.it/Members/loiudice/didattica

Work schedule			
Total	Lectures	Exercise workshops	Self-study hours
Hours			
225	*48*	*45*	*132*
ECTS			

Teaching strategy	
	Lectures and exercise workshops During the course, at the end of each chapter, a set of exercises will be proposed to the students in order to clarify and consolidate the course contents. The solution to such exercises will be checked during appropriate workshops where the active participation of students will be stimulated. Moreover, the diary of lessons will be published and regularly updated on the course webpage as a support to self- study.
Expected learning outcomes	
Knowledge and understanding on:	Students have to know the main course contents, i.e. the main tools related to elementary functions, differential and integral calculus, and the basic tools of Probability and Statistics. Knowledge and understanding of the basic concepts proposed during the course is a necessary condition in order to pass the exam. The level of completeness and deepness of such knowledge, which will be tested during the written and oral exam, will contribute to a positive evaluation.
Applying knowledge and understanding on:	Students must demonstrate to be able to apply the acquired theoretical knowledge to solve simple applied problems, to construct or get information from graphs of functions, to understand and apply the fundamental concepts of derivative and integral, to apply the basic notions of probability in the statistical framework. The achievement of these skills will be verified by means of the exercises proposed during the written exam and the oral colloquium and they are necessary for passing the exam.
Soft skills	*Making informed judgments and choices* The autonomy achieved by the students in selecting appropriate strategies in problem solving, the capacity of motivating the chosen procedures in carrying out exercises, the ability of correct reasoning and critical thinking will be assessed and they will contribute to a positive evaluation. *Communicating knowledge and understanding* By means of the written and oral exams, the correct use of notation and scientific language, the clarity in the exposition, the ability to communicate the acquired mathematical concepts and their applications will be evaluated. The mastery of the mathematical language and the rigor in the exposition of contents, together with the completeness of knowledge and understanding, will contribute to a positive evaluation up to the maximum grade. *Capacities to continue learning* The students must demonstrate to have acquired capacities to autonomous learning, ability in reading and correctly interpreting mathematical and statistical contents related to natural science. The acquisition of such skills will be shown through the capacity of providing examples and applications of the learned theoretical contents and the ability to establish links and comparisons between different scientific

	frameworks. These skills will contribute to increment the evaluation up to the maximum grade.

Assessment and feedback	
Methods of assessment	Written and Oral exam. Also some intermediate tests are planned during the course which exempt (totally or partially) from the written exam. The written exam consists in carrying out a set of exercises and it will precede the oral exam.. The oral exam consists in discussing theorems, definitions and applications. As a guide to the preparation of the oral exam, a list of the possible questions that will be proposed to the students will be made available at the end of the course. It will be required to the students to be able to illustrate the theoretical definitions by means of applications and to know the geometric meaning of theorems and definitions.
Evaluation criteria	*Knowledge and understanding* Students have to know the main course contents, i.e. the main tools related to elementary functions, differential and integral calculus, and the basic tools of Probability and Statistics. Knowledge and understanding of the basic concepts proposed during the course is a necessary condition in order to pass the exam. The level of completeness and deepness of such knowledge, which will be tested during the written and oral exam, will contribute to a positive evaluation. *Applying knowledge and understanding* Students must demonstrate to be able to apply the acquired theoretical knowledge to solve simple applied problems, to construct or get information from graphs of functions, to understand and apply the fundamental concepts of derivative and integral, to apply the basic notions of probability in the statistical framework. The achievement of these skills will be verified by means of the exercises proposed during the written exam and the oral colloquium and they are necessary for passing the exam. *Making informed judgments and choices* The autonomy achieved by the students in selecting appropriate strategies in problem solving, the capacity of motivating the chosen procedures in carrying out exercises, the ability of correct reasoning and critical thinking will be assessed and they will contribute to a positive evaluation. *Communicating knowledge and understanding* By means of the written and oral exams, the correct use of notation and scientific language, the clarity in the exposition, the ability to communicate the acquired mathematical concepts and their applications will be evaluated. The mastery of the mathematical language and the rigor in the exposition of contents, together with the completeness of knowledge and understanding, will contribute to a positive evaluation up to the maximum grade. *Capacities to continue learning* The students must demonstrate to have acquired capacities to autonomous learning, ability in reading and correctly interpreting mathematical and statistical contents related to natural science. The

	acquisition of such skills will be shown through the capacity of providing examples and applications of the learned theoretical contents and the ability to establish links and comparisons between different scientific frameworks. These skills will contribute to increment the evaluation up to the maximum grade.
Criteria for assessment and attribution of the final mark	The final mark is out of 30. The exam is passed when the final mark is greater or equal to 18/30.
Additional information	