820005 - F2FE - Physics II: Fundamentals of Electromagnetism

Degrees:
- Bachelor's Degree in Biomedical Engineering (Syllabus 2009). (Teaching unit Compulsory)
- Bachelor's Degree in Electrical Engineering (Syllabus 2009). (Teaching unit Compulsory)
- Bachelor's Degree in Energy Engineering (Syllabus 2009). (Teaching unit Compulsory)
- Bachelor's Degree in Industrial Electronics and Automatic Control Engineering (Syllabus 2009). (Teaching unit Compulsory)
- Bachelor's Degree in Mechanical Engineering (Syllabus 2009). (Teaching unit Compulsory)
- Bachelor's Degree in Chemical Engineering (Syllabus 2009). (Teaching unit Compulsory)
- Bachelor's Degree in Materials Engineering (Syllabus 2010). (Teaching unit Compulsory)
- Bachelor's Degree in Mechanical Engineering (Syllabus 2009). (Teaching unit Compulsory)
- Bachelor's Degree in Chemical Engineering (Syllabus 2009). (Teaching unit Compulsory)
- Bachelor's Degree in Biomedical Engineering (Syllabus 2009). (Teaching unit Compulsory)
- Bachelor's Degree in Energy Engineering (Syllabus 2009). (Teaching unit Compulsory)
- Bachelor's Degree in Industrial Electronics and Automatic Control Engineering (Syllabus 2009). (Teaching unit Compulsory)
- Bachelor's Degree in Electrical Engineering (Syllabus 2009). (Teaching unit Compulsory)

ECTS credits: 6

Teaching languages: Catalan, Spanish, English

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 748 - FIS - Department of Physics
Academic year: 2017

Prior skills
No prerequisites

Requirements
No requirements

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.
### 820005 - F2FE - Physics II: Fundamentals of Electromagnetism

**Teaching methodology**

Teaching methodology: exposition 30%, individual work 60%, group work 8% and guided activities 2%.

**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**

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>45h</th>
<th>30.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Hours small group:</td>
<td>15h</td>
<td>10.00%</td>
</tr>
<tr>
<td></td>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
</tr>
</tbody>
</table>
## Content

<table>
<thead>
<tr>
<th>Item 1. Electric field and Potential</th>
<th>Learning time: 32h 30m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 10h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 1h</td>
</tr>
<tr>
<td></td>
<td>Self study : 19h 30m</td>
</tr>
</tbody>
</table>

**Description:**
The electric charge. Coulomb's law. Principle of superposition. 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

**Related activities:**
Lab: Oscilloscope

**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.

<table>
<thead>
<tr>
<th>Item 2. Conductors and dielectrics.</th>
<th>Learning time: 26h 15m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 10h</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 0h 30m</td>
</tr>
<tr>
<td></td>
<td>Self study : 15h 45m</td>
</tr>
</tbody>
</table>

**Description:**

**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.
### Item 3. DC and AC

**Learning time:** 28h 45m  
- Theory classes: 5h  
- Practical classes: 6h  
- Guided activities: 0h 30m  
- Self study: 17h 15m

<table>
<thead>
<tr>
<th>Description:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Related activities:</th>
</tr>
</thead>
</table>
| Lab:  
- Electromotive force and internal resistance of a battery  
- DC Circuits. Kirchhoff rules  
- Capacitors. RC circuit.  
- AC Circuits. RLC serie. Reactances.  
- AC Circuits. RLC serie. Resonance. |  

<table>
<thead>
<tr>
<th>Specific objectives:</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
</tr>
</tbody>
</table>
### Item 4. Magnetic field

**Learning time:** 31h 15m  
Theory classes: 10h  
Laboratory classes: 2h  
Guided activities: 0h 30m  
Self study: 18h 45m

**Description:**  
Sources of magnetic field: Biot and Savart's laws. Force between parallel currents. Definition of the ampere.  

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

**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.

### Item 5. Electromagnetic induction

**Learning time:** 26h 15m  
Theory classes: 8h  
Laboratory classes: 2h  
Guided activities: 0h 30m  
Self study: 15h 45m

**Description:**  

**Related activities:**  
Lab:  
- Coils. RL circuit in non-stationary dynamics.  
- Magnetic field created by a set of coils. Determination of mutual inductance between two coils.  
- Electromagnetic induction. Determination of mutual inductance between two coils.

**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.
Item 6. Maxwell equations

<table>
<thead>
<tr>
<th>Learning time: 5h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td>Self study: 3h</td>
</tr>
</tbody>
</table>

Description:

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

Qualification system

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

MARK M2:
- Lab: 20%
- Test 3: 40%
- Problems: 40%

FINAL GRADE = maximum (M1; M2)

Regulations for carrying out activities

In all exams, students can use a pocket calculator and bring a printed copy of the physics formula sheet provided in Atenea.

Bibliography

Basic: