Course guide
820005 - F2FE - Physics II: Fundamentals of Electromagnetism

Last modified: 02/07/2026

Unit in charge: Barcelona East School of Engineering
Teaching unit: 748 - FIS - Department of Physics.

Degree: BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Compulsory subject).

Academic year: 2026 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish, English

LECTURER

Coordinating lecturer: JONATHAN FERNANDO GEBBIA - MARIA CRISTINA PERIAGO OLIVER

Others: Primer quadrimestre:
LLUIS AMETLLER CONGOST - Grup: M21, Grup: M22, Grup: M23, Grup: M24
JONATHAN FERNANDO GEBBIA - Grup: T11, Grup: T12, Grup: T13
POL MARCEL LLOVERAS MUNTANE - Grup: M11, Grup: M12, Grup: M13, Grup: M14
IGNASI PEREZ RAFOLS - Grup: T21, Grup: T22, Grup: T23
MARIA CRISTINA PERIAGO OLIVER - Grup: M13, Grup: M31, Grup: M32, Grup: M33, Grup: M34
ALEJANDRO SALVATORI - Grup: T21, Grup: T22
MARC SOLA GARCÍA - Grup: M21, Grup: M22, Grup: M33, Grup: M34, Grup: T11, Grup: T12, Grup: T13, Grup: T23
TRIFON TODOROV TRIFONOV - Grup: M11, Grup: M12, Grup: M23, Grup: M24, Grup: M31, Grup: M32

PRIOR SKILLS

No prerequisites

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
2. Understand the general laws of mechanics, thermodynamics, fields and waves, and electromagnetism and apply them to engineering problems.

Transversal:
1. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.

TEACHING METHODOLOGY

Teaching methodology: exposition 30%, individual work 60% and group work 10%.

LEARNING OBJECTIVES OF THE SUBJECT

The main objective is training students through the acquisition of a working method and providing knowledge of the principles and basic concepts of electromagnetism, so that can be applied to solving problems in the field of engineering.

STUDY LOAD

Type	Hours	Percentage
Hours large group	51,0	34.00
Hours small group	9,0	6.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

Item 1. Electric field and Potential

Description:
The electric charge. Coulomb's law. Electric field created by a system of discrete charge and continuous distributions. Gauss's law: 1st Maxwell equation. Potential energy and electric potential. Calculation of the potential created by a system of discrete charge and continuous charge distributions. Electric energy of a system of point charges

Specific objectives:
Understand the concept of electric field and its vector nature. Calculate the field created by a charge distribution. Interpret the concept of potential, potential difference and electrostatic potential energy of a charge distribution.

Full-or-part-time: 35h
Theory classes: 14h
Self study : 21h

Item 2. Conductors and dielectrics.

Description:
Conductor in electrostatic equilibrium. Electrostatic influence. Capacitors. Capacity. Associations of capacitors. Energy stored in a charged capacitor. Energy density of an electric field. Dielectrics: dielectric behavior inside an electric field. Capacitors with dielectrics.

Specific objectives:
Knowing the characteristics of a conductor in electrostatic equilibrium. Calculate the capacity of a capacitor of simple geometry and calculate the capacitor equivalent to an association of capacitors. Understand the concept of electrostatic field energy. Characterize the response of a dielectric in an electric field.

Related activities:
Lab:
- Parallel-plate capacitor with sheets of dielectric material.

Full-or-part-time: 32h 30m
Theory classes: 11h 30m
Laboratory classes: 1h 30m
Self study : 19h 30m

Item 3. DC and AC

Description:
Electric current. Intensity and current density. Ohm's law. Electric resistance. Joule's law. emf: generators, motors and batteries. DC circuits. Kirchhoff's rules. RC circuit: charging and discharging a capacitor.
Sinusoidal alternating quantities: graphical representation, phasors. AC: RLC series circuit. Impedance. Resonance. Active power. Power factor.

Specific objectives:
Knowing how to establish relationships of macroscopic Ohm's law. Understand energy relationships in electrical circuits. Applying Kirchhoff's laws to solve circuits. Understand the process of charging and discharging a capacitor in an RC circuit.
Working with alternating magnitudes. Determine the reactance and impedance in an RLC circuit. Identify and characterize the phenomenon of resonance. Knowing energy features of the AC.

Related activities:
Lab:
- Electromotive force and internal resistance of a battery
- DC Circuits. Kirchhoff rules
- Parallel-plate capacitor.
- AC Circuits. RLC serie. Reactances.
- AC Circuits. RLC serie. Resonance.

Full-or-part-time: 31h 15m
Theory classes: 8h
Practical classes: 4h 30m
Self study : 18h 45m

Item 4. Magnetic field

Description:
Öersted experiment. Lorentz Force. A moving charge in a magnetic field. Particle accelerators. Velocity selector. Mass spectrograph. Magnetic force on an element of current. Torque over current loops. Sources of magnetic field: Biot and Savart's laws. Force between parallel currents. Ampère's Law. The magnetic flux. Gauss's law for magnetism: 2nd Maxwell's equation.

Specific objectives:
Identify the electrical current as a source of magnetic field. Being able to calculate the force acting on a charge or a straight thread in the presence of a magnetic field. Calculate the magnetic dipole moment of a loop and identify the characteristics of motion of a loop under the action of a magnetic field. Calculate the magnetic field created by a distribution of currents using the Biot and Savart's law. Knowing Ampere's law and its applications.

Related activities:
Lab:
- Magnetic field in the center of a solenoid. Determination of the mutual inductance between two solenoids

Full-or-part-time: 28h 45m
Theory classes: 11h
Laboratory classes: 0h 30m
Self study : 17h 15m

Item 5. Electromagnetic inducction

Description:
Electromagnetic induction. Faraday-Lenz's law: 3rd Maxwell equation. Induced emf. Eddy currents. AC power generators. Self-inductance and mutual inductance. RL circuit. Energy stored in a coil. Magnetic energy density.

Specific objectives:
Be able to relate the temporal variation of the flow of magnetic field with induction. To apply the Faraday-Lenz's law to calculate the electromotive force induced in different practical cases. Describe the inductive phenomena that appear in electric circuits. RL circuit.

Related activities:
Lab:
- Magnetic field created by a set of coils. Determination of mutual inductance between two coils.
- Electromagnetic induction. Determination of mutual inductance between two coils.

Full-or-part-time: 18h 45m
Theory classes: 6h 30m
Laboratory classes: 1h
Self study : 11h 15m

Item 6. Maxwell equations

Description:
Displacement current: 4th Maxwell equation. Maxwell equations. Electromagnetic Waves.

Specific objectives:
Explain the appearance of the displacement current in free space. Write Maxwell equations. Reconize the electromagnetic field in non-stationary situations.

Full-or-part-time: 3h 45m
Theory classes: 1h 30m
Self study : 2h 15m

GRADING SYSTEM

Any academic fraud, plagiarism or use or possession of unauthorised means in an assessment activity leads to a mark of zero (0) for the affected test or assignment. Furthermore, in accordance with the University's regulations, if disciplinary proceedings are initiated the subject is recorded as "Pending Assessment" until a decision is reached. These incidents are managed in accordance with the **Action Framework for Academic Integrity in Assessment at the UPC**.

MARK M1:
- Lab: 15%
- Test 1: 15%
- Test 2: 20%
- Test 3: 25%
- Problems: 25%

MARK M2:
- Lab: 15%
- Test 2: 25%
- Test 3: 30%
- Problems: 30%

MARK M3:
- Lab: 15%
- Test 3: 42,5%
- Problems: 42,5%

FINAL GRADE = maximum (M1;M2:M3)

EXAMINATION RULES.

It is mandatory to attend all lab sessions in order to be evaluated.
In all exams, students can use a pocket calculator and bring a printed copy of the physics formula sheet provided in Atenea.
The final exam of Physics 2 consists of Test 3 and Problems.
No re-evaluation exam has been considered in the grading policy of Physics 2.

BIBLIOGRAPHY

Basic:
- Tipler, P. A.; Mosca, G. Física para la ciencia y la tecnología (vol.2). 6a ed. Barcelona [etc.]: Reverté, 2010. ISBN 9788429144284.
- Alcaraz i Sendra, Olga; López López, José; López Solanas, Vicente. Física : problemas y ejercicios resueltos. Madrid: Pearson Educación, cop. 2006. ISBN 8420544477.
- Alarcón Jordán, Marta [et al.]. Física : problemes resolts. 3a ed. Barcelona: Edicions UPC, 2000. ISBN 8483014157.