UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

CONSIGLIO INTERCLASSE IN MATEMATICA

COURSE OF STUDY	**TWO-YEAR MASTER OF SCIENCE PROGRAMME IN MATHEMATICS**
ACADEMIC YEAR	**2023-2024**
ACADEMIC SUBJECT	**ADVANCED MATHEMATICAL ANALYSIS 2**

General information	
Programme year	Second
Term	Second semester (February 26, 2024 – May 31, 2024)
European Credit Transfer and Accumulation System credits (ECTS)	7
SSD	MAT/05 – Mathematical Analysis
Language	Italian
Mode of attendance	Not mandatory

Lecturers	
Name and surname	Anna Maria Candela
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Department and office	Department of Mathematics, room 20 second floor
Virtual meeting room	Microsoft Teams, code s35iyu1
Web page	https://www.dm.uniba.it/en/members/candela
Office hours	In-person or online. Days and times have to be arranged by e-mail

Work schedule				
	Total	Lectures	Hands-on learning	Self-study
Hours	175	56		119
ECTS credits	7	7		

Learning objectives	
	Acquiring instruments of Distribution Theory and Sobolev Spaces with real exponent which allow one to study some differential equations coming from Mathematical Physics such as Volterra type equations, Laplace's equation, heat equation and wave equation.

Course prerequisites	
	In addition to the mathematical knowledge which usually is acquired during a degree of L–35 class, students have to master language and techniques of modern analysis such as basic theory of Banach spaces, convolution of functions and the Fourier transform on the Lebesgue spaces L^1 and L^2.

Syllabus	
Course contents	***Distribution Theory***. Distributions and their properties. Derivatives of distributions. Examples. Weak solutions of differential equations. Rankine-Hugoniot condition. Burger's equation. Convergence and series of distributions. The Dirac distribution and its approximating sequences. Periodic distributions. Fourier series of distributions. ***Convolution equations.*** Convolution of distributions and related theorems. Convolution algebra of distributions. Examples. Convolution equations and their fundamental solution. Volterra type equations.

	Fourier transform of distributions. Fourier transform of temperate distributions and its properties. Examples. Fourier transform of distributions with compact support and related theorems. ***Sobolev Spaces.*** Sobolev Spaces with real exponent and their properties. Duality, Imbedding, Interpolation, Extension, and Approximation Theorems. Traces theorems. ***Second order differential equations.*** Differential operator of order k. Total and principal symbol of differential operators. Elliptic operators and their characterization. Elliptic equations: weak solutions and regularity theorems. Heat equation. Wave equation.
Reference books	• R.A. Adams & J.J.F. Fournier, "Sobolev Spaces" (2nd Ed.), Academic Press, Amsterdam, 2003 • H. Brezis, "Functional Analysis, Sobolev Spaces and Partial Differential Equations", Springer, New York, 2011 • L. Schwartz, "Méthodes Mathématiques pour les Sciences Physiques", Hermann, Paris, 1965 • L. Schwartz, "Théorie des Distributions", Hermann, Paris, 1966
Additional course materials	It is recommended to complete textbooks with notes taken at lesson. The recommended textbooks can be replaced by any other books of Advanced Mathematical Analysis which cover the topics of the program. If using notes found on internet, a careful check about their author is strongly recommended.
Repository	Professor's notes are available upon request.

Expected learning outcomes	
Knowledge and understanding	Acquiring fundamental concepts of Distribution Theory and Sobolev Spaces with real exponent, their related theorems and how to apply them for studying some classical differential equations.
Applying knowledge and understanding	The acquired methods apply for studying some differential equations which describe some classical problems in Mathematical Physics such as Volterra type equations, Laplace's equation, heat equation, wave equation,
Soft skills	*Making judgements*: Ability to analyze the consistency of the logical arguments used in a proof. Problem solving skills should be supported by the capacity in evaluating the correct methods required for studying some classical differential equations.
	Communication skills: 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 some classical differential equations.
	Learning skills: Acquiring suitable learning methods, supported by text consultation and by solving some models of differential equations.

Teaching methods	
	Classroom lectures which include exercises whose purpose is to make students acquire the ability to apply theoretical concepts. Teaching will take place in-person, anyway according to the Academic Senate's resolutions.

Assessment	
Assessment methods	An oral exam which includes both a one-hour talk on some program topics (at the student's choice) and some questions on other theoretical results in the program.
Evaluation criteria	• *Knowledge and understanding*: Students have to master definitions and

	theoretical results in the program. • *Applying knowledge and understanding*: students have to be able to apply the acquired theoretical knowledge to the study of some models of differential equations in Mathematical Physics. • *Making judgement*: students have to be able to distinguish between essential and nonessential assumptions, and also to organize and present a talk dealing with some program topics which, selected independently, follow a logical thread within the available time. • *Communication skills*: students have to be able to discuss mathematical notions in a rigorous way. • *Learning skills*: students have to be able to contextualize mathematical topics and eventually extend their knowledge independently.
Grading policy	The final grade is out of thirty. The exam is passed if the final grade is greater than or equal to 18/30.

Further information	
	Attendance is strongly recommended.