Universitat Autònoma de Barcelona

2023/2024

Advanced Classical Physics

Code: 103286
ECTS Credits: 8

Degree	Type	Year	Semester
2501922 Nanoscience and Nanotechnology	OB	2	1

Contact

Name: Adam Valles Mari

Email: adam.valles@uab.cat

Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject. Please note that this information is provisional until 30 November 2023.

Teachers

Maria del Pilar Casado Lechuga

Prerequisites

There are no prerequisites.

Objectives and Contextualisation

The aim of this course is to provide the student with the fundamental concepts of classical physics by focusing on classical mechanics, light, and light-matter interaction. Specifically, we will analyze the mechanics of particle systems, review the behavior of the rigid solid under different external conditions, and introduce analytical mechanics, both conceptual and formal. In addition, the student will be introduced to electromagnetic optics and will work on the main models that describe the interaction between light and matter.

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.
- Be ethically committed.
- Communicate orally and in writing in one's 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.
- Propose creative ideas and solutions.
- 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 correctly with the formulas, chemical equations and magnitudes used in chemistry.

Learning Outcomes

1. Analyse and interpret optical phenomena in accordance with the principles of physics.
2. Analyse situations and problems in the field of physics and propose answers or studies of an experimental nature using bibliographic sources.
3. Apply the acquired theoretical contents to the explanation of experimental phenomena.
4. Be ethically committed.
5. Communicate orally and in writing in one's own language.
6. Correctly use computer tools to calculate, graphically represent and interpret the data obtained, as well as its quality.
7. Critically evaluate experimental results and deduce their meaning.
8. Employ information and communication technology in the documentation of cases and problems.
9. Identify and situate safety equipment in the laboratory.
10. Identify the origin of light as an electromagnetic wave.
11. Integrate experimental observations with physical theories.
12. Interpret basic texts and bibliographies in English on physics and materials.
13. Learn autonomously.
14. Make adequate use of laboratory materials and instruments.
15. Manage the organisation and planning of tasks.
16. Obtain, manage, analyse, synthesise and present information, including the use of digital and computerised media.
17. Perform bibliographic searches for scientific documents.
18. Propose creative ideas and solutions.
19. Reason in a critical manner
20. Recognise the principles of physical optics in relation to interference and diffraction of light.
21. Resolve electromagnetic problems using Maxwell's equations.
22. Resolve problems and make decisions.
23. Resolve problems with interference and diffraction of electromagnetic waves.
24. Resolve problems with the help of the provided complementary bibliography.
25. Use data processors to produce reports.
26. Work correctly with the formulas, chemical equations and magnitudes used in chemistry.

Content

1. Systems of particles

    1. Laws of conservation of a systems of particles.
    2. Collisions. Laboratory reference systems and the centre of masses.
    3. Two-body system. Reduced mass.

2. Rigid solid

    1. Rigid solid: rotation around a fixed axis. Moment of inertia.
    2. Moving reference systems. Coriolis theorem.
    3. Rigid solid: Total and rotational kinetic energy. Inertia tensor. Angular momentum of the rigid solid.
    4. Free rotation of a symmetrical spinning top. Euler angles. Euler equations.

3. Introduction to Analytical Mechanics

    1. Ligate systems: ligatures, degrees of freedom and generalized coordinates.
    2. Formulation of Lagrange. Formulation of Hamilton.

4. Maxwell equations

    1. Maxwell equations in homogeneous, isotropic, and linear media.
    2. Energyc relationships. Poynting theorem.

5. Light

    1. Electromagnetic waves. Plane waves. Non-monochromatic radiation.
    2. Polarization.
    3. Interferences and diffraction.

6. Interaction of light with matter

    1. Classic Lorentz model.
    2. Bohr atom and Einstein's theory of light-matter interaction.

Methodology

The subject consists of 1.34 ECTS of classroom or laboratory directed activities: 0.5 ECTS of theory lectures, 0.28 ECTS of exercises lectures, and 0.56 ECTS of laboratory sessions.

In addition to this, there are 0.64 ECTS of virtual classroom directed activities for theory lectures. Moreover, videos can be provided to complement the number of ECTS of the course: 0.5 ECTS of theory lectures and 0.28 ECTS of exercises lectures.

The theory lectures will be master classes where the contents of the subject will be discussed, encouraging the participation of students through questions.

In the exercises lectures, it is intended that the student participates in an active way either raising doubts or participating in the resolution of exercises and questions in the classroom.

In the laboratory sessions, the student will have to apply the theoretical contents to the explanation of experimental phenomena both in the field of classical mechanics and optics.

The student's autonomous work required in this subject includes the study of theoretical concepts, the preparation and resolution of questionnaires and exercises, and the preparation of laboratory sessions as well as the writing of the corresponding reports.

The course also presents supervised activities that consist in the delivery of exercises and questionnaires.

The teaching material for the course will be provided through the virtual campus.

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 lectures	16	0.64	2, 5, 17, 18, 19, 24, 23, 21, 22
Laboratory sessions	14	0.56	3, 7, 5, 9, 18, 19, 26, 14
Theory lectures	40	1.6	1, 5, 10, 11, 18, 19, 20
Type: Supervised			
Tutoring	6	0.24	5, 15, 18, 19, 26
Type: Autonomous			
Readings	2	0.08	2, 17, 24
Search of bibliography	8	0.32	2, 17
Solving exercises	18	0.72	13, 5, 15, 18, 19, 24, 23, 21, 22
Study of the theoretical background and preparation of the laboratory sessions	76	3.04	1, 3, 13, 17, 10, 11, 19, 20, 26
Writting working reports	10	0.4	3, 13, 7, 5, 8, 12, 16, 18, 19, 24, 22, 26, 25

Assessment

"Continuous evaluation"

The final grade of the course in the case of continuous evaluation will be obtained from the following proportions:

- 35%: Mark of the partial exam and/or final of Mechanics.
- 35%: Mark of the partial exam and/or final of Optics.
- 20%: Mark of the attendance and of the reports of the laboratory sessions.
- 10%: Mark of the activities to be delivered (questions, problems).

In order to apply these percentages it is necessary that the score (out of 10) of each of the partials is equal or higher than 3,5. In the event that one or both partial marks are lower than 3.5, the student must perform the retaken exam of the part he/she did not pass with a mark equal or higher than 3.5. If a student, despite having passed the course, wants to the imporve his/her mark, he/she can take the retaken exam of the part he/she wants to improve and the final mark will be calculated with the previous percentages considering for the mark of the exams that obtained in the retaken exam. A student will be considered "non-evaluable" when he/she does not take any exam or only takes one of the two partial exams. In order to take the retaken exam, the student must have taken both partial exams.

"Single evaluation"

Students who have opted for the single evaluation modality will have to take a final exam consisting of an examination of the whole theoretical syllabus and problems of the two parts of the subject: Mechanics and Optics. This test will take place on the day on which the students of the continuous evaluation take the second partial exam.
The final mark for the subject in this case will be obtained from the following proportions:

- 80%: Mark of the final exam.
- 20%: Mark of the attendance and of the reports of the laboratory sessions.

If the final mark does not reach 5, the student has another opportunity to pass the subject by means of a retaking exam to be held on the date set by thecoordination of the degree. In this exam, 80% of the grade corresponding to the theory and problems part can be recovered. The laboratory part is not recoverable.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Attendance to and delivery of the laboratory sessions reports	20	0	0	2, 3, 13, 7, 5, 8, 17, 15, 9, 12, 4, 16, 18, 19, 24, 22, 26, 6, 14, 25
Delivery of activities (questions, exercises)	10	0	0	1, 13, 7, 5, 10, 18, 19, 20, 23, 21, 22
Mechanics partial exam or/and retaken exam	35	5	0.2	5, 11, 18, 19, 22
Optics partial exam or/and optics retaken exam	35	5	0.2	1, 5, 10, 11, 18, 19, 20, 23, 21, 22

Bibliography

Basic Bibliography

T. W. B. Kibble, "*Mecánica Clásica*" (Ediciones Urmo)

J. B. Marion, "*Dinámica Clásica de Partícules y Sistemas*" (Editorial Reverté)

V. M. Pérez García, L. Vázquez Martínez, A. Fernández-Rañada, "*100 Problemas de Mecánica*" (Alianza Editorial)

R. K. Wangsness, "*Campos Electromagnéticos*", Editorial Limusa, Mexico, 1989.

J. Cabrera, F. J. López, F. Agulló, "*Optica Electromagnética. Fundamentos*" (Addison-Wesley Iberoamericana)

E. Hecht, "*Optica*" (Addison Wesley Iberoamericana)

A. N. Matveev, "*Optics*" (Mir Publishers)

R. W. Ditchburn, "*Optica*" (Editorial Reverté)

P. M. Mejías Arias, R. Martínez Herrero, "*100 problemas de óptica*" (Alianza Editorial)

Advanced Bibliography

H. Goldstein, "*Mecánica Clásica*" (Editorial Reverté)

M. Born, E. Wolf, "*Principles of Optics"* (Pergamon Press)

Software

No special software is needed.