Universitat Autònoma de Barcelona

2019/2020

Optics Laboratory

Code: 100159
ECTS Credits: 5

Degree	Type	Year	Semester
2500097 Physics	OB	3	2

Contact

Name: Francesc Pi Vila
Email: Francesc.Pi@uab.cat

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

Teachers

Juan Carlos Escalera Merino
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, and issue reports and judgments, with ethical and social responsibility, according to legal, prevention-based and environmental conditions.
- Develop critical thinking and reasoning and know how to communicate effectively both in the first language(s) and others

- Develop independent learning strategies
- 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.
- Respect the diversity and plurality of ideas, people and situations
- Use computer tools (programming languages and software) suitable for the study of physical problems
- 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. Act, and issue reports and judgments, with ethical and social responsibility, according to legal, prevention-based and environmental conditions.
2. Analyse and assess the adequacy of the assemblies prepared and carried out, in order to obtain measurements and the desired results.
3. Analyse the influence of various parameters on the simulation of an experiment.
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. Develop critical thinking and reasoning and communicate ideas effectively, both in the mother tongue and in other languages.
9. Develop independent learning strategies.
10. Discriminate to the most important dependencies and draw the most conclusions from a set of experimental measurements.
11. Foster discussion and critical thinking, evaluating the precision and characteristics of the results obtained.
12. Respect diversity in ideas, people and situations.
13. Suitably present the results of a series of measures through graphs and perform linear regressions.
14. Use basic programmes to write reports and carry out basic data processing.
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 course consists of a theoretical part that contemplates the topics:

Unit 1: Light sources

- The electromagnetic spectrum

- Light generation

- Inconsistent sources with collision excitation

- Other sources of incoherent radiation

- Laser Sources

- Properties and applications of laser radiation

- Laser types and emission characteristics

Unit 2: Light detectors

- General questions about detection

- Detection of time signals

- Detectors with spatial resolution

The subject consists of the following practices:

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 2-3 weeks of the course, 10 hours of theoretical introductory classes will be given in the Optics laboratory. These master classes will consist of a set of PowerPoint presentations that develop the theoretical content of the subject. Students will have this material available in advance through the Virtual Campus to follow the classes properly. Some videos related to the subject matter of the laboratory will also be shown.

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) Practices of collective Report (all practices except two, to present a single and brief report per group of practices with the measures and work done, results, conclusions and responding to the questions raised in the script; i b) practices with personal report, (each member of the group will choose a report to perform among any of the following practices: 5, 6, 7 or 9), to present before the examination period.

The personal report should contain the following parts: introduction and objectives, results and discussion, conclusions, bibliography and answer to the questions posed. The collective reports will only include the results and their discussion, as well as the conclusions of the experiment.

The correction of the collective reports by the professors of the laboratory will make it possible to detect conceptual errors in the performance of the practice. Students will have an additional period of time to present unsatisfactory reports.

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.

Demonstration sessions:

Several demonstration sessions will be held throughout the teaching period to show various phenomena related to Optics and Lasers. These demonstrative sessions will be relatively brief (about 1/2 hour) and will be included within the training period.

Tutorials:

Throughout the course, discussion will be encouraged between each of the groups of students and the practice teacher. A tutorial space will be defined and respected with the aim that all the students have met at least once with the practice teacher. Communication with the teachers will take place through the VIRTUAL CAMPUS.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Laboratory Practices	30	1.2	1, 2, 3, 4, 6, 9, 8, 7, 10, 11, 12, 16, 17, 15
theory lectures	10	0.4	4, 6, 5, 13, 15
Type: Autonomous			
Preparation and report writing	84	3.36	1, 2, 3, 4, 6, 5, 9, 8, 10, 11, 13, 18, 12, 16, 17, 14

Assessment

BLOCK WEIGHT Description

Personal work 33.3% Work carried out by the student in the laboratory and evaluated by means of the personal reports presented.

Group work 33.3% Work carried out by the group in the laboratory and evaluated using the collective practice reports presented.

Written or oral examination 33.3% Assessment of the basic concepts explained in the previous lectures and on the basic concepts of the practices carried out.

The intention, if the number of students is not very high, is to take a practical and oral exam in the laboratory in which each student demonstrates the practical knowledge acquired.

(The completion of all the practices is obligatory in order to have the right to take the exam.)

A minimum score of 3 in each block must be obtained in order to be able to make an average.

Giventhe 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
group collective reports	33.3%	0	0	1, 2, 3, 4, 6, 5, 8, 7, 10, 11, 13, 18, 12, 17, 14, 15
oral or written exam	33.3%	1	0.04	1, 2, 3, 4, 6, 5, 9, 8, 7, 10, 12, 16, 17, 15
personal report	33.3%	0	0	1, 2, 3, 4, 6, 5, 9, 8, 7, 10, 11, 13, 18, 12, 16, 14, 15

Bibliography

Theory books

The recommended books in the Optical Subject

- K.D. Möller. *Optics*. University Science Books, 1988.
- E. Hecht. *Optics.* Addison-Wesley, 1987.
- F.A. Jenkins, H.E. White. *Fundamentals of Optics*. McGraw-Hill, 1981.
- R.H. Kington. *Optical Sources, Detectors and Systems*. Academic Press, 1995.

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.
- Altres llibres de temàtica general recomanats en anteriors laboratoris docents