Course Unit	Electromagnetism			Field of study	Physics		
Bachelor in	Electrical and Computers Engineering			School	School of Technology and Management		
Academic Year	2022/2023	Year of study	2	Level	1-2	ECTS credits	6.0
Type	Semestral	Semester	1	Code	9112-742-2102-00-22		

Workload (hours)	162	Contact hours	T	TP	PL	TC	S	E	OT	O
			30	30	-	-	-	-	-	-

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s): Ângela Paula Barbosa da Silva Ferreira

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. understand a physical problem, establish a resolution plan, formulate the problem mathematically using the laws of physics and analyze the solution obtained;
2. enunciate and understand the physical meaning and apply accurately the Coulomb, Gauss, Biot-Savart, Ampère, Lorentz, Lenz, Faraday and Maxwell-Ampère laws;
3. describe practical applications of Electromagnetism, such as capacitors, resistors, inductors, electromagnets, motors, generators and electrical transformers;
4. understand the Electromagnetism as a unifying theory of various phenomena observed in the Nature and used in technological devices.

Prerequisites

Before the course unit the learner is expected to be able to:
1. apply concepts of analytic geometry.
2. apply concepts of vector spaces.

Course contents

Mathematics of Electromagnetics. The static electric field. The static magnetic field. Electromagnetic induction. Maxwell's equations. Electromagnetic waves.

Course contents (extended version)

1. Mathematics of Electromagnetics
   - Cylindrical and spherical coordinates.
   - Double and triple Integrals.
   - Scalar and vector fields.
   - Gradient, divergence and curl.
2. The static electric field
   - Coulomb's law: electric charge; superposition principle.
   - The electric field: continuous charge distributions; field lines.
   - Gauss's law: electric flux; the divergence theorem and the differential form of Gauss's law.
   - Electric potential: conservative fields; equipotencial surfaces; electrostatic energy.
   - Capacitance and capacitors; dielectric materials.
3. The static magnetic field
   - Steady electric currents: current density; Ohm's law and electric conductivity.
   - Magnetic field: magnetic force between conductors; Biot-Savart law.
   - Ampère's law; Stokes's theorem and the differential form of Ampère's law.
   - Lorentz force.
   - Magnetic materials: diamagnetism, paramagnetism and ferromagnetism.
   - Magnetic circuits.
4. Electromagnetic induction
   - Faraday's law; Lenz's law; principle of operation of an electric motor.
   - Mutual and self-inductance; ideal transformer.
   - Energy stored in the magnetic field.
   - Skin effect.
5. Maxwell's equations
   - Displacement current; Maxwell-Ampère law.
   - Electromagnetic waves. Reflection and transmission of plane waves at planar interfaces.

Recommended reading

1. S. M. Wentworth, Fundamentals of Electromagnetics with Engineering Applications, John Wiley&Sons, 2006
2. J. E. Villate, Electromagnetismo, McGraw Hill, cop. 1999
3. M. Sadiku, Elements of Electromagnetics, Oxford University Press, 7th Edition, 2018
4. R. Fitzpatrick, Maxwell's Equations and the Principles of Electromagnetism, Infinity Science Press, 2008
5. M. A. Plonus, Applied Electromagnetics, McGraw-Hill College, 2nd Edition, 1978

Teaching and learning methods

Lectures: presentation of the course contents. Lectures and problem-solving: presentation of practical examples to support the expected learning outcomes; problem-solving and critical analysis of the results. Non-presential hours: specific proposals on problem-solving.

Assessment methods

1. Global assessment - (Regular, Student Worker) (Final, Supplementary, Special)
   - Final Written Exam - 100%
2. Distributed assessment - (Regular, Student Worker) (Final, Supplementary)
   - Intermediate Written Test - 40% (Partial exams performed in the virtual. ipb. pt platform.)
   - Final Written Exam - 60% (A minimum rating of 25% is required.)

Language of instruction

Portuguese, with additional English support for foreign students.

Electronic validation

Ângela Paula Barbosa da Silva Ferreira	José Luís Sousa de Magalhaes Lima	Orlando Manuel de Castro Ferreira Soares	Paulo Alexandre Vara Alves
08-10-2022	16-10-2022	21-10-2022	03-11-2022