SUBJECT TEACHING GUIDE

G51 - Electricity and Magnetism

Double Degree in Physics and Mathematics
Degree in Physics

Academic year 2024-2025

1. IDENTIFYING DATA					
Degree	Double Degree in Physics and Mathematics Degree in Physics			Type and Year	Compulsory. Year 2 Compulsory. Year 2
Faculty	Faculty of Sciences				
Discipline	Subject Area: Electromagnetism and Optics Central Module				
Course unit title and code	G51 - Electricity and Magnetism				
Number of ECTS credits allocated	6	Term		Semester based (2)	
Web					
Language of instruction	Spanish	English Friendly	Yes	Mode of delivery	Face-to-face

Department	DPTO. FISICA APLICADA
Name of lecturer	ERNESTO ANABITARTE CANO
E-mail	ernesto.anabitarte@unican.es
Office	Facultad de Ciencias. Planta: + 3. DESPACHO (3031)
Other lecturers	

3.1 LEARNING OUTCOMES

- Be able to calculate directly Electric and Magnetic fields generated by charge distributions and current densities respectively
  Be able to determinate Electric and Magnetic fields by means of the Gauss theorem and the integral law of Ampere , when geometrical symmetry exists.
- Be able to describe the macroscopic behavior of conductors, dielectrics, magnetic materials and superconductors in the presence of electric and magnetic fields
- Understanding the Multipole Expansion of the Scalar Potential and the Vector Potential .
  Be able to calculate the electric dipole moment and the components of the electric quadrupole moment tensor for simple continuous charge distributions.
  Be able to calculate the magnetic dipole moment for simple current densities.

4. OBJECTIVES
To learn the basics of Electromagnetic Theory from a macroscopic viewpoint.
To learn the field concept and its utility in Physics.
To learn the historical, phenomenological and macroscopic approach to the Electromagnetic Theory in order to facilitate the compression of the experimental nature of Physics.
To learn rigor and mathematical formalism of Electromagnetism to acquire training in the language of Physics
Knowing and understanding the Maxwell equations in differential and integral form

6. SUBJECT PROGRAM	
CONTENTS	
1	VECTOR ANALYSIS Scalars and Vectors.- Vector operations.- Gradient, Divergence and Curl.-The Divergence Theorem.- Stokes' Theorem.- The Helmholtz Theorem.- Curvilinear Orthogonal Coordinates.- Field lines.- Classification fields.
2	ELECTRIC FIELD Electric Charge: conservation and quantization.- Coulomb's law.- Superposition principle.- electric field.- Charge distributions.- Fundamental equations of the electric field.- Integral form of the field equations.- Gauss's law
3	ELECTRIC POTENTIAL. Electrostatic Potential.- Charge distributions.- Poisson's Equation.- Laplace's equation.- Field lines and equipotential surfaces
4	CONDUCTORS. Conductors and insulators.- Conductors in equilibrium.- Electric field at the surface of a conductor.- Electrostatic pressure.- Systems of Conductors: coefficients of potential, coefficients of capacity and influence.- Electric shielding.- Capacity.- Capacitors
5	DIELECTRICS. The multipole expansion of the scalar potential.- The electric dipole field.- The linear quadrupole field.- Polarization.- Bound charge densities.- The D field.- Classification of dielectrics.- Electric breakdown field.-Boundary conditions.- The electric field within a dielectric (*)
6	ELECTROSTATIC ENERGY Energy of a system of charges.- Energy of a system of conductors.- Energy in terms of the electric field.- Electrostatics forces on conductors.- An electric dipole in a external field.- Forces between rigid dipoles
7	ELECTRIC CURRENTS. Electric current.- Current densities.- The equation of continuity.- Ohm' law: conductivity.- Electromotive force.- Joule's effect.- Kirchoff's laws.- Boundary conditions.- A Microscopic point of view.- The attainment of electrostatic equilibrium
8	THE MAGNETIC FIELDS OF STATIONARY CURRENTS. Interactions between currents: Ampere's law.- Magnetic induction.- Biot-Savart law.- Fundamental equations of the Magnetostatics.- The integral form of Ampere's law.- Field of a point charge moving with constant velocity.- Lorentz force
9	THE VECTOR POTENTIAL. Definition of the vector potential.- The multipole expansion of the vector potential.- The magnetic dipole moment
10	MAGNETISMIN THE PRESENCE OF MATTER. Magnatization.- Magnetization current densities.- Th H field.- The magnetic scalar potential.- Magnetic poles.- Linear, isotropic, homogeneous magnetic materials.- Ferromagnetic materials: the hysteresis loop
11	ELECTROMAGNETIC INDUCTION. Faraday's law. - The induced electric field.- Mutual inductance.- The case of two solenoids.- Electric generator.- Electric motor.- Transformer.- Eddy currents.- Superconductivity.- The Meissner effect
12	MAGNETIC ENERGY. Energy of a System of free currents.- Energy in terms of the Magnetic induction.- Energy and forces on magnetic dipoles.- Hysteresis losses
13	ELECTROMAGNETIC FIELD. The displacement current.- Maxwell's equations.- Maxwel's equations for linear, isotropic, homogeneous media.- The Poynting theorem.- The wave equation
14	Exam nº1. Lessons 1- 6.
15	Exam nº2 Lessons 7 - 13 .

7. ASSESSMENT METHODS AND CRITERIA

Description	Type	Final Eval.	Reassessn	%
Problems due + Oral presentations 20%.	Others	No	Yes	20,00
Exam nº1 Lessons 1-6 40%.	Written exam	No	Yes	40,00
Exam nº2 Lessons 7-13 40%.	Written exam	No	Yes	40,00
TOTAL				100,00

Observations

ORDINARY EXAM SESSION
The course can be passed before the final exam.
Exam No. 1 is a final exam. A mark equal to or higher than 4 will be required.
Exam No. 2 is a subject exam. A mark of 4 or higher is required for this exam.
Students who meet the above conditions (mid-term exams equal to or higher than 4) must obtain a grade equal to or higher than 5 (averaging the mid-term exams and the proposed problems with their corresponding weights) to pass the course.

Students who do not pass by continuous assessment may sit the exam in the ordinary exam session established by the centre for the final exam of the subject. In this exam there will be no minimum grade for any of the separate parts, although the subject as a whole is passed with a grade equal to or higher than 5.

Students may apply for a higher mark in the final exam. The mark of the final exam will be applied if it improves the mark of the continuous assessment. If the mark is lower, the average mark of the final exam and the continuous

Those students who do not pass by continuous assessment can take an additional exam on the date established by the center for the final exam of the subject.In this exam there will be no minimum mark for any of the separate parts, although the subject as a whole is passed with a mark equal to or higher than 5
Students may apply for a higher mark in the final exam. The mark of the final exam will be applied if it improves the mark of the continuous assessment. If the mark is lower, the average mark of the final exam and the continuous assessment mark will be applied. In any case, the final mark will not be less than 5.

EXTRAORDINARY EXAMS. Students who do not pass the course in the ordinary exam will have an extraordinary exam similar to the final exam in June and whose value will be up to 80% of the final grade. The other 20% corresponds to the non-recoverable part obtained during the course.

However, as established in the exam regulations, students may opt for the exam to account for 100% of the mark.

Observations for part-time students

Not applicable in this case

8. BIBLIOGRAPHY AND TEACHING MATERIALS

BASIC

R.K. Wangsness. Campos electromagnéticos.Limusa [1996]

J.R. Reitz, F.J. Milford and R. W. Christy Fundamentos de la Teoría Electromagnética.Addison-Wesley Iberoamericana [1996]

Edward M. Purcell and David J. Morin. Electricity and Magnetism Cambridge University Press (3ª Ed. 2013)

Colección de problemas y cuestiones suministrados por el profesor

Los tres libros recomendados como bibliografía básica cubren ampliamente los contenidos de la asignatura y cualquiera de ellos es un buen libro de referencia de la misma