Academic subject: Advanced Mathematical Analysis 2

Degree Class:	**Degree Course:**	**Academic Year:**	
L-40 Matematica	Mathematics	2018/2019	
	Kind of class: Mandatory/Optional depending on the Curriculum	**Year:**	**Period:** 2
		ECTS: 7 divided into **ECTS lessons:** 6,5 **ECTS exe/lab/tutor:** 0,5	

Time management, hours, in–class study hours, out–of–class study hours

lesson: 52 exe/lab/tutor: 8 in–class study: 60 out–of–class study: 115

Language:	**Compulsory Attendance:**	
Italian	no	

Subject Teacher:	**Tel:** +39-0805442669	**Office:**	**Office days and hours:**
Anna Maria Candela	**e–mail:** annamaria.candela@uniba.it	Department of Mathematics Floor II, Room 20	Days and times have to be arranged by email

Prerequisites:

In addition to the mathematical knowledge which usually is acquired during a degree of L–35 class, they are required 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.

Educational 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.

Expected learning outcomes (according to Dublin Descriptors)

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 and wave equation.

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:
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.

Lifelong learning skills:
Acquiring suitable learning methods, supported by text consultation and by solving some model differential equations.

Course program

Theory of Distribution Distributions and their properties. Derivatives of distributions. Examples. Distribution 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.

Laplace's equation Harmonic functions on spheres. Mean Value Inequality. Maximum Principle. Convergence theorems and their applications. Harnack's inequality.

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.
Teaching methods: Lectures and exercise sessions
Auxiliary teaching:
Assessment methods: Oral exam
Bibliography: • 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.C. Evans, “Partial Differential Equations”, AMS, Providence, 1998 • D. Gilbarg & N.S. Trudinger, “Elliptic Partial Differential Equations of Second Order” (Reprint of the 1998 Ed.), Springer, Berlin-Heidelberg, 2001