

**Differential Equations**

Code: 100152  
ECTS Credits: 8

Degree	Type	Year	Semester
2500097 Physics	OB	2	1

**Contact**

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**Teaching groups languages**

You can check it through this [link](#). To consult the language you will need to enter the CODE of the subject. Please note that this information is provisional until 30 November 2023.

**Teachers**

Maria del Pilar Casado Lechuga

Carles Sánchez Alonso

Oscar Blanch Bigas

**Prerequisites**

It is advisable to have a good knowledge of calculus in one variable

**Objectives and Contextualisation**

Give tools to solve the most common types of ordinary differential equations and equations with partial derivatives that appear in Physics. Learn to model different physical phenomena.

**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. Applying Sturm-Liouville's theory to physical problems with boundary conditions.
2. Identify situations in which a change or improvement is needed.
3. Solve Laplace and Poisson equations for simple geometries.
4. Solve the equations of simple harmonic, damped and forced motion.
5. Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
6. Use the mathematical tools developed in this subject for the quantitative study of advanced problems in any branch of knowledge.
7. Work independently, take initiative itself, be able to organize to achieve results and to plan and execute a project.

## Content

1. Introduction : Definition and classification of differential equations, Types of solutions : general and particular, Picard method of successive approximations, Theorem on Existence of Solution.
2. First order differential equation : Geometrical study, Clairaut equation, Envelopes and singular solutions, Linear, Bernoulli and Ricatti equations, Homogeneous equations, Exact equations, Integrating factors, Solution of second order equations by first order methods.
3. Linear equations : Wronskians, Reduced equation with constant coefficients, Complete equation : Undetermined coefficients, Parameter Variation, and Symbolic Methods, Second order complete equations solved by means of one solution of the reduced equation, Order reduction, Cauchy-Euler equation, Applications to Oscillators.
4. Laplace Transforms.
5. Power Series : Ordinary and regular singular points, Frobenius method, Gauss, Legendre, Bessel, Laguerre and Hermite equations, Applications to Equations in Physics.
6. Sturm-Liouville Theory : Fourier series and orthonormal functions, regular and singular eigenvalues Sturm-Liouville problems, Applications to Equations in Physics.

## Methodology

The subject is structured as follows:

- Theory lectures. The definitions, theorems, and methods of resolution of differential equations are presented, also solving some examples.
- Problem solving classes. Some of the problems of the lists that are made available to students at the beginning of the course through the Virtual Campus are resolved
- Supervised problem solving classes. Students try to solve problems in the classroom under the supervision of a teacher
- Homework assignments. Problems of more complexity and extension that are periodically posted throughout the course. The students must solve and submit before their correction in class in previously agreed dates. The objective is to encourage self-learning

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			
Problem solving classes	22	0.88	1, 5, 3, 4, 7, 6
Theory lectures	44	1.76	1, 5, 3, 4, 7, 6
Type: Autonomous			
Homework assignments	18.5	0.74	1, 5, 3, 4, 7, 6
Problem solving	60	2.4	1, 5, 3, 4, 7, 6
Study of the theoretical concepts and methods	47	1.88	1, 5, 3, 4, 7, 6

## Assessment

- First partial exam (45%-50%)
- Second partial exam (45%-50%)
- Homework assignments (0%-10%)
- Students with a resultant grade below 5, or students wishing to improve their grades, can take a final exam.
- Final exam (100%). There is a minimum grade requirement to be eligible for the make-up exams. The average of the partial grades cannot be lower than 3.5.

Single Assessment: Students opting for the single assessment modality will undergo a final test comprising a theory exam (45%) and a problem-solving test (45%). In addition, they are required to submit a previously completed assignment from home (10%). These assessments will take place concurrently with the tests for the second part of the continuous assessment modality, on the same day, time, and location.

## Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Final Exam	40% - 50%	2.5	0.1	1, 2, 5, 3, 7, 6
Homework assignments	0% - 20%	0	0	1, 2, 5, 3, 4, 7, 6
Midterm exam	40% - 50%	2.5	0.1	2, 5, 4, 7, 6
Resit Exam	100%	3.5	0.14	1, 2, 5, 3, 4, 7, 6

## Bibliography

- Notes on the subject by Dr. Marià Baig which are made available to students through *Virtual Campus*
- *Elementary Differential Equations and Boundary Value Problems*, W.E. Boyce & R.C. DiPrima, John Wiley and Sons Ltd (2012)
- *Teoría y Problemas de Ecuaciones Diferenciales Modernas*, Schaum, McGraw-Hill

- *Ecuaciones Diferenciales y sus Aplicaciones*, M. Braun, Grupo Editorial Iberoamericana

## **Software**

Basics of Python.