Universitat Autònoma de Barcelona

2020/2021

Physics

Code: 100090
ECTS Credits: 12

Degree	Type	Year	Semester
2500149 Mathematics	FB	1	A

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: Yes

Other comments on languages

First semester: Spanish. Second semester: Catalan.

Teachers

Pere Masjuan Queralt

External teachers

Pablo Sánchez Puertas (semestre 1)

Prerequisites

As a first-year course, it should not require any previous knowledge beyond that acquired at Secondary education (Bachillerato). Nonetheless, it is advantageous for the student to have some basic skills in calculus (functions, derivatives, and integrals) and basic notions in the use and operation with scalar and vectorial quantities. Regarding the knowledge in physics, this is a priori not required since the course starts at a basic level. Nevertheless, the students that have taken a physics course at Secondary educationwill have a certain advantage. For those who have not, it is recommended to have a quick look at any of the books in the bibliography in order to get familiar with the concepts, especially those related to the first semester. In the second part, the special relativity block is new for all the students, and thereby no previous knowledge is required beyond inertial reference frames and Galilean transformations, that are taught in the first semester.

Objectives and Contextualisation

While physicists need math more than mathematicians need physics, it is unquestionable that physics represents an important target field for mathematicians. Not only to test and to enrich mathematical concepts from a practical perspective, but from an epistemological point of view. For this reason, it is important that bachelor students in mathematics have a basic physics knowledge. The first part of the course aims to provide the student with the basic concepts of classical mechanics, a part of which should already be known to those students having taken a physics course at Secondary education. The main goal thereby will be to improve on the rigor of these concepts. The second part aims at introducing the laws concerning electric and magnetic fields as well as electric currents, that partly builds on concepts introduced in the first semester. Finally, the third large block of this course concerns the theory of special relativity, where the aim is to provide the student with a basic relativistic intuition, while showing how deep thinking on a priori obvious (but rather ad hoc) concepts can boost great advances in physics. Nonetheless, with the mind on future courses, its four-dimensional formulation could be used to exemplify some of the most important and profound mathematical concepts.

Competences

- Apply critical spirit and thoroughness to validate or reject both ones own arguments and those of others.
- Distinguish, when faced with a problem or situation, what is substantial from what is purely chance or circumstantial.
- 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 collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
- Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
- When faced with real situations of a medium level of complexity, request and analyse relevant data and information, propose and validate models using the adequate mathematical tools in order to draw final conclusions

Learning Outcomes

1. Apply critical spirit and thoroughness to validate or reject both ones own arguments and those of others.
2. Be introduced to the fundaments of Physics, including electromagnetism, classical mechanics and relativity.
3. Formulate and solve physical problems, identifying the relevant physical principles and using order-of-magnitude estimates and special limit cases to find solutions and present them along with explanations of suppositions and approximations.
4. Know and understand basic physical phenomena.
5. 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.
6. Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
7. Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
8. Use mathematics to describe the physical world, selecting appropriate equations, constructing adequate models, interpreting mathematical results and comparing critically through experimentation and observation

Content

1. Classical mechanics. (FIRST SEMESTER)

Introduction. System of units. Kinematics. Specific cases of motion. Concept of relative movement. Dynamics. Newton's laws. Inertial and non-inertial reference frames. Forces and moments. Work and kinetic energy. Conservative forces and potential energy. Mechanical energy and conservation theorem. One-dimensional harmonic oscillator: simple, damped and driven cases. Movement in two or three dimensions. Introduction to vector calculus. Central forces. Gravitation. Kepler's laws. Newton's law of universal gravitation. Systems of particles. Center of mass. Collisions. Solid and fluid mechanics. Waves on a string. Rotating reference frames. Coriolis' theorem.

2. Electricity and magnetism (SECOND SEMESTER)

Electric field. Coulomb's law. Gauss's law. Electric potential. Electrostatic potential energy. Electric current. Resistance and Ohm's law. Continuous current circuits. Magnetic field. The field produced by a moving charge. Field produced by currents: Biot-Savart's law and Ampere's law. Magnetic induction. Magnetic flux. Faraday's law. Lenz's law.

3. Relativity (SECOND SEMESTER)

Galilean and Einstein relativity principles. Basic principle of relativity and the constancy of the speed of light c. Michelson-Morley experiment. Relativistic paradox: the twins. Relativistic kinematics: Lorentz transformations and relativistic space-time. Velocity composition. Relativistic Doppler effect. Relativistic dynamics: relativistic energy and momentum; transformations. Momentum-energy.

Methodology

Two different methodologies are employed in this course: a theoretical and a practical one. On the one hand, the theory part will be organized as master classes. This will be dynamic and with a two-folded aim: i) to present, to discuss, and to demonstrate the subject in detail, andii) the lectures will be used as an effective tool, via questions addressed to the students, to test and to probe their level of knowledge as well as to track their knowledge acquisition. This will be particularly important for being a first-year course, with its consequent diversity of prior knowledge. The practical part will be dividedin problems classes and seminars. During the seminars, that will be organized in small groups of students (a third of the total), the students will work on their own or in groups of 2 or 3 students, and will tackle the proposed problems, consulting the bibliography and their class notes, with the aim of identifying their ability and concepts discussed in lectures. The professor will have an active and individualized as possible role in order to identify which are the most important conceptual barriers faced by the students. During the seminars, if necessary, some simpler problems will be outlined in order to illustrate what was taught in the theory part. Finally, the problem lectures will solve in detail the most complex and relevant problems among the proposed ones, with special emphasis in the most relevant theoretical aspects. Finally, these activities will be complemented with a series of problems of a higher level that students will have to submit at a fixed deadline. The goal of these problems will be to individually delve into the most relevant aspects of the course.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Problems	30	1.2	7, 5, 6
Theory	60	2.4	
Type: Supervised			
Seminars	32	1.28	5, 6
Type: Autonomous			
Personal study	154	6.16	

Assessment

The grade of the course during the first semester will be a combination of the exams and a continuous assessment. The exams will consist of a partial and a final exam that will contribute, respectively, to a total 20% and 50% of the final grade of the first semester. The continuous assessment will consist in a series of submitted problems as well as the assistance and participations to seminars; these will contribute, respectively, to a total 20% and 10% of the final grade of the first semester. In the second semester, the method of assessment will be the same. The final grade will be an average of the two semesters, being a necessary condition to pass both semesters. The honours distinction (matrícula de honor)will be awarded according to this final grade (without waiting for the resitting exams). The resitting exam consists in two parts, one per semester. The student will have to do the part(s) to the corresponding failed semester(s). The grade of each semester will correspond, exclusively, to the grade of the resitting exam.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Continuous assessment I. First semester	30%	5	0.2	1, 4, 3, 2, 5, 6, 8
Continuous assessment II. Second semester	30%	5	0.2	1, 4, 3, 2, 5, 6, 8
Exam (final). First semester	50%	3	0.12	4, 3, 7
Exam (final). Second semester	50%	3	0.12	4, 3, 7
Exam (partial). First semester	20%	2	0.08	4, 3, 7
Exam (partial). Second semester	20%	2	0.08	4, 3, 7
Resitting exam for the full course (two parts)	100%	4	0.16	4, 3, 7

Bibliography

P.A. Tipler, G. Mosca. *Physics for Scientists and Engineers* (Vols. I and II). W. H. Freeman and Company, 6th edition, New York, 2007.*

H. Young, R. Freedman, *University Physics with Modern Physics* (Vols. I and II), Addison-Wesley, Pearson Education, 12th edition, 2008.

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. *Special Relativity.* Taylor & Francis Ltd, United Kingdom, 1968.

*Note: Volumes I and II correspond to the references for the first and second semester, respectively; available online.