# COURSE DATA

| Data Subject | |
|---|---|
| **Code** | 43772 |
| **Name** | Advanced mathematics for actuaries |
| **Cycle** | Master's degree |
| **ECTS Credits** | 6.0 |
| **Academic year** | 2022 - 2023 |

**Study (s)**

| Degree | Center | Acad. year | Period |
|---|---|---|---|
| 2171 - Master's Degree in Actuarial and Financial Sciences | Faculty of Economics | 1 | First term |

**Subject-matter**

| Degree | Subject-matter | Character |
|---|---|---|
| 2171 - Master's Degree in Actuarial and Financial Sciences | 1 - Quantitative methods | Obligatory |

**Coordination**

| Name | Department |
|---|---|
| PEREZ-SALAMERO GONZALEZ, JUAN M | 113 - Financial and Actuarial Economics |

# SUMMARY

Advanced Mathematics for Actuaries is a subject of the first semester of the first year. Its location responds to the formative importance of the subject within the curriculum to establish the technical and methodological bases on which much of the subsequent developments are based, which the student will acquire in other subjects.
In accordance with the guidelines established by the basic Syllabus for actuarial training in Europe, the objective is to provide the mathematical foundations of actuarial and financial science. These fundamentals are essential when dealing with problems of a financial-actuarial nature, emphasizing the application of techniques that allow us to deal with other disciplines such as Financial Mathematics and Statistics for Actuaries with guarantees.
In this line, the topic is also linked to a part of the content developed in other areas, such as portfolio management, non-life insurance, life insurance, health and pensions, solvency, etc., which contributes to a better application of the skills requirements for professional practice.

# PREVIOUS KNOWLEDGE

## Relationship to other subjects of the same degree

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

## Other requirements

Prerequisites have not been established, but to understand the subject, the student must know the typical contents that are generally taught in the introductory courses of mathematics in social studies. Thus, for example, the student must have previous basic knowledge about differential and integral calculus, function representation and optimization.

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

## 2171 - Master's Degree in Actuarial and Financial Sciences

- Students should apply acquired knowledge to solve problems in unfamiliar contexts within their field of study, including multidisciplinary scenarios.
- Students should be able to integrate knowledge and address the complexity of making informed judgments based on incomplete or limited information, including reflections on the social and ethical responsibilities associated with the application of their knowledge and judgments.
- Students should demonstrate self-directed learning skills for continued academic growth.
- Ser capaces de construir modelos adecuados al entorno económico empresarial a partir de las posibilidades que ofrecen las modernas tecnologías de la información y de la computación.
- Alcanzar sólidos fundamentos en las técnicas matemáticas y estadísticas como base para la comprensión de otras materias y elaboración de modelos del riesgo utilizados en la práctica actuarial.
- Comprender y ser capaces de desarrollar las técnicas matemáticas y estadísticas que resultan relevantes para el trabajo actuarial: modelos de supervivencia, siniestralidad, tarificación, previsión y solvencia.

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

- Use mathematical tools in the development and understanding of quantitative techniques required in other subjects.
- Understand and know the mathematical concepts necessary for the analysis and control of risks.
- Propose, model and solve problems with financial and / or actuarial economic content through mathematical and statistical techniques.
- Manage computer applications of numerical and symbolic calculation to solve problems.
- Quantify in monetary units the risk assumed by the insurance entities.

## DESCRIPTION OF CONTENTS

### 1. The integration process

The Riemann Integral: Fundamentals (concept, interpretation, properties).
Integration methods.
Applications.
Numerical analysis: Numerical Integration.

### 2. Riemann-Stieltjes Integral

Introduction.
Formalization and Properties.
Practical approach (calculation).
Bounded variation functions.
Applications.

### 3. Introduction to Measurement Theory

Introduction.
Measurement of sets.
Measurement of functions.
Lebesgue integral.

### 4. Improper integration

Introduction.
Improper integrals of the first kind.
Improper integrals of the second kind.
Mixed improper integrals.

### 5. The Eulerian functions

Parametric integrals and functions defined by integrals.
Differentiation Under the Integral Sign. Leibniz integral rule.
The Gamma function.
The Beta function.
Applications.

## 6. Multiple Integral

Measure on product spaces. Volume.
Iterated integration. Fubini's theorem.
Change of Variables for Multiple Integrals: affine, polar coordinates.
Unbounded regions and discontinuous integrands.
Applications.

## 7. First order differential equations

Introduction to dynamic analysis: trajectories and models.
Basic concepts about differential equations.
Elementary resolution methods for ordinary first-order differential equations: homogeneous, separable variables, linear, reducible to linear and exact.
Graphic-qualitative analysis and stability.
Applications.
Numerical analysis: numerical calculation of differential equations

## 8. Differential equations of order n and systems

General approach.
Homogeneous linear differential equations of order n with constant coefficients.
Nonhomogeneous linear differential equations of order n with constant coefficients.
Systems of differential equations. Concept, meaning and resolution.
Partial differential equations.
Qualitative analysis.
Applications.

## 9. First Order Difference Equations

Discrete functions, discrete operators and difference equations.
First Order Difference Equations: general concepts and resolution.
Balance and stability of the solutions.
Applications.

## 10. Difference Equations of Higher Order

Difference Equations of order n: general concepts and resolution.
Equilibrium and stability of the solutions.
Approach to systems of difference equations.
Applications

### 11. Theory of Optimal Control

Problem Statement.
The problem of optimal control in continuous time.
The problem of optimal control in discrete time.
Economic, financial and actuarial applications.

## WORKLOAD

| ACTIVITY | Hours | % To be attended |
|---|---|---|
| Theory classes | 30,00 | 100 |
| Classroom practices | 30,00 | 100 |
| Attendance at events and external activities | 4,00 | 0 |
| Development of group work | 10,00 | 0 |
| Development of individual work | 8,00 | 0 |
| Study and independent work | 40,00 | 0 |
| Readings supplementary material | 6,00 | 0 |
| Preparation of evaluation activities | 4,00 | 0 |
| Preparation of practical classes and problem | 18,00 | 0 |
| **TOTAL** | **150,00** | |

## TEACHING METHODOLOGY

During the course, the contents of the program will be worked on, simulating theoretical contents with exercises and practical assumptions, and various tasks will be proposed that the student will have to deliver in the form and date that will detailed throughout the development of the course. To do this, they will use, in each case and according to the needs, all available resources (blackboard, audiovisual presentations, computer, etc.) that are considered most appropriate to achieve the correct achievement of the proposed objectives.

In general, the theoretical classes will be taught through the master class methodology, in which the teacher will highlight the fundamental aspects of each topic and guide the study through the relevant bibliography, which must be used inexcusably to complete and delve into the subject.

The practical classes will consist in proposing questions and exercises, some of character applied to the economic, financial and actuarial field, that the student will have to solve proceeding, in his case, to the pertinent modeling and discussion of the solution.

In the practical classes will be computer support, so that the student can have an updated view of the use of packages and techniques.

In the practical classes questions and problems previously presented in the theoretical classes will be taught, except in some cases, in which, given the practical nature of the subject, the teaching of the subject is taught only in the practical session.

The available teaching material can be accessed from the virtual classroom, http://aulavirtual.uv.es.

## EVALUATION

This subject uses an evaluation procedure similar to the rest of the subjects of the master:

1. A written exam or synthesis test, which may consist of theoretical questions as well as problems and real cases.

2. Continuous evaluation based on class attendance and other face-to-face training activities and participation and involvement in the teaching-learning process. This section will consist of an evaluation of the practical activities developed by the student, from the elaboration of problems in class and/or at home, manually and/or by computer; and the questionnaires/proof of the type of evidence presented.

In particular, a synthesis test will be carried out, which will represent 70% of the final grade and different activities and tasks will be proposed, which will be evaluated together with the continuous evaluation and which will have a joint weight of 30% of the total. total. Final note. For the evaluation of the proposed activities and tasks, they must be delivered on the date and in the form stipulated for each one of them.

The tasks of continuous assessment can be done in class and / or at home.

All the tests of continuous evaluation will be recoverable in the second call in the terms that inform the teaching team, but not in the first call.

To approve the subject it will be necessary to obtain, between the two parties, a minimum grade of 5. In addition, to pass the subject it will be necessary to obtain at least a 5 in the synthesis test. If the synthesis test is not passed, the final grade can not exceed 4'5.

Those students who do not pass the subject in the first call, will have the option of being evaluated in the second call. The marks obtained with the continuous evaluation during the course, can be maintained for the second call or recovery in the conditions established by the teaching team. On the second call, the same evaluation criteria will be used for the first call.

**NOTE: The use of illegal or fraudulent methods (copying, plagiarism, impersonation, etc.) to obtain undeserved results in the assessable evidence will be sanctioned with a suspension in the test for those involved, even though other sanctions could be derived from the Master's Direction or from the Academic Coordination Commission.**

# REFERENCES

## Basic

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