Universitat Autònoma de Barcelona

2021/2022

Introduction to Experimental Physics

Code: 100145
ECTS Credits: 6

Degree	Type	Year	Semester
2500097 Physics	OB	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

Name: Lluís Font Guiteras
Email: Lluis.Font@uab.cat

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

Teachers

Carlos Domingo Miralles
Markus Gaug
Carles Navau Ros
F. Xavier Alvarez Calafell

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 ones 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.- Fundamentals of the Theory of Probabilities

4.- Fundamentals of Statistics

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 2020-21 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 according to scripts that are given to them, 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 10 practices. The students will be informed in advance of the applicable rules.

Evaluation of the work done in the laboratory

The grade of the laboratory sessions is calculated as the average of the laboratory marks. In each session, the lecturers at the laboratory will evaluate the degree of preparation of the practice by the students,their behavior and attitude in the laboratory, their ability to carry out the practice and the degree of learning through the supervision of their work and by asking oral questions. At the end of the session, students must deliver a response sheet to the professors of the laboratory, whose evaluation is also part of the laboratory note.

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 2018-19

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.

Methodology

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.

Activities

Title	Hours	ECTS	Learning Outcomes

Type: Directed			
Laboratory sessions	30	1.2	1, 2, 4, 6, 5, 7, 8, 10, 12, 18, 16, 17, 13, 15
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, 14, 18, 16, 17, 13
Type: Autonomous			
Preparation of the laboratory session	15	0.6	1, 16, 15
Resolution of exercises	15	0.6	4, 5, 7, 8, 12, 16
Study and preparation for exams	39.5	1.58	2, 5, 8, 10, 12, 18, 16, 13

Assessment

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

- Evaluation of Methodology, Data Processing (20%) Professor Carles Domingo. Probability and Statistics and programming (20%). Prof. Carles Navau and Xavier Álvarez.

- Evaluation of laboratory work (60%). More detailed information will be given in the laboratory's rules sheet that will be uploaded to the virtual campus. Prof. Lluís Font

The lecturers responsible for each of the activities reserve the right to perform more than one test if they consider it appropriate. Each lecturer will inform of the specific evaluation criteria of the activity through the virtual campus.

IMPORTANT:

1.- In order to pass the subject, it is essential to be evaluated of all evaluation activities. Not submitting to an evaluation activity means suspending the subject.

2. Due to the experimental nature of this subject and to the continuous evaluation of the laboratory work, there are no re-evaluation opportunities.

Assessment Activities

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

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