1. OVERVIEW

Subject area	Optics
Degree	Bachelor's Degree in Industrial Systems Engineering
School/Faculty	Architecture, Engineering and Design
Year	Second
ECTS	6
Type	Compulsory
Language(s)	Spanish
Delivery mode	On campus
Semester	Second semester

2. INTRODUCTION

Optics is a branch of physics that has been studied for around 40 to 60 centuries, according to different sources, beginning with the invention of mirrors and their applicability to light (Egyptians) to present day, where we are still working to improve lasers, LEDS and wave-based communication, with optics playing a key role in fields such as telecommunication, astronomy and medicine.

The main aim of this subject area is to provide students with a solid theoretical and practical understanding of classical optics and physical optics, with a special focus on the development of electromagnetic waves and their properties. It is worth noting that the subject area is designed as a continuation of previous subject areas such as Fundamentals of Physics II and Electromagnetism, and it requires a prior knowledge of mathematics gained from the subject areas Algebra, Mathematical Analysis I and II and Differential Equations in Physics.

The purpose of this subject area is for students to be able to understand and identify different representations of polarised light, to understand the propagation of light in a homogeneous medium and to understand the different processes that can arise, such as interference and diffraction, as well as the fundamentals of interferometers and diffraction gratings.

3. SKILLS AND LEARNING OUTCOMES

Basic skills and general skills (CB and CG, respectively, by their acronym in Spanish):

- CB1. Students have shown their knowledge and understanding of a study area originating from general secondary school education, and are usually at the level where, with the support of more advanced textbooks, they may also demonstrate awareness of the latest developments in their field of study.
- CB4. Students can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
- CG1. To understand key concepts, methods and findings in the different branches of physics while gaining a historical perspective of their development.
- CG5. To understand diverse phenomena that, despite being physically different, share certain similarities, allowing known solutions to be applied to new problems.

Cross-curricular skills (CT, by the acronym in Spanish):

- CT4: Written communication/Oral communication: Ability to communicate and gather information, ideas, opinions and viewpoints in order to understand and be able to act upon them, whether they are through spoken word and gestures, or through written word and/or visual aids.
- CT5: Problem solving: Be able to critically evaluate information, separate complex situations into their constituent parts, recognise patterns, and consider alternatives, different approaches and perspectives in order to find optimal solutions and negotiate efficiently.

Specific skills (CE, by the acronym in Spanish):

- CE02. To describe and analyse physical systems, identifying fundamental concepts and principles to make the approximations needed to build a simplified model.
- CE03. To understand the inherent limitations of classical physics that led to the emergence of the general and special theories of relativity and quantum mechanics, resulting in solutions to new physics problems.
- CE04. To understand the laws and principles of physics, to identify their logical and mathematical structure, their experimental basis and the phenomena described through them.
- CE05. To understand and know how to use the mathematical and numerical methods used in physics and in handling experimental data.

Learning outcomes (RA, by the acronym in Spanish):

- RA1: To understand and explain in concrete terms the propagation of electromagnetic waves in a vacuum and in a homogeneous medium.
- RA2: To understand coherence theory and the superposition of fields to give a solid explanation of light interference phenomena.
- RA3: To understand scalar diffraction theory and how diffraction gratings work.

The following table shows how the skills developed in the subject area match up with the intended learning outcomes:

Skills	Learning outcomes
CB1, CB4, CG1, CG5, CT4, CE02, CE03, CE04	RA1
CB1, CB4, CG1, CT4, CE02, CE03, CE04, CE05	RA2
CB1, CB4, CG1, CT4, CE02, CE03, CE04, CE05	RA3

4. CONTENTS

1. **Background:** Brief history of Optics. Development of Optics and key discoveries over time.
2. **Propagation of light in a homogeneous medium:** Review of EM waves. Optical characterisation of different media. Refraction index. Light reflection and refraction.
3. **Geometrical optics:** Lenses. Diaphragms. Mirrors and prisms. Optical fibre. Optical systems. Thick lenses and lens systems. Ray tracing. Aberration.
4. **Superposition of waves:** Adding waves together according to their frequency. Periodic harmonic waves. Aperiodic waves.
5. **Scalar theory of the propagation of light in a homogeneous medium:** Nature of polarised light. Polarisation by reflection. Circular polarisers. Polarisation of polychromatic light.
6. **Interference:** Introduction to coherence theory. Field superposition. Interferometers.
7. **Scalar diffraction theory:** Fraunhoffer and Fresnel approximations. Resolving power of an instrument. Diffraction gratings. Introduction to spatial frequency filtering.

5. TEACHING/LEARNING METHODS

The types of teaching/learning methods are as follows:

- Clase magistral/Lectures
- Aprendizaje cooperativo/Collaborative learning

- Aprendizaje basado en problemas ABP/Problem-based learning
- Aprendizaje basado en proyectos/Project-based learning
- Actividades académicas dirigidas/Guided academic activities

6. LEARNING ACTIVITIES

The types of learning activities, plus the amount of time spent on each activity, are as follows:

On campus:

Learning activity	Number of hours
Lectures	40
Oral presentations of projects and debates	6
Report writing	8
Assessment	6
Practical activities (problems, written work, projects, workshops and/or lab work)	20
Tutorials	16
Independent working	54
TOTAL	**150**

7. ASSESSMENT

The assessment systems, plus their weighting in the final grade for the subject area, are as follows:

On campus:

ASSESSMENT SYSTEMS	Min%	Max. %
Pruebas para evaluar objetivos cognitivos teórico/prácticos (Pruebas objetivas tipo test, Exposiciones escritas, Exposiciones orales, Casos/problemas)/Tests to evaluate theoretical/practical cognitive objectives (objective tests, written presentations, oral presentations, case studies/problems)	20%	40%
Pruebas para evaluar objetivos de habilidades (Participación en sesiones grupales, Pruebas de simulación, Participación en casos/problemas Rol playing, Informes)/Tests to assess skill-based objectives (Participation in 20% 40% group sessions, simulation tests, participation in case studies/problems, role play, reports)		

Pruebas para evaluar actitudes (Participación en clase, Rúbricas de evaluación de actitudes)/Tests to assess attitude (Participation in class, attitude assessment rubrics)	10%	10%
Examen final de competencias (Prueba final de conjunto. Incluye diferentes tipos de las pruebas anteriormente citadas)/Final skill-based exam (final integrative test, including different types of the aforementioned tests)	20%	40%

On the Virtual Campus, when you open the subject area, you'll find details of your assessable tasks, including the submission dates and assessment procedures for each task

8. BIBLIOGRAPHY

The reference material for the subject area is as follows:

- E. Hecht. Óptica, Addison-Wesley Iberoamericana, Madrid (2000)

The recommended bibliography is indicated below:

- J. M. Cabrera, F. J. López y F. Agulló. Óptica Electromagnética, Addison-Wesley Iberoamericana, Wilmington (1993)
- J. Casas. Óptica, Librería Pons, Zaragoza (1994)
- G. R. Fowles. Introduction to Modern Optics, Dover, New York (1989)
- R. Guenther. Modern Optics, John Wiley & Sons, New York (1990)
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- F. Carreño y M. A. Antón, Óptica Física. Problemas y ejercicios resueltos, Prentice Hall (2001)
- P.M. Mejías y R. Martínez-Herrero.100 Problemas de Óptica. Alianza editorial (1996)
- D. V. Sivujin, Problemas de Física General. Óptica, Reverté (1984)