# Ordinary Differential Equations

Code: 104397
ECTS Credits: 6

2024/2025

| Degree | Type | Year |
|---|---|---|
| 2503740 Computational Mathematics and Data Analytics | OB | 2 |

## Contact

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## Teaching groups languages

You can view this information at the end of this document.

## Prerequisites

It is very convenient for the student to have achieved a good knowledge of the contents in Calculus in one variable, Linear algebra and Numerical analysis of the first course.

## Objectives and Contextualisation

The objective of the subject is to present differential equations as a quantitative deterministic modeling tool for many processes of physics, chemistry, biology, etc. Also, the study of the solutions of these differential equations when they can be obtained in a closed form, when qualitative analysis is convenient and when approximate numerical computation turns out to be indispensable.

## Learning Outcomes

1. KM10 (Knowledge) Describe the mathematical concepts and objects of differential equations and numerical methods.
2. KM10 (Knowledge) Describe the mathematical concepts and objects of differential equations and numerical methods.
3. KM11 (Knowledge) Devise demonstrations of mathematical results of numerical calculus and numerical integration of ordinary differential equations and partial differential equations.
4. KM11 (Knowledge) Devise demonstrations of mathematical results of numerical calculus and numerical integration of ordinary differential equations and partial differential equations.
5. SM11 (Skill) Numerically integrate ordinary differential equations and partial differential equations.

## Content

Ordinary differential equations
1. Differential equations as a modeling tool. The initial value problem. Existence and uniqueness and dependence on initial conditions and parameters.
2. The scalar differential equations. Autonomous differential equations. Asymptotic behavior. Examples and applications: the balance of matter and population dynamics.

4. Systems of nonlinear differential equations. Lyapunov stability. Linearization. Phase plane. Applications to mechanics, ecology and chemical kinetics.

## Activities and Methodology

| Title | Hours | ECTS | Learning Outcomes |
|---|---|---|---|
| Type: Directed | | | |
| Theory classes | 27 | 1.08 | |
| Type: Supervised | | | |
| Practical classes | 12 | 0.48 | |
| Seminars | 10 | 0.4 | |
| Type: Autonomous | | | |
| Personal study | 65 | 2.6 | |
| Program design and report writing | 30 | 1.2 | |

Two hours of theory class per week correspond to this subject. In addition, 11 hours of seminar will be held where students will solve exercises raised by the teacher, both with conventional tools and using a symbolic manipulator. There will also be 12 hours of practical classes that will be devoted mainly to the approximate calculation of solutions of differential equations. It is essential that students have at their disposal the software that teachers recommend during the course. The Virtual Campus of the subject will provide all the material and all the information related to this subject that is necessary for the student.

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.

## Assessment

## Continous Assessment Activities

| Title | Weighting | Hours | ECTS | Learning Outcomes |
|---|---|---|---|---|
| Final exam | 50% | 3 | 0.12 | KM10, KM11 |
| Partial exam | 35% | 3 | 0.12 | KM10, KM11 |
| Seminars evaluation | 15% | 0 | 0 | KM10, KM11, SM11 |

The assessment of the course will be carried out mainly from three activities:
Evaluable seminars (SEM), Partial exam (EP): exam of part of the subject, with theoretical questions and problems. Final exam (EF): exam of the whole subject, with theoretical questions and problems.
In addition, students will be able to submit to a recovery exam (ER).

The final grade of the subject will be

max( 0.15*SEM+0.35*EP+0.5*EF, 0.15*SEM+0.85*EF,ER)

as long as, if the maximum is attained at one of the first two numbers, EF>=3.5 must hold (otherwise the subject is not passed and the student must take the recovery exam.

Students who have taken the single assessment modality must take the subject's final exam (EF) on the same date as students taking the continuous assessment. This test will account for 80% of the grade (as long as EF >=3.5). On this same date, the student will have to deliver the seminar and practice project and, if the teacher requires it, an oral evaluation of it will take place. This evaluation will account for 15% of the final grade. If the grade is lower than 5 (or EF<3.5), the student can take the recovery exam (ER).

The "matrícula de honor" will be awarded to the first complete evaluation of the subject. Later achievements will not be considered for this purpose.

## Bibliography


Borrelli, R., Coleman C.S. *Ecuaciones diferenciales. Una perspectiva de modelación*. Oxford University Press (2002)

Lynch, Stephen *Dynamical Systems with applications using Python*. Birkhauser, 2018

Lynch, Stephen ***Dynamical Systems with applications using Mathematica***. Birkhauser, 2007 [Recurs electrònic]

Martínez, R. *Models amb Equacions Diferencials*, Materials de la UAB no. 149. Bellaterra, 2004

Noonburg, V. W. ***Differential Equations: From Calculus to Dynamical Systems***. AMS, 2019 [Recurs electrònic]

Perelló, C*. Càlcul Infinitesimal amb Mètodes Numèrics i Aplicacions*, Enciclopèdia Catalana, 1994

Zill, Dennis G. *Ecuaciones diferenciales con aplicacions de modelado*. Cengage Learning, 2015

Zill, Dennis G. ***A First Course in Differential Equations with Modeling Applications***, International Metric Edition, 2017 [Recurs electrònic]


## Software

There are no software requirements. The student will be able to use what he knows, in particular algebraic manipulation tools such as Maxima, Sage, Maple, etc., as well as numerical computation languages such as C. The use of one of the symbolic manipulators of open source could be mandatory.

## Language list

| Name | Group | Language | Semester | Turn |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| (PLAB) Practical laboratories | 1 | Catalan | first semester | morning-mixed |
| (SEM) Seminars | 1 | Catalan | first semester | morning-mixed |
| (TE) Theory | 1 | Catalan | first semester | morning-mixed |