COURSE DATA

Data Subject	
Code	34258
Name	Optics II
Cycle	Grade
ECTS Credits	6.0
Academic year	2023 - 2024

Study (s)

Degree	Center	Acad. year	Period
1105 - Degree in Physics	Faculty of Physics	3	Second term
1928 - D.D. in Physics-Mathematics	Double Degree Program Physics and Mathematics	4	First term
1929 - D.D. in Physics-Chemistry	Double Degree Program Physics and Chemistry	4	First term

Subject-matter

Degree	Subject-matter	Character
1105 - Degree in Physics	12 - Optics	Obligatory
1928 - D.D. in Physics-Mathematics	4 - Cuarto Curso (Obligatorio)	Obligatory
1929 - D.D. in Physics-Chemistry	4 - Cuarto Curso (Obligatorio)	Obligatory

Coordination

Name	Department
ESTEBAN MARTIN, ADOLFO	280 - Optics and Optometry and Vision Sciences
FERRANDO COGOLLOS, ALBERT	280 - Optics and Optometry and Vision Sciences
GARCIA MONREAL, FRANCISCO JAVIER	280 - Optics and Optometry and Vision Sciences

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.

OUTCOMES

1105 - Degree in Physics

- Knowledge and understanding of the fundamentals of physics in theoretical and experimental aspects, and the mathematical background needed for its formulation.
- 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.
- 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 .
- Theoretical understanding of physical phenomena: have a good understanding of the most important physical theories (logical and mathematical structure, experimental support, described physical phenomena).
- Be able to understand and master the use of the most commonly used mathematical and numerical methods.
- 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.

- 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.
- Learning ability: be able to enter new fields through independent study, in physics and science and technology in general.
- 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.
- 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 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 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.
- Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.
- Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.

LEARNING OUTCOMES

- Ability to refer to the basic principles of physical theories and experiments related to optics.

- Ability to build simplified models that describe the object of study with the necessary approximation and allow predictions to be made about its future evolution.

- Ability to use mathematics in a way related to the real world.

- Ability to solve optical problems.

- Ability to learn the state of the art of discipline and its upgrade processes.

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

ACTIVITY	Hours	% To be attended
Theory classes	45,00	100
Tutorials	15,00	100
Study and independent work	45,00	0
Preparation of evaluation activities	15,00	0
Preparing lectures	30,00	0
TOTAL	**150,00**	

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 is based on:

1) The completion of a written exam, involving theory and problems, whose maximum qualification is 7 points. The theoretical 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 problems part will evaluate the application capacity of the formalism, as well as the critical analysis of the obtained results. In both parts, a correct presentation and an adequate justification of the results will be evaluated.

2) Continuous assessment, in which the work done by the students during the course in resolving questions and problems and in the development of topics will be evaluated, both in the classroom and individually or through any other method that involves an interaction between teachers and students. This activity will provide a maximum qualification of 3 points.

The percentage (or weight) assigned to each of these activities, out of the total grade, will be:

* Exam: Theory 40%. Problems 30%.

* Continuous evaluation: 30%.

If the exam qualification (N1) is less than 3.5 (out of 10), this will be the qualification for the subject. Otherwise, the course grade will take into account the continuous assessment qualification (N2) as follows:

max{N1,0.7*N1+0.3*N2}

The qualification in the first and second call for exams will be calculated in the same way.

OBSERVATIONS: As long as the compensation criteria established for this purpose are accomplished, the grade for this subject may be averaged with the grade for the subject Optics I.

REFERENCES

Basic

- 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).