

27014 - Complex Analysis

Syllabus Information

Academic Year: 2022/23

Subject: 27014 - Complex Analysis

Faculty / School: 100 - Facultad de Ciencias

Degree: 453 - Degree in Mathematics

ECTS: 9.0

Year: 3

Semester: Annual

Subject Type: Compulsory

Module:

1. General information

1.1. Aims of the course

The aims and the approach to the course reply to its compulsory character in the degree. The subject covered in the course is present in any branch of mathematics as well as in natural and social sciences, which makes it of great theoretical and applied importance. The aims can be summarized, because of their importance in the study of mathematical analysis, in understanding the similarities and the differences between complex analysis and real analysis in one and several variables, as well as understanding which aspects in real analysis are embedded in complex analysis, which allows them to be better understood.

These approaches and objectives are aligned with the following Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda (<https://www.un.org/sustainabledevelopment/es/>), in such a way that the acquisition of the learning outcomes of the module provides training and competence to contribute to some extent to their achievement: (4) Quality education, (5) Gender equality, (8) Decent work and economic growth, (9) Industry, innovation and infrastructure, (10) Reducing inequality, (17) Partnerships for the goals.

1.2. Context and importance of this course in the degree

The course is embedded in the module *Introduction to Mathematical Analysis*, and is the unique course covering the topic *Complex variable functions*. To follow the course properly it is essential to have taken the courses *Mathematical analysis I* and *Mathematical Analysis II* in advance.

On the other hand, it is an important course in order to get a proper academic achievement in other courses of the degree like: Probability, Fourier analysis, Functional analysis, Topology of surfaces, Differentiable manifolds...

1.3. Recommendations to take this course

- Attend continuously, and paying attention, to the theoretical and practical lectures.
- Work with the material delivered by the instructors in a continuous way.
- Make a good use of the office hours, whose exact schedule will be delivered at the beginning of the course.
- It is specially urged to have passed the courses *Mathematical analysis I* and *Mathematical analysis II*.
- The students who cannot attend the lectures should communicate their situation to the instructors.

2. Learning goals

2.1. Competences

After passing this course the student will be more competent in the aims described in the paragraph *Learning goals*.

Among the competences that the graduate in mathematics should acquire, we point out the following ones:

- CE1. Comprehend and use the language and mathematical methods. Know rigorous proofs of the basic theorems in the course.
- CT3. Recognise, when facing a problem, what is substantial and what is accessory, make conjectures and reason in

order to prove or disprove them, identify mistakes in incorrect reasonings, and so on.

- CE3. Solve mathematical problems by means of basic calculus and other techniques.
- CE2. Propose, analyse, validate and interpret models of real simple situations, using the most suitable mathematical tools depending on the ends that are pursued.

2.2. Learning goals

In order to pass this course the student must show the following skills:

- Knowing, understanding and learning the definition, first properties and basic theory of holomorphic or analytic functions, meromorphic functions, as well as the basics in complex integration and local Cauchy's theory.
- Comprehension and easy handling of power series and Laurent series, and their convergence conditions.
- Master the computation of residues and some of its applications.
- Knowing the geometric and analytic aspects of conformal representation and possible applications.

2.3. Importance of learning goals

They give a basic formation in the degree (see the paragraph *Context and importance of this course in the degree*). Moreover, the concepts and techniques included in this course are basic to model numerous problems that are present in other sciences.

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

The assessment of the course is divided in two terms. In order to pass the course each of both terms must be passed. With this requisite, the final mark will be the mean of the marks in both terms.

In each term, several continuous evaluation examinations will take place during some lecture hours, and a long exam in the official assessment calls.

The estimated number of continuous evaluation examinations will be two in each term, although this number could vary if the circumstances so require. The total weight of the marks in these continuous evaluation examinations will be 20 per cent. Such continuous evaluation examinations will be fundamentally theoretical and will consist in the presentation of some topics explained during the course. If the circumstances of the course allow it, these examinations can be complemented or substituted with the exposition of some topics.

In the first term there will also be a long exam in the first exam period of the course, giving the student the possibility to pass the first term in this exams period.

Those students who have not passed some of the terms will take a long exam on the corresponding term in the official assessment calls. The mark of a passed term will be kept through the whole academic year.

According to the University regulations, the students can refuse the aforementioned system and take only a global test in the official exam periods.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The methodology followed in this course is oriented towards the achievement of the learning objectives. A wide range of teaching and learning tasks are implemented, such as lectures, problem-solving sessions, tutorials and individual work and study.

4.2. Learning tasks

This course could include the following learning tasks:

- **Lectures.** Three weekly hours on theoretical results and key problems.
- **Problem-solving sessions.** With the purpose of understanding and applying the theoretical results.
- **Individual work and study.** Including problem assignments for individual work.
- **Exposition of some topics,** as a complement of the continuous evaluation.
- **Tutorials.** Individual tutoring.
- **Assessment tasks.** Several midterm continuous evaluation exams will be done during the period of classes as well as a bigger midterm exam at the end of the first semester.

More information and material is available at <http://anamat.unizar.es/docencia.html> and <https://moodle.unizar.es/add/>.

The teaching activities and assessment tasks will take place in a face-to-face mode, except in the case that, due to the health situation, the dispositions emitted by the competent authorities and by the University of Zaragoza compel to take them to a greater or lesser extent in a telematic form.

4.3. Syllabus

Section I. First term.

- **Topic 1.** Holomorphic functions. Cauchy-Riemann conditions. Harmonic functions.
- **Topic 2.** Analytic functions. Power series. Elementary functions.
- **Topic 3.** Complex integration. Cauchy local theory.

Section II. Second term.

- **Topic 4.** Cauchy global theory. Cycles and homology. Simple connection.
- **Topic 5.** Zeroes and singularities. Meromorphic functions. Laurent expansions.
- **Topic 6.** Residue theorem and applications.
- **Topic 7.** Conformal mappings.

4.4. Course planning and calendar

- Three weekly face-to-face lectures will be delivered during the whole course.
- Topics 1, 2 y 3 correspond to the first term. Topics 4, 5, 6 y 7 correspond to the second term.
- At the end of the first term there will be a written exam on the topics covered up to that time.
- There will be a written exam in each official assessment calls.
- The exam periods, the precise dates and the academic calendar can be seen in the Faculty of Sciences website (<https://ciencias.unizar.es/>).
- During the class period several continuous evaluation exams will be taken, on some dates that will be announced in advance.
- The first day of the course additional information will be provided.

4.5. Bibliography and recommended resources

<http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=27014>