General information	
Academic subject	Differential Equations
Degree course	Degree in Mathematics
Academic Year	I or II
European Credit Transfer and Accumulation System (ECTS)	7
Language	Italian
Academic calendar (starting and ending date)	II semester (february 2022- may 2022)
Attendance	Non mandatory

Professor/ Lecturer	
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Virtual headquarters	Microsoft Teams
Tutoring (time and day)	By appointment to be arranged upon e-mail or telephone (at the Department of Mathematics or online)

Syllabus	
Learning Objectives	Knowledge of theory and techniques of ordinary differential equations, especially local and global existence, uniqueness theorems, regularity and stability of the solutions, qualitative analysis of solutions, study of linear systems. Examples and applications accompany the theory.
Course prerequisites	Mathematical knowledge which usually is acquired during the first three years of a degree of L-35 class. Especially: classical analysis of one and several variables, general topology, linear algebra.
Contents	**Some Elementary Methods** Generalities on first order differential equations. Equivalence of differential equation of order n to vector equation of the first order. The linear equation of the first order. The equation with separable variables. Exact differential equations. The uniqueness problem: an example. Some Integral inequalities. Gronwall's Lemma. Bihari's Lemma. Generalities on Banach spaces. Banach fixed point Theorem. **Existence Theorems for Differential Equations** The first order equation. First order differential systems. Equations and systems of higher order. Cauchy problem. Local existence and uniqueness Theorem: proof of the result via the method of successive approximations and via Banach fixed point Theorem. Ascoli-Arzelà Theorem. Peano existence Theorem: proof via the polygonal method and via Schauder point fixed Theorem. Other uniqueness Theorems. **Some global problems for ordinary differential equations** Statement of the problem. Global uniqueness. Global existence and the behavior of saturated solutions. Dependence of solutions on initial values. Differential

	inequalities and the comparison method. A criterion of global existence. Qualitative analysis of solutions. **Some special classes of differential systems and equations** Linear systems: generalities. Linear homogeneous systems. Linear nonhomogeneous systems. Linear equations of higher order. Autonomous systems. Linear systems and equations with constant coefficients. Linear homogeneous systems with periodic coefficients: Floquet theory. **Stability theory of ordinary differential systems** Definitions and examples. Stability of linear systems. Stability in the first approximations. Stability theorems by comparison method. Linear equations of second order. Ascoli's theorem. Bessel's equation. Perturbed linear systems. Poincaré-Lyapunov theorems. Lyapunov's direct method (*). Stability theorems: I e II Lyapunov's theorems (*), Parsidski's theorem. Instability theorem. Stability for autonomous systems. Applications to some models in Biology and Physics: logistic equation, a prey-predator model, a model of competition between two species, the pendulum equation, the Van der Pol's equation. Linear autonomous systems. Orbits near to an equilibrium point: node, focus, center.
Books and bibliography	A. Ambrosetti, Appunti sulle equazioni differenziali ordinarie, Springer, Milano 2012. C. Corduneau, Principles of Differential and Integral Equations, Allyn and Bacon Inc., Boston 1971. M. Rama Mohana Rao, Ordinary Differential Equations Theory and Applications E. Arnold Ed., London 1980.
Additional materials	

Work schedule			
Total	Lectures	Hands on (Laboratory, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
Hours			
175	52	8	115
ECTS			
7	6,5	0,5	

Teaching strategy	Lessons and exercises on the various topics of the course will be held using traditional blackboard. They could be held in mixed mode, frontal and remote, or only online, if the pandemic situation requires it.
Expected learning outcomes	
Knowledge and understanding on:	Knowledge of basic and advanced concepts in ordinary differential equations. Knowledge of different mathematical proof techniques.
Applying knowledge and understanding on:	The acquired theoretical knowledge is useful in great part of mathematics and its applications.
Soft skills	• *Making informed judgments and choices* Problem solving skills should be supported by the capacity in evaluating the consistency of the found solutions with the theoretical knowledge.

	• *Communicating knowledge and understanding* Students should acquire the mathematical language and formalism necessary to read and comprehend textbooks, to explain the acquired knowledge and to describe, analyze and solve problems. • *Capacities to continue learning* Knowledge of suitable learning methods, supported also by consultation of the texts and by solution of exercises and problems suggested during the course.

Assessment and feedback	
Methods of assessment	Oral examination which will be held using traditional blackboard, or online if the pandemic situation requires it.
Evaluation criteria	The examination consists of an exercise and some questions on the main topics of the course. The student must demonstrate that it knows basic and advanced concepts and the main demonstrative techniques in the study of ordinary differential equations.
Criteria for assessment and attribution of the final mark	The final mark is expressed out of thirty. The exam is passed when the mark is greater than or equal to 18.
Additional information	