Universitat Autònoma de Barcelona

2020/2021

Electromagnetism

Code: 100149
ECTS Credits: 10

Degree	Type	Year	Semester
2500097 Physics	OB	2	A

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Teachers

Joan Costa Quintana
Nuria del Valle Benedi

Prerequisites

It is advisable to have passed the subject Electricity and Magnetism of the first course of Physics.

Objectives and Contextualisation

Have a basic knowledge of the electromagnetic field, from electrostatics and magnetostatics (in vacuum and in material media) to electromagnetic induction and Maxwell's equations.

To be able to calculate various solutions of Maxwell's equations, including electromagnetic waves and their propagation.

Competences

- Develop strategies for analysis, synthesis and communication that allow the concepts of physics to be transmitted in educational and dissemination-based contexts
- Formulate and address physical problems identifying the most relevant principles and using approximations, if necessary, to reach a solution that must be presented, specifying assumptions and approximations
- Know the fundamentals of the main areas of physics and understand them
- Make changes to methods and processes in the area of knowledge in order to provide innovative responses to society's needs and demands.
- Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments

- Use mathematics to describe the physical world, selecting appropriate tools, building appropriate models, interpreting and comparing results critically with experimentation and observation
- Work independently, have personal initiative and self-organisational skills in achieving results, in planning and in executing a project

Learning Outcomes

1. Correctly handle vector calculus.
2. Describe electrostatic phenomena.
3. Describe magnetostatic phenomena.
4. Describe phenomena that involve time-dependent electromagnetic processes.
5. Formulate and solve mathematical problems concerning electrostatic phenomena.
6. Formulate and solve mathematical problems on electromagnetic phenomena that involve time-dependent processes.
7. Identify situations in which a change or improvement is needed.
8. Solve complex problems of an electromagnetic nature from the establishment of hypotheses that, even being approximate, contain the essence of physics in the original problem.
9. Translate specific physical problems of electromagnetic nature to a mathematical formulation that allows subsequent resolution, either exact or approximate.
10. Transmit, orally and in written format, physical concepts of a certain complexity, making them understandable to non-specialist settings.
11. Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
12. Work independently, take initiative itself, be able to organize to achieve results and to plan and execute a project.

Content

1. Vector analysis

Vector algebra.- Gradient.- Divergence.- Theorem of divergence.- Curl.- Stokes theorem.- Helmholtz theorem.- Vectors in curvilinear coordinates. Gradient, divergence and curl in curvilinear coordinates

2. Electrostatics

Electrical charge and Coulomb law.- Electric field: divergence and curl.- Electrical potential: Poisson and Laplace equations.- Systems of conductors: capacitors.- Energy of a distribution of charges.- Energy of a system of charged conductors .

3. Electrostatics in dielectrics

Multipolar development.- Electric dipole.- Field created by a dielectric.- Vector displacement.- Electrical susceptibility and dielectric constant.- Boundary conditions.- Energy dependence on the field.

4. Magnetostatics

Electric current: Ohm's law.- Continuity equation.- Force between circuits.- Magnetic induction: Biot and Savart's law.- Lorentz force.- Curl of B: Ampere law.- Divergence of B.- Potential vector

5. Magnetism in media

Multipolar development.- Magnetic dipole.- Field created by a magnetic material.- Magnetic strength H.- Types of magnetic materials.- Boundaryconditions.

6. Fields slowly varying

Electromagnetic induction: Faraday law.- Mutual inductance and selfinductance.- Magnetic energy of coupled circuits.- Energy based on the field.

7. Electromagnetic fields

Displacement current.- Maxwell's equations.- Boundaryr conditions.- Unicity of the solution.- Scalar potential and vector potential.- Wave equations for V and A.- Retarded potentials.- Electromagnetic energy.

8. Electromagnetic waves

Wave equation for E and H.- Planar monochromatic wave.- Electromagnetic spectrum.- Waves in a conductor.- Wave guides.

Methodology

Classes of theory and problems.

In addition, the students will have to do practical exercises in the form of independent problems.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Problems and practical cases	28	1.12	2, 3, 4, 5, 6, 1, 11, 8, 9
Theory classes	55	2.2	2, 3, 4, 5, 6, 1, 11, 9
Type: Autonomous			
Study and solution of problems and practical cases	154.5	6.18	2, 3, 4, 5, 6, 1, 11, 8, 9, 10

Assessment

Theory: Tests of short duration, after the first 7 chapters to know and understand the fundamentals of electromagnetism.

Practice: Problems made individually.

The first problem will be done at the end of the first semester.

The second problem will be done at the end of the second semester.

In addition, there will be delivery of problems during the course.

Written exam in June.

Recovery exam: There will be a written synthesis exam, of the whole subject with a maximum of 10 points. The student may be admitted to the recovery exam whenever he/she has been submitted to a set of activities that represent a minimum of two thirds of the total grade of the subject.

For repeating students, from the second enrollment,they can take the recovery exam without the above requirement.

All the tests will have to be done in the group where the student is enrolled.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Brief exams after the first 7 chapters	40%	2	0.08	2, 3, 4, 5, 6, 1, 11, 8, 9, 10
Delivery of problems during the course	6%	2.5	0.1	2, 3, 4, 5, 1, 11, 8, 9
Exams recovery	up to 100%	3	0.12	2, 3, 4, 5, 6, 7, 1, 11, 8, 9, 10, 12
Individual problems	20%	2	0.08	2, 3, 4, 5, 6, 1, 11, 8, 9
Written exam in June	34%	3	0.12	2, 3, 4, 5, 6, 7, 1, 11, 8, 9, 12

Bibliography

Theory books

1. J. Costa Quintana y F. López Aguilar, *Interacción electromagnética. Teoría clásica*, (Reverté 2007). ISBN: 978-84-291-3058-4.
2. R.P. Feynman, R.B. Leighton y M. Sands, Feynman. *Física. Vol. II (Addison-Wesley Iberoamericana, 1987)*. ISBN: 0-201-06622-X
3. P. Lorrain y D.R. Corson, *Campos y Ondas Electromagnéticos* (Selecciones Científicas, 1990). ISBN: 84-85021-29-0
4. J. R. Reitz, F. J. Milford, y R. W. Christy, *Fundamentos de la Teoría Electromagnética*, (Addison-Wesley Iberoamericana, 1996). ISBN: 0-201-62592-X
5. R. K. Wangsness, *Electromagnetic fields*, (John Wiley & Sons, 1986, 2nd edition) ISBN: 0-471-81186-6; *Campos electromagnéticos*, (Limusa, 1989).ISBN: 968-18-1316-2.

Problems books

1. E. Benito; *Problemas de campos electromagnéticos*, (AC, 1984) ISBN: 84-7288-007-9
2. J.A. Edminister; *Electromagnetismo* (McGraw-Hill, 1992). ISBN: 970-10-0256-3
3. J.M. De Juana Sardón y M.A. Herrero García; *Electromagnetismo* (Paraninfo 1993) ISBN: 84-283-1992-8
4. E. López Pérez y F. Núñez Cubero; *100 problemas de electromagnetismo*, (AlianzaEditorial, 1997) ISBN: 84-206-8635-2