

COURSE GUIDE

**Mathematical Methods 2 (2671125)**

Approval date:

Departamento de Análisis Matemático: 22/06/2023  
 Departamento de Matemática Aplicada: 23/06/2023  
 Departamento de Física Atómica, Molecular y Nuclear: 23/06/2023

<b>Grado (Bachelor's Degree)</b>	Grado en Física	<b>Branch</b>	Sciences
----------------------------------	-----------------	---------------	----------

<b>Module</b>	Métodos Matemáticos y Programación	<b>Subject</b>	Métodos Matemáticos
---------------	------------------------------------	----------------	---------------------

<b>Year of study</b>	2º	<b>Semester</b>	1º	<b>ECTS Credits</b>	6	<b>Course type</b>	Compulsory course
----------------------	----	-----------------	----	---------------------	---	--------------------	-------------------

**PREREQUISITES AND RECOMMENDATIONS**

It is recommended that the student has taken the following subjects: Linear Algebra and Geometry, Mathematical Analysis and Mathematical Methods for Physics I.

**BRIEF DESCRIPTION OF COURSE CONTENT (According to the programme's verification report)**

- Methods of solving ordinary differential equations and systems.
- Partial differential equations. The method of separation of variables.
- Special functions.

**SKILLS**

**GENERAL SKILLS**

- CG01 - Skills for analysis and synthesis
- CG02 - Organisational and planification skills
- CG03 - Oral and written communication
- CG05 - Skills for dealing with information
- CG06 - Problem solving skills
- CG07 - Team work
- CG08 - Critical thinking
- CG09 - Autonomous learning skills
- CG10 - Creativity
- CG11 - Initiative and entrepreneurship

**SUBJECT-SPECIFIC SKILLS**

- CE03 - Knowing and understanding the mathematical methods necessary to describe physical phenomena



- CE05 - Modelling complex phenomena, translating a physical problem into mathematical language

## LEARNING OUTCOMES

- To know the fundamental results of the theory of Differential Equations.
- To know some of the applications of the ordinary differential equations in different fields in Physics, especially in Classical Mechanics, Electromagnetism and Quantum Physics.
- To understand how special functions arise in the study of ordinary differential equations and understand how to apply them.
- To know the fundamental results of the theory of Partial Differential Equations.
- To know some applications of the theory of Partial Differential Equations the in different fields in Physics, especially in Classical Mechanics, Electromagnetism and Quantum Physics.

## PLANNED LEARNING ACTIVITIES

### THEORY SYLLABUS

#### Differential equations

- Lesson 1. Ordinary differential equations of first order. Methods of integration.
- Lesson 2. Ordinary linear differential equations of higher order. Systems of linear equations.
- Lesson 3. Solving differential equations by power series.

#### Special functions

- Lesson 4. Basic special functions.
- Lesson 5. Hypergeometric and Bessel functions.

#### Partial differential equations

- Lesson 6. Partial differential equations of interest in physics: The method of separation of variables.
- Lesson 7: The wave equation, the heat equation and the Laplace equation.
- Lesson 8. Introduction to the Sturm-Liouville problem.

### PRACTICAL SYLLABUS

#### Seminars:

1. The role of the Differential Equations in Newton's Mechanics
2. The one dimensional Schrödinger equation: application to the Kronig-Penney model in the study of bands in solids.
3. Oscillations and resonance.
4. Variational Methods. Dirichlet Method.
5. Multidimensional Schrödinger equation. Application to the hydrogen atom.
6. Fourier transform and applications to Partial Differential Equations.
7. The variable length pendulum.
8. Lyapunov stability for systems in the plane. Application to the stability of the Prey-Predator equations of Lotka-Volterra.



## RECOMMENDED READING

### ESSENTIAL READING

- M. Abramowitz, I. A. Stegun, Handbook of mathematical functions, Dover, 1975.
- L. C. Andrews, Special functions of mathematics for engineers, Oxford Science Publications, 1998.
- W.E. Boyce, R.C. DiPrima, Elementary differential equations and boundary value problems, Wiley 2012.
- L. C. Evans, Partial Differential Equations, AMS, 2002.
- V. Nikiforov, V. Uvarov, Special functions of mathematical physics (Birkhäuser Verlag, 1988).
- I. Peral, Primer curso de Ecuaciones en derivadas parciales. Addison-Wesley, Wilmington, 1995.
- C. Henry Edwards, David E. Penney, David T. Calvis, Differential Equations and Boundary Value Problems: Computing and Modeling, Pearson Education 2015.
- C. Henry Edwards, David E. Penney, David Calvis, Differential Equations and Linear Algebra, Pearson 2017.
- E. Rainville, Intermediate Differential Equations, MacMillan, 1964.
- G.F. Simmons, Ecuaciones diferenciales con aplicaciones y notas históricas. McGraw Hill, 1993.
- W. A. Strauss, Partial differential equations, an introduction, New York, John Wiley and Sons, 2008.
- D.G. Zill, M.R. Cullen, Differential Equations with Boundary-Value Problems, Cengage Learning, 2009.

### COMPLEMENTARY READING

- F. Brauer y Nohel, Ordinary Differential Equations with Applications, Harper & Row, 1989.
- C. Carlson, Special Functions of Applied Mathematics, Academic Press.
- R. K. Nagle, E. B. Saff y A.D. Snider, Ecuaciones diferenciales y problemas con valores en la frontera, Pearson Educación, 2005.
- F.W. Olver, Asymptotic and Special functions, Academic Press, 1974.
- R.D. Richtmyer, Principles of Advanced Mathematical Physics, vol. 1, Springer-Verlag, 1978.

## RECOMMENDED LEARNING RESOURCES/TOOLS

- Notes by Prof. R. Ortega “Métodos Matemáticos de la Física IV”:  
<http://www.ugr.es/~rortega/M4.htm>
- Notes by Prof. M. Calixto “Métodos Matemáticos de la Física II”:  
<https://www.ugr.es/~calixto/MMII.pdf>

## TEACHING METHODS

- MD01 - Theoretical classes



**ASSESSMENT METHODS (Instruments, criteria and percentages)****ORDINARY EXAMINATION DIET**

In general, the attendance to lectures is not compulsory without being an impediment to apply the evaluation criteria described below.

In order to evaluate the knowledge and competences acquired by the students, the following criteria will be used with the indicated percentages:

- Written examination including basic questions and problems/exercises. This will count 70% of the total score. It will be required to obtain a mark of at least 4 over 10 in this item.
- Homework and seminars done individually or in groups. This covers all work and seminars made by the students during the course (exercises and solving proposed problems). Importance will be given to the work itself, the slides presentation and the defense. Participation, attitude and personal work in all programmed activities will be considered. The final score for this part will count 30% of the final score.

The final score will be the sum of the weighted scores obtained in the different aspects of the evaluation system.

**EXTRAORDINARY EXAMINATION DIET**

- It will be in written form and will consist of questions and problems/exercises to guarantee that the student can get the total score from it (100%).

**SINGLE FINAL ASSESSMENT (evaluación única final)**

Besides the above-mentioned evaluation procedure, the students will be allowed to apply for a unique evaluation in the terms established in the regulation of evaluation of students at the University of Granada, approved on May the 20th of 2013.

The test consists of a written examination that includes theory and problems on the list of topics of the course, similar to the extraordinary assessment session, where the student can get the total score from it (100%).

**ADDITIONAL INFORMATION**

All regarding evaluation will be applied according to the “Normativa de evaluación y calificación de los estudiantes” existing at the University of Granada, which can be found at:  
<http://www.ugr.es/~minpet/pages/enpdf/normativaevaluacionycalificacion.pdf>

