UAB
Universitat Autònoma de Barcelona

Numerical Methods II

Code: 103951
ECTS Credits: 5

2025/2026

Degree	Type	Year
Physics	OB	3

Contact

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Teachers

(External) José Maria Escartín

Teaching groups languages

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

Prerequisites

It it highly recommended to have passed the subject "Mètodes Numèrics I".

it is recommended to have a good knowledge in calculus.

Objectives and Contextualisation

Deepening knowledge in phisical systems modeling.

Deepening knowledge in the basic concpets of numerical methods: precisión, discretization, numerical error, conditioning, normalization...

To set and solve complex physical problems, using numerical techniques.

To know the theoretical basis of error estimation in the numerical simulations.

Competences

- Communicate complex information in an effective, clear and concise manner, either orally, in writing or through ICTs, and before both specialist and general publics
- Develop strategies for analysis, synthesis and communication that allow the concepts of physics to be transmitted in educational and dissemination-based contexts

- Use computer tools (programming languages and software) suitable for the study of physical problems
- Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments

Learning Outcomes

1. Analyse and describe clearly the strategy in addressing a particular problem from the numerical point of view.
2. Analyse and describe physical problems from an approximate perspective, modelling complex physical systems and solving them in an approximate manner.
3. Apply finite element methods to solving specific problems in some of the most common problems.
4. Communicate complex information in an effective, clear and concise manner, either orally, in writing or through ICTs, in front of both specialist and general publics.
5. Control errors produced in the various numerical methods, giving a fuller analysis of these.
6. Develop programmes in a specific programming language.
7. Develop programming strategies that allow the collaborative use of the programmes developed.
8. In pseudocode, design and implement programmes for solving calculations in a real variable: integration, derivation, solving equations, solving ordinary differential equations.
9. Present numerical results accurately, including the processing of statistical errors.
10. Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
11. Use distinct numerical methods to solve computational problems in a real variable and evaluate the numerical error in implementing these within a particular problem.
12. Use the most common numerical methods to describe complex systems and to solve some of the most usual problems.

Content

1. Basic concepts.

- Numerical error.
- Discretization.
- Normalization.

2. Solving non-linear equations

- Newton-Raphson method.
- Systems of non-linear equations.

3. Numerical derivation.

4. Numerical integration.

5. Solving differential equations.

- Euler method.
- Runge-Kutta method.
- Other methods (shooting, ...)

6. Solving equation with partial derivatives

- Finite elements and differences.
- Implícit andi explícits schemes.
- Systems of linear equations.

7. Modeling of complex systems.

- Concepts of modeling and simulation
- Simulation of physical systems. Examples.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Simulation tasks	21	0.84	
Theoretical lectures	20	0.8	
Type: Autonomous			
Personal study	10	0.4	
Reports preparation	71	2.84	

Development of reports. Students have to report on the practices and simulations, checking and analyzing the obtained simulations, and reporting the main results.

Personal study. It is necessary to study, personally, the theory, and to prepare the simulations.

Theoretical lectures. Guided lectures, the lecturer will give the key aspects of the different parts of the course. Also, the main lines to follow using bibliography and complementary media. A complete and ordered description of the course is pretended.

Simulation work. It is pretended that students develop several simulations and/or practices.

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
Practice 1. Guided problem	30%	0	0	1, 2, 4, 5, 7, 8, 6, 9, 10, 11
Simulation Practice A	40%	0	0	1, 2, 3, 4, 5, 7, 8, 6, 9, 10, 11, 12
Theory exam	30%	3	0.12	1, 2, 3, 4, 5, 9, 12

Practice 1: Guided problem. It will be valued the written report, taking into account the approach to the problems, its resolution, and the presentation of the results. Eventually, we will also consider an interview to evaluate the knowledge and skills of the different authors of the report.

Practice: Simulation A. It will be valued the written report, taking into account the approach to the problems, its resolution, and the presentation of the results. Eventually, we will also consider an interview to evaluate the knowledge and skills of the different authors of the report.

All the simulations will be done in groups. All members of the group are coauthors of all the works. They must know the content, the development, the results, and the used techniques of all the simulations in detail.

Theory exam. It will be valued the relevant theoretical concepts. (Not Recuperable)

To access the recuperation, the student has to be previously evaluated to a set of activities, whose weight is at least 2/3 of the total qualification. Recuperation consists of the resubmission of the practice report and, eventually, an interview with the authors of the report. The maximum qualification of the resubmitted reports is 6 over 10.

We consider that we do not have enough evaluation evidence (thus the qualification will be "not evaluable") when we evaluate a maximum of the first practice or the theory exam.

In the case of irregularities that would produce a significant variation in an evaluation item, this item will be qualified as 0, independently of the disciplinary process that could be started. In the case of several irregularities, the final qualification will be 0.

Unique evaluation: Those who opt for the unique evaluation mush deliver all the practices and do the exam the same day (to be determined, at the end of the semester).

Bibliography

1. Introducción al Análisis Numérico. A. Ralston, Limusa-Wiley.

2. Análisis numérico. Las matemáticas del cálculo científico, D. Kinkaid, D. Cheney, Wesley Iberoamericana.

3. Mètodes numèrics per a la física, R. Guardiola, E. Higón, J. Ros, Materials 9, Universitat de València.

4. Métodos numéricos para la Física i la Ingeniería. Luis Vázquez, Salvador Jiménez, CarlosAguirre, Pedro José Pascual, McGraw Hill.

Software

We will explain how to install and use the software needed.

Groups and Languages

Please note that this information is provisional until 30 November 2025. You can check it through this link. To consult the language you will need to enter the CODE of the subject.

Name	Group	Language	Semester	Turn
(PLAB) Practical laboratories	1	Catalan	first semester	morning-mixed
(PLAB) Practical laboratories	2	Catalan	first semester	morning-mixed
(PLAB) Practical laboratories	3	Catalan	first semester	morning-mixed

(PLAB) Practical laboratories	4	Catalan	first semester	morning-mixed
(TE) Theory	1	Catalan	first semester	morning-mixed