COURSE DATA

DATA SUBJECT

Code: 34258
Name: Optics II
Cycle: Undergraduate Studies
ECTS Credits: 6
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
1105 - Degree in Physics	Facultat de Física	3	Second quarter
1928 - Double Degree Program Physics-Mathematics	Facultat de Ciències Matemàtiques	4	Second quarter
1929 - Double Degree Program in Physics and Chemistry	Facultat de Física	4	Second quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
1105 - Degree in Physics	Optics	COMPULSORY
1928 - Double Degree Program Physics-Mathematics	Cuarto Curso (Obligatorio)	COMPULSORY
1929 - Double Degree Program in Physics and Chemistry	Cuarto Curso (Obligatorio)	COMPULSORY

COORDINATION

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SUMMARY

It is a theoretical subject (without laboratory sessions), with 6 ECTS assigned to the second semester of the subject Optics and a natural continuation of the subject Optics I. Its main objective is that students acquire basic knowledge about the behavior of light, completing and complementing what they have seen in the subject Optics I. Specifically, they study fundamental aspects of the wave nature of light (interference and diffraction) and light-matter interaction (stimulated emission, nonlinear optics). To complete the subject, the light-matter interaction is analyzed with the purpose of explaining the basic mechanisms of the laser and other light sources of optical interest (optical frequency conversion). The subject Optics is part of the third year program of the degree in physics, together with the subjects Electromagnetism and Quantum Physics, and obviously has a very direct relationship with the Experimental Physics Laboratories,

particularly with the Optics Laboratory. In addition, the subject is part of the fourth year program of the double degree in physics and mathematics, as well as in physics and chemistry. The subject Optics is basic in physics and as such, knowledge in optics is very useful in many other subjects, especially with regard to wave behavior. On the other hand, this subject has continuity in the optional subjects Quantum Optics and Photonics: Diffraction and Coherence.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

There are no specified enrollment restrictions with other subjects of the curriculum.

OTHER REQUIREMENTS

Previous knowledge acquired in the subject optical Optics I. Knowledge of general math (trigonometry, mathematical analysis, solving simple differential equations, vectors). Very basic knowledge of electromagnetism.

COMPETENCES / LEARNING OUTCOMES

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Be able to understand and master the use of the most commonly used mathematical and numerical methods.

Communication Skills (written and oral): Being able to communicate information, ideas, problems and solutions through argumentation and reasoning which are characteristic of the scientific activity, using basic concepts and tools of physics.

Foreign Language skills: Have improved command of English (or other foreign languages of interest) through: use of the basic literature, written and oral communication (scientific and technical English), participation in courses, study abroad via exchange programmes, and recognition of credits at foreign universities or research centres.

Knowledge and understanding of the fundamentals of physics in theoretical and experimental aspects, and the mathematical background needed for its formulation.

Learning ability: be able to enter new fields through independent study, in physics and science and technology in general.

Modelling & Problem solving skills: be able to identify the essentials of a process / situation and to set up a working model of the same; be able to perform the required approximations so as to reduce a problem to an approachable one. Critical thinking to construct physical models.

Physics general culture: Be familiar with the most important areas of physics and with those approaches which span many areas in physics, or connections of physics with other sciences.

Problem solving: be able to evaluate clearly the orders of magnitude in situations which are physically different, but show analogies, thus allowing the use of known solutions in new problems .

Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.

Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.

Students must have acquired knowledge and understanding in a specific field of study, on the basis of general secondary education and at a level that includes mainly knowledge drawn from advanced textbooks, but also some cutting-edge knowledge in their field of study.

Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.

Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.

Theoretical understanding of physical phenomena: have a good understanding of the most important physical theories (logical and mathematical structure, experimental support, described physical phenomena).

To know how to apply the knowledge acquired to professional activity, to know how to
solve problems and develop and defend arguments, relying on this knowledge.

DESCRIPTION OF CONTENTS

1. Interference

1.1. The phenomenon of interference.
1.2. Conditions of interference.
1.3. Wavefront division interference: Young's experiment.
1.4. Amplitude division interference.

2. Diffraction

2.1. Preliminary considerations. Far field and near field diffraction .
2.2. Fresnel diffraction.
2.3. Fraunhofer diffraction.

3. The laser

3.1. Einstein's theory of light-matter interaction.

3.2. Stimulated emission. Population inversion.
3.3. The laser. Constituent elements.
3.4. The optical cavity.
3.5. The laser emission.

4. Introduction to nonlinear optics

4.1. The generalized Lorentz model.
4.2. Centrosymmetric media: Kerr effect and third harmonic generation.
4.3. No centrosymmetric media: second harmonic generation and frequency summation and substraction.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Tutorials	15,00
Theory	45,00
Total hours	**60,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	0,00
Independent study and work	45,00
Preparation of lessons	30,00
Preparation for assessment activities	15,00
Resolution of case studies	0,00
Total hours	**90,00**

TEACHING METHODOLOGY

Teaching 40%:

Practical theoretical lessons, which address the conceptual and formal aspects of the subject and the resolution of problems or cases, with the application of theoretical concepts. It is based mainly on lectures with experimental demonstrations, animations or videos, graphic representation of solutions, projection of presentations, etc.

Sessions in small groups, focused on the work of the students and their active participation in resolving doubts in facing theoretical concepts and problem solving, reinforcement in aspects of greater difficulty , questions of a conceptual nature, experimental demonstrations pertinent to the case studies, associated

with a component of continuous assessment, verification of the progress of the students in the subject.

Student's personal work 60%:

- Study of the theoretical fundamentals.

- Problem solving (individually or in groups).

- Individual assistance to students about doubts and difficulties encountered in the study and in solving problems, or discussions about topics of interest, bibliography, etc.

EVALUATION

The evaluation of this subject will be carried out by means of:

1) The completion of a written exam, of theory and problems, the maximum grade of which is 7 points. The theory part will assess the understanding of the theoretical-conceptual aspects and the formalism of the subject, both through theoretical questions and through conceptual and numerical questions or simple particular cases. The problem part will assess the ability to apply the formalism, as well as the critical analysis of the results obtained. In both parts, correct argumentation and adequate justification of the results will be assessed.

2) Continuous assessment, in which the work carried out by students during the course in the resolution of questions and problems and/or in the development of topics will be assessed, both in the classroom and individually or by any other method that assumes interaction between teachers and students. The resolution of assessable questions and problems may be by means of audiovisual or audio methods, which will not be made public and will only be used by the teaching staff for assessment purposes. This activity will be assessed up to 3 points.

The percentage (or weight) assigned to each of these activities as a percentage of the total grade will be:
* Exam: Theory 40%. Problems 30%.
* Continuous assessment: 30%.

If the exam mark (N1) is lower than 3.5 (out of 10), this will be the mark for the course. Otherwise, the grade for the course will be the grade for the course.

REFERENCES

- E. Hecht and A. Zajac. *Óptica*. Addison Wesley Iberoamericana (1990).

- P. W. Milonni and J. H. Eberly, *Lasers*. John Wiley & Sons (1988).

- R. D. Guenther. *Modern Optics*. John Wiley & Sons (1990).