Bachelor in Physics
(Academic Year 2025-26)

Physics Fundamentals II	Code	800491	Year	1st	Sem.	2nd
Module	Basic Core	**Topic**	Physics	**Character**	Basic	

	Total	Theory	Exercises	Seminars
ECTS Credits	9	4	4	1
Semester hours	84	35	40	9

Learning Objectives (according to the Degree's Verification Document)

The student :

- will be able to deal with the basic concepts of Physics: particle, wave, field, reference system, energy, momentum, conservation law, macro and microscopic points of view, etc.
- will understand basic phenomena in Physics, including those related to electromagnetism, wave phenomena, optics and the properties of matter.
- will become familiarized with the formulation and resolution of simple problems in Physics, identifying the relevant principles and making use of estimations of orders of magnitude in them.
- will develop a panoramic vision of the range of problems within nowadays Physics.

Brief description of contents

Electromagnetism, wave phenomena, optics, introduction to modern Physics.

Prerequisites

Phisics Fundamentals I and Mathematics

Coordinator	Ana Urbieta Quiroga / Marta Ábalos Álvarez		Dept.	FM/FTA
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Theory/Problems – Schedule and Teaching Staff

Group	Lecture Room	Day	Time	Professor	Period/ Dates	Hours	T/E	Dept.
B	7	T Th F	12:00 – 14:00 11:00 – 13:00 09:00 – 11:00	María Luisa Montoya Redondo	19/01/26 until 06/03/26	42h	T/E	FTA
				Marta Ábalos Álvarez	09/03/24 until 08/05/24	42h	T/E	FTA

T: Theory, E: Exercises

Tutorías				
Grupo	**Profesor**	**horarios**	**e-mail**	**Lugar**
B	María Luisa Montoya Redondo	We: 09.00h-12.00h + 3h. online	mmontoya@ucm.es	00.319.0
	Marta Ábalos Álvarez	Mo, We: 12.00h-13.30h + 3h online	mabalosa@ucm.es	04.234.0

Syllabus

1. **Electric field.** Electric charge. Conductors and insulators. Coulomb's law. Concept of electric field. Superposition of electric fields. Electric field lines. Electric dipole moment. Gauss's law and its applications. Electric fields and charges in conductors. Potential energy and electric potential. Equipotential surfaces. Potential gradient. Compute electric potential. Capacitors. Capacitance. Connection of capacitors. Energy in a capacitor. Dielectrics: electric polarization. Molecular models of dielectrics. Electric current: intensity. Electric resistance: Ohm's law. Electromotive force. Energy and power in circuits.
2. **Magnetic field.** Magnetism. Magnetic field: Lorentz force. Magnetic field lines and flux. Motion in a magnetic field. Magnetic force on a conductor. Magnetic field created by a current. Magnetic field created by a current loop: magnetic dipole and torque. Ampère's law: applications. Hall's effect. Magnetic materials.
3. **Electromagnetic field.** Electromagnetic induction: Faraday's law. Induced motional electromotive force. Induced electric field. Self-inductance. Mutual inductance. Magnetic field energy. Transformers. LRC circuits. Displacement current. Maxwell's equations.
4. **Waves: a general description.** Types of waves. Mechanical waves. Periodic waves and pulses. Speed of propagation. Energy and intensity of a wave. Boundary conditions for waves in a rope: reflection and transmission. Plane and spherical waves. Harmonic waves. Wave interference. Standing waves. Normal modes. Pulses. Dispersion. Waves of particular interest: sound waves, beats, Doppler effect.
5. **Electromagnetic waves and light.** Maxwell equations and electromagnetic waves. Electromagnetic spectrum. Energy and momentum of an electromagnetic wave. Electromagnetic waves in materials and interfaces. Dispersion, reflection and refraction. Geometric optics on the boundaries: rays and wave fronts. Fermat's principle. Polarization. Wave interference: concept of wave coherence. Diffraction. Fraunhofer diffraction by a slit. Diffraction grating. Resolving power.
6. **Quantum Physics.** Planck's quantum hypothesis for emission and absorption of light. Photoelectric effect. Photons. Compton's effect. Energy levels spectra. Bohr's model of the atom. Particles behaving as waves: de Broglie's wave length. Wave-particle duality: diffraction. Heisenberg uncertainty principle. Schrödinger equation.

Bibliography

Basic:

Sears, F. W., M.W. Zemansky, H.D. Young y R.A. Freedman, *University Physics*, 11th Ed., Pearson Education, 2004.

Serway, R. A., *Physics for Scientists and Engineers*, 5th Ed, McGraw-Hill. 2002.

Tipler, P. A. and G. Mosca, *Physics for Scientist and Engineers*. 5th Ed. W. H. Freeman and Company, New York, 2004.

Supplementary:

Alonso, M. and E. J. Finn, *Physics.* Addison-Wesley Iberoamericana. 1992.
Fernández Rañada, A. *Física Básica* (Alianza, Madrid, 2004)
Rex, A and R. Wolfson, Essential College Physics. Pearson Education, 2010.
Lea, S. M. and J.R. Burke, Physics: The Nature of Things, West Publishing Company, College and School Division, 1997.
Mengual, J. I., M.P. Godino y M.Khayet, *Cuestiones y problemas de fundamentos de física*, Ariel, Barcelona, 2004.
Sánchez del Río, C., *Los principios de la física en su evolución histórica*, Ed. Instituto de España, Madrid, 2004.

Seminars Program

Dates:

- February 12th. Seminar 1
- February 26th. Seminar 2
- March 19th. Seminar 3
- April 9th. Seminar 4
- April 23th. Seminar 5

These dates are not absolutely fixed and can suffer changes according to availability of the speaker.

Schedule: Thursdays 11:00-12:30 or 14:30-16:00

Tentative topics of the program: Astrophysics, condensed matter, quantum physics, geophysics, magnetism and superconductivity, biophysics, climate change, artificial intelligence, etc …

Online Resources

Course materials and tests will be provided through the Virtual Campus.

Other resources:

· Interactive website course by Ángel Franco García http://www.sc.ehu.es/sbweb/fisica_/
· College Physics: http://cnx.org/contents/031da8d3-b525-429c-80cf-6c8ed997733a:1/College_Physics
· Physclips: http://www.animations.physics.unsw.edu.au/
· PHET interactive simulations for Physics: ttps://phet.colorado.edu/es/simulations/category/physics
· OSCAR Physics demonstrations: http://www.ucm.es/theoscarlab
· Feynman Lectures: http://www.feynmanlectures.caltech.edu/
· MIT open courses (course 8.02 and units II and III of course 8.03):
http://ocw.mit.edu/OcwWeb/Physics/index.htm
· Hyperphysics: http://hyperphysics.phy-astr.gsu.edu/hbase/HFrame.html
· Caltech, the Mechanical Universe: http://www.acienciasgalilei.com/videos/video0.htm

Methodology

The course involves the following educational items:

• Theoretical lessons (lectures) including explanations for the main concepts of the course, including examples and practical demonstrations of concepts using easy-to-carry laboratory materials (3 hours per week).

• Practical lessons involving the resolution of exercises and coordinated discussion of quiz and frequently asked questions (3 hours per week).

• Five seminar talks about topical subjects at the forefront of present day Physics. The seminars will take place during regular course days and will be repeated in a morning and afternoon slot so that all student groups can attend. The seminar talks will be attended both by students and professors. A 6^{th} seminar will take place in the classroom addressing topics organized by the professors and/or the students.

Theoretical lessons will be developed using the chalkboard and/or slide show presentations. These lectures will be complemented by experimental demonstrations that can be developed in the classroom or in the lab. Ad. Hoc. computer simulations and supporting web interactive demonstrations will be additionally used.

Student cooperation will be encouraged during exercise or tutoring workshops. Materials will be available for the students beforehand in the Virtual Campus. Students will have to resolve and deliver specifically addressed exercises and/or tests in the Virtual Campus as part of the ongoing evaluation.

Evaluation Criteria

Exams	**Weight:**	75%

Midterm Exam: Yes Eliminatory: Yes Minimum grade for elimination: $N_{Midterm} \geq 5$

Midterm weight: 50%

Final Exam:

- If $N_{Midterm} < 5$: the entire subject will be covered.
- If $N_{Midterm} \geq 5$, there are two options:

a) Take an exam that will cover only the content explained in the second part of the subject, on the same date and time as the final exam. The grade will be $N_{Final2ndPart}$, between 0 and 10.

b) Take the final exam. The grade will be N_{Final}, between 0 and 10.

In the July extraordinary session, a single final exam will be given that will cover the entire subject.

Final mark for the Exams section, N_{Exam}:

- If option a) is chosen and $N_{Final2ndPart} \geq 4$: $N_{Exam} = 0.5\ N_{Partial} + 0.5\ N_{Final2ndPart}$
- If $N_{Midterm} < 5$ or in case option b) is chosen: $N_{Exam} = N_{Final}$

According to the faculty board's agreement, at least 60% of the first-year midterm and final exams must be shared by all groups.

Other Activities	**Weight:**	25%

The following activities will be developed and evaluated:

- Exercises hand outs and/or tests in Virtual Campus.
- Assistance to seminar talks and hand out of short reports.
- Other coordinated workshop or tutorship activities, classroom presentations, specifically

assigned exercises/reports, etc.

The final mark for this section will be $N_{OtherActiv}$ and will range from 0 to 10.

Final Mark

Final mark:

$$C_{Final} = \max \{ 0.75N_{Exam} + 0.25\, N_{OtherActiv} ,\ N_{Exam} \}$$

Minimum final Exams mark for weighting: $N_{Exam} \geq 4.5$

The final mark criterion, as well as the mark corresponding to other activities, will be maintained in the exam of the extraordinary call.