

Degree	Type	Year
2500149 Mathematics	OB	3

## Contact

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## Teaching groups languages

You can view this information at the [end](#) of this document.

## Prerequisites

Linear Algebra

Fundamentals of mathematics

Calculus in 1 and several real variables.

## Objectives and Contextualisation

The Theory of Differential Equations is distinguished both by the richness of ideas and methods as well as by its applicability. Thus the subject Differential Equations and Modeling I has a theoretical aspect (that will be used in theory and problem lessons) as well as a very applied aspect (which will be introduced in the theory sessions and will be developed in problems and practical sessions). Practical lessons will be carried out in the computer lab. On the one hand we will emphasize the presentation of the theory and the demonstration of the results and on the other hand the students will learn how to model real situations that allow them to predict the studied behaviors.

We believe that this subject is good to show to the students that certain theoretical results that they already know about other subjects (topological properties of normed spaces and Jordan canonical forms, for example) can be applied to develop the theory of differential equations.

## Competences

- Actively demonstrate high concern for quality when defending or presenting the conclusions of one's work.
- Identify the essential ideas of the demonstrations of certain basic theorems and know how to adapt them to obtain other results.
- Recognise the presence of Mathematics in other disciplines.
- Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
- Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.

- Use computer applications for statistical analysis, numeric and symbolic calculus, graphic display, optimisation or other purposes to experiment with Mathematics and solve problems.
- Work in teams.

## Learning Outcomes

1. Actively demonstrate high concern for quality when defending or presenting the conclusions of one's work.
2. Apply the main methods for resolving ordinary differential equations and some simple partial derivative equations.
3. Resolve linear systems of ordinary differential equations.
4. Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
5. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
6. Translate some real problems into the terms of ordinary differential equations and partial derivative equations.
7. Work in teams

## Content

1. Differential Equations of the first order.
  - 1.1 Introduction to differential equations. Separable equations. Exact equations.
  - 1.2 Applications to modelling.
2. The linear equation.
  - 2.1 Uniqueness and existence theorems. Algebraic properties of the space of solutions. Liouville's theorem.
  - 2.2 The autonomous case: Exponential of a matrix.
  - 2.3 The linear equation of order  $n$ .
3. Uniqueness and existence theorems
  - 3.1 The Cauchy's problem. Picard and Peano theorems.
  - 3.2 Prolongation of solutions. Wintner's lemma
  - 3.3 Continuous and differentiable dependence on initial data and parameters.
4. Qualitative theory of autonomous systems.
  - 4.1 Dynamical systems. Critical points and periodic orbits. Stability. Conjugation of dynamical systems.
  - 4.2 Tubular flow theorem. Hartman's theorem.
  - 4.3 Qualitative study of the autonomous linear equation.

## Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
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Type: Directed		
Practical modelization problems	24	0.96
Theory classes	30	1.2
Type: Supervised		
Problem classes	30	1.2
Type: Autonomous		
Study of the theory and resolution of problems	114	4.56

Fundamental in the learning process of the subject is the work by the student, who can count on the guidance of the teacher at each moment.

There will be three types of guided activities:

*Theory Classes:* The teacher introduces the basic concepts of the subject matter showing examples, demonstrating properties and fundamental results. The student must complement the teacher's explanations with personal study.

*Classes of Problems:* We work on the understanding and application of the concepts and tools introduced to theory, with the realization of theoretical and/or practical exercises. It is well known that the only way to learn mathematics is by solving lots and lots of problems. For this reason the student must dedicate a minimum of 5 hours a week to solving problems in this subject. The student will have a list of problems for each theme, which he must think about, try to solve and which will be worked on in the problem classes. A delivery of problems is requested for each theme to ensure that this work is done continuously.

*Computer practices:* in each session a different type of differential equation will be dealt with to model a real situation and predict future behaviors depending on circumstantial parameters.

The exercises that appear in the lists of Problems or Computer Practices and that have not finished in the corresponding session the student will have to solve them like part of his autonomous work.

The notes on the Theory, the lists of Problems and Computer Practices will be posted on the subject's Moodle Aules website; a summary of the Theory and Problem classes will be posted weekly.

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
First partial exam	35%	4	0.16	1, 2, 3, 4, 6
Handout of practical work	20%	15	0.6	3, 4, 5, 6, 7
Retake exam	80%	4	0.16	1, 2, 3, 4, 6

The single assessment will consist of a single examination of the entire subject on the day of the second partial examination, which will weigh 100% of the grade.

Continuous evaluation: It will consist of the following evaluation activities

- Practice deliveries. This activity is NOT recoverable.
- A partial exam in the middle of the semester.
- A partial exam at the end of the semester. This exam will cover all the material that has not been evaluated in the first part.

Make-up exam: it will consist of an exam of the entire subject that replaces the two partial exams.

NOTE: None of the two partial exams release material for the make-up exam. As stated before, the resit exam weighs 80% of the grade.

## Bibliography

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## Software

In the computer sessions the students makes use of the programs SAGE and Excel; to resolve the problems proposed in these sessions students often receive information in the language of the computer algebra package of Mathematica.

There will also made use of the program P4 to show the behavior in the neighbourhood of critical points for polinomial systems in two dimensions.

## Language list

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	1	Catalan	first semester	morning-mixed
(PAUL) Classroom practices	2	Catalan	first semester	morning-mixed
(PLAB) Practical laboratories	1	Catalan	first semester	morning-mixed
(PLAB) Practical laboratories	2	Catalan	first semester	morning-mixed
(TE) Theory	1	Catalan	first semester	morning-mixed