Stampare su carta intestata del CdS

General information		
Academic subject	Advanced Mathematical Analysis no. 2	
Degree course	LM 40 - Matematica	
Academic Year	Second	
European Credit Transfer and Accumulation System (ECTS)		7
Language	Italian	
Academic calendar (starting and ending date)	Second semester (February 28, 2022 – May 27, 2022)	
Attendance	Discretionary	

Professor/ Lecturer	
Name and Surname	Anna Maria Candela
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Department and address	Department of Mathematics (Floor II, Room 20), Campus, via E. Orabona 4
Virtual headquarters	Microsoft Teams Code: 63uef9r
Tutoring (time and day)	In-person or online. Days and times have to be arranged by e-mail

Syllabus	
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. Moreover, acquiring tools concerning Modern Analysis that can be useful in order to constructively approximate functions by means of positive operators and enlighten the connection among these matters, positive semigroups theory and the study of certain evolution problems.
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.

<table>
<tr><td>Contents</td><td>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.
Approximation theory. Positive linear operators and their properties. Korovkin theorems and their consequences. Bernstein Operators. Kantorovich Operators. Szasz-Mirakjan Operators. Positive semigroups. Generation and approximation of positive semigroups. Applications.</td></tr>
<tr><td>Books and bibliography</td><td>• R.A. Adams & J.J.F. Fournier, “Sobolev Spaces” (2nd Ed.), Academic Press, Amsterdam, 2003
• F. Altomare & M. Campiti, “Korovkin-Type Approximation Theory and its Applications”, De Gruyter Series Studies in Mathematics 17, De Gruyter & Co., Berlin-New York, 1994
• H. Brezis, “Functional Analysis, Sobolev Spaces and Partial Differential Equations”, Springer, New York, 2011
• K.-J. Engel & R. Nagel, “One-Parameter Semigroups for Linear Evolution Equations”, Graduate Texts in Mathematics 194, Springer, 2000
• L.C. Evans, “Partial Differential Equations”, AMS, Providence, 1998
• L. Schwartz, “Méthodes Mathématiques pour les Sciences Physiques”, Hermann, Paris, 1965
• L. Schwartz, “Théorie des Distributions”, Hermann, Paris, 1966</td></tr>
<tr><td>Additional materials</td><td>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.</td></tr>
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<tr><td colspan="2">Work schedule</td><td colspan="3"></td></tr>
<tr><td>Total</td><td colspan="2">Lectures</td><td>Hands on (exercises)</td><td>Out-of-class study hours/ Self-study hours</td></tr>
<tr><td colspan="5">Hours</td></tr>
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175	52	8	115
ECTS			
7	6.5	0.5	

Teaching strategy	
	Classroom lectures which include exercises whose purpose is to make the student acquire the ability to apply theoretical concepts. Due to the ongoing health emergency, teaching will take place according to the Academic Senate's resolutions.
Expected learning outcomes	
Knowledge and understanding on:	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. Moreover, acquiring tools in Approximation Theory concerning positive linear operators and positive semigroups with applications to some evolution problems.
Applying knowledge and understanding on:	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, some evolution equations.
Soft skills	• *Making informed judgments and choices* 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. • *Communicating knowledge and understanding* 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. • *Capacities to continue learning* Acquiring suitable learning methods, supported by text consultation and by solving some model differential equations.

Assessment and feedback	
Methods of assessment	Oral exam.
Evaluation criteria	Students have to organize and give a one-hour seminar on some parts of the course program. They must be able to prove theoretical results, to distinguish between essential and nonessential assumptions, to discuss mathematical notions in a rigorous way, to contextualize mathematical topics.
Criteria for assessment and attribution of the final mark	The final grade is out of thirty. The exam is passed if the final grade is greater than or equal to 18/30.

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Additional information	
	The course is carried out in collaboration with Prof. Mirella Cappelletti Montano e-mail: mirella.cappellettimontano@uniba.it Telephone number: 0805442689 Department and address: Department of Mathematics (Floor III, Room 12) Tutoring is in person or online. Days and times have to be arranged by e-mail.
	Attendance is strongly recommended.