Universitat Autònoma de Barcelona

**2019/2020**

# Complementary Mathematics Topics

Code: 100160
ECTS Credits: 5

| Degree | Type | Year | Semester |
|---|---|---|---|
| 2500097 Physics | OB | 2 | 2 |

## 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

## Other comments on languages

If it is agreed by the students unanimously the theory lectures will be given in English

## 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 critical thinking and reasoning and know how to communicate effectively both in the first language(s) and others
- Develop independent learning strategies
- 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.
- Respect the diversity and plurality of ideas, people and situations
- 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

## Learning Outcomes

1. Calculate real integrals using the method of residues.
2. Determine the Taylor or Laurent series for a complex variable function.
3. Develop critical thinking and reasoning and communicate ideas effectively, both in the mother tongue and in other languages.
4. Develop independent learning strategies.
5. Handle simple distributions with ease.
6. Obtain Fouriers transform for a function.
7. Respect diversity in ideas, people and situations.
8. Use complex numbers and multiform functions with ease.
9. Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
10. Use the mathematical tools developed in this subject for the quantitative study of advanced problems in any branch of knowledge.

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

5) Fourier series and transform

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.

## Activities

| Title | Hours | ECTS | Learning Outcomes |
|---|---|---|---|
| Type: Directed | | | |
| Exercises | 14 | 0.56 | 1, 2, 5, 6, 8, 10 |
| Theory Lectures | 27 | 1.08 | 1, 2, 5, 6, 8, 10 |

| | | | |
|---|---|---|---|
| Type: Autonomous | | | |
| Discussion, Work Groups, Group Exercises | 19 | 0.76 | 1, 4, 3, 2, 5, 6, 9, 7, 8, 10 |
| Study of Theoretical Foundations | 36 | 1.44 | 1, 4, 3, 2, 5, 6, 9, 7, 8, 10 |

## 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, 6, 9, 7, 8, 10 |
| Delivery of Exercises: topics 6, 7, 8, 9 and 10 | 15% | 10 | 0.4 | 1, 4, 3, 2, 9, 7, 10 |
| Exam: topics 1, 2, 3, 4 and 5 | 35% | 3 | 0.12 | 4, 3, 5, 6, 9, 8, 10 |
| Exam: topics 6, 7, 8, 9 and 10 | 35% | 3 | 0.12 | 1, 4, 3, 2, 9, 10 |
| Make-up Exam: all topics | 70% | 3 | 0.12 | 1, 4, 3, 2, 5, 6, 9, 8, 10 |

## 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