Universidad Zaragoza

Academic Year/course: 2024/25

26918 - Computational Physics

Syllabus Information

Academic year: 2024/25
Subject: 26918 - Computational Physics
Faculty / School: 100 - Facultad de Ciencias
Degree: 447 - Degree in Physics
ECTS: 6.0
Year: 2
Semester: Second semester
Subject type: Compulsory
Module:

1. General information

The objective of the subject is for students to acquire advanced skills in the scientific use of the computer.

Theoretical classes will explain the physical or mathematical basis of the problem and the algorithms to be used. The organization of the code (in C programming language) into functions, macros, etc. and the particularly complicated aspects of the code will be briefly discussed. Students should complete the code writing work individually and prior to the practical class. In the practices, we will try to solve common problems, give indications to those who are lagging behind, and propose extensions and improvements.

This subject belongs to the Mathematical Methods module of the Degree in Physics. It is recommended to have taken the following subjects: Computer Science, Algebra and Fundamentals of Physics.

2. Learning results

2.1. Competencies

Upon completion of the subject, the student will have achieved:

- Computer and programming skills.

- Mastery of basic mathematical and numerical methods applicable to Physics.

-Some of the most used numerical analysis methods in the field of Physics.

- Identify the numerical tools needed to solve physical problems.

- Implement numerical methods in a programming language.

- Acquire the ability to analyse and evaluate the results of a numerical method.

2.2. Learning Results

In order to pass this subject, the students shall demonstrate they has acquired the following results:

- Solve numerically the dynamics of one and many particles under different interactions: gravitational, electromagnetic, or other types.

- Solve physical problems requiring the use of matrices.

- Analyse signals by spectral methods. -Perform Fourier transforms in one and more dimensions.

- Generation of random numbers in the computer, with flat distribution; use this distribution to generate arbitrary distributions . - Homogeneous dot generation on surfaces.

- Perform stochastic simulations on simple physical problems.

- Statistically analyse the results of a simulation. -Calculation of statistical errors.

- Monte Carlo simulations of simple models.

- Numerically solve physical problems with appropriate boundary conditions.

3. Syllabus

- Differential Equations.
- Partial Differential Equations in Partial Derivatives.
- Random Numbers.
- Arbitrary probability distributions.

- Statistical analysis and error calculation.
- Advanced statistical analysis.
- Brownian motion.
- The Ising model.
- Basic principles of Statistical Mechanics.
- Advanced simulation of the Ising model.
- Simulated Annealing.
- Complex Networks.
- Neural Networks.

4. Academic activities

The learning process designed for this subject is based on the following:

- **Theory classes**: One hour per week, where the necessary basic notions of physics, mathematics and programming will be taught..

- **Types of problems**: The implementation in code of the topics proposed in theory class will be discussed. One hour weekly.

- **Sessions in computer classrooms**: Two hours (in a single session), where the code marked in the theory and practical classes must be finished , until its compilation and execution.

- **Tutoring**: The necessary hours will be fixed, depending on the rest of the schedules.

5. Assessment system

The student must demonstrate that the expected learning outcomes have been achieved. The course will be assessed in the form of a comprehensive evaluation through the following activities:

- Intermediate tests (25% of the grade): correct resolution of two practical problems and completion of an individual practical test after each of them.
- Project (15% of the grade): completion and presentation of a brief simulation project of a physical system.
- Written test (60% of the grade, minimum 5 out of 10): examination of the knowledge acquired during the course.

Students who do not achieve a minimum score of 5 out of 10 on the written test will not pass the course. In other words, the scores from the activities carried out during the course will only be added to the final grade if the written test is successfully passed.

6. Sustainable Development Goals

4 - Quality Education
9 - Industry, Innovation and Infrastructure