UNIVERSITÀ DI PAVIA

Anno Accademico 2020/2021

DIFFERENTIAL EQUATIONS AND DYNAMICAL SYSTEMS

Enrollment year	2020/2021
Academic year	2020/2021
Regulations	DM270
Academic discipline	MAT/05 (MATHEMATICAL ANALYSIS)
Department	DEPARTMENT OF PHYSICS
Course	
Curriculum	Fisica teorica
Year of study	1°
Period	1st semester (05/10/2020 - 20/01/2021)
ECTS	6
Lesson hours	50 lesson hours
Language	Italian
Activity type	WRITTEN AND ORAL TEST
Teacher	SCHIMPERNA GIULIO FERNANDO (titolare) - 9 ECTS
Prerequisites	In order to follow this course with the due preparation it is necessary to have acquired the basic competences resulting from the courses of the first year, in particular: differential and integral calculus for scalar and vector-valued functions, matrices and linear transformations, sequences and series, complex numbers, differential forms, polar coordinates.
Learning outcomes	Learn the basic results and techniques of the theory of ordinary differential equations and dynamical systems. Be able to apply the methods of the ODE theory to study simple real-world applications and physical models. Acquire the baic notions of pointwise and uniform convergence for sequences and series of functions, with particular reference to the case of power series. Understand the first but deep results of complex function theory and become familiar with transformations in the complex plane. Learn the main integration techniques based on the Residue theorem.

Course contents

The course is divided into two parts: the first one is devoted to the theory of ordinary differential equations and systems, with an introduction to the study of dynamical systems. The second part is an introduction to the theory of functions of one complex variable.

Extended summary

Models and examples of ODE's. General results concerning existence, uniqueness, comparison and stability for Cauchy problems. Elementary techniques for solving simple differential equations. Cauchy-Peano's theorem (existence without uniqueness). Linear systems of ODE's: general results and structure of the space of solutions, exponential matrix. Asymptotic behaviour of dynamical systems, stability (linearisation and Lyapunov method).

Sequences of functions. Pointwise and uniform convergence. Function series and power series. Examples of complex functions. Differentiability. Contour integrals. Holomorphic functions. Cauchy's theorem. Singularities, Laurent expansion and residues. Cauchy's theorem. Application to the evaluation of integrals. Analytic extension. Argument principle. Rouché's theorem. Sequences of holomorphic functions. Further geometrical properties of holomorphic functions.

Teaching methods

Lectures and exercise sessions.
The two parts of the course (1 - ordinary differential equationa and 2 - complex analysis) will proceed in parallel (generally 2 or 3 hours per week will be devoted to complex anlysis and the remaining ones to differential equations).
The exercise sessions will be scheduled after finishing the corresponding part of the theory.

Reccomended or required readings

M. W. Hirsch, S. Smale, R. L. Devaney: Differential equations, dynamical systems, and an introduction to chaos. Pure and Applied Mathematics, Vol. 60. Elsevier/Academic Press, Amsterdam, 2004.

S. Salsa, A. Squellati: Esercizi di analisi matematica 2. Masson, 1994.

G. Gilardi, Analisi Matematica 3, McGraw- Hill Italia.

Lecture notes will be also provided.

Assessment methods

Written and oral test.
The written test will be constituted by a number of exercises. Some of the exercises will have a theoretical character (proofs of simple properties or construction of examples or counterexamples); other ones will be aimed at verifying the acquisition of the basic computational techniques developed in the course (explicit resolution of differential equations or calculus of some integral by complex variable methods).
The oral exam will be aimed at verifying the comprehension of the main results of the theory and the capacity to illustrate them by means of concrete examples. The evaluation will be focused mainly on the comprehension of the main results and of their implications, rather than on the "technical" aspects of the proofs.
Whenever the number of students who subscribed for an exam session is low, the written test may be skipped. In that case, the oral exam will be a bit longer and include practical exercises.

Further information

Further information on the course and the exam will be made available on a specific web page.

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