Universitat Autònoma de Barcelona

2022/2023

Optics Laboratory

Code: 100159
ECTS Credits: 5

Degree	Type	Year	Semester
2500097 Physics	OB	3	2

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Other comments on languages

Catalan: In theory and practical classes. Spanish: In practical classes.

Teachers

Octavi López Coronado

Angel Lizana Tutusaus

Prerequisites

NONE, but it is recommended to be studying or to have studied the subject of OPTICS.

Objectives and Contextualisation

1. Apply the fundamental laws and theoretical principles acquired by the student in the Optics course.

2. Familiarize the student with an experimental subject: importance of instrumentation in the design of experiments, use of measuring devices, data acquisition, data analysis, etc.

3. Know how to analyse the influence and importance of the various variables and their dependence on the phenomenon studied and/or analysed.

4. To awaken in the student a critical mentality with respect to the level of confidence of his measurements, calculations and the interpretation of the results.

5. Motivate the student in the bibliographic search to interpret the experimental results and / or delve into other approaches on a particular experiment.

6. Encourage experimental work and scientific discussion in groups.

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 subject, which is eminently practical, and consists of a theoretical part and a practical part.

The theoretical part delves into some important aspects of diffraction, interferometry, instrumentation, optical systems, accuracy, etc. which are seen in the practices.

Each of the practices are:

1.- Deflection of a laser beam by a material with a non-uniform refractive index. Application to the measurement of the relative concentration of two liquids in contact.

2.- Measurement of the refractive index of a planar-parallel sheet with the microscope and the Pfund method.

3.- Geometric optics. Images, the telescope as an optical system.

4.- Optical spectra. Determination of wavelengths with a prism spectroscope.

Polarization of light and study of anisotropic and photoelastic media. Verification of Malus' law.

6.- Interferences by amplitude division. The Michelson interferometer.

7.- Interferences by division of the wave front. Fresnel Biprism. Qualitative study with a white light source. Determination of the wavelength of a monochromatic light.

8.- Fresnel diffraction and Fraunhofer diffraction.

Spectroscopy with a diffraction network. Calibration of the network with a lamp of known wavelengths. Determination of the Rydberg constant from the hydrogen Balmer series.

10.- Photoelectric effect. Determination of the Planck constant.

Methodology

Theoretical classes:

During the first 3 weeks of the course, 10 hours of theoretical introductory classes will be given in the Optics laboratory for developing a few theoretical contents of the subject.

Laboratory practices:

The students, in groups of 2 students, will carry out a total of 7 laboratory sessions, during which the practices will be done. The students will have the scripts of the practices previously available for their preparation, through the Virtual Campus.

There are two different categories of practices:

a) All the practices except two, to present an only and brief report by group of practices with the measures and work realized, results, conclusions and answering to the questions posed in the script. Maximum 10 pages.

b) Personal reporting practices. Each team member will make a report between one of the practices. Between 10 and 40 pages.

The personal report should consist of the following parts: introduction and objectives, results and discussion, conclusions, bibliography and answer the questions raised. Collective reports will only collect the results and their discussion, as well as the conclusions of the experiment. All the results obtained in the laboratory must be presented correctly in tables with the corresponding uncertainties and units. Graphs should be presented with a title, magnitudes, units, and uncertainties. If necessary, the results will be adjusted accordingly. It is necessary to present correctly all the results obtained in the laboratory in tables with the errors and the corresponding units. Graphs must be presented with a title, magnitudes, units and error bars. If necessary, an adjustment of the results should be made.

Tutorials:

Throughout the course, discussion will beencouragedbetween each of the student groups and the teachers. The teachers of the subject will be available to resolve doubts in tutorial sessions. At the beginning of the course, it will be easier to contact the teachers to define these possible tutorials.

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 Practices	30	1.2	1, 2, 4, 6, 7, 8, 10, 16, 17, 15
theory lectures	10	0.4	4, 6, 5, 12, 15
Type: Autonomous			
Preparation and report writing	84	3.36	1, 2, 4, 6, 5, 8, 10, 12, 18, 16, 17, 13

Assessment

BLOCK WEIGHT Description

Personal work 30 % Work carried out by the student in the laboratory and evaluated by means of the personal reports presented.

Group work 30 % Work carried out by the group in the laboratory and evaluated using the collective practice reports presented.

Oral or written defense 40 % An oral presentation on a new practice or a written exam on the practices carried out.

It is mandatory to carry out all the practices, in order to have the right to take the oral or written defense.

A minimum score of 3 in each block (Personal work, group work and Oral defense) must be obtained in order to be able to make an average.

Given the eminently practical character of the subject the possibility of recovery is NOT CONTEMPERATED

All those students who have completed two evaluation activities cannot be qualified as "Not assessable".

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Oral or written defense	40 %	1	0.04	1, 2, 4, 3, 6, 5, 7, 8, 10, 14, 16, 17, 15
group collective reports	30%	0	0	1, 2, 4, 3, 6, 5, 7, 8, 9, 10, 11, 12, 14, 18, 17, 13, 15

personal report	30 %	0	0	1, 2, 4, 3, 6, 5, 7, 8, 9, 10, 11, 12, 14, 18, 16, 13, 15

Bibliography

Theory books:

- The recommended books in the subject "Òptica".
- K.D. Möller. *Optics*. University Science Books, 1988.
- E. Hecht. *Optics.* Addison-Wesley, 2017.
- F.A. Jenkins, H.E. White. *Fundamentals of Optics*. McGraw-Hill, 1981.
- J. Casas. *Óptica*. L. Pons. 1994
- M.L. Calvo (ed). *Óptica avanzada*. Editorial Ariel. 2002

Laboratory practice books:

- M.D. Baró, G. Orriols, F. Pi, R. Pintó i S. Suriñach. *Tècniques Experimentals en Física*. Col. Materials, 37. Servei de Publicacions de la UAB, Barcelona,1997.
- Other books on general topics recommended in previous teaching laboratories

Videography (YouTube list):

- https://youtube.com/playlist?list=PLKIOJCSTg5dqVUJzTnS0oA1eVDjQqFkys

Software

Excel, Matlab, and any other data processing.