1. OVERVIEW

Subject area	Complex variables
Degree	Bachelor's Degree in Physics
School/Faculty	School of Architecture, Engineering and Design
Year	second
ECTS	6
Type	Compulsory
Language(s)	Spanish
Delivery mode	on campus
Semester	First semester

2. INTRODUCTION

Complex Variables is a core subject area in physics studies and, as such, a fundamental tool for solving problems in diverse areas of science such as signal transmission, automatic control, circuit theory, electric machines and fluid mechanics.

The subject area Mathematical Analysis I will allow students to approach Complex Variables with a confident grasp of the mathematical techniques seen in the first semester, which can now be applied in this discipline.

3. SKILLS AND LEARNING OUTCOMES

Key skills (CB, by the acronym in Spanish):

- CB3: Students have the ability to gather and interpret relevant data (usually within their study area) to form opinions which include reflecting on relevant social, scientific or ethical matters.

Transversal skills (CT, by the acronym in Spanish):

- CT04. Written communication/Oral communication: Ability to communicate and gather information, ideas, opinions and viewpoints in order to understand and be able to act upon them, whether they are through spoken word and gestures, or through written word and/or visual aids.
- CT05. Problem solving: Be able to critically evaluate information, separate complex situations into their constituent parts, recognise patterns, and consider alternatives, different approaches and perspectives in order to find optimal solutions and negotiate efficiently.

Specific skills (CE, by the acronym in Spanish):

- CE04 - To understand the laws and principles of physics, to identify their logical and mathematical structure, their experimental basis and the phenomena described through them.
- CE05 - To understand and know how to use the mathematical and numerical methods used in physics and in handling experimental data.

Learning outcomes (RA, by the acronym in Spanish):

- To understand the principles of complex variable calculus and its application in different branches of physics.
- To know how to analyse complex functions and, in particular, their analyticity. To understand the properties of elementary complex functions.
- To understand residue theorem and its connection to integral calculus.
- To confidently apply the Fourier transform and the Laplace transform in the context of applied physics problems.

The following table shows how the skills developed in the subject area match up with the intended learning outcomes:

Skills	Learning outcomes
CB1, CT2, CT3	To understand the principles of complex variable calculus and its application in different branches of physics.
CB2, CT4, CT5, CE5	To know how to analyse complex functions and, in particular, their analyticity. To understand the properties of elementary complex functions.
CB2, CT4, CE5	To understand residue theorem and its connection to integral calculus.
CB2, CT4, CE5	To confidently apply the Fourier transform and the Laplace transform in the context of applied physics problems.

4. CONTENTS

1. Complex numbers.
2. Analytic functions.
3. Representation of analytic functions as series.
4. Residue calculus.
5. Integral transforms.

5. TEACHING/LEARNING METHODS

The types of teaching/learning methods are as follows:

- Collaborative learning: Students learn to collaborate with other people (classmates and professors) in order to find creative, comprehensive and constructive solutions to questions and problems that arise from the given case studies, using all relevant knowledge and material resources available.
- Problem-based learning: Students are given problems and asked to solve them, working individually or in groups.
- Lectures: Presentations by the professor with the necessary technological tools to maximise comprehension of the learning content.
- Guided academic activities: Individual and group work that is more independent, including information searches, written summaries, debates and the public defence of projects.

6. LEARNING ACTIVITIES

The types of learning activities, plus the amount of time spent on each activity, are as follows:

Type of learning activity (AF, by the acronym in Spanish)	Number of hours
Lectures	50
Oral presentations of projects and debates	6
Report writing	20
Assessment	6
Practical activities (problems, written work, projects, workshops and/or lab work)	20
Tutorials	16
Independent working	32h
TOTAL	**150**

7. ASSESSMENT

The assessment systems, plus their weighting in the final grade for the subject area, are as follows:

Assessment system	Weighting
Individual on-campus knowledge tests (theory and/or practice).	50%

Submission of group and/or individual reports, written work, projects or exercises	35%
Oral defence	5%
Performance observation	10%

On the Virtual Campus, when you open the subject area, you'll find details of your assessable tasks, including the submission dates and assessment procedures for each task.

8. BIBLIOGRAPHY

The recommended reading for the subject area is listed below. All publications are available in the Dulce Chacón University Library for reference or loan.

- Apostol, T.M. Introducción a la teoría analítica de números. Ed. Reverté, Barcelona, 1984.
- Burckel, R.B. An introduction to classical complex analysis. Academic Press, New York, 1979.
- Clarke, L.E. y Singer, J. On Circular Permutations, Amer. Math. Monthly 65 (1958), 609–610.
- Conway, J.B. Functions of one complex variable. Springer, New York, 1978.
- Edwards, H.M. Riemann's zeta function. Academic Press, New York, 1975.
- Lang, S. Algebraic Number Theory. Addison Wesley, Massachussetts, 1970.
- López Fdez. Asenjo, F., Galindo Soto, F. y Tristán Vega, L.A. Funciones analíticas multiformes. Universidad de Valladolid, 1996