



# Bachelor in Physics (Academic Year 2022-23)

<b>Physics Fundamentals I</b>		<b>Code</b>	800490	<b>Year</b>	1st	<b>Sem.</b>	1st
<b>Module</b>	Basic Core	<b>Topic</b>	Physics		<b>Character</b>	Obligatory	

	Total	Theory	Exercises
<b>ECTS Credits</b>	9	4.5	4.5
<b>Semester hours</b>	84	39	45

Learning Objectives (according to the Degree's Verification Document)
<ul style="list-style-type: none"> <li>• To handle fundamental concepts in Physics such as: particle, field, system of reference, energy, momentum, conservation laws, macroscopic and microscopic points of view.</li> <li>• To get knowledge and understanding of fundamental physical phenomena, including those related to classical mechanics and thermodynamics.</li> <li>• To begin to formulate and solve simple problems in Physics, identifying the relevant physical phenomena involved and carrying out order estimates and order-of-magnitude calculations.</li> <li>• To get an overview of the state of the art in Physics.</li> </ul>
Brief description of contents
Newtonian mechanics, introduction to the special theory of relativity, ideal fluids, thermodynamics.
Prerequisites
Physics and mathematics knowledge acquired in "Bachillerato".

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Theory/Exercises – Schedule and Teaching Staff								
Group	Lecture Room	Day	Time	Professor	Period/Dates	Hours	T/E	Dept.
B	7	Tu, Th, Fr	11:00-13:00	Charles Creffield	Inicio semestre	38	T/E	FM
				Carlos Díaz-Guerra Viejo	Hasta final semestre	46	T/E	FM

T: Theory, E: Exercises

Office hours				
Group	Professor	Schedule	E-mail	Location
B	Carlos Díaz-Guerra Viejo	Mo, Tu, We, Th 14:30-16:00 On line/Presential	<a href="mailto:cdiazgue@ucm.es">cdiazgue@ucm.es</a>	East wing, 2 <sup>nd</sup> floor, room 111
	Charles Creffield	Mo, We, Fr 14:30-16:00 +3h On line	<a href="mailto:c.creffield@fis.ucm.es">c.creffield@fis.ucm.es</a>	106 (2 <sup>nd</sup> floor)

## Syllabus

### 1. Introduction.

Magnitudes and units of measurement. Scalar and vector quantities. Introduction to vector calculus. Coordinate systems.

### 2. Kinematics.

Speed and acceleration. Acceleration components. Relative translation movement: Galilean transformations.

### 3. Dynamics.

Newton's laws: inertial mass. Linear momentum and its conservation. Principle of relativity. Inertial forces. Torque. Angular momentum. Central forces.

### 4. Work and Energy.

Kinetic energy. Potential energy. Gradient. Conservative forces. Potential energy curves. Conservative and dissipative forces. Energy dissipation.

### 5. Motion of a system of particles. Rigid objects.

Center of mass of a system of particles. Linear momentum and angular momentum. Orbital angular momentum. Spin. Kinetic energy of a system of particles and its conservation. Moment of inertia. Rotational motion of a rigid object. Binding energy of a system of particles.

### 6. Relativity.

The Michelson–Morley experiment. Lorentz's transformation. Time dilation. Lorentz contraction. Simultaneity. Velocity transformation equations. Momentum. Relativistic energy.

### 7. Oscillatory Motion. Kinematics of a harmonic oscillator.

Kinematics of a harmonic oscillatory movement. Force and energy. The simple pendulum. Superposition of harmonic movements. Damped oscillations.

### 8. Universal Gravitation.

Kepler's laws. Newton's law of universal gravitation. Gravitational potential energy. The gravitational field: field lines, flux, Gauss's theorem. Gravitational potential. Gravitational field of a spherical body.

### 9. Fluids.

Hydrostatics. Pressure in a fluid. Pascal's principle. Archimedes's principle. Fluid Dynamics. Bernoulli's equation. Viscosity.

### 10. Thermodynamics.

*Heat and temperature:* Temperature and thermal equilibrium. Temperature scales. Equation of state for an ideal gas. Kinetic theory of gases. Heat and specific heat. Mechanical work. *First law:* thermodynamic processes. Internal energy of an ideal gas. Adiabatic processes for an ideal gas. Reversible and irreversible processes. *Second Law:* cyclic transformations. The second law of Thermodynamics. Entropy.

## Bibliography

### Basic

- M. Alonso and E. J. Finn, *Physics* (Pearson Education) [*Física* (Addison-Wesley Iberoamericana, 1995)].
- Sears, Zemansky, Young and Freedman, *University Physics with Modern Physics, 13<sup>th</sup> Edition*, Pearson [*Física Universitaria* (12<sup>a</sup> Ed., Pearson Educación, México 2009)].
- R. A. Serway and J.W Jewett, *Physics for Scientists and Engineers* (Brooks/Cole, 9<sup>th</sup> Ed. (2014). [*Física*, 1<sup>er</sup> vol., 4<sup>a</sup> Ed. (McGraw-Hill, Madrid, 2001)].
- P. A. Tipler and G. Mosca, *Physics for Scientists and Engineers with Modern Physics* (Freeman, 6<sup>th</sup> Ed. (2007). [*Física para la ciencia y la tecnología*, 1<sup>er</sup> vol., 6<sup>a</sup> Ed. (Reverté, Barcelona, 2010)].

### Complementary

- Feynman R.P., Leighton R.B. & Sands M., *Physics*, (Addison Wesley, 1987).
- F.A. González, *La física en problemas*, (Tébar, 2000).
- M. Lozano Leyva, *De Arquímedes a Einstein: los diez experimentos más bellos de la física*, (Debate, 2005).
- J.I. Mengual, M.P. Godino y M. Khayet, *Cuestiones y problemas de fundamentos de física*, (Ariel, Barcelona, 2004).

Online Resources
<p><b>UCM Virtual Campus</b></p> <p>Other resources:</p> <ul style="list-style-type: none"> <li>• Catalogue of experiments for General Physics. <a href="http://www.ucm.es/centros/webs/oscar">http://www.ucm.es/centros/webs/oscar</a></li> <li>• Interactive Physics Course, by Ángel Franco García. <a href="http://www.sc.ehu.es/sbweb/fisica/">http://www.sc.ehu.es/sbweb/fisica/</a></li> <li>• MIT open course <a href="http://ocw.mit.edu/OcwWeb/Physics/index.htm">http://ocw.mit.edu/OcwWeb/Physics/index.htm</a></li> <li>• Caltech videos “The mechanical universe” <a href="http://www.acienciasgalilei.com/videos/video0.htm">http://www.acienciasgalilei.com/videos/video0.htm</a></li> </ul>

Methodology
<p>Teaching activities:</p> <ul style="list-style-type: none"> <li>• Theory lessons. Main concepts will be explained and will be illustrated with examples and practical applications. (3 h/week).</li> <li>• Practical lessons: exercises, case studies and other activities. (3 h/week).</li> </ul> <p>Both blackboard and computer-aided classroom presentations will be used for theory lessons. Occasionally, theory lessons will be complemented with computer simulations or virtual exercises. Students will be provided in due time and through the Virtual Campus with the list of exercises and problems that will be solved during the practical lessons. Continuous assessment will be partially based on out-of-class works and exercises.</p>

Evaluation Criteria		
<b>Exams</b>	<b>Weight:</b>	75%
<p>A midterm and a final exam, both of the same type, will be evaluated to obtain the so- called <math>N_{Final}</math> mark. Such mark is the best score of the following options:</p> $N_{Final} = 0.3N_{Ex\_Parc} + 0.7N_{Ex\_Final}$ $N_{Final} = N_{Ex\_Final}$ <p>where <math>N_{Ex\_Parc}</math> is the mark obtained in the midterm exam and <math>N_{Ex\_Final}</math> is that obtained in the final exam (both over 10).</p> <p>To pass the subject, (<math>N_{Ex\_Final}</math>) must be <math>\geq 4</math>.</p> <p>Exams will be divided in two parts: short questions (theoretical or practical) and problems. A single theory book, to be selected by each student, might be consulted in the second part (problems) of the exams.</p> <p>The same exam will be taken by all the students, irrespective of their group.</p>		
<b>Other Activities</b>	<b>Weight:</b>	25%
<p>Continuous assessment activities may include:</p> <ul style="list-style-type: none"> <li>• Problems and exercises to be solved in group or individually.</li> <li>• Short exams or tests (classroom)</li> <li>• Online tests or questionnaires (Virtual Campus)</li> </ul>		
Final Mark		
<p>The final mark is the best score of the options as follows:</p> $C_{Final} = 0.75 N_{Final} + 0.25N_{OtherActiv} \quad \text{or} \quad C_{Final} = N_{Final} .$ <p>where <math>N_{OtherActiv}</math> is the mark corresponds to <i>Other Activities</i> score and <math>N_{Final}</math> to the exam score. The final mark in July will be obtained following exactly the same assessment procedure.</p>		