Academic subject: Differential Equations

Degree Class: LM – 40 Matematica		**Degree Course:** Mathematics	**Academic Year:** 2018/2019	
		Kind of class: Mandatory/Optional depending of the curriculum	**Year:**	**Period:** 2
			ECTS: 7 divided into **ECTS lessons:** 6,5 **ECTS exe/lab/tutor:** 0,5	

Time management, hours, in–class study hours, out–of–class study hours
lesson: 52 exe/lab/tutor: 8 in–class study: 60 out–of–class study: 115

Language: Italian	**Compulsory Attendance:** no		
Subject Teacher: Addolorata Salvatore	**Tel:** +39 080 5442705 **e–mail:** addolorata.salvatore@uniba.it	**Office:** Department of Mathematics Room 10, IV Floor	**Office days and hours:** Tuesday 11-13. Other days and times by appointment.

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.

Educational objectives:
Acquiring language 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.

Expected learning outcomes (according to Dublin Descriptors)

Knowledge and understanding:
Acquiring basic and advanced concepts in the field of ordinary differential equations. Acquiring different mathematical proof techniques.

Applying knowledge and understanding:
The acquired theoretical knowledge is useful in great part of mathematics and its applications.

Making judgements:
Problem solving skills should be supported by the capacity in evalueting the consistency of the found solutions with the theoretical knowledge.

Communication:
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.

Lifelong learning skills:
Acquiring suitable learning methods, supported also by consultation of the texts and by solution of exercises and problems suggested during the course.

Course program

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.

Teaching methods:
Lectures and exercise sessions.

Auxiliary teaching:

Assessment methods:
Oral exam

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.