Universitat Autònoma de Barcelona

2020/2021

Numerical Methods II

Code: 103951
ECTS Credits: 5

Degree	Type	Year	Semester
2500097 Physics	OB	3	1

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

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Use of Languages

Principal working language: catalan (cat)

Some groups entirely in English: No

Some groups entirely in Catalan: Yes

Some groups entirely in Spanish: No

Teachers

Leonardo Gastón González Gómez

Josep Castell Queralt

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.

Methodology

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.

Activities

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	

Assessment

Practice: Simulation 0 (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. (Not Recuperable)

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.

Practice: Simulation B. 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. Nevertheless, all members of the group are responsible and coauthors of all the works and is mandatory that they know in detail the content, the development, the results, and the used techniques of all the simulations.

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

To access to 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 one practice.

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

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Practice 1. Guided problem	20%	0	0	1, 2, 4, 5, 8, 6, 10, 11
Simulation Practice A	30%	0	0	4, 5, 8, 6, 9, 10, 11, 12
Simulation Practice B	30%	0	0	1, 2, 3, 4, 5, 7, 8, 6, 9, 10, 11, 12
Theory exam	20%	3	0.12	1, 2, 3, 4, 5, 7, 9, 12

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. Guardiona, 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.