1. OVERVIEW

Subject area	Fundamentals of Physics II
Degree	Bachelor's Degree in Physics
School/Faculty	School of Architecture, Engineering and Design
Year	First
ECTS	6
Type	Core
Language(s)	Spanish
Delivery mode	On campus
Semester	Second

2. INTRODUCTION

Fundamentals of Physics II is a core subject area in the Universidad Europea Bachelor's Degree in Physics. It is the natural continuation of the subject area Fundamentals of Physics I, focusing on the consolidation of knowledge about systems of particles and their conservation principles, the fundamental properties of fluids, electrostatics and magnetostatics (both in a vacuum and in matter) and the study of electrodynamics, concluding with the presentation of Maxwell's laws from a formal perspective. Using Maxwell's equations, we'll look at how solutions arise naturally in the form of plane waves (photons), leading to an introduction to electromagnetic optics. As such, students will gradually discover how the challenges to classical physics posed by certain experimental findings led to the formulation of modern physics. The semester then ends with an introductory topic on special relativity.

As such, students should see this subject area as a general overview of classical physics and use it as a starting point to consolidate their knowledge and practise the way that abstract mathematical concepts are applied to the study of nature. The aim is for students to create a foundation of knowledge that they can use as a conceptual point of reference later in their degree when studying the same topics in greater depth, in subject areas such as Electromagnetism I, Electromagnetism II and Optics.

3. SKILLS AND LEARNING OUTCOMES

General skills (CG, by the acronym in Spanish):

- **CG1**: To understand key concepts, methods and findings in the different branches of physics while gaining a historical perspective of their development.

Key skills (CB, by the 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.

Transversal 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):

- **CE1**. To estimate orders of magnitude in order to interpret diverse phenomena.
- **CE2**. To describe and analyse physical systems, identifying fundamental concepts and principles to make the approximations needed to build a simplified model.
- **CE3**. 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.

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

- **RA1**. To understand the treatment of systems of particles in classical physics.
- **RA2**. To interpret electrical and magnetic phenomena in nature in terms of electromagnetic fields and their interactions with matter.
- **RA3**. To acquire a sufficient preliminary understanding of the shortcomings of classical physics and of the experimental findings that led to the formulation of special relativity.

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

Skills	**RA1. To understand the treatment of systems of particles in classical physics.**
CB1, CT4, CT5, CE1, CE2	RA1. To understand the treatment of systems of particles in classical physics.
CB1, CT4, CT5, CE1, CE2	RA2. To interpret electrical and magnetic phenomena in nature in terms of electromagnetic fields and their interactions with matter.
CB1, CT4, CE2, CE3	RA3. To acquire a sufficient preliminary understanding of the shortcomings of classical physics and of the experimental findings that led to the formulation of special relativity.

4. CONTENTS

This subject is organised into the following learning units (UA, by the acronym in Spanish):

Unit 1: Fluids

- Pressure in fluids, Pascal's principle and Archimedes' principle.
- Perfect fluids, continuity equation and Bernoulli's equation. Viscosity. Turbulence.

Unit 2: Electric fields

- Coulomb's law. **E**-field and Gauss's law. Electric potential. Electrostatic energy.
- Discrete and continuous charge distribution.
- Properties of conductors in electrostatic equilibrium.
- Dielectric materials, **D** and **P** vectors. Electric susceptibility and permittivity.
- RLC circuits.

Unit 3: Magnetic fields

- Lorentz force law. Biot–Savart law. **B**-field sources. Ampère's law.
- Magnetization in matter: **M** and **H** vectors. Magnetic susceptibility and permeability.
- Lenz's law. Magnetic induction. Maxwell's equations.

Unit 4: Electromagnetic waves and optics

- Plane electromagnetic waves.
- Energy and momentum of an electromagnetic wave. Radiation pressure.
- Principles of optics: laws of reflection and refraction.

Unit 5: Waves and acoustics

- Types of waves. Mathematical description of a wave.
- Wave interference, boundary conditions and the superposition principle.
- Standing waves on a string.

Unit 6: Special relativity

- 6.1. Speed of light: Michelson–Morley experiment.
- 6.2. Time dilation and length contraction. The relativistic Doppler effect.
- 6.3. Linear momentum and relativistic energy. Mass–energy equivalence.

The distribution of this content is subject to change for logistical reasons. Students will be informed of any changes in due time and course.

5. TEACHING/LEARNING METHODS

The types of teaching/learning methods are as follows:

- **Lectures**: presentations by the professor with the necessary technological tools to maximise comprehension of the learning content.
- **Collaborative learning:** Students learn to collaborate with other people (classmates and professors) in order to find creative, comprehensive and constructive solutions to questions and problems that arise from the given case studies, using all relevant knowledge and material resources available.

- **Problem-based learning:** Students are given problems and are asked to solve them, working individually or in groups.
- **Guided academic activities:** Individual and group work that is more independent, including information searches, written summaries, debates and the public defence of projects.

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	36
Oral presentations of projects and debates	7
Report writing	7
Assessment	6
Practical activities (problems, written work, projects, workshops and/or lab work)	22
Tutorials	16
Independent working	56
TOTAL	**150**

7. ASSESSMENT

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

On campus:

Assessment system	Weighting
On-campus knowledge tests (assessment system 1 or SE1) Students will sit two exams with theoretical/practical questions and/or problems: one midterm exam and one final exam. The weighting of the midterm exam (**Ex_{par}** by its acronym in Spanish) is 15% and the weighting of the final exam (**Ex_{fin}** by its acronym in Spanish) is 35%.	50%
Submission of exercises (SE2) During the course, exercises are submitted that are, as a compulsory requirement, completed in groups (20%). The members of the group will assess between them the individual performance of each member (10%).	30%

Group project (SE3) Students will complete a group project on a topic of their choosing related to the content of the subject area, and they will present their project in front of the class.	20%

On the Virtual Campus, when students open the subject area, they'll find details of the assessable tasks they have to carry out, including the submission dates and assessment procedures for each task.

8. BIBLIOGRAPHY

The main bibliography for the subject area is as follows:

- H.D. Young, R.A. Freedman, F.W. Sears y M.W. Zemansky, Física universitaria, Vol. 1 y 2. 12ª ed. Pearson Education (2013).
- D. C. Giancoli, Physics: Principles and applications, 7ª ed. Pearson Education (2014).
- P.A. Tipler y G. Mosca, Física para la Ciencia y la Tecnología, Vol. 1 y 2. 6ª ed. Ed. Reverté (2010).
- M. Alonso y E.J. Finn, Física. Addison-Wesley Iberoamericana (1995).