

## SUBJECT TEACHING GUIDE

### G2100 - Electromagnetism I

#### Double Degree in Physics and Mathematics Degree in Physics

Academic year 2025-2026

1. IDENTIFYING DATA					
Degree	Double Degree in Physics and Mathematics Degree in Physics			Type and Year	Compulsory. Year 3 Compulsory. Year 2
Faculty	Faculty of Sciences				
Discipline					
Course unit title and code	G2100 - Electromagnetism I				
Number of ECTS credits allocated	6	Term	Semester based (1)		
Knowledge Field	Physics and astronomy				
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.anabitarate@unican.es				
Office	Facultad de Ciencias. Planta: + 3. DESPACHO (3031)				
Other lecturers	JOSE ANGEL MIER MAZA				

4. OBJECTIVES
To learn the basics of electromagnetic theory in a vacuum
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
Understand and be able to apply Maxwell's equations in their differential and integral forms to solve basic electromagnetic problems.

6. SUBJECT PROGRAM	
CONTENTS	
1	VECTOR ANALYSIS Scalars and Vectors Fields.- Gradient, Divergence and Curl.-The Divergence Theorem.- Stokes' Theorem.- The Helmholtz Theorem.- Curvilinear Orthogonal Coordinates.- Classification fields.
2	ELECTRIC FIELD AND POTENTIAL Electric Charge: conservation and quantization.- Coulomb's law.- Principle of superposition.- electric field.- Charge distributions.- Fundamental equations of the electric field.- Integral form of the field equations.- Gauss's law.- Electric potential. -Poisson and Laplace equations
3	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
4	ELECTROSTATIC ENERGY Energy of a system of charges.- Energy of a system of conductors.- Energy in terms of the electric field.- Energy of a system of conductors.- Forces and moments on a system of conductors at equilibrium.
5	ELECTRIC CURRENTS. Electric current.- Current densities.- The equation of continuity.- Ohm' law: conductivity.- Electromotive force.- Joule's effect.- A Microscopic point of view.- The attainment of electrostatic equilibrium
6	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.- The Vector Potential
7	ELECTROMAGNETIC INDUCTION. Faraday's law. - The induced electric field.- Inductance.- The case of two solenoids.- Electric generator.- Electric motor.- Transformer.- Eddy currents.- Magnetic energy in systems of stationary currents - Magnetic field energy - Magnetic forces on circuits
8	ELECTROMAGNETIC FIELD. The displacement current.- Maxwell's equations.- The Poynting theorem.- Electromagnetic Momentum.- The wave equation
9	CHARGED PARTICLE MOTION Uniform E and B fields. - Non-uniform B field - Non-uniform E field - Time-varying E field - Time-varying B field - Time-varying B field
10	Written test no. 1 Around week 7 a written test will be given on the contents of lessons 1-4.
11	Written test no. 2 Around week 14 a written test will be given on the contents of lessons 5 - 9.

7. ASSESSMENT METHODS AND CRITERIA				
Description	Type	Final Eval.	Reassessn	%
Problems due + Oral presentations 15%.	Others	No	Yes	15,00
Exam nº1 Lessons 1-4 40%.	Written exam	No	Yes	40,00
Exam nº2 Lessons 5-9 45%.	Written exam	No	Yes	45,00
<b>TOTAL</b>				<b>100,00</b>
<b>Observations</b>				
<p><b>ORDINARY EXAM SESSION</b>            The subject can be passed before the final exam.            Exam #1 exempts material. A grade equal to or higher than 4 is required.            Exam #2 exempts material. A grade equal to or higher than 4 is required.            Students who meet the above conditions (grades of 4 or higher on partial exams) must achieve a grade equal to or higher than 5 (averaging partials and proposed problems weighted accordingly) to pass the subject.</p> <p>Students who do not pass through continuous assessment may take the regular session exam established by the school for the final exam of the subject. There is no minimum grade required for any part of this exam separately, although the subject as a whole is passed with a grade equal to or higher than 5.</p> <p>Students may take the final exam to improve their grade. The final exam grade will be applied if it improves the continuous assessment grade. If it is lower, the average between the final exam grade and the continuous assessment grade will be applied. In any case, the final grade will not be lower than 5.</p> <p><b>EXTRAORDINARY SESSION EXAM.</b>            Students who do not pass the subject in the regular session will have an extraordinary exam similar to the June final exam, which will count for up to 85% of the final grade. The remaining 15% corresponds to the non-recoverable part obtained throughout the course.            However, as established by the examination regulations, the student may choose to have the exam that counts for 100% of the grade</p>				
<b>Observations for part-time students</b>				
Not applicable in this case				

8. BIBLIOGRAPHY AND TEACHING MATERIALS
<b>BASIC</b>
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