Program	59EC – Communications Electronic Engineering B. Eng. 59SC – Telecommunications Systems Engineering B. Eng. 59SO – Sound and Image Engineering B.Eng. 59TL – Telematics Engineering B. Eng.

Course code and name	
Code	595000013, 595000312, 595000112, 595000212
Name	Electromagnetism and Waves
Semester	S7 [(September-January)] & S8 [(February-June)]

Credits and contact hours	
ECTS Credits	6
Contact hours	60

Coordinator's name	Barrutia Poncela, Laura [laura.barrutia@upm.es]

Specific course information	
Tuition language	Spanish
Description of course content	
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List of topics to be covered	
1. Oscillations 1.1. Introduction 1.2. Simple harmonic motion 1.3. Composition of harmonic motions 1.4. Hard and soft oscillations 2. Waves in elastic media 2.1. Wave function, equation and character 2.2. Harmonic waves 2.3. Wave in two and three dimensions. Intensity and intensity level 2.4. Sound. Doppler effect 2.5. Laws of reflection and refraction 2.6. Interferences 2.7. Stationary waves 3. Electrostatics 3.1. Quantification and conservation of the charge 3.2. Coulomb's law and the principle of superposition 3.3. Electric potential 3.4. Gauss's law 3.5. Electric dipole 3.6. Electric field in conducting media 3.7. Electric field in dielectric media	

3.8. Electrostatic force

4. Magnetostatics
   - 4.1. Stationary waves
   - 4.2. Lorentz force. Magnetic field
   - 4.3. Laplace's law. Pairs on circuits. Magnetic moment
   - 4.4. Biot-Savart law
   - 4.5. Ampère's theorem
   - 4.6. Magnetic field on the matter
   - 4.7. Magnetic materials

5. Electromagnetic fields
   - 5.1. Electromagnetic induction. Faraday's law
   - 5.2. Self-induction and mutual induction
   - 5.3. Ampère-Maxwell's law
   - 5.4. Energy of the electromagnetic field
   - 5.5. Maxwell's equations (integral form)

6. Laboratory sessions:
   - 6.1. Measurement and uncertainty
   - 6.2. Hard and soft oscillations
   - 6.3. Stationary waves on a string
   - 6.4. Speed of sound. Kundt's tube
   - 6.5. Potential distributions and electric fields
   - 6.6. Magnetic field. electromotive force

Prerequisites or co-requisites

- Calculus I & II
- Linear Algebra
- Circuit Analysis I & II

Course category in the program

☑ **R (required)**	☐ **E (elective)** *(elective courses may not be offered every year)*

Specific goals for the course

Specific outcomes of instruction

1. Ability to calculate work and energy and use the principles of conservation.
2. Understand and analyze the harmonic oscillations.
3. Know and use the function and the equation of waves.
4. Understand the mechanisms associated with the propagation of waves in elastic media.
5. Understand and analyze the process of interference and standing waves.
6. Know and apply Gauss's law for electric field in vacuum and material means.
7. Understand and use the relationship between field and electric potential.
8. Understand and use the concepts of density and current and the continuity equation.
9. Know and estimate the effects of magnetic fields on electrical currents and material means.
10. Know and apply the theorem of Ampere in vacuum and material means.
11. Know and use the Faraday law of electro-magnetic induction and calculate the

magnetic energy.
12. Know and apply the Ampère-Maxwell law.
13. Understand Maxwell's equations in integral form.

Further reading and supplementary materials
– Moodle. – Física Universitaria. Young-Freedman. Ed.12ª. Addison-Wesley. Vol. I & II. – Exercise and Laboratory books by the Department.