COMILLAS
UNIVERSIDAD PONTIFICIA
ICAI ICADE CIHS

Syllabus
2022 - 2023

GENERAL INFORMATION

Data of the subject	
Subject name	Electromagnetic Fields
Subject code	DIE-GITT-221
Mainprogram	Bachelor's Degree in Engineering in Telecommunication Technologies
Involved programs	Grado en Ingeniería en Tecnologías de Telecomunicación [Second year] Grado en Ingeniería en Tecnologías de Telecom. y Grado en Análisis de Negocios/Business Analytics [Second year] Grado en Ingeniería en Tecnologías de Telecom. y Grado en Análisis de Negocios/Business Analytics [Second year]
Level	Reglada Grado Europeo
Quarter	Semestral
Credits	6,0 ECTS
Type	Compulsory
Department	Department of Electrical Engineering
Coordinator	Francisco Javier Herraiz Martínez
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Teacher Information	
Teacher	
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DESCRIPTION OF THE SUBJECT

Contextualization of the subject

Course contents

Contents

Chapter 1: Electrostatics. Charges and fields

1.1. Coulomb law

1.2 Electric field: concept and vectorial representation

1.3 Gauss's law and application to the calculation of the electric field in plane, spherical and cylindrical symmetries

1.4 Electrostatic energy

1.5 Force on a layer of charge

Chapter 2: Electric potential. Vector operators.

2.1. Equipotential surfaces and gradient operator

2.2. Definition of electric potential

2.3. Divergence and Differential Gauss's Law

2.4. Poisson and Laplacian equation.

2.5. Curl and Stokes' theorem.

Chapter 3: Conductors

3.1. General characteristics of conductors

3.2. Uniqueness of solutions theorem

3.3. Screen effect

3.4. Image method.

3.5. Metallized equipotential bonding

3.6. Analytical solution of Laplace's equation

3.7. Capacity of conductors and capacitors

3.8. Energy stored in a condenser

3.9. Forces on conductors and method of virtual works for the calculation of forces

3.10. Calculation of the field by numerical methods: relaxation method

Chapter 4: Electric field in matter

4.1. Dielectric polarization. Internal and external fields

4.2. Capacitors with dielectric material

4.3. Electric dipole moment: field of a dipole, torques and forces in a dipole

4.4. Polarized materials and type of polarization

4.5. Electric Displacement Vector and Applications

4.6. Industrial applications of electrostatics

Chapter 5: Electric current

5.1. Ohm's law

5.2. Current density

5.3. Vector Ohm's Law

5.4. General calculation of resistances

5.5. Equation of conservation of charge and continuity

5.6. Joule's Law

5.7. Theories of electrical conduction: kinetic and wave theory

5.8. Industrial applications

Chapter 6: Magnetic field in the empty space

6.1. Definition of the magnetic field

6.2. Field and forces produced by a current line

6.3. Ampère's Law

6.4. current sheets
6.5. Magnetic field properties and uniqueness theorem
6.8. Differential Biot-Savart law
6.9. Magnetic potential vector

Chapter 7: Electromagnetic induction
7.1. Integral and differential Faraday's law
7.2. Magnetic force and induced stress
7.3. Self-induction and mutual induction
7.4. industrial applications.

Chapter 8: Electromagnetic fields in matter
8.1. Analogies between magnetization and polarization
8.2. Magnetic dipole moment: field of a dipole, torques and forces on a dipole
8.3. Vector H magnetic field intensity and Ampère's law
8.4. magnetic materials. B-H curve and hysteresis loop.
8.5. Eddy's currents
8.6. Magnetic circuits
8.7. Industrial applications of magnetostatics. Electromechanical analysis of magnetic systems with air gap. Force in systems with linear motion. Torque in systems with circular motion. Conductors embedded in magnetic materials
8.8. Numerical methods for the solution of complex magnetostatic problems

Chapter 9: Maxwell's equations and electromagnetic waves
9.1. Ampère–Maxwell law
9.2. Maxwell's equations
9.3. Wave equation
9.4. Properties of electromagnetic waves
9.5. Energy of an electromagnetic wave and Poynting vector.
9.6. Industrial applications.

EVALUATION AND CRITERIA

Evaluation activities	Evaluation criteria	Weight
• **Exams:** Mid-term exam Final exam	• Theory understanding. • Application of concepts to the resolution of practical problems. • Analysis and interpretation of the results obtained in solving problems. • Written communication.	85 %
	• Follow-up test • Theory understanding.	

Continuous performance assessment	• Application of concepts to the resolution of practical problems. • Analysis and interpretation of the results obtained in solving problems. • Written communication. • Attendance and attitude in class. • Class attendance level. • Class participation.	15 %

Grading

- **Ordinary call:**
  - 5% participation in class
  - 10% follow-up test
  - 25% mid-term exam mark
  - 60% mark of the final exam
- Failure to attend more than 15% of the classes may result in the loss of the right to take the ordinary call exam (and even the retake exam)
  of the subject (article 93.3 of the General Regulations, and articles 7.2 and 7.3 of the Academic Norms).
- **If a retake exam is required (extraordinary call):**
  - 3.75% participation in class
  - 7.5% follow-up test
  - 18.75% mid-term exam
  - 70% retake exam

BIBLIOGRAPHY AND RESOURCES

Basic References

- E. M. Purcell. Electricidad y Magnetismo, 2ª edición. Reverté 1994.
  T.A. Moore. Six ideas that shaped physics, Unit. E. 2ª ed. McGraw-Hill