Electromagnetism and Optics

Academic Year: (2023 / 2024) **Review date: 12-02-2024**

Department assigned to the subject: Physics Department

Coordinating teacher: GALIANA BLANCO, BEATRIZ

Type: Compulsory ECTS Credits : 6.0

Year : 2 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Physics I, Physics II, Differential Equations

SKILLS AND LEARNING OUTCOMES

CB1. Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2. Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB4. Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG1. Analyze and synthesize basic problems related to physics and engineering, solve them and communicate them efficiently.
CG2. Learn new methods and technologies from basic scientific and technical knowledge, and being able to adapt to new situations.
CG3. Solve problems with initiative, decision making, creativity, and communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the engineering activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG5. Use the theoretical and practical knowledge acquired in the definition, approach and resolution of problems in the framework of the exercise of their profession.
CE5. Understand and handle the basic concepts of the general laws of mechanics, thermodynamics, fields and waves and electromagnetism and apply them to the resolution of engineering problems.
CE12. Understand and handle the mechanisms of propagation and transmission of electromagnetic waves both in free space and guided, including concepts of wave optics, and the corresponding transmitting and receiving devices.
CT1. Work in multidisciplinary and international teams as well as organize and plan work making the right decisions based on available information, gathering and interpreting relevant data to make judgments and critical thinking within the area of study.

RA1. To have acquired sufficient knowledge and proved a sufficiently deep comprehension of the basic principles, both theoretical and practical, and methodology of the more important fields in science and technology as to be able to work successfully in them.
RA2. To be able, using arguments, strategies and procedures developed by themselves, to apply their knowledge and abilities to the successful solution of complex technological problems that require creating and innovative thinking.
RA3. To be able to search for, collect and interpret relevant information and data to back up their conclusions including, whenever needed, the consideration of any social, scientific and ethical aspects relevant in their field of study.
RA6. To be aware of their own shortcomings and formative needs in their field of specialty, and to be able to plan and organize their own training with a high degree of independence.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Electrostatics in vacuum. Coulomb¿s law. Electric field. Differential and integral formulations of the equations of electrostatics. Electric dipole. Multipolar formalism.
2. Electrostatics in material media. Polarization vector. Polarization charge densities. Electric displacement vector D. Electric susceptibility and permitivity. Boundary conditions for D and E. Electric forces and electric energy.
3. Magnetostatics in vacuum. Electric current and current density. Magnetic induction vector B. Biot-Savart Law. Ampere¿s law. Differential and integral formulation of magnetostatics. Magnetic vector potential. Magnetic dipole. Magnetic scalar potential.
4. Magnetostatics in material media. Magnetization vector. Magnetization currents and magnetic poles. Magnetic intensity vector H. Magnetic susceptibility and permittivity. Boundary conditions for B and H. Magnetic forces and magnetic energy.
5. Electromagnetic fields. Faraday¿s law. Self- and mutual inductance. Displacement current. Maxwell equations. Poynting vector and Poynting¿s theorem. Electromagnetic moment and energy.
6. Electromagnetic waves. Plane waves. Paraxial aproximation and Geometrical Optics Reflection and refraction laws. Polarization of light. Fresnel coefficients. Propagation of waves in dielectric and conducting media.
7. Electromagnetism and the theory of special relativity. The electromagnetic tensor.

LEARNING ACTIVITIES AND METHODOLOGY

1) LECTURES: where the theoretical concepts are explained
The lecturer will provide with the following information (1 week in advance)
- Main topics to be discussed during the session (short description)
- Chapters/sections in each of the text books provided in the bibliography where the student can read about these topics.

2) RECITATIONS: Discussion sessions and activities in small groups to solve problems:
The lecturer will provide a file with problems (few days in advance)
The main skills to be acquired in these activities are:
- To understand the statement of a problem
- To identify the physical laws involved.
- To develop a solving strategy to reach the objective (by simplification, studying similar problems already solved¿
- Training in mathematical skills
- To analyze the reasonability of the result (order of magnitude, dimensional analysis¿)

3) LABORATORY: sessions dedicated to perform and analyze experiments
The main skills to be developed in this activity are:
- To understand that physics is an experimental science and they can reproduce the laws that have been theoretically explained in the lectures
- To use scientific instruments and to be careful in its operation
- To be careful in the acquisition of experimental data
- To apply Experimental measurement and data analysis techniques.
- To be able to write a report with the main results of the experiment
- To be able to discuss in a critical way the experimental results.

ASSESSMENT SYSTEM

1) Laboratory sessions (20% of final mark)
Attendance to the laboratory sessions is compulsory.
Evaluation of the reports. The mark is shared by the members of the group.

2) Assessment during the course (20% of final mark)
- Midterm exams
- Delivery and evaluation of assigned homework

3) Final exam (60% of final mark)
The exam is made at the end of the semester and it is the same for all the students
Contents:
- Problems to be solved covering the topics of the program
- Short theoretical questions.

The minimum required grade in each one of the sections of the final exam is 3/10.

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

BASIC BIBLIOGRAPHY

- David J. Griffiths Introduction to Electrodynamics, Pearson.
- Roald K. Wangsness Electromagnetic Fields, John Wiley & Sons.

ADDITIONAL BIBLIOGRAPHY

- Andrew Zangwill Modern Electrodynamics, Cambridge University Press.
- F. Salazar at al. Solved problems in electromagnetics, Springer, 2017
- John D. Jackson Classical Electrodynamics, John Wiley & Sons.

BASIC ELECTRONIC RESOURCES

- A. J. de Castro, J.R. Martín Solís . Problemas de Electromagnetismo: http://hdl.handle.net/10016/32231