Universitat Autònoma de Barcelona

2021/2022

Complex Variable Analysis

Code: 106072
ECTS Credits: 5

Degree	Type	Year	Semester
2500097 Physics	OB	2	2

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Teachers

Antonio Méndez Vilaseca
Francisco Javier García Garrido

Prerequisites

Prior knowledge of real variable functions is required, so it is advisable to have studied the Calculus I, Calculus II and Calculus of Several Variables.

Objectives and Contextualisation

The main goal of this course is to introduce the analysis of complex functions of a complex variable, its calculation and applications, beginning with the presentation of complex numbers and ending with advanced applications and topics.

Competences

- Develop the capacity for analysis and synthesis that allows the acquisition of knowledge and skills in different fields of physics, and apply to these fields the skills inherent within the degree of physics, contributing innovative and competitive proposals.
- Make changes to methods and processes in the area of knowledge in order to provide innovative responses to society's needs and demands.
- Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
- Use mathematics to describe the physical world, selecting appropriate tools, building appropriate models, interpreting and comparing results critically with experimentation and observation
- Work independently, have personal initiative and self-organisational skills in achieving results, in planning and in executing a project

Learning Outcomes

1. Calculate real integrals using the method of residues.
2. Determine the Taylor or Laurent series for a complex variable function.
3. Handle simple distributions with ease.
4. Identify situations in which a change or improvement is needed.
5. Obtain Fouriers transform for a function.
6. Use complex numbers and multiform functions with ease.
7. Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
8. Use the mathematical tools developed in this subject for the quantitative study of advanced problems in any branch of knowledge.
9. Work independently, take initiative itself, be able to organize to achieve results and to plan and execute a project.

Content

1) Complex numbers: representation, Euler's formula, powers and roots

2) Topology of complex numbers

3) Elementary and multiple-valued functions: exponential, trigonometric, hyperbolic, logarithm, power

4) Fourier series and transform

5) Complex differentiation: limits and continuity, Cauchy-Riemann equations, differentiation

6) Cauchy's theorem: integrals in the complex plane, primitives

7) Cauchy's integral formula: index of a closed path, nth derivative of a regular function

8) Series expansions: Taylor series, Laurent series, singularities of an analytic function

9) The residue theorem: calculation of residues, applications

10) Advanced topics: Riemann surfaces, analytic continuation, monodromy theorem, Schwarz's reflection principle

Methodology

Theory Lectures and Exercises.

Classwork and Homework.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Exercises	14	0.56	1, 2, 3, 5, 6, 8
Theory Lectures	27	1.08	1, 2, 3, 5, 6, 8
Type: Autonomous			

Discussion, Work Groups, Group Exercises	19	0.76	1, 2, 4, 3, 5, 7, 9, 6, 8
Study of Theoretical Foundations	36	1.44	1, 2, 4, 3, 5, 7, 9, 6, 8

Assessment

Exam and delivery of exercises for topics 1, 2, 3, 4 and 5;

Exam and delivery of exercises for topics 6, 7, 8, 9 and 10;

Make-up exam: all topics;

In order to participate in the make-up exam you have to be evaluated of the two partial exams without requiring a minimal mark;

The make-up exam covers the whole subject;

You can come to the make-up exam to improve your mark. If so, your final mark will be that of this exam.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Delivery of Exercises: topics 1, 2, 3, 4 and 5	15%	10	0.4	4, 3, 5, 7, 9, 6, 8
Delivery of Exercises: topics 6, 7, 8, 9 and 10	15%	10	0.4	1, 2, 4, 7, 9, 8
Exam: topics 1, 2, 3, 4 and 5	35%	3	0.12	4, 3, 5, 7, 9, 6, 8
Exam: topics 6, 7, 8, 9 and 10	35%	3	0.12	1, 2, 4, 7, 9, 8
Make-up Exam: all topics	70%	3	0.12	1, 2, 4, 3, 5, 7, 9, 6, 8

Bibliography

Bibliography: Complex Variables

• "Complex Variables", M. R. Spiegel *et al.*, Schaum's Outline Series, McGraw-Hill

• "Complex Variable and Appications", J. W. Brown and R. V. Churchill, McGraw-Hill

Bibliografia: Fourier Series and Transform

• "Mathematical Methods for Physicists", G. B. Arfken and H. J. Weber, Elsevier Academic Press

Software

It is recommended to use Mathematica Student Edition.