COURSE DATA

DATA SUBJECT

Code: 44079
Name: Mathematical analysis and applications
Cycle: Master's Degree
ECTS Credits: 3
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
2183 - Master's Degree in Mathematical Research	Facultat de Ciències Matemàtiques	1	Second quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
2183 - Master's Degree in Mathematical Research	Specialty in fundamental mathematics	ELECTIVES

COORDINATION

BLASCO DE LA CRUZ OSCAR FCO

SUMMARY

The aim of the course is to present some of the classical theorems of Mathematical Analysis that have been commonly used as tools in the proof of other results. The course seeks to introduce students to concepts from Fourier Analysis and Measure Theory that build upon those already covered in other courses, focusing on those that represent key milestones in Fourier Analysis. The course will review notions of continuous and integrable functions, both periodic and defined on Euclidean space that will be used throughout, extending Fourier Analysis to spaces of measures rather than functions. Likewise, emphasis will be placed on concepts of both linear and sublinear operators that play an important role in this theory.

The interpolation theorems of Marcinkiewicz and Riesz-Thorin, where tools from real and complex variable theory are crucial respectively, will be specifically addressed in this course. A fundamental objective is to prove the weak and strong type boundedness theorems for the Hardy-Littlewood maximal function, Riesz's theorem on the boundedness of the Hilbert transform together with its application to the summability of Fourier series and Young's and Hausdorff-Young's theorems on convolutions and Fourier coefficients, among others.

To achieve these results, the necessary preliminary notions on convolution, Fourier coefficients, and

Marcinkiewicz and Lorentz spaces will be developed.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

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

OTHER REQUIREMENTS

The student should have knowledge of the Lebesgue integral and basic concepts of complex variables, as well as some understanding of Functional Analysis.

COMPETENCES / LEARNING OUTCOMES

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Capacidad de integrar conocimientos y formular juicios.

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 posean la capacidad para enunciar y verificar proposiciones en alguna de las áreas de las Matemáticas y para transmitir los conocimientos matemáticos adquiridos, oralmente y por escrito.

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 sean capaces de comprender de manera autónoma artículos de investigación o innovación en alguna de las áreas de las Matemáticas.

Que los estudiantes tengan capacidad para elaborar y desarrollar razonamientos lógico-matemáticos e identificar errores en razonamientos incorrectos.

Students should apply acquired knowledge to solve problems in unfamiliar contexts within their field of study, including multidisciplinary scenarios.

Students should demonstrate self-directed learning skills for continued academic growth.

Students should possess and understand foundational knowledge that enables original thinking and research in the field.

DESCRIPTION OF CONTENTS

1. Preliminaries on continuous functions, integrable functions, and complex measures.
2. Preliminaries of Fourier Analysis.
3. Interpolation theorems of Marcinkiewicz and Riesz-Thorin.
4. Basic theorems:
4.1 Duality.
4.2 Young's and Hausdorff-Young's theorems.
4.3 Harmonic functions. Poisson kernel.
4.4 Maximal functions. Hardy-Littlewood maximal function.
4.5 The conjugate function. Riesz's theorem.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Theory	30,00
Total hours	**30,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	15,00
Independent study and work	20,00
Preparation of lessons	10,00
Preparation for assessment activities	0,00
Resolution of case studies	0,00
Total hours	**45,00**

TEACHING METHODOLOGY

Classes will be taught at the blackboard, encouraging student participation through questions related to the topic, and various exercises on the subjects covered will be developed.
Each student will present a previously selected theorem at the blackboard, with the aim of being able to organize a specific topic and present a result from it to their classmates.

EVALUATION

Assessment will be based on the presentation of problems and questions related to the subject, proposed individually, as well as on the student's presentation of a part of the course at the blackboard.

REFERENCES

Y. Katznetson, An introduction to Harmonic Analysis. John Wiley and Sons, New York, (1968).

J. Duoandikoetxea, Análisis de Fourier. Addison-Wesley/Universidad Autónoma de Madrid, (1995)

W. Rudin, Real and complex analysis. McGraw Hill, New York, (1974).

A. Zygmund, Trigonometric series. Cambrigde Univ. Press. New York, (1959).