Universitat Autònoma de Barcelona

2021/2022

General Physics: Mechanics and Waves

Code: 103270
ECTS Credits: 7

Degree	Type	Year	Semester
2501922 Nanoscience and Nanotechnology	FB	1	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: No
Some groups entirely in Spanish: No

Other comments on languages

The theory classes will be in catalan and the exercises ones in spanish

Teachers

Santiago Suriñach Cornet
Jose Lopez Barbera Martin
Carla Rodríguez Mangues
David Viedma Palomo
Josep Gutiérrez Martínez

Prerequisites

There are no prerequisites

Objectives and Contextualisation

The main objective of the course is that the student acquires the basic knowledge of mechanics and waves both conceptually and mathematically. Special emphasis will be placed on the qualitative and quantitative understanding of the phenomena and laws that will be relevant later in the field of Nanoscience.

Competences

- Apply the concepts, principles, theories and fundamental facts of nanoscience and nanotechnology to solve problems of a quantitative or qualitative nature in the field of nanoscience and nanotechnology.
- Apply the general standards for safety and operations in a laboratory and the specific regulations for the use of chemical and biological instruments, products and materials in consideration of their properties and the risks.

- Communicate orally and in writing in ones own language.
- Demonstrate knowledge of the concepts, principles, theories and fundamental facts related with nanoscience and nanotechnology.
- Handle the standard instruments and materials of physical, chemical and biological testing laboratories for the study and analysis of phenomena on a nanoscale.
- Interpret the data obtained by means of experimental measures, including the use of computer tools, identify and understand their meanings in relation to appropriate chemical, physical or biological theories.
- Learn autonomously.
- Manage the organisation and planning of tasks.
- Obtain, manage, analyse, synthesise and present information, including the use of digital and computerised media.
- Reason in a critical manner
- Recognise and analyse physical, chemical and biological problems in the field of nanoscience and nanotechnology and propose answers or suitable studies for their resolution, including when necessary the use of bibliographic sources.
- Recognise the terms used in the fields of physics, chemistry, biology, nanoscience and nanotechnology in the English language and use English effectively in writing and orally in all areas of work.
- Resolve problems and make decisions.
- Work on the synthesis, characterisation and study of the properties of materials on a nanoscale from previously established procedures.

Learning Outcomes

1. "Formulate and address physical problems; identify relevant physical principles, and use estimates of order of magnitude and special limit cases to reach a solution and present the assumptions and approaches."
2. Apply Newtons laws to resolve problems with dynamic systems with one or several particles.
3. Apply the acquired theoretical contents to the explanation of experimental phenomena.
4. Apply the principles of mechanical equilibrium and moments to rigid bodies.
5. Apply the wave equation to study phenomena of superposition and interference.
6. Communicate orally and in writing in ones own language.
7. Correctly handle common measurement instruments in a physics laboratory.
8. Correctly use the basic terminology in the field of classical physics.
9. Critically evaluate experimental results and deduce their meaning.
10. Define the characteristics of wave movement and obtain the general equation of waves.
11. Explain the concepts of work and energy.
12. Explain the simple, damped and driven oscillator systems.
13. Identify a conservative force and calculate the corresponding potential energy.
14. Identify and situate safety equipment in the laboratory.
15. Identify the magnitudes and units associated with the basic physical principles of mechanics, waves, electricity and magnetism.
16. Learn autonomously.
17. Manage the organisation and planning of tasks.
18. Obtain, manage, analyse, synthesise and present information, including the use of digital and computerised media.
19. Perform basic analysis procedures of a physics laboratory.
20. Perform bibliographic searches for scientific documents.
21. Rationalise the results obtained in the laboratory in terms of physical magnitudes and their relation with the observed physical phenomena.
22. Reason in a critical manner
23. Resolve problems and make decisions.
24. Resolve problems with the help of the provided complementary bibliography.
25. Understand the laws of Newton and apply them to the movement of particles.
26. Use kinematic equations to describe the movement of a particle in one, two or three dimensions.

Content

- Introduction: Measures and Units. Orders of magnitude. Unit systems. Length, mass and time. Fundamental quantities.

- Kinematics: Movement of a particle. Speed. Acceleration. Movement in one dimension: Rectilinear movement and free fall, Movement in two dimensions: Parabolic movement and circular movement, Movement in three dimensions.

- Dynamics: Newton's Laws. Linear momentum and conservation of momentum. Forces and types of forces. Inertial and non-inertial reference frame. Fictitious forces.

- Work and energy: Impulse, work, energy and power. Energy conservation. Force fields.

- Systems of particles: Conservation of linear momentum. Centre of masses. Centre of masses reference frame. Kinetic energy. Total energy and conservation. Collisions.

- Rigid solid: Rotation with respect to a fixed axis. Moment of inertia. Kinetic energy of rotation. Pair of forces. Translation, rotation and rolling motion. Angular momentum of a particle. Angular momentum of a system of particles. Conservation of angular momentum. Static equilibrium. Centre of gravity.

- Oscillations: Simple harmonic oscillatory movement. Oscillator energy. The simple pendulum. The physical pendulum. The torsion pendulum. Damped oscillations. Forced oscillations. Resonance frequency.

- Waves: Wave movement. Types of waves. Equation of waves. Harmonic waves. Propagation speed. Wavefront. Polarization. Doppler effect. Superposition principle. Interference. Stationary waves. Harmonic analysis and synthesis. Sound.

Methodology

The course includes theory classes, exercises classes and laboratory work.

In the theory classes the contents of the subject will be discussed, always encouraging the participation of the student by asking questions.

In the classes of exercises it is intended that the student participates in an active way either posing doubts or participating in the resolution of exercises and questions.

It will be required that the students deliver some solved exercises during the course.

Some of the sessions of exercises will be of guided problems type, where the students will solve the problems raised in group with the help of the teacher and at the end of the class they will have to deliver individually some solved questions on the problem solved.

The attendance to the laboratory is compulsory and there will be four sessions of three hours each in which students in groups of three people will have to make a series of experiments related to the concepts discussed in the classes of theory and exercises.

The first practice, to be carried out by all groups, will be "Instrumentation: length and mass measurements and error calculation" (P1). Each student, on an individual level, will have to prepare a report of this practice, which will be delivered through the virtual campus at the latest two weeks after the lab session.

The students will have to do three more practices between the following four:

P2: Free fall

P3: Waves and sound

P4: Energy conservation

P5: Movement of projectiles

A collective report (one per group) will be delivered through the virtual campus, which will also be delivered no later than two weeks after the corresponding lab session.

The material for theory classes, exercises and laboratory work will be provided through the virtual campus of the subject.

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.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Exercises classes	17.5	0.7	1, 3, 4, 2, 5, 9, 6, 10, 25, 11, 12, 20, 17, 15, 13, 18, 22, 24, 23, 8, 26
Laboratory work	12.25	0.49	1, 4, 2, 5, 6, 10, 25, 11, 12, 17, 14, 15, 13, 7, 18, 21, 22, 23, 8, 26
Theory classes	31.5	1.26	4, 10, 25, 11, 12, 15, 13, 22, 8
Type: Supervised			
Tutoring and problem-solving assistance	8.75	0.35	1, 3, 4, 2, 5, 9, 6, 10, 25, 11, 12, 15, 13, 18, 22, 26
Type: Autonomous			
Bibliographic work	6	0.24	3, 16, 9, 6, 20, 18, 24, 8
Preparation of lab reports	12	0.48	3, 4, 16, 9, 6, 10, 25, 11, 12, 20, 17, 15, 13, 18, 21, 24, 8
Reading lab scripts	5	0.2	3, 4, 16, 9, 10, 25, 11, 12, 20, 17, 15, 13, 18, 24
Resolution of exercises	38	1.52	1, 3, 4, 2, 5, 16, 9, 6, 10, 25, 11, 12, 20, 15, 13, 18, 22, 24, 23, 8, 26
Study of theory concepts	38	1.52	3, 4, 16, 9, 10, 25, 11, 12, 20, 17, 15, 13, 18, 22, 24, 8

Assessment

The final grade of the course will be obtained from the following percentages:

- 35% : Mark of the first partial exam.

- 35% : Mark of the second partial exam.

- 20% : Mark of the delivered laboratory reports.

- 10% : Mark of the delivered activities.

In order to apply these percentages, the score (out of 10) of each of the partial exams must be equal to or higher than 4 and all the laboratory work must have been carried out. In the case that in one or both of the partial exams, the mark is lower than 4, the student will have to take the retaking exam of the part that has been failed with a mark lower than 4. If a student, even if he/she has passed the subject, wants to improve the mark of the written exams, he/she can take the retaking exam of the part he/she wants to improve and the final

mark that will be considered will be the mark obtained in the retaking exam. The mark will be "no avaluable" when the student does not take any exam or only takes one of the two partial exams and does not attend the retaking exam.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Activities to deliver	10%	0	0	1, 3, 4, 2, 5, 16, 9, 6, 10, 25, 11, 12, 20, 15, 13, 18, 22, 24, 23, 8, 26
Laboratory reports	20%	0	0	1, 3, 4, 2, 5, 16, 9, 6, 10, 19, 25, 11, 12, 17, 14, 15, 13, 7, 18, 21, 22, 23, 8, 26
Partial exam 1	35%	3	0.12	1, 3, 4, 2, 5, 6, 10, 25, 11, 12, 15, 13, 22, 23, 8, 26
Partial exam 2	35%	3	0.12	1, 3, 4, 2, 5, 6, 10, 25, 11, 12, 15, 13, 22, 23, 8, 26
Retaking exam partial 1	35%	0	0	1, 3, 4, 2, 5, 6, 10, 25, 11, 12, 15, 13, 22, 23, 8, 26
Retaking exam partial 2	35%	0	0	1, 3, 4, 2, 5, 6, 10, 25, 11, 12, 15, 13, 22, 23, 8, 26

Bibliography

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Software

No specific software is required.