Course guide
240031 - 240031 - Electromagnetism

Last modified: 20/07/2023

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

Degree: BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: RAÙL RODRÍGUEZ

Others: CARINA SERRA DE LARROCHA
RAÚL RODRÍGUEZ
PERE TALAVERA
FRANCESC ZARAGOZA

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Understanding and dominion of basic concepts on mechanics, thermodynamics, fields and waves and electromagnetism laws and their application to solve engineering problems.

TEACHING METHODOLOGY

The learning of electromagnetism means to understand the theory concepts and know how to apply them in contextualized situations. For this reason, there is no temporary separation between the theory sessions and the sessions of resolving exercises. The expositoriest character of the class will be given by the learning objectives set and the most suitable situation to promote their learning.

LEARNING OBJECTIVES OF THE SUBJECT

· Acquirement of basic knowledge for a right interpretation and application of the fundamental principles of the electromagnetism.
· A complete knowledge of the electromagnetic theory fundamentals.
· Description of several physic phenomena by means of the electromagnetic theory.
· The familiarization with some of the most relevant applications of the electromagnetism.
· The resolution of easy numerical problems for which the electromagnetic theory is necessary.

STUDY LOAD

Type	Hours	Percentage
Self study	90,0	60.00
Hours large group	52,0	34.67
Hours small group	8,0	5.33

Total learning time: 150 h

CONTENTS

Theme 1: Electrostatic fields in the vacuum

Description:
Fields theory. Electric charge. Coulomb's law. Electric field E. Electric potential V. Gauss's law. Equations of Poisson and Laplace. Potential energy.

Related competencies :
CE2. Understanding and dominion of basic concepts on mechanics, thermodynamics, fields and waves and electromagnetism laws and their application to solve engineering problems.

Full-or-part-time: 23h
Theory classes: 4h
Practical classes: 4h
Laboratory classes: 2h
Self study : 13h

Theme 2: Conductors

Description:
Electrostatic equilibrium of conductors. Electric field at the surface of a conductor. Capacity of an isolated conductor. Definition of capacitor and capacitance. Potential energy in a capacitor. Electrostatic pressure. Capacitors in parallel and in series.

Related competencies :
CE2. Understanding and dominion of basic concepts on mechanics, thermodynamics, fields and waves and electromagnetism laws and their application to solve engineering problems.

Full-or-part-time: 18h
Theory classes: 4h
Practical classes: 4h
Self study : 10h

Theme 3: Electrostatic fields in dielectric media

Description:
Electric dipoles. Dielectric materials. Electric polarization. Bound charge density. Electric susceptibility and permittivity. Electric flux density field D. First Maxwell's equation. Electric field in dielectric materials. Electrostatic energy in dielectric materials. Boundary conditions for V, E i D.

Related competencies :
CE2. Understanding and dominion of basic concepts on mechanics, thermodynamics, fields and waves and electromagnetism laws and their application to solve engineering problems.

Full-or-part-time: 20h
Theory classes: 3h
Practical classes: 5h
Self study : 12h

Theme 4: Electrocinetic. Theory of circuits

Description:
Electric current. Intensity. Current density. Ohm's law. Electric resistance, resistivity and conductivity. Dependence of resistivity on temperature. Joule's effect. Sources of voltage. Direct current circuits and motors. Kirchhoff's laws. Charge and discharge of a capacitor.

Related competencies :
CE2. Understanding and dominion of basic concepts on mechanics, thermodynamics, fields and waves and electromagnetism laws and their application to solve engineering problems.

Full-or-part-time: 21h
Theory classes: 2h
Practical classes: 3h
Laboratory classes: 2h
Self study : 14h

Theme 5: Magnetostatic fields

Description:
Oersted's experience. Magnetic force. Magnetic flux density B. Biot-Savart's laws. Lorentz's force. Magnetic fields interacting with charges on movement. Selector of velocities. Mass spectrometer. Cyclotron. Second Maxwell's equation. Vector potential A. Ampère's law. Curl of B.

Related competencies :
CE2. Understanding and dominion of basic concepts on mechanics, thermodynamics, fields and waves and electromagnetism laws and their application to solve engineering problems.

Full-or-part-time: 26h
Theory classes: 3h
Practical classes: 5h
Laboratory classes: 2h
Self study : 16h

Theme 6: Electromagnetic induction

Description:
Experiences on electromagnetic induction. Faraday ¿ Lenz's laws. Third Maxwell's equation. Foucault's currents. Transformers. Self inductance and mutual inductance. RL Circuit. Magnetic energy. LC and RLC circuits.

Related competencies :
CE2. Understanding and dominion of basic concepts on mechanics, thermodynamics, fields and waves and electromagnetism laws and their application to solve engineering problems.

Full-or-part-time: 20h
Theory classes: 3h
Practical classes: 5h
Self study : 12h

Theme 7: Magnetisable materials

Description:
Magnetic dipole. Magnetic materials. Atomic magnetic moments. Diamagnetism, paramagnetism and ferromagnetism. Magnetic dipole moment per volume unit. Ampère's currents. Magnetic field strength H. Magnetic susceptibility and permeability. Cycle of magnetic hysteresis and dissipation of magnetic energy. Magnetic circuits. Permanent magnet. Dependence of magnetization on temperature.

Related competencies :
CE2. Understanding and dominion of basic concepts on mechanics, thermodynamics, fields and waves and electromagnetism laws and their application to solve engineering problems.

Full-or-part-time: 16h
Theory classes: 3h
Practical classes: 2h
Self study : 11h

Theme 8: Maxwell's equations

Description:
Conservation of electric charge. Fourth Maxwell's equation. Boundary conditions for B and H. Electromagnetic wave equation in the vacuum and dielectric materials.

Related competencies :
CE2. Understanding and dominion of basic concepts on mechanics, thermodynamics, fields and waves and electromagnetism laws and their application to solve engineering problems.

Full-or-part-time: 6h
Theory classes: 2h
Practical classes: 1h
Self study : 3h

ACTIVITIES

EXPERIENCES IN THE LABORATORY

Description:
The working groups are constituted by two students. Every working group of students has to complete 3 experiences of two hours length in the laboratory. After finishing every one of the three experiences, working groups have to written a report answering questions concerning laboratory experiences. These reports should be hand in a week after the laboratory session.

The available experiences are:
1. Characterization of electric fields: electrolytic pail.
2. Electric permittivity of vacuum and relative permittivity of dielectric media.
3. Measurements of direct current.
5. Charge and discharge processes of a capacitor.
6. Magnetostatic field generated by a solenoid.
8. Evaluation of the horizontal component of the magnetic field of the Earth.
9. Ferromagnetism. Hysteresis cycle.

Material:
Guides lab.

Delivery:
Report practice.

Full-or-part-time: 15h
Laboratory classes: 6h
Self study: 9h

PARTIAL EXAM

Description:
Assessment of knowledge.

Delivery:
Solved exam.

FINAL EXAM

Description:
Assessment of knowledge.

Delivery:
Solved exam.

GRADING SYSTEM

The final exam (EF) will consist in a part which the student will have to answer some excercises.
The exam of the middle of the semester will consist in a closed questions questionnaire format.
In both tests the student will be allowed to check a formulary given by the professor at the beginning of the course. Calculator can also be taken.
Students must carry out three practices in the lab. Once the practice in the lab is performed, a report must be elaborated and handed in a week after the practice has been carried out.
NTOT= 0.6* NEF + 0.25* NMQ + 0.15* NLAB
NTOT: Final mark of the subject
NEF: Mark of the final exam.
NMQ: Mark of the middle of the semester test
NLAB: Average mark of the lab reports.

BIBLIOGRAPHY

Basic:
- G. Fernández Mills, J. Fernández Ferrer. Electricidad, teoría de circuitos y magnetismo. Barcelona: Edicions UPC, 2006. ISBN 8483018454.
- Tipler, Paul Allen. Física para la ciencia y la tecnología, Volum 2A, Electricidad y magnetismo [on line]. 6a ed. Barcelona: Reverté, 2010 [Consultation: 08/09/2020]. Available on: http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=6537. ISBN 9788429144246.

Complementary:
- Bohigas, Xavier ; Xavier Jaén ; Cristina Periago. Electromagnetisme per a l'enginyeria. Barcelona: Edicions UPC, 2007. ISBN 9788483019252.
- Lorrain, Paul; Corson, Dale R. Campos y ondas magnéticos. 6a ed. Madrid: Selecciones científicas, 1994. ISBN 848521290.
- Plonus, Martin A. Electromagnetismo aplicado. Barcelona: Reverté, 1982. ISBN 8429130632.
- Serway, Raymond A; Jewett, John W. Electricidad y magnetismo. 6a ed. México: Thomson, 2005. ISBN 9706865381.
- X. Bohigas,G. Fernández, X. Jaén, M. Novell, c. Periago, C. Serra. Problemes resolts d'electromagnetisme. Barcelona: CPDA, 2000. ISBN 849535221.
- X. Bohigas, G. Fernández, X. Jaén, M. Novell, C. Periago, C. Serra. Electromagnetisme : tests resolts i comentats [on line]. Barcelona: Edicions UPC, 2001 [Consultation: 08/09/2020]. Available on: http://hdl.handle.net/2099.3/36236. ISBN 8483015676.
- Reitz, J.R.. Fundamentos de teoría electromagnética. 4a ed. Wilmignton: Addison-Wesley, 1996. ISBN 020162592X.

RESOURCES

Other resources:
ATENEA UPC