Stampare su carta intestata del CdS

General information		
Academic subject	**Mathematical Analysis no. 4**	
Degree course	Mathematics	
Academic Year	2021-2022	
European Credit Transfer and Accumulation System (ECTS)		8
Language	Italian	
Academic calendar (starting and ending date)		28.02.22-27.05.22
Attendance	No. Optional but recommended attendance	

Professor/ Lecturer	
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Tutoring (time and day)	By appointment via email

Syllabus	
Learning Objectives	Acquiring language and basic tools concerning the theory of differential ordinary equations and their qualitative behavior, the theory of Lebesgue integration for functions of several variables, the theory of differential forms and their applications, the theory of line integrals.
Course prerequisites	Mathematical knowledge which usually is acquired during the Mathematical Analysis courses during the first two years of a degree of L-35 class. More precisely: classical analysis of one and several variables, elements of topology in metric spaces and Euclidian spaces, linear algebra, analytic geometric in the plane and in the space.
Contents	**1. <u>DIFFERENTIAL ORDINARY EQUATIONS</u>** Introduction to differential ordinary equations. Differential ordinary equations in normal form: Cauchy problem. The Theorem of Peano. Peano's brush. Local and global existence and uniqueness theorem for differential ordinary equations in normal form. Prolongability of solutions and maximum range of solutions. The sublinear case. General, particular and singular integrals. Boundary value problems. Equivalence between a differential equation of order n and a system of n differential equations of the first order. Systems of linear differential equations of the first order: existence and uniqueness of the solution in large. Wronskian of n solutions and its properties. Dimension of the solutions set of a homogeneous system of linear first order differential equations. General integral of a complete linear system of first order differential equations. Lagrange method for the computation of a particular integral. Linear differential n-order equations with constant coefficients: characteristic equation. Linearly independent integrals for differential equations with constant coefficients, once known the roots of the characteristic equation. Linear differential n-order equations with variable coefficients. Solution methods for the following first order differential equations: separable variables, Manfredi's (or homogeneous), of the type y'=f[(ax+by+c)/(a'x+b'y+c')], linear, Bernoulli's, Clairaut's, Lagrange's, with an integrating factor. Second order differential equations which may be reduced to first order differential equations. Lowering the order of a differential equations of order n with constant coefficients. Euler's equations. Simple systems of linear differential equations. **2. <u>LINE INTEGRALS AND DIFFERENTIAL FORMS</u>** Curves. Simple, open and closed curves. Parametric representation of a curve and equivalent curves. Regular curves and piecewise regular curves. Tangent to a curve in a regular point. Rectifiable curves and length of a curve. Rectifiability of a piecewise regular curve. Invariance with respect to change of variables. Curvilinear abscissa. Curvature of a plane curve. Line integrals of a function and its properties.

	Geometric meaning. Vector field and differential forms. Exact differential forms and their primitives: properties. Linear integral of a differential form. Physical meaning: conservative fields, potential, work. Integration criteria for differential forms. Closed differential forms and irrotational fields. Relation between closed and exact differential forms. Closed differential forms in starshaped open domains. Positive homogeneous closed differential forms. Gauss-Green formulas in the plane. Closed differential forms in simply connected open domains: properties. **3. <u>THEORY OF INTEGRATION</u>** Outline on plurintervals in IR^n and Peano-Jordan measurable sets (bounded and unbounded): properties. Measure of product spaces. Outline on Riemann integral in bounded or in unbounded measurable sets. Cylindroid. Integration in product spaces. Barycenter. Normal sets and reduction formulas for multiple integrals. Change of variables for multiple integrals. Lebesgue measurable functions. The Lebesgue integral. The theorems of passage to the limit under the integral sign. **4. SURFACES AND SURFACE INTEGRALS** Vectorial product. Parametric surfaces in the space. Examples. Singular and regular points. Tangent plane and normal versor. Regular surfaces. Area of a regular surface. Area of a rotational surface. Surface integral of a function. Oriented surfaces. Flow of a vector field through a surface. Divergence (or Gauss) Theorem. Stokes (or rotor) Theorem. **5. SURFACES IN IR^n AND *k*-FORMS** k-dimensional varieties in IR^n. Tangent space and normal space to a manifold. Measurement and integration on the k-dimensional varieties of IR^n. The divergence theorem
Books and bibliography	[1] E. ACERBI - L. MODICA – S. SPAGNOLO, Problemi Scelti di Analisi Matematica II, Liguori Editore, Napoli 1986. [2] N. FUSCO – P. MARCELLINI – C. SBORDONE, Lezioni di Analisi Matematica due, Zanichelli, Bologna 2020 [3] J. LELONG-FERRAND – J. M. ARNAUDIÈS, Cours de mathématiques, Tome 4, 2e édition, Dunod Université, Paris, 1977. [4] P. MARCELLINI – C. SBORDONE, Elementi di Analisi Matematica due, Liguori Editore, Napoli, 2001. [5] P. MARCELLINI – C. SBORDONE, Esercitazioni di Matematica, Parte I e Parte II, Zanichelli Editore, Bologna, 2018. [6] C. D. PAGANI – S. SALSA, Analisi Matematica 2, Seconda edizione, Zanichelli Editore, Bologna, 2016
Additional materials	Books should be completed with the notes of the lessons. It is suggested not to take notes from Internet.

Work schedule			
Total	Lectures	Hands on (Laboratory, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
Hours			
200	40	30	130
ECTS			
8	5	3	
Teaching strategy	Lectures and exercise sessions		
Expected learning outcomes			
Knowledge and understanding on:	Acquiring fundamental concepts of Cauchy problems, of curves and of line integrals, of differential forms and of the results related to the computation of the potential of a differential form. Acquisition of the understanding of the integral calculus for functions of several variables and of the notion of surfaces.		
Applying knowledge and understanding on:	Ability to solve linear systems, ability to solve double integrals and to compute the length of curves, ability to compute potentials for differential forms and line integrals and ability to study a differential ordinary equation.		

Soft skills	• *Making informed judgments and choices* Ability to analyze the consistency of the logical arguments used in a proof, problem solving skills and ability to choose suitable mathematical tools consistent with the theoretical knowledge. Recognize correct proof and identify wrong reasonings. • *Communicating knowledge and understanding* Acquiring the mathematical language and the formalism necessary to read and understand textbooks, to explain the acquired knowledge, and to describe, analyze and solve problems. • *Capacities to continue learning* Acquiring suitable learning methods, supported by consultation of texts and by solving exercises and problems related to the contents of the course. Acquiring the learning ability to interpret mathematical formulations of applied phenomena.

Assessment and feedback	
Methods of assessment	The course has a written exam and a subsequent oral one. In particular, the written exam is designed to assess the ability of solving concrete problems which are related to the principal arguments of the course and they are modelled on those solved during the lessons. The time to solve the written test is about 2 hours. Possibly the written test can be replaced by two ongoing assessments. The oral test is mandatory and is designed to assess the level of knowledge attained by the student on the theoretical contents of the course, provided that the written exam is sufficient. The exam is passed if the final grade is at least 18/30.
Evaluation criteria	• *Knowledge and understanding* It will be evaluated the acquisition of the fundamental concepts and results in the setting of the classical Mathematical Analysis considered in this course and their proof techniques. In particular, it will be evaluated the acquisition of the notion of Cauchy problem, of curves and of line integrals, of differential forms and of the results related to the computation of the potential of a differential form; the acquisition of the meaning and the calculus of integrals for several variables functions and of the notion of surfaces. • *Applying knowledge and understanding* It will be evaluated the ability to solve linear systems, the ability to solve double integrals and to compute the length of curves, the ability to compute potentials and line integrals for differential forms and the ability to study a differential ordinary equation. • *Autonomy of judgment* It will be evaluated the ability to analyze the consistency of the logical arguments used in a proof, the problem solving skills and the ability to choose the suitable mathematical tools consistent with the theoretical knowledge • *Communication skills* It will be evaluated the acquisition of the mathematical language together with the formalism and the preciseness necessary to explain the acquired knowledge, and to describe, analyze and solve problems. • *Capacities to continue learning* It will be evaluated the acquisition of suitable learning methods, supported by consultation of texts and by solving exercises and problems related to the contents of the course. It will be evaluated the learning ability to interpret mathematical formulations of applied phenomena.
Criteria for assessment and attribution of the final mark	In order to pass the written test, the student is expected to be able to solve the assigned problems and correctly carry out part of them. In the oral exam, the student must be able to use an appropriate language. He/She must show to know the fundamental

	concepts (definitions and sentences) of the various arguments of the course and to use them correctly in the proof of other theorems.
Additional information	In collaboration with Prof. Elvira Mirenghi. Email: elvira.mirenghi@uniba.it. Tutoring: by appointment via email. Telephone: + 39 080 544 2675