Bachelor in Physics
(Academic Year 2025-26)

Electromagnetism II				Code	800502	Year	2nd	Sem.	2nd
Module	General Core	Topic	Classical Physics			Character	Obligatory		

	Total	Theory	Exercises
ECTS Credits	6	3.6	2.4
Semester hours	55	31	24

Learning Objectives (according to the Degree's Verification Document)

- To get basic knowledge of electromagnetism radiation emission mechanisms.
- To get knowledge of electromagnetic field energy and momentum concepts.
- To understand the relation between electromagnetism and theory of relativity.

Brief description of contents

Electromagnetic potentials. Electromagnetic waves. Radiant systems. Relativist formulation.

Prerequisites

Electromagnetism I. Mathematics, Calculus, Algebra.

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Theory/Problems – Schedule and Teaching Staff

Group	Lecture Room	Day	Time	Professor	Period/ Dates	Hours	T/E	Dept.
B	19	Tu, Th	12:00 – 14:00	Norbert Nemes	Full term	55	T/E	FM

T: Theory, E: Exercises

Office hours

Group	Professor	Schedule	E-mail	Location
B	Norbert Nemes	Tu: 8:00-11:00 Fr: 9:00-12:00 On line	nmnemes@fis.ucm.es	03.119.0

Syllabus

1.- Fundamentals

Phasor representation. Differential, integral and phasor formulation of Maxwell equations. Constitutive relationships. Boundary conditions. Electromagnetic potentials. Wave equation. Quasi-static approach.

2.- Boundary problems: static fields

The boundary problem in electrostatics. Uniqueness theorem. Reciprocity theorem. Method of images. Separation of variables.

3.- Monochromatic plane waves

Harmonic fields. Monochromatic plane waves. Propagation in dielectrics and conductors. Reflection by conductive surfaces. Energy and moment of electromagnetic waves. Radiation pressure.

4.- Guided waves

Confinement in propagating electromagnetic waves. Rectangular waveguides. TE and TM Modes. TEM modes. Resonant cavities.

5.- Radiation

Retarded potentials. Liénard-Wiechert potentials. Velocity and acceleration fields. Accelerated charges in free space: equations of movement, fields. Radiation generated by currents in conductors. Dipole radiation. Radiant systems.

6.- Electromagnetism and relativity

Lorentz transformations. Space-time structure: interval, light cone, invariant. Four-vectors (position, velocity, moment...). Relativistic electrodynamics: four-current. Four-potential. The magnetic field as a relativistic effect. Transformations of the fields. Electromagnetic tensor.

Bibliography

[1] RP Feynman, RB Leighton y M Sands, “The Feynman Lectures on Physics, New Millennium Edition Vol. II: Mainly Electromagnetism and Matter”, Caltech, (2010). https://www.feynmanlectures.caltech.edu/info/

[2] DJ Griffiths, “Introduction to Electrodynamics”, 5ª Ed., Cambridge University Press, (2023).

[3] P Lorrain, D Corson, F Lorrain, “Electromagnetic Fields and Waves”, 3ª Ed., Freeman and Co., (1988).

[4] MH Nayfeh, MK Brussel, “Electricity and Magnetism”, Dover Publications, (2015).

[5] DM Pozar, "Microwave Engineering", 4ª Ed., Wiley, (2021).

[6] JR Reitz, FJ Milford, RW Christy, “Foundations of Electromagnetic Theory”, Addison-Wesley, 4ª Ed., (2008).

[7] MNO Sadiku, “Elements of Electromagnetics”, 3ª Ed. OUP USA, (2000).

[8] F Sánchez, LL Sánchez, M Sancho, J Santamaría, “Fundamentos del Electromagnetismo”, Síntesis, (2000).

[9] RK Wangsness, “Campos Electromagnéticos”, Limusa, (2006).

[10] A Zangwill, “Modern Electrodynamics”. Cambridge University press, (2013).

Online Resources

Course materials will be provided at the Campus Virtual of the UCM.
“Fundamentals of Applied EM”, https://www.youtube.com/channel/UCn-0FOjOLbuSZq7PkJUmzqg

Methodology

The following training activities will be developed:

- Theory lessons (lectures) where most of the main concepts will be explained, including examples and applications.
- Problem-solving practical lessons.

In theory lessons both the board and slides will be used. Sometimes these lessons will be complemented with computer simulations and virtual experiments.

The problems of each lesson will be delivered to the students before their solving in the classroom. Also, briefings and documents of some special subjects will be distributed.

Short tests, solved problems and short classroom seminars will be considered as a part of the continuous assessment.

Evaluation Criteria

Exams	**Weight:**	80%

Final mark for the Exams section: N_{Exam}, between 0 and 10.

Final exam, with a part of questions and another of problems

Other Activities	**Weight:**	20%

Up to 2 points will be granted by completing continuous assessment activities such as: tests, interactive in-class quizzes, hand-in exercises, short individual exercises completed during class, or by accrediting other merits that demonstrate good learning achievements on the course topics.

The final mark for this section will be $N_{OtherActiv}$ and will range from 0 to 10.

Final Mark

The final mark will be obtained from the following equation:

$$C_{Final} = 0.8N_{Exam} + 0.2N_{OtherActiv}$$

The final mark criterion, as well as the mark corresponding to other activities, will be maintained in the exam of the extraordinary call.