

COURSE DATA

Data Subject			
Code	46956		
Name	Espacios de funciones y sus duales		
Cycle	Master's degree		
ECTS Credits	3.0		
Academic year	2024 - 2025		
Study (s)			
Degree		Center	Acad. Period year
2183 - Master's Deg Research	gree in Mathematical	Faculty of Mathematics	1 First term
Subject-matter			
Degree	12 12 12	Subject-matter	Character
2183 - Master's Deg Research	gree in Mathematical	4 - Specialty in fundamental mathematics	Optional

SUMMARY

Objectives of the Course

The purpose of this course is to study the behavior of various operators between different function spaces. Locally convex spaces, which naturally generalize normed and Banach spaces, are introduced to explain the behavior of many function and sequence spaces that are not normed. Various types of operators are studied, such as multiplication operators, composition operators, partial differential operators, and integration operators when acting between locally convex spaces of analytic functions in the unit disk, entire functions in the complex plane, and differentiable functions. The course examines their continuity, surjectivity, when they are isometries, and in some cases their spectral and dynamic properties. An example of a paradigmatic locally convex space is the space of rapidly decreasing functions, as well as its dual, the space of tempered distributions. The Fourier transform in these spaces will be studied. Finally, different properties of partial differential operators in spaces of distributions will be analyzed.

Contextualization of the Course

The course is elective and provides basic and fundamental training in mathematical analysis to the student, especially in functional analysis and operator theory. At the same time, it is a natural continuation of the study of Banach space theory for any mathematics degree.



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PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

2183 - Master's Degree in Mathematical Research

- Students should apply acquired knowledge to solve problems in unfamiliar contexts within their field of study, including multidisciplinary scenarios.
- Students should be able to integrate knowledge and address the complexity of making informed judgments based on incomplete or limited information, including reflections on the social and ethical responsibilities associated with the application of their knowledge and judgments.
- Capacidad de integrar conocimientos y formular juicios.
- Students should possess and understand foundational knowledge that enables original thinking and research in the field.
- Que los estudiantes comprendan los conceptos y las demostraciones rigurosas de teoremas fundamentales de áreas transversales de las Matemáticas.
- Que los estudiantes comprendan los conceptos y las demostraciones rigurosas de teoremas fundamentales de alguna de las áreas específicas de las Matemáticas.
- Que los estudiantes sean capaces de aplicar los resultados y técnicas aprendidas para la resolución de problemas complejos de alguna de las áreas de las Matemáticas, en contextos académicos o profesionales.
- Que los estudiantes tengan capacidad para elaborar y desarrollar razonamientos lógico-matemáticos e identificar errores en razonamientos incorrectos.
- Que los estudiantes sean capaces de comprender de manera autónoma artículos de investigación o innovación en alguna de las áreas de las Matemáticas.

LEARNING OUTCOMES (RD 1393/2007) // NO CONTENT (RD 822/2021) English version is not available



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DESCRIPTION OF CONTENTS

- 1. Pointwise and Uniform Convergence of Sequences of Functions
- 1.1. Convergence Theorems
- 1.2. Power Series

2. Introduction to Locally Convex Spaces

- 2.1. Seminorms, Neighborhoods, and Topology
- 2.2. Metrizable and Normable Spaces
- 2.3. Duality

3. Function Spaces

- 3.1. Spaces of Continuous Functions
- 3.2. Spaces of Differentiable Functions
- 3.3. Spaces of Holomorphic Functions

4. Operators between Function Spaces

- 4.1. Multiplication Operators
- 4.2. Composition Operators
- 4.3. Partial Differential Operators
- 4.4. Differentiation and Integration Operators
- 4.5. Spectral and Dynamic Properties

5. Distributions and Tempered Distributions

- 5.1. Test Functions and the Space S of Rapidly Decreasing Functions
- 5.2. Fourier Transform in S
- 5.3. Fourier Transform in the Space of Tempered Distributions S'
- 5.4. Partial Differential Operators Acting on Distributions



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WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	30,00	100
TOTAL	30,00	

TEACHING METHODOLOGY

Lectures, problem-solving sessions, and assignment submission.

EVALUATION

The student's evaluation will consist of three assessment components: the submission of solutions to exercises periodically proposed in class, which will account for 30% of the final grade of the course and will also be used to assess transversal competencies, and the resolution and submission of two problem sets, each accounting for 35% of the grade. These latter two problem sets can be partially personalized for each student. Submission deadlines will be set for each proposed problem set, both the periodic submissions and the two sets with a greater weight in the final grade.

The recovery assessment will involve the submission of the two problem sets, each accounting for 35% of the grade, if they have not been submitted by the deadline for the regular assessment, if the grade on these problems does not exceed 3 in the regular assessment, or if the overall average grade with all submissions does not exceed 5. The periodically proposed problems in class, which account for 30% of the final grade, are not recoverable. If none of them are submitted by the established deadlines, the maximum grade for the course will be 7.

The evaluation of students with a UPV exemption from attending any classes will be the same as for students without an exemption.

REFERENCES

Basic

- Function Spaces and Operators Between Them (Bonet, José Jornet, David Sevilla-Peris, Pablo)
- Elementary functional analysis (MacCluer, Barbara D.)
- Composition operators and classical function theory (Shapiro, Joel)
- Introduction to functional analysis (Meise, Reinhold)
- Analisis real y complejo (Rudin, Walter)
- Functional analysis (Rudin, Walter)



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- Distributions and operators (Grubb, Gerd)

