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 2026/2027

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

Approved by the EPS School Board on June XXth, 2026

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 generation of the magnetic field and its treatment in matter 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 to Wire, Plane, Solenoid and Toroid. The phenomenon of magnetization: magnetic moment and magnetization vector. Magnetic materials: Magnetic excitation vector and Ferromagnetic materials. Susceptibility for linear media: Diamagnetic and Paramagnetic materials.

Topic 2. Magnetic induction. Motional EMF. Faraday's Law. The induced Electric Field. Self-induction and mutual induction. Magnetic energy. Circulation and flux of the magnetic field. Boundary conditions for the magnetic field. Applications to telecommunications.

Topic 3. The electromagnetic phenomenon. Maxwell's displacement current: Maxwell's equations in vaccum and in matter (integral and differential formulation); Boundary conditions. Conservation theorems: Charge and energy; Poynting's theorem. Applications.

Topic 4. Electromagnetic waves. Oscillatory and wave phenomena. Types of waves. Wave equation and its solutions (wave functions). Harmonic wave (monochromatic) functions. 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. Polarization. Dispersion: phase velocity, group velocity. Energy and momentum of electromagnetic waves. Applications.

Topic 5. Properties of waves. Reflection and transmission of electromagnetic waves. Stationary waves. Snell's laws. Total internal reflection. Fiber optic applications (waveguide). Interference from different sources. Interference by incidence on thin films. Diffraction phenomenon. Optical systems. Geometric optics: elements, characteristics, and applications.

Practial Contents:

Laboratory sessions focused on learning experimental techniques in Physics, including data acquisition and processing, uncertainty analysis, and validation of theoretical models.

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.
- **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, assessment quizzes, 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.

According to current regulations and considering that the experimental laboratory is essential for the acquisition of the course skills, attendance to all laboratory sessions is compulsory as well as passing its evaluation, for both the ordinary and the extraordinary evaluation (Article 6, paragraph 4, NRPEA). For this reason, the laboratory attendance and evaluation are common and essential in the two types of evaluation: continuous and non-continuous.

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.

EVALUATION INSTRUMENTS

To assess the evaluation criteria, the following evaluation instruments will be used.

1. Intermediate Assessment Tests (PEI): consisting on solving several questions, on analysis and/or synthesis, on specific aspects of the concepts related to the theory, problems and laboratory classes.
2. In class activities (ACTP): consisting on solving problems, theoretical or practical tests, and formative and evaluation activities.
3. Out of class activities (ACTNP): consisting on previous study, and its verification through questionnaires, and formative and evaluation activities.
4. Laboratory practices (PL): consisting on using instrumentation equipment to study physical laws related to the course. In the lab a continuous assessment on the students' progress is carried out.
5. Final evaluation exam (PEF): a written exam on problem solving, related to the concepts exposed in all the course units.

PROCEDURES AND GRADING TOOLS

Ordinary Call:

Continous Evaluation:

Students shall perform the following tests throughout the course:

a. In class activities (ACTP, theoretical or practical tests or problems, and formative and evaluation activities), and out of class activities (ACTNP, previous study and its verification through questionnaires, and formative and evaluation activities (15% of the final grade of the student).
b. One or more intermediate assessment tests (PEI) which consist of several questions and/or problems, covering one or more topics within the course content (25% of the final grade of the student).
c. Laboratory assignments, of compulsory attendance. The assignment will complement the knowledge acquired in the theoretical part of the course (20% of the final grade of the student).
d. Overall exam (PEF), held at the end of the course, with several questions and problems (analysis and/or synthesis) on specific aspects of the full course syllabus, covered by the theory, problems and laboratory classes (40% of the final mark student). With this exam the capability of relating and integrating the learnt concepts is evaluated and allows revising the concepts of the intermediate tests. For all this, the overall exam allows to improve the final mark if the score is better than the one obtained in the accumulation of the intermediate tests and the overall exam.

Students are deemed to have passed the course (proving the acquisition of the theoretical and practical skills) if the following requirements are met:

- They have successfully acquired the skills related to the laboratory assignment (paragraph c. above). It is understood that a student successfully acquire these skills, if her/his score is equal or higher to 50% of the maximum obtainable score.
- They have successfully acquired the skills related to the set of all tests, exercises and theoretical-practical written or oral assignments (if any), intermediate assessment tests (PEIs), and the overall exam (paragraph a., b. and d.). It is understood that a student successfully acquire these skills, if her/his average score in all related assignments and tests is equal or higher to 45% of the maximum obtainable score.
- The final weighted score of all of the above items (paragraphs a., b., c., and d.) turns out to be equal or higher than 5 out of 10.

Non-continous evaluation:

Students who opt for the non-continuous evaluation will make a final exam and the mandatory laboratory assignment, with the following weights in the final grade:

a. The theoretical and practical final test (PEF), broadly covering the contents of all the course topics (80%).
b. The laboratory practices (PL), of compulsory attendance, described in the continuous evaluation section (20%).

The criteria for passing the course are the same as those established in the ordinary continuous assessment, with regard to the achievement of competencies related to laboratory work and those assessed in the theoretical exams.

Extraordinary Call:

For the continuous and non-continuous assessment: Students will make an exam with a number of questions and problems (analysis and/or synthesis) on specific aspects of the full course syllabus, covered by the theory, problems and laboratory classes, and providing 80% of the final score. The laboratory score will provide the additional 20% to calculate the final course score. Students that did not pass the laboratory assignment in the ordinary evaluation will have a specific theoretical and practical test to demonstrate the acquisition of the corresponding skills. The criteria for passing the course are the same as those established in the ordinary continuous assessment, with regard to the achievement of competencies related to laboratory work and those assessed in the theoretical exams.

Criteria for considering as not presented (NP) in the Calls

Regardless of the call (ordinary or extraordinary) and the type of evaluation (continuous or non-continuous), it will be considered not presented (NP) in the call, when the student does not take the PEF.

GRADING CRITERIA

This section quantifies the grading criteria to pass the course.

Next we show, for every evaluation type, tables describing the relationship between the evaluation instruments, the evaluation criteria, the learning results and skills, as well as the grading percentage assigned to each evaluation instrument.

Ordinary Call, Continuous Evaluation:

Skill	Learning Outcomes	Evaluation Criteria	Grading Tool	Grading Weight
TR2, TRU1, CB3	RA1, RA2, RA4	CE1-CE6	ACTP ACTNP	15%
			PEI	25%
			PEF	40%
TR2, TRU1, CB3	RA3, RA4	CE1-CE6	PL	20%

Ordinary Call, Final Evaluation:

Skill	Learning Outcomes	Evaluation Criteria	Grading Tool	Grading Weight
TR2, TRU1, CB3	RA1, RA2, RA4	CE1-CE6	PEF	80%
TR2, TRU1, CB3	RA3, RA4	CE1-CE6	PL	20%

Extraordinary call

En la convocatoria ordinaria regida por evaluación final la relación entre los criterios, instrumentos y porcentaje en la calificación es la siguiente:

Skill	Learning Outcomes	Evaluation Criteria	Grading Tool	Grading Weight
TR2, TRU1, CB3	RA1, RA2, RA4	CE1-CE6	PEF	80%
TR2, TRU1, CB3	RA3, RA4	CE1-CE6	PL	20%

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

- Teaching materials from the professors.
- D. Griffiths, Introduction to Electrodynamics, Ed. Cambridge University Press (5ª ed.) (2023)
- H. D. Young, R. A. Freedman, *Física universitaria con física moderna, Vol. 2*, Ed. Pearson (14ª ed.) (2018)
- P. A. Tipler, G. Mosca, *Física para la ciencia y la tecnología, Vol. 2: Electricidad y magnetismo, luz y física moderna*, Ed. Reverté (6ª ed.) (2010)
- E. Hecht, *Óptica*, Ed. Pearson (5ª ed.) (2017)

6.2. Additional Bibliography

- M. A. Raposo, E. González, J. Álvarez-Ude, Fundamentos de campos electromagnéticos y ondas. Ejercicios y problemas resueltos de física. Ed. FEBCCS (2012)
- M. Alonso, E. J. Finn, Física, Ed. Addison Wesley Iberoamericana (1995)
- 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)
- W. H. Hayt, J. A. Buck, Teoría electromagnética, McGraw-Hill, (6ª ed.) (2006)
- R. K. Wangsness, Campos electromagnéticos, Ed. Limusa (1996)
- R. P. 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)
- A. P. French, Vibraciones y ondas, Ed. Reverté (1974)
- J. D. Kraus, D. A. Fleisch, Electromagnetismo con aplicaciones, Ed. McGraw-Hill, 5ª ed. (2000)
- F. T. Ulaby, Fundamentos de aplicaciones en electromagnetismo, Ed. Pearson / Prentice Hall, 5ª ed. (2007)

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.