Bachelor in Physics
(Academic Year **2021-22**)

Classical Electrodynamics	**Code**	800525	**Year**	4º	**Sem.**	1º
Module	Fundamental Physics	**Topic**	Compulsory in Fundamental Physics	**Character**	Obligatory	

	Total	**Theory**	**Exercises**
ECTS Credits	6	4	2
Semester hours	43	28.5	14.5

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

- To master concepts as gauge invariance and Lorentz transformation of electromagnetic fields
- To understand the Lagrangian and covariant formulation of electromagnetism
- To understand the movement of relativistic electric charges under Lorentz force and the resultant emission of radiation
- To solve problems of wave propagation and electromagnetic radiation emission

Brief description of contents

Special relativity and Maxwell equations; Lorentz force; potentials and gauge invariance; covariant and Lagrangian formulation of electromagnetism; conservation theorems; radiation of moving charges; multipolar expansion of the electromagnetic field.

Prerequisites

Maxwell equations; Lorentz force; basics of special relativity (space time structure, light cone, invariants, four vectors, Lorentz trasformations); Lagrange and Hamilton mechanics; basic notion of tensors.

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Theory/Exercises – Schedule and Teaching Staff

Group	**Lecture Room**	**Day**	**Time**	**Professor**	**Period/ Dates**	**Hours**	**T/E**	**Dept.**
B	**3**	Tu Th	14:00-15:30 14:00-15:30	Ignazio Scimemi	Whole semester	43	T/E	FT

T: Theory, E: Exercises

Office hours

Group	**Professor**	**Schedule**	**E-mail**	**Location**
B	Ignazio Scimemi	Tu, We, Th 11.00-12.00 + 3h online	ignazios@ucm.es	Room 23, 2nd floor, West, FT

Syllabus

1. **Maxwell equations:** definitions, conservation laws, plane waves, electromagnetic pontentials
2. **Special relaltivity and Lorentz transformations:** Minkowski space time, Poincaré group and its transformations. Relativistic Dynamics.
3. **Classic Field Theory:** Transformation laws, variational principle, Noether Theorem, fields and particles, Hamiltonian formalism.
4. **Charged particles in electromagnetic fields:** particles in electromagnetic fields, point charges in constant electromagnetic fields, dipoles in constant electromagnetic fields, dynamics of electromagnetic fields
5. **Electromagnetic radiation:** radiation of a moving charge, radiation from reaction, multipolar radiation.

Bibliography

Basic:

- J.D. Jackson, “Classical Electrodynamics”, 3rd. ed. Wiley and Sons (1999).
- Landau y E.M. Lifshitz, “Teoría clásica de campos”, Reverté (1986) (“Théorie des Champs”, 4ème éd., Mir, Moscú; “The Classical Theory of Fields”, 4th. ed., Butterworth-Heinemann).
- Lecture notes of prof. I. Scimemi on Classical Field Theory (available on Virtual Campus)

Complementary:

- S. Kruchinin, Problems and Solutions in Special Relativity and electromagnetism, World Scientific (2018)
- F. Scheck Classical Field Theory, Springer (2012)
- Griffiths, D.J.: Introduction to Electrodynamics (3rd. Edition). Prentice Hall International (1999).

Online Resources

Relevant course materials will be made available online through the Virtual Campus

Methodology

On-campus teaching 100% (Scenario 0)

Theory and problem classes

Semi-online teaching (Scenario 1)

Classes will be given with the established schedule and only one of the two sub-group of the classes is allowed in the classroom. The rest of students will attend classes from remote. A rotation of the sub-group is assumed. The online classes are transmitted with Google Meet or similar devices available in the Faculty. The classes can use slides, electronic blackboard, traditional blackboard. There exists the possibility that some material is pre-registered and successively put available to students by the Virtual Campus. In the latter case classes are mainly devoted to problem resolution, practical sessions etc. It is possible to use videos of the subject from internet as support for classes.

Online teaching (Scenario 2)

The class material is provided through the Virtual Campus including the content and problems to be discussed in the course. Online session will be done with Google Meet or similar devices available in the Faculty. Online session will be announced in advance in the Virtual Campus. The content of classes can include theory and problem resolution. It is possible to show videos from internet to support classes.

Evaluation Criteria		
Exams	**Weight:**	70%
Final Exam		
Other Activities	**Weight:**	30%
Other activity include: Resolution of problems, participation to classes, seminars, tutorship assistance, oral presentations of homeworks		
Final Mark		
If the mark of the final exam is less or equal to 3.5/10, that will be the final mark. In any case the final mark will not be inferior to the one obtained in the final exam. The final mark is calculated in the same way in all exam sessions.		