COURSE DATA

Data Subject	
Code	34257
Name	Optics I
Cycle	Grade
ECTS Credits	6.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
1105 - Degree in Physics	Faculty of Physics	3	First term

Subject-matter

Degree	Subject-matter	Character
1105 - Degree in Physics	12 - Optics	Obligatory

Coordination

Name	Department
ROLDAN SERRANO, EUGENIO	280 - Optics and Optometry and Vision Sciences
VALCARCEL GONZALVO, GERMAN JOSE DE	280 - Optics and Optometry and Vision Sciences

SUMMARY

This is a theoretical course (no labs) with 6 ECTS credits allocated and quarterly basis Optics corresponding to matter. Its primary objectives are the students acquire basic knowledge about the behavior of light, in the most basic aspects (geometrical optics), and aspects associated with its wave and electromagnetic (polarization) interaction and light- material (refractive index, dispersion). The course is part of the third year of the degree in physics, along with materials Electromagnetism and Quantum Physics, and obviously has a direct relationship with the Experimental Techniques Optical. Matter Optics is basic physics and as such, the knowledge that the optical behavior are useful in many other subjects, especially with respect to knowledge of wave behavior. Moreover, this course continues in Optics II relating to the same subject matter Optics in the second semester of the third year of the degree in physics.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

Knowledge of general math (trigonometry, mathematical analysis, solving simple differential equations, vectors). Very basic knowledge of electromagnetism. No prior knowledge of optics is required.

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 a discipline and its upgrade processes.

DESCRIPTION OF CONTENTS

1. Fundamental laws of geometrical optics

1.1 Fermat's principle.
1.2 Laws for reflexion and refraction.
1.3 Trajectory equation.
1.4 Waves and rays. Malus-Dupin theorem.
1.5 Optical systems.
1.6 Paraxial optics. Spherical diopter.
1.7 Matrix optics.

2. Electromagnetic theory of light. Maxwells equations

2.1 Maxwell equations in dielectric media. Light as an electromagnetic wave.
2.2 Monochromatic waves. Helmholtz's equation.
2.3 Basic properties of electromagnetic waves.
2.4 The geometrical optics limit. Eikonal equation.
2.5 Trajectory equation.

3. Polarization

3.1 Concept of light polarization.
3.2 Polarization ellipse. Special cases.
3.3 Natural light and completely polarized light.
3.4 Polarizers and retarders.
3.5 Algebra of polarization states: Jones vectors and matrices.

4. Reflexion and refraction in isotropic dielectric interfaces

4.1 Introduction. Electromagnetic theory of light reflection and refraction.
4.2 Fresnel's formulae.
4.3 Reflection and transmission factors.
4.4 Total internal reflection.
4.5 Frustrated total internal reflection. Optical tunnel effect.

5. Introduction to the optics of anisotropic media

5.1 The dielectric tensor. Optical classification of crystals.
5.2 Plane monochromatic wave in an anisotropic dielectric. Normal modes.
5.3 Uniaxial media.
5.4 Index surface. Refraction in anisotropic crystals.
5.5 Wave plates and polarization by double refraction.

6. Refractive index. Lorentz theory

6.1 Electromagnetic nature of the refractive index.
6.2 Classical theory of light-mater interaction.
6.3 Polarizability.
6.4 Refractive index in gases.
6.5 Refractive index in dense dielectrics.
6.6 Refractive index in gases in metals and plasmas.

7. Scattering

7.1 General properties of light diffusion.
7.2 Fluctuations as the origin of diffusion.
7.3 Scattering coefficient and scattering cross section.
7.4 Rayleigh scattering. Properties of scattered light.

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

Contact teaching

Theoretical and practical classes: They address the conceptual and formal aspects of the matter, as well as the resolution of problems as an application of theoretical concepts and developments. They are based mainly on master-class technique with students participation.

Working sessions in small groups, with focus on student’s work and their active participation. The content of these sessions can be broad, dealing with theoretical concepts and problem solving, studying and discussion of diverse material like scientific papers, presentation of works, summaries, etc.

Student's personal work

- Study.

- Problem solving, both individually and in group.

- Preparation of works, summaries, or memoirs, individually or in group.

- Tutoring sessions.

EVALUATION

The evaluation consists of:

1) Exam, whose result (**N1**) can reach up to 10 points. The exam evaluates the understanding of the theoretical-conceptual aspects and the formalism as well as the ability to apply them, and the critical capacity with respect to the obtained results. In any case, correct argumentation and appropriate justification will be appreciated. There will be an exam in each summon.

2) Continuous evaluation, whose result (**N2**) can reach up to 10 points. The work done by the students through the resolution of questions and problems, the elaboration of works, resumes, memories, etc., both individually and in group, will be evaluated.

In the first summon, the score of the course will be 0,5*N1+0.5*N2.

In the second summon, the score of the course will be max{N1,0.5*N1+0.5*N2}.

In both summons, it is a necessary condition for passing the course that N1 exceeds the minimum value 3.5 over 10. Either, the score will be N1.

NOTICE: Provided that the stablished balancing criteria be fulfilled, the score of that course can make average with that of the Optics II course.

REFERENCES

Basic

- E. Hecht and A. Zajac. Óptica. Addison Wesley Iberoamericana (1990).
- R. D. Guenther. Modern Optics. John Wiley & Sons (1990).
- J. M. Cabrera, F J. López y F. Agulló. Óptica Electromagnética. Tomos I y II. Addison-Wesley Iberoamericana (1993), (2000).