

Degree	Type	Year
Physics	FB	1

Contact

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Teachers

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Teaching groups languages

You can view this information at the [end](#) of this document.

Prerequisites

The course is divided into two parts, each lasting approximately 7 weeks. There are no formal prerequisites, but the following recommendations apply to each part:

For the Mechanics and Waves I section:

- Mathematics: students should have a good understanding of trigonometry and elementary algebra, including vector algebra; also basic knowledge of calculus, particularly differentiation, and some familiarity with integration.
- Physics: a basic grasp of mechanics is recommended, especially kinematics, forces, and elementary Newtonian dynamics.
- Other: students are expected to maintain an open mindset, think critically, and develop good study habits to keep up with the course.

For the Special Relativity and Waves II section:

- Mathematics: a solid command of basic mathematics and fluency with elementary algebra is recommended.
- Physics: students should be familiar with basic kinematics and Newtonian dynamics.
- Other: an open attitude and consistent study habits are essential for following the course effectively.

Objectives and Contextualisation

To deepen students' understanding of mechanics and waves, which are essential for grasping more advanced courses. To introduce them to the world of special relativity, a fundamental part of modern physics. To help students achieve a solid grasp of the core concepts and formalism of these disciplines. To develop their ability to solve intermediate-level exercises and problems that do not necessarily follow standard formats, as well as to strengthen their analytical skills. To prepare them for further study and deeper exploration in subsequent courses.

A more specific objective concerning special relativity is to enable students to use Lorentz transformations to describe events from different reference frames and to resolve the most common paradoxes of the theory. The course also aims to equip them with practical understanding of wave phenomena.

Learning Outcomes

1. CM01 (Competence) Solve problems in the sciences using the fundamentals of the main areas of physics in a professional context.
2. CM02 (Competence) Evaluate the principal magnitudes involved in a given basic physical system, manipulating them according to fundamental physical laws to draw conclusions about the predictable behaviour of the system under study.
3. KM01 (Knowledge) State Newton's laws and their relationship with the movement of particles and fluids.
4. KM02 (Knowledge) Describe the elementary paradoxes of relativistic kinematics and Lorentz transformations.
5. SM01 (Skill) Correctly use scientific language, magnitudes and units associated with fundamental physical concepts.
6. SM02 (Skill) Apply the theory, fundamentals and numerical methods of general physics to the resolution of simple problems and the explanation of experimental phenomena.

Content

1. Classical Mechanics

- Kinematics of a point particle in one, two, and three dimensions.
- Dynamics of a point particle: Newton's laws.
- Inertial and non-inertial reference frames.
- Galilean relativity.
- Dynamics of systems of particles: linear momentum, center of mass, and conservation of momentum.
- Torque and angular momentum.
- Statics of rigid bodies.
- Work and energy.
- Conservative forces, potential energy, and mechanical energy.
- Introduction to the dynamics of rigid bodies (fixed or parallel axes of rotation).
- Moment of inertia.

2. Waves

- Wave motion: propagation speed, amplitude, and wavefronts.
- Longitudinal and transverse waves. Polarization.
- Wave equation. Harmonic waves: characteristics, phase, and phase difference.
- Energy and intensity associated with a wave.
- Sound: propagation speed, intensity, decibels, ultrasound, and the functioning of the ear.
- Doppler effect.
- Principle of superposition.
- Interference:
 - Superposition of waves with the same frequency.
 - Superposition of waves with different frequencies.
- Standing waves.
- Harmonic analysis and synthesis.

3. Special Relativity

- Introduction.
- Einstein's principle of relativity.
- Principle of the constancy of the speed of light.
- Relativistic kinematics:
 - Lorentz transformations.
 - Relativistic spacetime and spacetime diagrams.
- Paradoxes, applications, and experimental tests of relativistic kinematics.
- Relativistic Doppler effect and expansion of the universe.
- Linear momentum and energy in relativity.
- Conservation laws.
- Collisions and decays.

The topics listed are indicative and may be subject to slight adjustments depending on the specific dynamics of each academic year. The order shown does not necessarily reflect the sequence in which the topics will be presented in class.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			

Lectures	28	1.12	CM01, CM02, KM01, KM02, SM01, SM02, CM01
Problem-solving classes	14	0.56	CM01, CM02, SM01, SM02, CM01
Type: Supervised			
Focused seminars	8	0.32	CM01, CM02, KM02, SM01, SM02, CM01
Type: Autonomous			
Independent learning	86	3.44	CM01, CM02, KM01, KM02, SM01, SM02, CM01

Face-to-face activities (guided and supervised)

There will be two hours of weekly lectures and one hour per week of problem-solving sessions.

In addition, eight hours of specialized seminars will be scheduled. During these seminars, each group will be split into two subgroups to facilitate interaction between students and instructors, who will supervise the activities.

The lectures will cover the key concepts of special relativity, mechanics, and waves, as well as the necessary developments to build (at a reasonable level) a consistent and well-structured theoretical framework that enables students to study applications and solve problems. These problems will be solved and discussed both in the problem sessions and in the specialized seminars.

Independent (self-guided) activities

Students will have access to the content of both the theory and problem classes. In addition to the recommended textbooks (see bibliography), they will find -via the Virtual Campus- the lecture materials and the problem statements to be discussed and solved in class.

Problem sets will be proposed, and their evaluation will contribute positively to the final grade of the course.

Note: 15 minutes of one class will be reserved, in accordance with the schedule set by the faculty/degree program, for students to complete the teaching and course evaluation surveys.

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

Continuous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Final or resit written exam (optional for students who have passed both previous exams)	100%	4	0.16	CM01, CM02, KM01, KM02, SM01, SM02
Problem set submission for Mechanics and Waves I (the grade can be improved through the written exam of the first part)	10%	3	0.12	CM01, CM02,

					KM01, KM02, SM01, SM02
Problem set submission for relativity and waves II (the grade can be improved through the written exam of the second part)	10%	3	0.12		CM01, CM02, KM02, SM01, SM02
Written exam of the first part (the grade can be improved through the final written exam)	40-50%	2	0.08		CM01, CM02, KM01, SM01, SM02
Written exam of the second part (the grade can be improved through the final written exam)	40-50%	2	0.08		CM01, CM02, KM02, SM01, SM02

The course will be assessed through three exam sessions. Each session will include a written exam with theoretical questions and problems. In the first two sessions, there will also be a problem set to be completed at home, individually or in groups, as specified. The grade for this problem set may be improved through the corresponding written exam.

The first session will cover Newtonian mechanics and mechanical waves.

The second session will cover special relativity and further topics in wave physics.

Each part will carry equal weight in the final grade.

The course is considered passed by components if the geometric mean of the two scores (including the problem set grade) is 5.0 or higher (out of 10).

The third session, or resit, will consist of two written exams, one for each part. Students who have not passed one or both parts must take them. The final grade for each part will be solely that obtained in the resit exam. Students who take the resit exam to improve their grade may only raise it: if the new grade is lower than a previously obtained one, it will not be considered. The global grade will again be calculated as the geometric mean of the two part scores.

To participate in the resit, students must have taken part in the two ordinary assessment sessions corresponding to each part of the course.

In addition, a minimum final grade of 3.5 is required.

If the final grade is below 3.5, the course will be considered failed.

The theoretical questions will be brief and will not require complex calculations; they are intended to assess conceptual understanding of the course material.

The problems will be longer and involve more elaborate calculations. They will assess the student's depth of understanding, ability to formulate problems mathematically, and calculation skills. These problems will not necessarily be variations of those solved in class.

Note: Both parts of the course are core foundations in a physicist's education. A high grade in one part cannot compensate for a very low grade in the other. For this reason, the geometric mean is used, as it penalizes large discrepancies between parts. When both scores are similar, the geometric mean differs little from the arithmetic mean, but it better reflects imbalances when one result is significantly lower than the other.

Bibliography

Textbooks

- M. Alonso and E. J. Finn, *Physics. Vol. 1: Mechanics*. Addison Wesley Longman, 1st edition (2000).
- P. Tipler and G. Mosca, *Physics for Scientists and Engineers*. Reverté, 5th edition (2003) and 6th edition (2010).
- E. Massó, *Course on Special Relativity*. UAB Manuals (1998). Specific for the special relativity section.
- A. P. French, *Special Relativity*. Reverté (1988), reprinted in 2002.

Problem books and resources

- Problem set collection available on the Virtual Campus.
- P. Tipler and G. Mosca, *Physics for Scientists and Engineers*. Reverté, 5th edition (2003) and 6th edition (2010).

Software

No specific software is required to follow the course.

If any simulation or numerical computation is needed, the course will use Google Colab, a platform that allows programming in Python directly from the browser, without the need to install local software. This tool is free, accessible from any device with an internet connection, and very useful for interactively visualizing results.

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/Spanish	first semester	morning-mixed
(PAUL) Classroom practices	2	Catalan/Spanish	first semester	afternoon
(SEM) Seminars	11	Catalan/Spanish	first semester	morning-mixed
(SEM) Seminars	12	Catalan/Spanish	first semester	morning-mixed
(SEM) Seminars	21	Catalan/Spanish	first semester	afternoon
(SEM) Seminars	22	Catalan/Spanish	first semester	afternoon
(TE) Theory	1	Catalan/Spanish	first semester	morning-mixed
(TE) Theory	2	Catalan/Spanish	first semester	afternoon