UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Fisica e Chimica - Emilio Segrè
ACADEMIC YEAR	2017/2018
MASTER'S DEGREE (MSC)	PHYSICS
SUBJECT	MATHEMATICAL METHODS FOR PHYSICS
TYPE OF EDUCATIONAL ACTIVITY	C
AMBIT	20901-Attività formative affini o integrative
CODE	05076
SCIENTIFIC SECTOR(S)	MAT/07
HEAD PROFESSOR(S)	SCIACCA VINCENZO Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	94
COURSE ACTIVITY (Hrs)	56
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	1
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**SCIACCA VINCENZO** Thursday 15:00 18:00 Dipartimento di Matematica e Informatica, via Archirafi 34, Ufficio n° 216 (2° piano)

DOCENTE: Prof. VINCENZO SCIACCA

PREREQUISITES	Classical knowledge of the concepts of Mathematical Analysis of functions of several real variables, Euclidean Geometry and Linear Algebra. No formal propedeuticity with respect to other courses.
LEARNING OUTCOMES	Knowledge and Understanding Knowledge of methodologies and techniques for a rigorous approach to mathematical problems typically encountered in quantitative description of physical processes. Introduction to the theory of Hilbert spaces and to the theory of distributions. Elements of spectral theory of operators and the Fourier transformed. Introduction to the theory of Sturm-Liouvile and orthogonal functions, the fundamental solutions of Laplace equation, the heat equation and the wave equation. Representation of solutions of partial differential equations in terms of eigenfunctions. The student acquire the ability to read and to comprise advanced texts in mathematics, and mathematical physics, and to consult research articles. The student acquire the ability to produce personal originals elaborated in mathematics and its applications, in theoretical physics and in mathematical physics. Applying knowledge and understanding The students will know to solve ordinary differential equations using series expansion; to solve some classical partial differential equations; to use orthogonal polynomials, to analyze the spectrum of operators. The students will acquire abilities to apply the main techniques of qualitative analysis to partial differential equations with analogous structure to those introduced in the course. They will acquire ability to formalize problem mathematically and to elaborate demonstrations using technical drafts from the consolidated mathematical literature. The student gains knowledge and understanding via class attendance, participation in classrooms and individual study. Making judgements The complete understanding of the fundamental concepts, the methodologies and the main techniques introduced in the course, will bring the student to acquire the ability to recognize the most appropriate methodologies for qualitative analysis of some mathematical-physics models used for the description of physical phenomena. The student will acquire the ability to critically analyze scientific articles. The student will acquire the ability to formalize and analyze new problems in full autonomy, both in qualitative way and in rigorous way. The formative objectives will be reached using frontal lessons and problems and exercises solved in classroom. The attainment of the objectives is verified by written test and oral examination. Communication skills The student will acquire the ability to expose in clear and rigorous way, using adequately the disciplinary lexicon, the results of the characterized qualitative solution and problem analysis. The communication abilities will be verified in the oral examination. Learning skills The student will acquire the ability to contextualize own knowledges, eventually adapting in an independent way, in wide and multidisciplinary area of interests. The ideal scope of this course is also to allow the student to approach a meaningful portion of specialized literature on advance mathematical methods for physics and sciences. The student will be able to approach a meaningful portion of specialized literature on partial differential equations. The methodologies and the arguments developed in this course will contribute also to form the interested students to continue in scientific research.
ASSESSMENT METHODS	The final verification aims to estimate: the knowledge and the understanding of the student about the contents of the course; the competence of the student to apply this knowledge and understanding; if the student owns autonomy of judgments and suitable communication and learning skills. The final verification consists of a written test and an oral examination. In the written test the resolution of four/six exercises is demanded. The exercises make reference to all the objects of the program and are consistent to the examples and the discussion hours developed during the course. During the oral examination the student should correctly answer to two/three questions based on all the contents of the course. Moreover, the student should give a critical explanation of the exercises' resolution proposed in the written test. The final evaluation will be based on both the written test and the oral examination and it will be scaled according to the following conditions: a)does not possess an acceptable knowledge of the contents of the presented

	topics (no sufficient); b)minimal base knowledge of the contents of the course and of the technical language, sufficient ability to apply the acquired knowledge independently (18-20); c)not have full mastery of the main contents of the course but possesses knowledge, satisfactory property of language, insufficient ability to independently apply the acquired knowledge (21-23); d)knowledge of base treated contents, discrete property of language, with limited ability to independently apply the competence to solve the proposed problems (24-25); e)good mastery of the contents of the course, very good property of language, good competence in problem-solving (26-29); f)optimal knowledge of the contents of the course, optimal property of language, very good analytic abilities and competence in problem solving (30-30 with honors).
EDUCATIONAL OBJECTIVES	The objective of the course is to supply the students the foundations for a rigorous approach to mathematical problems typically encountered in the quantitative description of physical processes. The complete understanding of the fundamental concepts, the methodologies and the main techniques introduced in the course, will bring the student to acquire the ability to recognize the most appropriate methodologies for qualitative analysis of some mathematical-physics models used for the description of physical phenomena.
TEACHING METHODS	The course is given in the first semester of the year of the CdL in Physics. The course consists of frontal lessons and discussion in which illustrative problems are resolved. The objective of the course is to supply the students the foundations for a rigorous approach to mathematical problems typically encountered in the quantitative description of physical processes. The students will acquire the following knowledges: - Elements of theory of Hilbert spaces and the theory of distributions. - Elements of spectral theory for operators and the Fourier transform. - The theory of Sturm-Liouvile, orthogonal functions. - The fundamental solutions of the Laplace equation, the heat equation and the wave equation. - Representation of solutions of some partial differential equations of mathematical physics in terms of eigenfunctions. These arguments will be introduced and analyzed in rigorous way during the frontal lessons. Through the exercises the students will acquire greater understanding of the presented topics. Moreover, two written tests (not obligatory) of verification will be proposed: one approximately at the half time of the course regarding the arguments of the theory of distributions, the Fourier transform and the Fourier series; and the last one at the end of the course that will comprise the remained arguments.
SUGGESTED BIBLIOGRAPHY	Testi di base: I.Stakgold: Green's Functions and Boundary Value Problems, Wiley L. Debnath, P. Mikusihski: Introduction to Hilbert Spaces with Applications, Academic Press Testi di consultazione: G.B.Arfken, H.J.Weber: Mathematical Methods for Physicists, Elsevier P. Dennery, A. Krzywicki: Mathematics for Physicists, Dover W.A.Strauss: Partial Differential Equations, an introduction, Wiley

SYLLABUS

Hrs	Frontal teaching
8	The theory of distributions. Convergence of sequences and series of distributions. Fourier series and Fourier transform. Differential equations in distributions. Fundamental solutions.
8	Ordinary differential equations with singularities. Frobenius method. Sturm-Liouville problems. Eigenfunctions. Special functions.
8	Hilbert spaces. Separable Hilbert spaces. Closed operators. Adjoint operators. Compact operators. Spectral theory for operators.
8	Partial differential equations. Laplace equation, fundamental solution. Diffusion equation, fundamental solution. Wave equation. Method of separation of variables.

Hrs	Practice
3	Examples and exercises on sequences and series of distributions and delta-sequences.
3	Examples and exercises on Fourier series and Fourier transform.
3	Examples and exercises on Green functions for second order differential operator.
2	Applications of the theory of distributions to partial differential equations.
3	Resolution of partial differential equations using Fourier series and Fourier transform.

Hrs	Practice
3	Examples and exercises on adjoint operators. Examples and exercises on the spectrum of an operator.
2	Resolution of ordinary differential equations using series expansions.
3	Examples and exercises on special functions.
2	Problem solving for the final test