Universidad de Alcalá

TEACHING GUIDE

Fundamentals of Physics II

Degree in
Telecommunication Technologies Engineering (GITT)
Telecommunication Systems Engineering (GIST)
Telematics Engineering (GIT)
Electronic Communications Engineering (GIEC)

Universidad de Alcalá

Academic Year 2025/2026

2nd Year - 1st Semester (GITT+GIST+GIT+GIEC)

Approved by the EPS School Board on June 16th, 2025

TEACHING GUIDE

Course Name:	**Fundamentals of Physics II**
Code:	**350008 (GITT+GIST+GIT+GIEC)**
Degree in:	**Telecommunication Technologies Engineering (GITT)** **Telecommunication Systems Engineering (GIST)** **Telematics Engineering (GIT)** **Electronic Communications Engineering (GIEC)**
Department and area:	**Física y Matemáticas** **All in Teaching Unit of Physics**
Type:	**Basic (GITT+GIST+GIT+GIEC)**
ECTS Credits:	**6.0**
Year and semester:	**2nd Year - 1st Semester (GITT+GIST+GIT+GIEC)**
Teachers:	Antonio Guerrero Ortega
Tutoring schedule:	To be defined
Language:	English

1. COURSE SUMMARY

Fundamentals of Physics II is a basic subject which goal is to establish the scientific background for the development of the knowledge and understanding of the telecommunication technology. The contents of this subject are though as a continuation of those from Fundamentals of Physics I, which is taught during the first semester of the first course. Along both subjects, a general study of physical phenomena involved in the understanding of electromagnetic field is presented and fundamental concepts needed for the training in other more technological subjects taught in this degree are established.

The subject starts dealing with the different performances of the matter under the presence of an external magnetic field and follows on with the study of the laws for the phenomena related to time-variable fields. General properties of waves are studied as an introduction to be followed by a detailed analysis of electromagnetic waves. Last topic is devoted to study different wave phenomena, and in particular to electromagnetic waves, including light with a geometrical optics approach.

Prerequisites and Recommendations

The course assumes a good working knowledge of Fundamentals of Physics I, Calculus I and Linear Algebra upon entering the course.

2. SKILLS

Basic, Generic and Cross Curricular Skills.

This course contributes to acquire the following generic skills, which are defined in the Section 3 of the Annex to the Orden CIN/352/2009:

en_TR2 - Knowledge of basic subjects and technologies that enables to learn new methods and technologies, as well as to provide versatility that allows adaptation to new situations.

en_TRU1 - Capacity of analysis and synthesis.

Professional Skills

This course contributes to acquire the following professional skills, which are defined in the Section 5 of the Annex to the Orden CIN/352/2009:

en_CB3 - Understanding and knowledge of basic issues related to the general laws of Mechanics, Thermodynamics, Electromagnetic Fields and Waves and developing the ability to find solutions to engineering problems.

Learning outcomes:

- **RA1: Understanding and knowledge**

To define, to show and to explain the scientific concepts and the most relevant physical-mathematical models concerning Information and Communication Technologies (ICT) and the approaches and simplifications commonly applied. Among them, the following ones can be highlighted:

1. To define the magnetic flux and its temporal variation. To understand Faraday's Law and Lentz's Law.
2. To determine the magnetic properties of material media
3. To describe the displacement current introduced by Maxwell, and to extent the Electromagnetic equations to the definitive formulation.

4. To discuss the solutions of the wave equations of electric and magnetic fields: travelling and standing waves; the associated phenomena of reflection, refraction, diffraction and polarization.

- **RA2: Engineering analysis**

To draw up, to analyse and to solve problems related to previous concepts. It can be highlighted:

1. Applications of the electromagnetic induction laws.
2. To use the magnetism in material media to solve highly symmetric systems.
3. To identify and to understand basic and general electromagnetic systems.
4. To appreciate the properties of electromagnetic waves, specifically the visible and microwaves spectral regions.

- **RA3: Research and innovation**

To manipulate different equipment and instruments in the laboratory experiences, which are specifically designed to illustrate and to calculate parameters related to the induction concepts and the electromagnetic properties.

- **RA4: Engineering experience**

To know the limits of validity of the theories and models included in this subject.

3. CONTENTS

Theoretical Contents:

Topic 1. The magnetic field. Biot and Savart's Law: Applications. Ampère's Law: Applications. The magnetic field in material media. The phenomenon of magnetization. Magnetization and linear magnetic materials. Magnetic excitation vector: Ampère's law in material media. Magnetic energy. Types of magnetic materials: dia, para and ferromagnetic. Boundary conditions for the magnetic field and applications.

Topic 2. Magnetic induction. Faraday's Law. Coefficients of self-induction and mutual induction. Magnetic energy of a circuit system. Applications in the field of electronics.

Topic 3. The electromagnetic phenomenon. Maxwell's displacement current. Maxwell's equations (integral and differential formulation). Power and energy of the electromagnetic field: Poynting's vector and Poynting's theorem (conservation of energy). Boundary conditions of the electromagnetic field. Applications to different interfaces.

Topic 4. Electromagnetic waves. Oscillatory and wave phenomena. Types of waves. Wave equation and its solutions (wave functions). Harmonic wave (monochromatic) functions: characteristics. Wave equation for electric and magnetic fields, based on Maxwell's equations. Solutions of the wave equation. Planar waves: Propagation of planar electromagnetic waves in different types of media (vacuum, dielectric, lossy dielectrics, good conductors): propagation characteristics and properties: impedance of the medium. Energy carried by electromagnetic waves and their intensity. Electromagnetic spectrum. Polarization: Concept. Types of polarization. Methods of obtaining polarized waves: Polarization by reflection and Brewster angle. Applications. Non-monochromatic waves: phase rate, group rate, and dispersive media: applications to telecommunications.

Topic 5. Properties of waves. Introduction to Reflection and Transmission: General Behavior of Waves at the Boundary Between Two Media. Reflection and transmission of planar electromagnetic waves: reflection and transmission coefficients (Fresnel coefficients) for different polarization states. Snell's laws. Total internal reflection. Fiber optic applications (waveguide). Interference phenomenon. Interference from two or more coherent sources. Performance of the light spectrum on thin films. Stationary electromagnetic waves. Diffraction phenomenon. Optical systems. Geometric optics:

elements, characteristics, and applications: integration with other systems (MOEMS Micro-Opto-Electro-Mechanical Systems).

Practical contents:

Laboratory practices dedicated to learning the methodology and measurement techniques used in Physics. The internships show experiences related to theoretical knowledge developed throughout the course.

The student will carry out a total of three practices in sessions of 2 hours each, doing a total of 6 hours of in-person laboratory.

Units (Topics)	Total number of hours
Magnetism and electromagnetic fields (Topics 1, 2 and 3)	**24 hours**
Waves, features and properties (Topics 4 and 5)	**32 hours**

4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

4.1. Credits Distribution

Number of on-site hours:	58 hours (including 56h for traditional lectures, training lectures, seminars and laboratory classes and one 2h exam)
Number of hours of student work:	92 hours (including homework, own-study, online activities and exams preparation)
Total hours	150

4.2. Methodological strategies, teaching materials and resources

The methodologies of this course are as follows:

- **Traditional lectures**. Lectures to communicate the main theoretical contents of each Unit.
- **Training lectures and seminars**. Active lectures devoted to identifying the physical concepts involved in practical problems related to the theoretical concepts explained. It will be emphasized the appropriate methodology to understand the phenomena involved, to distinguish between essential and accessory inputs, to analyse the procedure and to wonder about the validity of the obtained results. They will also be used to clarify any doubts that arise throughout the course, whether related to the theoretical lessons, unsolved problems from class, proposed assignments, etc.
- **Lab sessions**. Active lectures at Physics laboratory in small groups where the students will

acquire skills to handle different equipment and laboratory instruments, learning to handle experimental data, to check physical laws and to get relevant magnitudes. Laboratory experiences will be complementary to theoretical and training lectures. A script will be provided for the students before the lecture and they will develop the laboratory experience under the supervision and with the help of the Professor. The student shall draw up a report with the results derived from the experience made.

- **Online activities and tutorials**. During the tutorials, the student work will be guided by the professors, who will solve / advise on matters arising during the course and will guide the student on the literature and methodology appropriate to address the issues raised.

The tools used will be:

Traditional lectures	Use of blackboard, slides, web resources and apps.
Training lectures and seminars	Problem sets and question sets available through Aula Virtual.
Lab sessions	Lab session guide and the help of the professor in the lab and with the use of specific instrumentation.
Online activities and tutorials	Assignments, self-assessment quizzes, participation in forums, using the Aula Virtual, and personalized attention through online or in-person tutoring in the office.

5. ASSESSMENT: procedures, evaluation and grading criteria

Preferably, students will be offered a continuous assessment model that has characteristics of formative assessment in a way that serves as feedback in the teaching-learning process.

5.1. PROCEDURES

The evaluation must be inspired by the criteria of continuous evaluation (Learning Assesment Guidelines, LAG, art 3). However, in compliance with the regulations of the University of Alcalá, an alternative process of final evaluation is made available to the student in accordance with the Learning Assesment Guidelines as indicated in Article 10, students will have a period of fifteen days from the start of the course to request in writing to the Director of the Polytechnic School their intention to take the non-continuous evaluation model adducing the reasons that they deem convenient. The evaluation of the learning process of all students who do not apply for it or are denied it will be done, by default, according to the continuous assessment model. The student has two calls to pass the subject, one ordinary and one extraordinary.

Ordinary Call:

1. **Continuous evaluation:** Students will be asked to take two partial exams and participate in three laboratory sessions. The first partial exam takes place in the middle of the course. Students who do not take the second partial exam will not receive a mark.
2. **Final exam evaluation:** Students must pass a final exam. If a student is unable to follow the continuous evaluation process, they must request to be assessed through the final exam in accordance with University regulations. Students who do not take the final exam will not receive a mark.

Extraordinary Call:

Students must pass a final exam. Those who do not take the final exam will not receive a mark.

General Passing Requirement

In all cases, students must obtain a minimum score of 5 out of 10 to pass the subject.

5.2. EVALUATION

Evaluation criteria:

CE1. Knowledge of main physical principia included in the contents of the subject, and of the magnitudes and parameters involved and their value ranges.

CE2. Ability to identify those physical principia in a variety of situations and processes, applying them for diagnosis and forecasting in case-studies, both qualitatively and using the mathematical expressions of the discipline.

CE3. Ability to relate different topics of the subject to solve problems involving scientific and technological aspects.

CE4. Ability to discuss topics at length and to make meaning clear.

CE5. Appropriateness of scientific-technological terminology used, including the suitability of symbols and units for the magnitudes and parameters involved in the subject.

CE6. Self-involvement and awareness of the processes involved in the skills of this subject, shown in the appropriateness of the deliverables, including exams, laboratory and other tasks, being responsible for completing assignments on time, and in the class attendance and participation.

Grading tools:

This section describes the assessment tools, which will be applied for every Evaluation Criteria:

- Two Partial Exams (**PEI1 and PEI2**). **PEI1** will be taken in the middlel of the course and**PEI2** will be taken the date of the final exam. They will include solving problems and/or questions concerning the contents of all units in the course.
- A Final Exam (**PEF**): for students that follows the Final Evaluation mode. This exams will include solving problems and questions concerning the contents of all units in the course.
- To deliver three laboratory reports (**PL1**, **PL2** and **PL3**, both student following Continuous Evaluation and those granted by Final Evaluation). Students will deliver a report with the results derived from every laboratory experience made (**EL1**, **EL2** and **EL3**).
- Extraordinary Call Exam (**PCE**): It consists on an exam covering all units in the course.

Mark procedure:

This Section quantifies the Evaluation Criteria to pass the subject.

Ordinary Call, Continuous Evaluation:

Skills	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
TR2, TRU1, CB3	RA1 (1,2,3), RA2 (1,2,3) RA4	CE1-CE6	PEI 1	40%
TR2, TRU1, CB3	RA1 (4), RA2 (4), RA4	CE1-CE6	PEI 2	40%
TR2, TRU1, CB3	RA3, RA4	CE1-CE6	PL1, PL2, PL3, EL1, EL2, EL3	20%

The final grade of the students depends on their performance in partial exams (40% each) and their performance in the laboratory (20%). In order to pass the subject, students need a mark equal or greater than 5 out of 10. Students not attending **PEI1** or **PEI2** will be marked as **"Not Present" (NP)**, and this will not count as an attempt.

Ordinary Call, Final Evaluation:

Skills	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
TR2, TRU1, CB3	RA1, RA2, RA4	CE1-CE6	PEF	80%
TR2, TRU1, CB3	RA3, RA4	CE1-CE6	PL1, PL2, PL3, EL1, EL2, EL3	20%

Students must take a final exam, which will account for**80%** of the final grade. The remaining**20%** will be based on the evaluation of laboratory practices. If a student does not attend the final exam (**PEF**), they will be marked as **"Not Present" (NP)**, and this will not count as an attempt.

Extraordinary call

Skills	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
TR2, TRU1, CB3	RA1, RA2, RA3, RA4	CE1-CE6	PCE	100%

In the **extraordinary call**, students will be considered to have used an attempt if they take the exam, regardless of the chosen evaluation method (continuous evaluation or final evaluation). Students who do not attend the **PCE** will be marked as **"Not Present" (NP)**, and this will not count as an attempt.

Students have the option to keep their laboratory grade obtained throughout the course or to forfeit it. In the first case, the exam and laboratory will account for 80% and 20% of the final grade, respectively. In the second case, the exam will count for 100% of the final grade and will include laboratory-related questions.

The teaching-learning methodology and the assessment process will be adapted as needed, in accordance with the guidelines of the Diversity Support Unit, to implement curricular adaptations for students with specific needs.

6. BIBLIOGRAPHY

6.1. Basic Bibliography

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- H.D. Young, R.A. Freedman, M.W. Zemansky, F.W. Sears, A.L. Ford, Física Universitaria, Ed. Addison Wesley (12ª ed.) (2009)
- P.A. Tipler, G. Mosca, Física, (Vol. 1a), Ed. Reverté (5ª ed.) (2005)
- R. A. Serway, J. W. Jewett, Física, Ed. Thomson (3ª ed.) (2003)
- J. M. De Juana, Física General, Vol II, Ed. Pearson Prentice Hall (2ª ed.) (2007)
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- R. K. Wangsness, Campos electromagnéticos, Ed. Limusa (1996)
- M. A. Raposo, E. González, J. Alvarez-Ude, Fundamentos de campos electromagnéticos y ondas. Ejercicios y problemas resueltos de física. Ed. FEBCCS (2012)

6.2. Additional Bibliography

- R. Feynman, R. B. Leighton, M. Sands, Física, Vol II: Electromagnetismo y materia, Ed. Adisson Wesley Iberoamericana (1998)
- E. M. Purcell, Electricidad y Magnetismo, Berkeley Physics Course – Vol II, Ed. Reverté (1994)
- F. S. Crawford, Jr., Ondas, Berkeley Physics Course – Vol III, Ed. Reverté (1991)
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Disclosure Note

During the evaluation tests, the guidelines set out in the Regulations establishing the Rules of Coexistence of the University of Alcalá must be followed, as well as the possible implications of the irregularities committed during said tests, including the consequences for committing academic fraud according to the Regulation of Disciplinary Regime of the Students of the University of Alcalá.