COURSE DATA

Data Subject	
Code	34257
Name	Optics I
Cycle	Grade
ECTS Credits	6.0
Academic year	2021 - 2022

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 a simplified model describing the necessary approximation order study and allow to make predictions about its future.

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

- Ability to resolvar 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 Principle of Fermat.
1.2 Laws of reflection and refraction.
1.3 Equation of trajectories.
1.4 Waves and rays. The Malus-Dupin theorem.
1.5 Optical systems.

2. Electromagnetic theory of light. Maxwell's equations

2.1 Electromagnetic theory of light.
2.2 monochromatic waves: Helmholtz equation.
2.3 The limit of geometrical optics: the eikonal equation.
2.4 Equation of trajectories.
2.5 Basic properties of electromagnetic waves.

3. Polarization

3.1. Superposition of perpendicular vibrations: polarization ellipse.
3.2 Special cases.
3.3 Natural and fully polarized light.
3.4 Polarizers and Retarders.
3.5 Algebra of polarization states: Jones vectors and matrices.

4. Reflexion and refraction at isotropic dielectric interfaces

4.1 Introduction.
4.2 Fresnel formulas.
4.3 Reflection and transmission coefficients and factors.
4.4 Total Internal Reflection. Frustrated total internal reflection
4.5. Optical tunnel effect.

5. Introduction to the optics of anisotropic media

5.1 The anisotropic Lorentz model.
5.2 Faraday Effect.
5.3 Retarders.
5.4 Anisotropic media. The index ellipsoid.
5.5 Uniaxial and biaxial media.
5.6 General characteristics of the propagation in anisotropic media.

6. Refractive index. Lorentz theory

6.1 Electromagnetic nature of refractive index.
6.2 Radiation-matter interaction: Lorentz model.
6.3 The complex refractive index.
6.4 Refractive index in dielectric.
6.5 Refractive index in plasmas and metals.

7. Difusion

7.1 General characteristics of light diffusion.
7.2 Fluctuations as a source of diffusion.
7.3 Diffusion coefficient and effective diffusion section.
7.4.Larmor Formula
7.5 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 assessment system is as follows:

1) Examination, whose mark (**N1**) can reach 10 points.

This part will assess the understanding of the theoretical-conceptual and formal nature of the subject, as well as the ability to apply the formalism and concepts to problem solving and the critique of the obtained results. Proper argumentations and adequate justifications will be important in both cases.

2) Continuous assessment, whose mark (**N2**) can reach 10 points.

Assessment of exercises and problems presented by students, questions proposed and discussed in class, oral presentation of problems, summaries, etc., both individually and in group.

In the first term, the total score will be 0,5*N1+0.5*N2.

In the second term, the total score will be max{N1,0.5*N1+0.5*N2}.

COMMENTS: Subject to compliance with the compensation criteria established for this purpose, this course's score can be averaged with the one of Optics II.

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).

ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

TEACHING METHODOLOGY:

In case that health situation requires blended teaching, the teaching model approved by the Academic Degree Committee on July 23, 2020 will be adopted. For lectures this model consist of 50% student attendance in the classroom, while the rest of students attend the class in streaming broadcast. Two groups will be set with alternate days attendance to the classroom in order to guarantee 50% of teaching hours attendance for all students. The rest of the teaching activities (laboratories and tutorials) will have a 100% attendance.

If a total reduction in attendance is necessary, classes will be broadcast by synchronous videoconference at their regular schedule, along the period determined by the Health Authority.