UAB
Universitat Autònoma de Barcelona

Electromagnetism and Relativity

Code: 107843
ECTS Credits: 6

2025/2026

Degree	Type	Year
Mathematics	FB	1

Contact

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Teaching groups languages

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

Prerequisites

As a first-year course in the Mathematics degree program, it should not require any prior knowledge beyond that acquired in high school. However, it is advisable for students to have some basic skills in function theory, differentiation, integration, and concepts related to the use and operations of vector and scalar quantities. Regarding knowledge of Physics, it is not strictly necessary, since the course starts from elementary principles at a zero level. Nevertheless, it is true that students who have taken Physics in high school have a significant advantage. In this regard, it is recommended that students who have not studied Physics in high school take an initial look at the bibliography to begin familiarizing themselves with the topics that will be covered. The section on Special Relativity is new material for all students and, therefore, no prior knowledge is required, beyond the concepts of inertial reference frames and Galilean transformations.

Objectives and Contextualisation

While it is true that Mathematics is more essential for those who wish to approach Physics than the other way around, it is undeniable that Physics serves as a very important testing ground for Mathematics students. Not only does it enrich and challenge mathematical concepts from a practical perspective, but also from an epistemological one. For this reason, it is crucial that future Mathematics graduates receive training in Physics.

The course aims to provide students with the fundamental concepts of the electric and magnetic fields, as well as relativity-some of which may already be familiar to those who have studied Physics in high school. The main goal here is to increase the level of rigor in understanding these concepts. Specifically, the course will present the laws governing the electric field, the magnetic field, and electric current, making use of some of the concepts introduced in the Classical Mechanics course from the first semester.

Finally, the third major topic of the course is relativity. In this case, the objective is to provide students with a certain intuitive understanding of relativity, while also demonstrating how significant advances can be made through deep reflection on aspects that may seem obvious but actually conceal ad hoc assumptions. The mathematics associated with relativity presented in this course is adapted to a first-year level. However, as a long-term goal in later courses (not in this one), its four-dimensional formulation can be used to illustrate some of the most important mathematical concepts.

Learning Outcomes

1. CM03 (Competence) Formulate physical problems, identifying the relevant physical principles and their mathematical formulation.
2. CM04 (Competence) Apply mathematical tools to the resolution of elementary problems in the field of Physics.
3. KM05 (Knowledge) Identify the main foundations of Physics, as well as its mathematical formulation.
4. KM07 (Knowledge) Describe the physical principles of heat, electromagnetism, radiation, and energy.
5. SM04 (Skill) Solve elementary Physics problems based on their mathematical formulation.
6. SM05 (Skill) Analyse experimental data and observations in the context of Physics, identifying patterns, relationships, and conclusions.
7. SM06 (Skill) Properly express fundamental physical information using the relevant mathematical language and the magnitudes and units associated with the basic concepts.

Content

I. Electricity and Magnetism

- Electric field
- Coulomb's law
- Gauss's law
- Electric potential
- Electrostatic potential energy
- Electric current
- Resistance and Ohm's law
- Direct current circuits and Kirchhoff's laws
- Capacitors
- Magnetic field
- Field produced by a moving charge
- Field produced by currents: Biot-Savart law, Ampère's law
- Magnetic induction
- Magnetic flux
- Faraday's law
- Lenz's law

II. Relativity

- Principles of relativity: Galileo and Einstein
- Principle of the constancy of the speed of light
- Michelson-Morley experiment
- Relativistic paradoxes: the twins
- Relativistic kinematics: Lorentz transformations; relativistic space-time
- Velocity composition
- Relativistic Doppler effect
- Relativistic dynamics: energy and linear momentum, and collisions
- Mass-energy equivalence: $E=mc^2$

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Problems	15	0.6	CM03, CM04, SM04, SM06, CM03

Theory	30	1.2	CM03, KM05, KM07, SM05, SM06, CM03
Type: Supervised			
Seminars	18	0.72	CM03, CM04, SM04, SM06, CM03
Type: Autonomous			
Personal work	78	3.12	CM03, CM04, KM05, KM07, SM04, SM05, SM06, CM03

This course employs two types of teaching methodologies: one for the theoretical component and another for the practical component.

On the one hand, the theoretical part will be organized through lecture-based classes. These will be dynamic and serve a dual purpose: i) to present, discuss, and thoroughly demonstrate the course content, and ii) to use the lectures as a tool, through questions posed to students, to directly assess their level, both in terms of prior knowledge and their ongoing understanding of the course. This is particularly important in a first-year course, given the wide range of knowledge levels among students.

On the other hand, the practical part of the course will be structured around problem-solving sessions and seminars. During the seminars, which will be organized in smaller groups whenever possible, students will work individually or in small teams to tackle proposed problems, consulting the bibliography and lecture notes to assess their grasp of the concepts presented. The instructor will take an active and personalized role, as much as possible, to identify the main conceptual difficulties faced by students.

Finally, in the problem-solving sessions, the most complex and significant exercises will be solved in detail, with emphasis on the most relevant theoretical aspects. These learning activities will be complemented by a set of more advanced problems, which will be assigned for submission on scheduled dates. The aim of these problems is to encourage deeper personal study of some of the most important aspects of the subject matter.

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
Continuous Assessment	30%	0	0	CM03, CM04, SM05, SM06
Exam (two tests)	70%	6	0.24	CM03, CM04, KM05, SM04, SM06
Resit exam of the course	100%	3	0.12	CM03, CM04, KM05, KM07, SM04, SM06

The final grade for the course will be based on synthesis exams and continuous assessment.

The synthesis exams will consist of:

- A midterm exam on the electromagnetism section, accounting for 35% of the final grade.
- A second exam at the end of the course on the relativity section, also accounting for 35% of the final grade.

The continuous assessment will be based on:

- Problem set submissions, which will account for 20% of the grade.
- Attendance and participation in seminars, which will contribute 10%.

Honors distinctions will be awarded based on this final grade, without waiting for the resit exam.

The resit exam will consist of two parts: one on electromagnetism and one on relativity.
The grade obtained in the resit exam will completely replace the course grade and will therefore become the final grade. To pass the course, a minimum grade of 4.9 is required. If a student does not attend either of the two partial exams or the resit exam, the course will be marked as not presented. In all other cases, if the minimum of 4.9 is not reached, the course will be considered failed.

Bibliography

P.A. Tipler, G. Mosca. Fisica para la Ciencia y la Tecnología (vol II). Ed. Reverté, 6a. edició, Barcelona, 2010.

H. Young, R. Freedman, Fisica universitaria (II), Addison-Wesley, Pearson Education, Decimosegunda edicion, Mexico 2009

E. Massó, Curs de relativitat especial, Universitat Autònoma de Barcelona. Servei de Publicacions, ed.(06/1998), Idioma: Català, ISBN: 8449012848, Barcelona 1998.

A.P. French. Relatividad Especial. Ed. Reverté, 1974.

Software

Not applicable.

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
(PAUL) Classroom practices	1	Catalan	second semester	morning-mixed
(SEM) Seminars	1	Catalan	second semester	morning-mixed
(SEM) Seminars	2	Catalan	second semester	morning-mixed
(SEM) Seminars	3	Catalan	second semester	morning-mixed
(TE) Theory	1	Catalan	second semester	morning-mixed