Physics II

Academic Year: (2024 / 2025) **Review date: 16-04-2024**

Department assigned to the subject: Physics Department

Coordinating teacher: GARCIA-TABARES VALDIVIESO, ELISA

Type: Basic Core ECTS Credits : 6.0

Year : 1 Semester : 2

Branch of knowledge: Engineering and Architecture

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

First semester Algebra and Calculus courses and knowledge on single particle dynamics.

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, formulate and solve problems with initiative, decision-making, creativity,critical reasoning skills and ability to efficiently communicate and transmit knowledge, skills and abilities in the Energy Engineering field
CG10. Being able to work in a multi-lingual and multidisciplinary environment
CE2 Modulo FB. Understanding and command of the fundamental concepts of the general laws of mechanics, thermodynamics, fields and waves, electromagnetism and their application for solving engineering problems.
CT1. Ability to communicate knowledge orally as well as in writing to a specialized and non-specialized public.
CT2. Ability to establish good interpersonal communication and to work in multidisciplinary and international teams.
CT3. Ability to organize and plan work, making appropriate decisions based on available information, gathering and interpreting relevant data to make sound judgement within the study area.
CT4. Motivation and ability to commit to lifelong autonomous learning to enable graduates to adapt to any new situation.

By the end of this content area, students will be able to have:
RA1.1 knowledge and understanding of the physics principles underlying their branch of engineering;
RA2.1 the ability to apply their knowledge and understanding to identify, formulate and solve physics problems using established methods;
RA4.2 the ability to design and conduct appropriate experiments, interpret the data and draw conclusions;
RA4.3 the ability to select and use appropriate tools and methods to solve physics problems;
RA5.1 the ability to combine theory and practice to solve physics problems;
RA5.2 workshop and laboratory skills.

OBJECTIVES

This course should make the student familiar with the basics concepts of electromagnetism. Since this is a first year course one of the main goals is to develop the student abilities in understanding abstract physical concepts through the combination of lectures, experiments and problem solving with the aid of mathematical tools.

In order to achieve this goal, the following competences and skills have to be acquired:

- Disposition to learn and comprehend new abstract concepts.
- Ability to understand and use the mathematics involved in the physical models.
- Ability to understand and use the scientific method.
- Ability to understand and use the scientific language.
- Develop abilities in problem solving.
- Ability to use scientific instruments and analyze experimental data.
- Ability to retrieve and analyze information from different sources.
- Ability to work in a team.

DESCRIPTION OF CONTENTS: PROGRAMME

1 ¿ Coulomb¿s Law
- 1.1 Electric charge
- 1.2 Coulomb¿s Law. Electromagnetic interaction
- 1.3 Dimensions and units.
- 1.4 The Superposition Principle

2 ¿ The Electric field
- 2.1 Definition of Electric Field
- 2.2 The Electric Field created by a point charge
- 2.3 The Superposition Principle
- 2.4 The Electric Field Lines. Graphic representation
- 2.5 Electric Field created by continuous distributions of charge. Examples

3 ¿ Gauss¿s Law in vacuum
- 3.1 Flux of Electric Field through a surface.
- 3.2 The Electric Field created by various charge distributions
- 3.3 Gauss¿s Law
- 3.4 Application of Gauss¿s Law: Calculate the Electric Field

4 ¿ The Electric Potential
- 4.1 Electrostatic potential Energy of a point charge
- 4.2 Electric potential. Electric potential created by different charge distributions
- 4.3 Electric field and potential. Graphical representation. Equipotential surfaces
- 4.4 Electrostatic energy. Discrete and continuous distribution of charge
- 4.5 Electric dipole. Dipolar approximation. Effect of the electric field on a dipole

5 ¿The Electric Field in matter. Conductors
- 5.1 Conductors and insulators
- 5.2 Conductors in electrostatic equilibrium
- 5.3 Charge distribution in conductors
- 5.4 Electric shielding and edge effect

6 ¿ The electric field in matter: Dielectrics. Generalized Gauss¿s Law
- 6.1 Capacitors and capacitance. Combination of capacitors
- 6.2 Energy stored in a charged capacitor
- 6.3 Faraday experiments with dielectric materials. Effects on capacitor parameters
- 6.4 Electric polarization in matter. Vector P. Electric susceptibility
- 6.5 Electric Displacement D. Constitutive equation. Generalized Gauss¿s Law

7 ¿ Electric Current
- 7.1 The Electric Current: Current and Current Density. Generalized Ohm¿s Law
- 7.2 Electric Resistance and Electric Conductivity
- 7.3 Power dissipated in an electric conductor. Joule¿s Law. Differential form
- 7.4 Electromotive force (emf)

8 ¿ Magnetic field. Magnetic Forces
- 8.1 The Magnetic Field
- 8.2 Lorenz¿s Force. Charged particle movement in a magnetic field
- 8.3 Magnetic force acting on a current-carrying conductor. Ampere¿s Law
- 8.4 Magnetic moment
- 8.5 Torque on current loops. Magnetic potential energy. Analogy with electric dipole

9 ¿ Sources of Magnetic Field
- 9.1 Biot-Savart Law. Application to the magnetic field created by currents
- 9.2 Ampère¿s Law. Application to the calculation of magnetic fields.
- 9.3 Magnetism in matter: Magnetization(M). Magnetic field strength H. Constitutive equation.
- 9.4 Magnetism in matter: Magnetic materials. Ferromagnetism

10- Electromagnetic induction: Faraday¿s Law
- 10.1 Faraday¿s Law. Faraday¿s experiments. Applications. Exceptions to the flux rule
- 10.2 Induced emf on a moving circuit in a magnetic field
- 10.3 Induced emf on a circuit in a time varying magnetic field. Eddy/Foucault currents
- 10.4 Self-Induction and Mutual Induction
- 10.5 Magnetic energy in an inductor. RL circuit

11- Ampère ¿ Maxwell¿s Law. Continuity Equation
- 10.1 Displacement Current
- 10.2 Ampère-Maxwell¿s Law
- 10.3 Continuity equation
- 10.4 RC circuit

12 ¿ Electromagnetic waves
- 12.1 Maxwell equations (integral form)
- 12.2 Wave equation. Particular solution: monochromatic plane wave.
- 12.3 Wave parameters. Phase and group velocities. Impedance. Refraction index
- 12.4 Power and energy carried by an EM wave. Poynting vector
- 12.5 Stationary waves
- 12.6 EM waves generation: oscillating dipole

LEARNING ACTIVITIES AND METHODOLOGY

Lectures, where the theoretical concepts are explained

The lecturer provide a file with the following information (1 week in advance)
- Main topics to be discussed during the session
- Chapters/sections in each of the text books provided in the bibliography were the student can read about these topics

Recitations (~ 40 students divide in 2-3 people groups) to solve problems.

The main skills to be developed in these activities are:
- To understand the statement of the problem (for instance drawing an scheme that summarizes the statement)
- To identify the physical phenomenon involved in the statement and the physical laws related to it.
- To develop a strategy to reach the objective (for instance breaking the problem in small sub-problems).
- To be careful in the use of mathematics
- To analyze the result (is the final number reasonable?, are the dimensions consistent?)

Small works focused to the search of scientific information in different sources (mainly internet).

Laboratory sessions (~ 24 students divide in 2 people groups)

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 the experimental data
- To learn the basis of the management of a scientific data set
- To write a report with the main results of the experiment
- To reason in a critical way these results: have we achieve the goals of the experiment?

ASSESSMENT SYSTEM

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

Despite the final mark is obtained with the percentages indicated bellow, attendance to the laboratory sessions is COMPULSORY to pass the course. Additionally, it is OBLIGATORY to obtain at least a score of 3 out of 10 in the final exam to pass the course.

Laboratory sessions (15% of final mark) Evaluation based on:

- Attendance to the laboratory sessions, participation and attitude. Activities in groups of two students.
- Laboratory reports quality. Mark is shared by the members of the group.

Recitation groups (25% of final mark). Evaluation based on:

- Attendance.
- Short test exams.
- Delivery and quality of proposed activities

Written exam (60% of final mark)

This exam is made at the end of the semester and it is the same for all the students
Consists in:
- Problem solving covering the topics of the program

and perhaps
- Short theoretical questions

BASIC BIBLIOGRAPHY

- Alan Giambattista, Betty McCarthy Richardson and Robert C. Richardson College Physics, Fourth Edition, McGraw Hill, ISBN 978-0-07-131794-8, 2010

- Paul A. Tipler and Gene Mosca Physics for Scientists and Engineers, Volume 2, 6th Edition, W.H. Freeman, ISBN-10:0716789647, ISBN-13: 978-0716789642, 2007

ADDITIONAL BIBLIOGRAPHY

- Alan Giambattista, Betty MacCarthy Richardson and Robert C. Richardson College Physics, Fourth Edition, McGraw Hill, 2010

- J.R. Reitz, F.J. Milford y R.W. Christy Foundations of Electromagnetic Theory, Ed. Addison Wesley; ISBN-10: 0321581741; ISBN-13, 2008

- R.K. Wangsness Electromagnetic Fields, Ed. Willey; ISBN-10: 0471811866 ISBN-13: 978-0471811862, 1986