UAB
Universitat Autònoma de Barcelona

Introduction to Experimental Physics

Code: 100145
ECTS Credits: 6

2024/2025

Degree	Type	Year
2500097 Physics	OB	1

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Teachers

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Teaching groups languages

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

Prerequisites

There are not requirements

Objectives and Contextualisation

In this subject it is intended that the student:

1.- Acquires basic knowledge and skills to be able to work correctly in a laboratory.
2.- Knows how to interpret the results obtained, sees what physical phenomena are behind the experiment and understands the process that has observed.
3.- Knows how to perform an experiment correctly, acquiring the experimental data and obtaining the results with the proper uncertainties.
4.- Acquires some basic knowledge of Probability and Statistics.

At the end of this course, students should be able to:

1.- Prepare the practice.
2.- Take data correctly, based on the appropriate methodology.
3.- Collect and treat experimental data adequately.

4.- Analyze, interpret and discuss the results obtained in accordance with the phenomenology of the experiment.
5.- Relate a phenomenon observed with the part of the corresponding physics in order to understand it.
6.- Describe clearly the realization of an experiment, what phenomenology is behind it, and explain the conclusions that can be drawn.

In addition, the acquistion of the following skills is pursued:

1. Ability to participate critically in a discussion and teamwork through the realization of group practices.

2. Capacity to apply the scientific method.

Competences

- Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
- Communicate complex information in an effective, clear and concise manner, either orally, in writing or through ICTs, and before both specialist and general publics
- Develop strategies for analysis, synthesis and communication that allow the concepts of physics to be transmitted in educational and dissemination-based contexts
- Formulate and address physical problems identifying the most relevant principles and using approximations, if necessary, to reach a solution that must be presented, specifying assumptions and approximations
- Plan and perform, using appropriate methods, study, research or experimental measure and interpret and present the results.
- Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
- Use computer tools (programming languages and software) suitable for the study of physical problems
- Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
- Work independently, have personal initiative and self-organisational skills in achieving results, in planning and in executing a project
- Working in groups, assume shared responsibilities and interact professionally and constructively with others, showing absolute respect for their rights.

Learning Outcomes

1. Analyse and assess the adequacy of the assemblies prepared and carried out, in order to obtain measurements and the desired results.
2. Analyse the influence of various parameters on the simulation of an experiment.
3. Communicate complex information in an effective, clear and concise manner, either orally, in writing or through ICTs, in front of both specialist and general publics.
4. Correctly assess the uncertainty associated with a measure or set of measures.
5. Describe physical phenomena, identify variables, analyse the influence, presenting the results and conclusions of the work developed in a clear and precise manner.
6. Describe the function and manner of operation of the measuring instruments used.
7. Determine and measure the variables that describe a physical system.
8. Discriminate to the most important dependencies and draw the most conclusions from a set of experimental measurements.
9. Explain the explicit or implicit code of practice of one's own area of knowledge.
10. Foster discussion and critical thinking, evaluating the precision and characteristics of the results obtained.
11. Identify the social, economic and environmental implications of academic and professional activities within one's own area of knowledge.
12. Suitably present the results of a series of measures through graphs and perform linear regressions.

13. Use basic programmes to write reports and carry out basic data processing.
14. Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
15. Use digital sensors for measuring magnitudes.
16. Work independently, take initiative itself, be able to organize to achieve results and to plan and execute a project.
17. Working in groups, assume shared responsibilities and interact professionally and constructively with others, showing absolute respect for their rights.
18. Write and present the results and conclusions of experimental work with rigor and conciseness.

Content

The contents are grouped into the two main blocks of the subject:

BLOCK 1.- Theory classes.

1.- Metrology. Physical magnitudes, units and uncertainties.

2.- Treatment of experimental data

3.- Introduction to Probability and Statistics

4.- Introduction to programming

BLOCK 2. Gral. Physics Practices. in the laboratory of Gral. Physics

The content of the practices may vary every year. The updated list of practices will be posted on the virtual campus during the first semester; as an example, the list corresponding to the academic year 2022-23 is shown below. The students must perform, in 3 hour sessions and in groups of 2 students, practices related to different aspects of the physical world. Regardless of the practical content of a specific year, the following two main categories of practices are distinguished:

- Basic Instrumentation practices, where students learn to handle basic instrumentation that will be used in different practices. All the students do the instrumentation practices.

- Gral. Physics practices. The students have to carry out a series of practices related to all aspects of General Physics, and fill out a questionnaire for each practice. Not all students do the same practices.

The laboratory regulations are distributed before the beginning of the practices together with the calendar of practices that each group must carry out. The practices in the laboratory will be carried out throughout the course, although most will be done in the second semester (the updated calendar will be available on the virtual campus). Each student will do 9 practices. The students will be informed in advance of the applicable rules.

Attendance to practices is mandatory. If an absence is justified, it is essential to provide a proof to the person in charge of the laboratory. In this case, whenever possible, the practice will be carried out another day agreed with the laboratory manager. If the absence is not justified, the corresponding practice note will be 0. If a student has more than two unjustified absences, the subject will be suspended automatically.

List of practices course 2022-23

1.- Data processing and evaluation of uncertainties.
2.- Basic instrumentation: measurements of length and mass.
3.- Basic instrumentation: tester and oscilloscope.
4.- Conservation of energy.
5.- Second law of Newton
6.- Projectile movement

7.- Freefall
8.- Viscosity
9.- Archimedes' principle
10.- Ideal gases
11.- DC circuits
12.- Circuits of alternating current.
13.- Charge and discharge of a capacitor
14.- e/m ratio of the electron
15.- Mechanical waves
16.- Torque pendulum
17.- Interference and diffraction of light
18.- Forming images with lenses.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Laboratory sessions	27	1.08	1, 2, 4, 5, 6, 7, 8, 10, 12, 13, 15, 16, 17, 18
Practical sessions of programming and probability and statistics	16	0.64	2, 4, 7, 8, 10, 12, 13
Theory lectures of metrology and data treatment and practical exercises	11	0.44	4, 5, 7, 8, 10, 12, 16
Type: Supervised			
Preparation of practical programming sessions and homework	15	0.6	2, 4, 5, 7, 8, 12, 13, 14, 16, 17, 18
Type: Autonomous			
Preparation of the laboratory session	15	0.6	1, 15, 16
Resolution of exercises	15	0.6	4, 5, 7, 8, 12, 16
Study and preparation for exams	42.5	1.7	2, 5, 8, 10, 12, 13, 16, 18

The workload in hours that is specified in the table of training activities corresponds to an average student: of course, not all students need the same time to learn concepts and carry out certain activities, so that the distribution of time is must be understood as orientative. Before the start of the course, students will have a calendar of the subject uploaded on the virtual campus where there will be the days and hours in which each of the different activities will be carried out.

Directed training activities

Theory lectures and practical exercises: in these lectures the teacher explains the theory of acquisition, treatment and analysis of data necessary for the realization of the practices. An introduction to statistics and probability distributions is given as well.

Laboratory practices: students must perform, in sessions of 3 hours duration and in groups of 2 people, practices related to different aspects of the physical world. The laboratory regulations will be distributed before

the beginning of the practices, along with the calendar of practices that each group must carry out. The practices in the laboratory will be carried out throughout the course, although most of them will be done in the second semester (the updated calendar will be available on the virtual campus).

Autonomous training activities

Study and preparation of exams: Students should devote some time to study the contents of the theory and prepare the different examinations.

Exercise solving: The theory lecturer gives students a list of exercises they must solve.

Preparation of the practices: In order to enter into the laboratory, students must have prepared the practice well. This means not only having read the script of the practice but having consulted the necessary books to understand the concepts related to the practice and bring the laboratory book or a file to the laptop with all the expressions which must be deduced or obtained from calculations (for example, assessments of the combined uncertainty) already developed. In this way the student will be able to carry out the complete practice within the 3 hours available and will not have time problems. There are practices that, for calendar reasons, are carried out before the phenomenology or the corresponding theory has been seen in a subject. Therefore, it is necessary for the student to make the effort to study and understand on his own account the physics of the practice performed.

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
Evaluation of the laboratory sessions	60%	3	0.12	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18
Evaluation of the programming course	20%	3	0.12	2, 4, 5, 7, 8, 10, 12, 13, 14, 18
Evaluation of the theory contents of metrology and data treatment	20%	2.5	0.1	2, 4, 5, 7, 8, 10, 12, 13, 16

The evaluation of this subject is continuous throughout the course and is obtained from the following activities:

- Evaluation of Metrology and Data Processing (20%). Professor Carles Domingo.

- Evaluation of laboratory work (60%). It includes the evaluation of the laboratory sessions (30%) and an individual exam in the laboratory (30%). More detailed information will be given in the lab rules sheet that will be posted on the virtual campus. Prof. Lluís Font

- Evaluation of Probability, Statistics and Programming (20%). Professors Carles Navau and Xavier Álvarez

The lecturers responsible for each of the different activities reserve the right to carry out more than one test if they consider it appropriate. Each teacher will inform of the specific assessment criteria of the activity through the virtual campus.

Detailed information on the evaluation of each part:

Metrology and Data Processing.

This section, as mentioned above, represents 20% of the overall grade of the course. In the first part the students must pass a basic test (8%) and solve some exercises (12%). Important: in order to pass the subject, it is essential to have passed the basic test. Passing the basic test means answering it without any mistakes. Students will have several opportunities throughout the course to pass the test. The mark for the basic test will decrease as opportunities are used up according to the information given by the lecturer in charge. But regardless of the grade obtained, it is necessary to pass the basic test.

Laboratory practicals.

The mark for practical work is obtained from two evaluations:

1) Evaluation of the laboratory sessions (30%).In each session, the laboratory teachers will evaluate the degree of preparation of the practical by the student, their ability in carrying out the practical and their degree of learning by supervising their work. At the end of the session, students must hand in an answer sheet to the laboratory teachers, the evaluation of which also forms part of the laboratory mark.

2) Individual practical assessment (30%). Students will have to take an individual practical exam in the laboratory where they will be evaluated on several of the practical exercises they have done during the course.

Attendance to the practical is compulsory. If an absence is justified, it is essential to hand in the proof of absence to the person in charge of the laboratory. In this case, whenever possible, an attempt will be made to carry out the practical on another day agreed with the laboratory responsible. If the absence is not justified, the grade for the corresponding practical will be 0. If a student has more than two unexcused absences, the course will automatically be failed.

Probability, statistics and programming

The mark for this part (20% of the overall mark) is obtained as follows:

- Partial exam: 8%.

- Programming assignments: 8%.

- Other training activities carried out during the course through the virtual campus: 4%.

IMPORTANT:

1.- In order to pass the course, it is essential to be evaluated in all the evaluation activities. Failure to take an assessment activity means failing the course. In the case of a single evaluation, the rules indicated in point 3 apply.

2.- Due to the experimental nature of this subject and the continuous assessment, there is no recovery system.

3.- Single assessment:

Due to the experimental nature of this subject, the student has to participate in several assessment activities throughout the course, regardless of whether he/she chooses the single assessment or not. These activities are the laboratory practicals (30% of the final grade) and the evaluation activities of the part of probability, statistics and programming that are done throughout the course and that represent 4% of the final grade. These two activities are not recoverable. Students who have taken the single assessment will be assessed for the remaining 66% of the overall mark for the course in the following way:

1. They will have to take a final laboratory test (30%).A morning will be set for this test.

2. On the afternoon of the very same day, they will have to take a theory exam where they will have to answer the questions corresponding to the block of lectures on metrology theory and data processing (20%) and probability, statistics and programming (8%) (two exams, one per midterm).When they have finished, they must hand in the programming work (8%).

If one fails the course, he/she will have a second chance to take the metrology and data processing part (20%) and probability, statistics and programming (8%). It should be noted that in order to pass the course, students must have passed the basic test. Students who take the single assessment will therefore have two opportunities to pass the basic test.

Bibliography

Teacher's notes on the virtual campus

Scripts of the practicals available on the virtual campus

Physics for Science and Technology. Tipler and Mosca. 6th edition. Volumes 1, 2 and 3. Editorial Reverté, 2010

Statistical Data Analysis. Glen Cowan. Oxford Science Publications, 1998.

For probability excercises:
http://www.dartmouth.edu/~chance/teaching_aids/books_articles/probability_book/amsbook.mac.pdf

Software

No specific software required

Language list

Name	Group	Language	Semester	Turn
(PLAB) Practical laboratories	1	Catalan	annual	morning-mixed
(PLAB) Practical laboratories	2	Catalan	annual	morning-mixed
(PLAB) Practical laboratories	3	Catalan	annual	morning-mixed
(PLAB) Practical laboratories	4	Catalan	annual	morning-mixed
(PLAB) Practical laboratories	5	Catalan	annual	morning-mixed
(PLAB) Practical laboratories	6	Catalan	annual	morning-mixed
(TE) Theory	1	Catalan	annual	morning-mixed
(TE) Theory	2	Catalan	annual	morning-mixed