Universitat Autònoma de Barcelona

2022/2023

General Physics: Electricity and Magnetism

Code: 103271
ECTS Credits: 7

Degree	Type	Year	Semester
2501922 Nanoscience and Nanotechnology	FB	1	2

Contact

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Use of Languages

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

Teachers

Enric Menendez Dalmau

Prerequisites

High school level in physics and mathematics is highly recommended.

Objectives and Contextualisation

1. To describe the vectorial nature of the electric field and its relation with the scalar potential.

2. To understand the Gauss law, its generality and its relation with the Coulomb's law. Use both to calculate electric fields.

3. To describe the vectorial nature of the static magnetic fields. To be able of calculating the magnetic field using Biot-Savart's law and/or Ampere's law.

4. To relate electric and magnetic fields in the domain of applicability of the Faraday's law.

5. To understand the devices that use electromagnetism, especially the different circuit types both ac and dc current cases.

6. To know the Maxwell Equations and the electromagnetic nature of light.

Competences

- Apply the concepts, principles, theories and fundamental facts of nanoscience and nanotechnology to solve problems of a quantitative or qualitative nature in the field of nanoscience and nanotechnology.
- Apply the general standards for safety and operations in a laboratory and the specific regulations for the use of chemical and biological instruments, products and materials in consideration of their properties and the risks.
- Communicate orally and in writing in one's own language.

- Demonstrate knowledge of the concepts, principles, theories and fundamental facts related with nanoscience and nanotechnology.
- Handle the standard instruments and materials of physical, chemical and biological testing laboratories for the study and analysis of phenomena on a nanoscale.
- Interpret the data obtained by means of experimental measures, including the use of computer tools, identify and understand their meanings in relation to appropriate chemical, physical or biological theories.
- Learn autonomously.
- Manage the organisation and planning of tasks.
- Obtain, manage, analyse, synthesise and present information, including the use of digital and computerised media.
- Reason in a critical manner
- Recognise and analyse physical, chemical and biological problems in the field of nanoscience and nanotechnology and propose answers or suitable studies for their resolution, including when necessary the use of bibliographic sources.
- Recognise the terms used in the fields of physics, chemistry, biology, nanoscience and nanotechnology in the English language and use English effectively in writing and orally in all areas of work.
- Resolve problems and make decisions.
- Work on the synthesis, characterisation and study of the properties of materials on a nanoscale from previously established procedures.

Learning Outcomes

1. "Formulate and address physical problems; identify relevant physical principles, and use estimates of order of magnitude and special limit cases to reach a solution and present the assumptions and approaches."
2. Apply the acquired theoretical contents to the explanation of experimental phenomena.
3. Communicate orally and in writing in one's own language.
4. Correctly handle common measurement instruments in a physics laboratory.
5. Correctly use the basic terminology in the field of classical physics.
6. Critically evaluate experimental results and deduce their meaning.
7. Describe the operation of simple devices that operate by electromagnetism, especially those with direct or alternating currents.
8. Describe the vectorial nature of a static magnetic field and understand Biot and Savart's law and Ampere's law.
9. Describe the vectorial nature of the electrical field and its relation with scalar potential.
10. Identify and situate safety equipment in the laboratory.
11. Learn autonomously.
12. Manage the organisation and planning of tasks.
13. Obtain, manage, analyse, synthesise and present information, including the use of digital and computerised media.
14. Perform basic analysis procedures of a physics laboratory.
15. Perform bibliographic searches for scientific documents.
16. Rationalise the results obtained in the laboratory in terms of physical magnitudes and their relation with the observed physical phenomena.
17. Reason in a critical manner
18. Recognise Gauss's law, its general use, and its relation with Coulomb's law.
19. Resolve electromagnetic problems using Maxwell's equations.
20. Resolve problems and make decisions.
21. Resolve problems with the help of the provided complementary bibliography.
22. Use Gauss's and Coulomb's laws to calculate stationary electric fields
23. Use the Biott-Savart and Ampere laws to calculate stationary magnetic fields.

Content

THEORETICAL CONTENTS

- Electrostatics: Electric charge and Coulomb's law. Electric field. Discrete and continuous charge distributions. Electric potential. The energy of a charge distribution. Conductors.

- Magnetostatics: Electric current. Ohm's law. Magnetic induction field: Biot-Savart's law. Lorentz force. Ampere's law. Displacement current.

- Materials: Electric dipole and magnetic dipole. Dielectrics. Polarization. Dielectric constant. Magnetic materials. Magnetization. Types of magnetic materials.

- Slowly varying fields: Electromotive force. Electromagnetic induction: Faraday's law. Mutual and self-inductance. Transformers. The magnetic energy of coupled circuits.

- Electric circuits: RC, RL and RLC circuits.

- Electromagnetic waves: Maxwell equations. Electromagnetic waves. Electromagnetic spectra.

Practicum (could be at the laboratory, or at home, with virtual and/or technical support):

-AC/DC circuits.

-Coulomb's force.

-Induction.

Methodology

Guided activities:

- ***Basis Theory:*** the lecturer will give the basic concepts in each chapter, in an ordered way, providing the needed written material and the indications for complementing the study with the bibliography and other resources (preferably virtual). The classroom classes will be devoted mainly to solve the doubts and to the orientation in the study of the most relevant aspects of the subject.

- Problem lectures: The problems lecturers will explain, and provide with the needed material, how to solve the typical problems of each part. Also, they will provide the necessary material and/or indications for completing the study with the bibliography and extra resources (preferably virtual). The classroom classes will be devoted mainly to solve doubts and to emphasize the key points in the problem-solving process.

- Laboratory work: several practices will be done during the course. They could be made at the faculty labs or directly at home with the minimum necessary presence in the labs. Some practices could be done virtually, using "virtual labs" to make the experiments.

Supervised activities:

- Personal (small group) work: during the students' attention time, the lecturers will be available to solve individual questions.

Autonomous activities:

- ***Preparation of lectures:*** students have to prepare the lectures, checking the virtual campus for the provided material.

- Preparation of practice work: students have to prepare the practice work, following the indications, and doing the tasks that will be given on the virtual campus.

- ***Solving problems:*** students have to solve the problems of the list given by the lecturers, independently of the problem classes done. The classroom classes will be used basically for solving the doubts that could have been emerged and to indicate the key points in the resolution.

- Study and preparation of exams: Personal work of the student to acquire the theoretical concepts as well as the ability to solve the problems.

- Preparation of the lab reports.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Practice work	13	0.52	11, 3, 14, 12, 10, 4, 13, 16, 17, 20
Problems lectures	17.5	0.7	2, 11, 6, 15, 13, 17, 21, 19, 20, 23, 22
Theoretical lectures	31.5	1.26	7, 9, 8, 18
Type: Supervised			
Personal (small group) work	17.5	0.7	2, 11, 6, 3, 7, 9, 8, 14, 15, 12, 10, 4, 13, 16, 17, 18, 21, 19, 20, 23, 22
Type: Autonomous			
Bibliographic work	5.25	0.21	15
Laboratory guide's reading	3.5	0.14	11, 14, 15, 10, 16, 17, 21
Laboratory report's preparation	8.75	0.35	11, 3, 14, 12, 10, 13, 16, 20
Preparation of lectures	10	0.4	7, 9, 8, 18
Solving problems + group solving problems	35	1.4	2, 11, 6, 3, 15, 12, 17, 21, 19, 23, 22
Study and preparation of exams	25	1	2, 11, 6, 7, 9, 8, 15, 17, 18, 21, 19, 23, 22

Assessment

The final grade of the course will be obtained using the following proportions:

- 80% Grade of the two partial exams (40% each).

- 20% Grade of laboratory practice and practice exam (can include reports, lab work, written exam, ...).

- The problems and delivered activities will be used to improve the marks.

Only if the overall score obtained after the application of these percentages is equal to or higher than 5.0 (out of 10), the subject can be passed. However, in order to apply these percentages, the score (out of 10) of each of the partial exams must be equal to or higher than 3.5 and all the laboratory work must have been carried out. In the case that in one or both of the partial exams, the mark is lower than 3.5, the student will have to take the retaking exam of the part that has been failed with a mark lower than 3.5.

Laboratory reports and delivered problems cannot be retaken.

UAB Regulations: To be able to retake partial exams, the student must have previously been evaluated in a set of activities the weight of which is equivalent to a minimum of two-third parts of the total qualification of the subject.

Each partial exam will be retaken independently through a new exam. The mark of the retake exam will replace the mark of the corresponding partial exam.

Students who have been evaluated only 1/3 or less of the total subject will be considered "Not Evaluable".

UAB Regulations: In the event that the student realizes any irregularity that might lead to a significant variation in the qualification of some evaluation activity, he or she will qualify with 0 this evaluation activity, irrespective of the disciplinary process that could be started. If there are several irregularities in the evaluation of the same subject, the final qualification of this subject will be 0.

Any plagiarism (total or partial), copying or attemptedcopying, letting oneself be copied, etc., in any of the evaluable activities will be considered "irregularities leading to a significant variation in the qualification".

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
1st Partial Exam	40%	4	0.16	1, 2, 3, 7, 9, 8, 17, 18, 19, 5, 23, 22
2nd partial exam	40%	4	0.16	1, 2, 7, 9, 8, 17, 18, 19, 20, 5, 23, 22
Evaluation other activities	0% (see details)	0	0	2, 11, 6, 3, 15, 12, 13, 17, 21, 19, 20, 23, 22
Laboratory report evaluation	20%	0	0	2, 11, 3, 14, 15, 12, 10, 4, 13, 16, 17, 20
Retake Exam	Up to 80%	0	0	1, 11, 3, 7, 9, 8, 17, 18, 19, 20, 5, 23, 22

Bibliography

P. A. Tipler, G. Mosca, *Physics: for scientists and engineers*. W. H. Freeman Company. 6a edició (2008).

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F. W. Sears, M. W. Zemansky, H. D. Young, R. A. Freedman. *Física Universitaria*. Addison-Wesley. 12a edició (2009).

R. P. Feynman, R. B. Leighton, M. Sands, *The Feynman lectures on physics*. Addison-Wesley. 6à impressió (1977).

R. A. Serway, *Física para ciencias e ingenierías*. International Thompson. 6a edició (2005).

R. K. Wangsness, *Campos electromagnéticos*. Ed. Limusa (1983).

Software

No specific software is needed.