COURSE DATA

Data Subject	
Code	34256
Name	Electromagnetism II
Cycle	Grade
ECTS Credits	6.0
Academic year	2021 - 2022

Study (s)

Degree	Center	Acad. year	Period
1105 - Degree in Physics	Faculty of Physics	3	Second term

Subject-matter

Degree	Subject-matter	Character
1105 - Degree in Physics	11 - Electromagnetism	Obligatory

Coordination

Name	Department
CANTARERO SAEZ, ANDRES	175 - Applied Physics and Electromagnetism
GARCIA CRISTOBAL, ALBERTO	175 - Applied Physics and Electromagnetism

SUMMARY

The subject Electromagnetism II is a subject matter of the third year of the Bachelor's Degree in Physics, being imparted along the second term of the academic year. This subject is a part of the more general matter “Electromagnetism” and has 6 ECTS credits (about 45 hours of theoretical and practical presential classes, 15 hours of presential supervised work and 90 hours of home work).

The descriptors for this course are: electrostatic and magnetostatic fields in matter, Maxwell's equations and electromagnetic waves in matter, the electromagnetic energy and momentum, circuit theory of localized and distributed parameters, waveguides and cavities.

This course aims to give an overview of the electromagnetic interaction in matter, presented as a field theory. This implies the need of an introduction to the properties of polarization and magnetization of matter. The electromagnetic energy and momentum will be also studied, being formulated from conservation principles in the frame of a purely electromagnetic interaction. Finally, another object of study will be the circuit theory of localized and distributed parameters, the guided propagation of electromagnetic waves and the solution of the Maxwell equations in cavities.

The relationship of this subject with other subjects in the degree in Physics is evident through his own content. The consequences of the electromagnetic interaction are studied in the subject Mechanics. The analysis of wave solution of Maxwell's equations requires the knowledge obtained in Oscillations and Waves and constitutes the basis of Optics. The mathematical tools needed to solve Maxwell's equations are studied in different Mathematical Methods subjects. Finally, the study of electromagnetic interaction with matter and its consequences directly affects the subject Laboratory of Electromagnetism and other subjects that will be studied later as the Solid State Physics and Semiconductor Physics. As well, circuit theory and guided conduction will constitute the necessary basis to study other subjects such as Electromagnetic Waves and Electronics.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

To have completed subjects of the first and second year, especially: Physics, Calculus, Mechanics, Oscillations and Waves and Mathematical Methods. To have completed the subject Electromagnetism I.

OUTCOMES

1105 - Degree in Physics

- Knowledge and understanding of the fundamentals of physics in theoretical and experimental aspects, and the mathematical background needed for its formulation.
- To know how to apply the knowledge acquired to professional activity, to know how to solve problems and develop and defend arguments, relying on this knowledge.
- Problem solving: be able to evaluate clearly the orders of magnitude in situations which are physically different, but show analogies, thus allowing the use of known solutions in new problems .
- Theoretical understanding of physical phenomena: have a good understanding of the most important physical theories (logical and mathematical structure, experimental support, described physical phenomena).
- Be able to understand and master the use of the most commonly used mathematical and numerical methods.
- Modelling & Problem solving skills: be able to identify the essentials of a process / situation and to set up a working model of the same; be able to perform the required approximations so as to reduce a problem to an approachable one. Critical thinking to construct physical models.
- Physics general culture: Be familiar with the most important areas of physics and with those approaches which span many areas in physics, or connections of physics with other sciences.

- Foreign Language skills: Have improved command of English (or other foreign languages of interest) through: use of the basic literature, written and oral communication (scientific and technical English), participation in courses, study abroad via exchange programmes, and recognition of credits at foreign universities or research centres.
- Learning ability: be able to enter new fields through independent study, in physics and science and technology in general.
- Communication Skills (written and oral): Being able to communicate information, ideas, problems and solutions through argumentation and reasoning which are characteristic of the scientific activity, using basic concepts and tools of physics.
- Students must have acquired knowledge and understanding in a specific field of study, on the basis of general secondary education and at a level that includes mainly knowledge drawn from advanced textbooks, but also some cutting-edge knowledge in their field of study.
- Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.
- Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.
- Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.
- Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.

LEARNING OUTCOMES

At the end of the course the student should have competences that allow to him/her:

- Learn to solve simple problems in electrostatics and magnetostatics in the presence of matter, applying correctly the boundary conditions.

- Know how to determine correctly the basic properties of plane waves in matter from the corresponding dielectric constant, conductivity and magnetic permeability.

- Know how to calculate the electrostatic and magnetostatic energy of the electromagnetic field in simple systems: distributions of electric charge and current.

- Know how to calculate the action of a stationary electromagnetic field on an electric or magnetic dipole.

- Know how to apply the conservation theorems of energy and momentum in simple electromagnetic systems.

- Be able to determine transients in simple circuits and solve AC circuits by using Kirchhoff's laws and the fundamental theorems of the circuit theory.

- Be able to deduce the distributed parameters of a simple transmission line.

- Be able to deduce the transmission modes of waveguides and cavities.

DESCRIPTION OF CONTENTS

1. The electromagnetic field in the material media

1.1. Introduction. The influence of material media on the fields.
1.2. The microscopic fields. The Maxwell's microscopic equations.
1.3. The macroscopic fields. General approach.
1.4. Phenomenological description of electric polarization.
1.5. Phenomenological description of magnetization.
1.6. The constitutive relations of the material media.
1.7. Discontinuities of the electromagnetic field at the interface between two media.

2. Electromagnetic waves in material media

2.1. Introduction.
2.2. The wave equation in the material media.
2.3. Plane monochromatic electromagnetic waves.
2.4. Reflection and transmission of electromagnetic waves on the interface between two media.
2.5. Electromagnetic waves in an ideal insulating medium.
2.6. Electromagnetic waves in an insulating medium with losses.
2.7. Electromagnetic waves in a conducting medium. Skin effect.

3. The electrostatic energy

3.1. Introduction.
3.2. Electrostatic energy of a system of point charges.
3.3. Electrostatic energy of a charge distribution. Energy density
3.4. Electrostatic energy in the presence of material media. Polarization energy.
3.5. The electrostatic force. Action of a field on an electric dipole.

4. The magnetic energy

4.1. Introduction.
4.2. Magnetic energy of a system of filamentary current loops.
4.3. Magnetic energy of a current distribution. Magnetic energy density.
4.4. The magnetic energy in the presence of material media. Magnetization energy
4.5. The magnetic force. Action of a field on a magnetic dipole.

5. The electromagnetic energy and momentum

5.1 Introduction.
5.2 Poynting's theorem. Poynting vector.
5.3 Poynting theorem for harmonic fields.
5.4 The electromagnetic momentum. Maxwells tensor.

6. Transmission lines, waveguides and resonant cavities

6.1. Introduction.
6.2. Transmission lines.
6.3. Guiding of electromagnetic waves in systems with translation symmetry.
6.4. Propagating modes of a conductive waveguide: TE and TM modes.
6.5. Propagation properties in a waveguide.
6.6. The rectangular conductive waveguide.
6.7. Dielectric waveguides.
6.8. The rectangular cavity: quality factor.

7. Circuit theory

7.1. Introduction.
7.2. Theorems of circuit theory.
7.3. Power in alternating current.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	45,00	100
Tutorials	15,00	100
Study and independent work	35,00	0
Preparation of evaluation activities	15,00	0
Preparing lectures	10,00	0
Preparation of practical classes and problem	20,00	0
Resolution of case studies	10,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The course will consist of: (i) Theoretical and practical classes, (ii) tutorized work.

In the classes of type (i), basic theoretical contents joined to model problems that illustrate this theory will be taught (with a proportionality of about 2 h theory/1 h problems). PowerPoint presentations could be used, including graphs, drawings, videos and animations, combined with discussions/presentations on the blackboard. These slides will be available to students in the Virtual Classroom.

Additionally, in these types of classes simple practical demonstrations may be presented, including particularly relevant examples, applets, simulations, etc. that allow the illustration of some of the phenomena explained. Likewise, the student will be encouraged and guided to expand the content received in this type of class through recommended readings.

In the classes of type (ii) different problems will be set and solved in small groups by means of a tutorial system. Students will be asked in the same classroom to explain the resolution of problems not solved in the theoretical classes, or to hand over solved problems provided in advance as homework.

EVALUATION

The assessment system is as follows:

1) Written examinations: One part (50%) will assess the understanding of the theoretical-conceptual and formal nature of the subject, both through theoretical questions, conceptual questions and numerical or simple particular cases. Another part (50%) will assess the applicability of the formalism, by solving problems and critical capacity regarding the results. Proper argumentations and adequate justifications will be important in both cases.

To pass the subject, it is necessary to obtain at least a mark of 3.5/10 in the evaluation of the written examinations.

2) Continuous assessment: assessment of exercices and problems presented by students, questions

proposed and discussed in class, oral presentation of problems solved or any other method that involves an interaction with students.

A regular and participative attendance to the classes is necessary to have the right to a continuous assessment mark.

In case of complying with the aforementioned minimum grade and having participated in the continuous evaluation, a weighted grade will be obtained: written examinations (80%) and

continuous assesment (20%).

The final grade will be obtained as the maximum between said weighted grade and the grade obtained only of the consideration of written exams.

The qualification needed to pass the subject is 5 out of 10.

COMMENTS:

Subject to compliance with the compensation criteria established for this purpose, the grade of this this course can be averaged with those of the others belonging to the same matter so as to pass that matter.

REFERENCES

Basic

- Griffiths,D.J., Introduction to Electrodynamics. Prentice Hall, 1989.
- Reitz, J.R., Milford, F.J., Christy, R.W., Fundamentos de la Teoría Electromagnética. Addison-Wesley Iberoamericana, 1986.
- Pomer,F., Electromagnetisme Bàsic. Universitat de València, 1993.

Additional

- Wangness, R.K., Campos electromagnéticos. Limusa, 1983
- Feynman, R., Leighton, R.B., Sands, M., Física (Volumen II: electromagnetismo y materia). Addison-Wesley Iberoamericana, 1987.
- Sánchez, F., Sanchez, J.L., Sancho, M., Santamaría, T., Fundamentos de Electromagnetismo. Síntesis, Madrid, 2000.
- Vanderlinde, J., "Classical electromagnetic theory", John Wiley & Sons, 1993.
- Marshall,S., Dubroff ,R.and Skitek,G., "Electromagnetismo, conceptos y aplicaciones". Prentice Hall, 1997.

ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

TEACHING METHODOLOGY:

In case that health situation requires blended teaching, the teaching model approved by the Academic Degree Committee on July 23, 2020 will be adopted. For lectures this model consist of 50% student attendance in the classroom, while the rest of students attend the class in streaming broadcast. Two groups will be set with alternate days attendance to the classroom in order to guarantee 50% of teaching hours attendance for all students. The rest of the teaching activities (laboratories and tutorials) will have a 100% attendance.

If a total reduction in attendance is necessary, classes will be broadcast by synchronous videoconference at their regular schedule, along the period determined by the Health Authority.