COURSE DATA

Data Subject	
Code	34248
Name	Mathematical methods II
Cycle	Grade
ECTS Credits	6.0
Academic year	2023 - 2024

Study (s)

Degree	Center	Acad. year	Period
1105 - Degree in Physics	Faculty of Physics	2	Second term
1929 - Double Degree Program in Physics and Chemistry	Double Degree Program Physics and Chemistry	2	Second term

Subject-matter

Degree	Subject-matter	Character
1105 - Degree in Physics	8 - Mathematical methods	Obligatory
1929 - Double Degree Program in Physics and Chemistry	2 - Segundo Curso (Obligatorio)	Obligatory

Coordination

Name	Department
GONZALEZ ALONSO, MARTIN	185 - Theoretical Physics
LLEDO BARRENA, M. ANTONIA	185 - Theoretical Physics

SUMMARY

- Objectives: To acquire the knowledge of complex variable necessary for the degree Physics
- Relationship with previous, current and future courses: Because the subject is instrumental, all the other courses of the degree in Physics may require the concepts and techniques
developed in this course. It is advisable to have passed the Mathematics courses (Algebra and Geometry I and II, Calculus I and II).
- Descriptors: Complex Numbers and Functions of complex variable. Differentiation, integration and series. Applications to the calculation of certain integrals. Integral transforms. Laplace and Fourier Transforms.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

It is essential to have already a good understanding of the objectives included in the Mathematics courses of the first year (Algebra and Geometry I and II, and Calculus I and II), namely
1. Differential calculus in one and several variables.
2. Integration in one variable and multiple integrals.
3. Real, numerical sequences and series
4. Power series
5. Linear systems
6. Vector Spaces
7. Matrices and determinants, linear operators, eigenvalues and eigenvectors.

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

1105 - Degree in Physics

- To know how to apply the knowledge acquired to professional activity, to know how to solve problems and develop and defend arguments, relying on this knowledge.
- Be able to understand and master the use of the most commonly used mathematical and numerical methods.
- Modelling & Problem solving skills: be able to identify the essentials of a process / situation and to set up a working model of the same; be able to perform the required approximations so as to reduce a problem to an approachable one. Critical thinking to construct physical models.
- Foreign Language skills: Have improved command of English (or other foreign languages of interest) through: use of the basic literature, written and oral communication (scientific and technical English), participation in courses, study abroad via exchange programmes, and recognition of credits at foreign universities or research centres.
- Learning ability: be able to enter new fields through independent study, in physics and science and technology in general.
- Communication Skills (written and oral): Being able to communicate information, ideas, problems and solutions through argumentation and reasoning which are characteristic of the scientific activity, using basic concepts and tools of physics.
- Students must have acquired knowledge and understanding in a specific field of study, on the basis of general secondary education and at a level that includes mainly knowledge drawn from advanced textbooks, but also some cutting-edge knowledge in their field of study.

- Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.
- Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.
- Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.
- Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.

LEARNING OUTCOMES (RD 1393/2007) // NO CONTENT (RD 822/2021)

1. To be able to perform computations with complex numbers. To know the characteristics of complex variable functions and the conditions of analyticity.

2. To understand the residue theorem and its applications to the calculation of integrals and series.

3. To be able to construct a Fourier series. To be able to compute the Fourier or Laplace transform of a function and the inverse transforms.

DESCRIPTION OF CONTENTS

1. 1. Complex numbers and complex functions.

Representation and operations with complex numbers. Curves C. The point of infinity. Functions of a complex variable. Differentiability and analyticity. Cauchy-Riemann conditions. Multivalued functions. Branch cuts, singularities and zeros. Power and logarithm function. Exponential trigonometric functions, hyperbolic functions

2. Integrals in the complex plane. Cauchy Theorem.

Integrals in the complex plane. Primitives. Cauchy theorem. Cauchy integral formula.
High derivatives of a regular function.

3. Series in the complex plane. Residue theorem.

Numerical and functional series in the complex plane. Power series: Taylor and Laurent.
Singularities. Classification. Residue theorem. Calculating residues. Examples.

4. Applications

Real improper integrals. Integration of single-valued functions. Poles in the way of integration. Examples. Integration of multiple-valued functions. Sum of series. The Gamma function. Properties.

5. Integral Transforms: Laplace and Fourier

The concept of integral transform. The Laplace transform and its properties. Inverse transform. Convolution. Heaviside function and Dirac delta. Operating Rules. Application to the resolution of differential equations. Fourier series. Dirichlet conditions. Fourier coefficients. Theorem of Parseval. Fourier transform and properties. Convolution and Fourier transforms.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	45,00	100
Tutorials	15,00	100
Development of individual work	30,00	0
Study and independent work	60,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The methodology of the course will be the following: 3 of the four weekly hours will correspond to theoretical-practical classes and 1 hour to tutoring classes for small groups.

In the theoretical-practical classes, the professor will develop the content of the course, emphasizing both conceptual aspects and applications. Part of the content -some demonstration and/or particular application- may be left as work for tutorials.

Tutorial classes will be devoted to solve and/or discuss some of the problems of the list that the professor will, previously, make available to the students, either on paper or through the virtual classroom. Theoretical questions assigned to the students may also be addressed and the presentation and results obtained will be evaluated.

EVALUATION

The evaluation will take into account the work done during the course (continuous evaluation, CE) and the final exam (FE).

The final exam will consist of a written test, which may consist of a part with questions of a more theoretical nature, and another part of problems.

The continuous evaluation may take into account the work and participation in class of the student throughout the course, as well as the results obtained in possible tests carried out before the final exam.

Correct argumentation, critical thinking with respect to the results obtained and a clear and legible presentation will be taken into account, both in the final exam and in the activities carried out throughout the course.

In the event that the grade of one of the parts of the final exam is less than 3.5 out of 10, it will not be averaged with the continuous evaluation, and the final grade for the course (FG) will be given by the formula: FG = Min [3.5, FE]. Therefore, the final grade will be "Fail".

If the scores in both parts of the final exam are both equal to or greater than 3.5 out of 10, the final exam grade may be averaged with the continuous evaluation, and the final marks for the course will be obtained as follows:

Final grade = max (0.7 * FE + 0.3 * CE, FE),

where CE is the result of the continuous evaluation out of 10.

Also, the grade of this subject can be averaged with that of Mathematical Methods I so that both are considered to have been passed if the average is equal to or greater than 5 points out of 10 and the grade in both is equal to or greater than 4 points out of 10.

REFERENCES

Basic

- J. Peñarrocha, A. Santamaría, J. Vidal, "Mètodes Matemàtics: Variable Complexa, Universitat de València.
- J.E. Marsden, "Basic Complex Analysis", W. H. Freeman and Company.
- K.F. Riley, M.P. Hobson, S.J. Bence, "Mathematical methods for physics and engineering: A comprehensive guide", Cambridge University Press.
- G. B. Folland, "Fourier analysis and its applications", AMS (2009).

Additional

- Ruel V. Churchill, James W. Brown, "Variable Compleja y Aplicaciones", MacGraw-Hill.
- William R. Derrick, "Complex Analysis and Applications", Wadsworth International Group.
- I. Stakgold, M. Holst, "Green's functions and boundary value problems", Third Edition. Wiley (2011).