



## IDENTIFYING DATA

### Physics: Physics 2

Subject	Physics: Physics 2			
Code	V12G320V01202			
Study programme	Degree in Electrical Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Basic education	1st	2nd
Teaching language	Spanish			
Department				
Coordinator	Fernández Fernández, José Luís			
Lecturers	Álvarez Fernández, María Inés Blanco García, Jesús Fernández Fernández, José Luís López Vázquez, José Carlos Lusquiños Rodríguez, Fernando Méndez Morales, Trinidad Paredes Galán, Ángel Quintero Martínez, Félix Ribas Pérez, Fernando Agustín Sánchez Vázquez, Pablo Breogán Soto Costas, Ramón Francisco Val García, Jesús del Wallerstein Figueirôa, Daniel			
E-mail	jlfdez@uvigo.es			
Web	<a href="http://fatic.uvigo.es">http://fatic.uvigo.es</a>			
General description	This undergraduate course is the second quarter of introductory physics. The focus is on electricity, magnetism and thermodynamics			

## Competencies

Code	
B3	CG3 Knowledge in basic and technological subjects that will enable students to learn new methods and theories, and provide them the versatility to adapt to new situations.
C2	CE2 Understanding and mastering the basics of the general laws of mechanics, thermodynamics, waves and electromagnetic fields, as well as their application for solving engineering problems.
D2	CT2 Problems resolution.
D9	CT9 Apply knowledge.
D10	CT10 Self learning and work.

## Learning outcomes

Expected results from this subject	Training and Learning Results			
Understanding the basic concepts of electromagnetism and thermodynamics.	B3	C2		
Knowing the basic instruments for the measurement of physical quantities.		C2		
Knowing the basic techniques for experimental data evaluation.	B3	C2	D9	D10
Ability to develop practical solutions to basic technical problems in engineering, within the framework of electromagnetism and thermodynamics.	B3	C2	D2	D9 D10

## Contents

Topic
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1.- ELECTRIC CHARGE AND ELECTRIC FIELD	<ul style="list-style-type: none"> <li>1.1.- Electric Charge.</li> <li>1.2.- Conductors, Insulators and Induced Charges.</li> <li>1.3.- Coulomb's Law.</li> <li>1.4.- Electric Field and Electric Forces.</li> <li>1.5.- Electric Field Calculations.</li> <li>1.6.- Electric Field Lines.</li> <li>1.7.- Electric Dipoles.</li> </ul>
2.- GAUSS'S LAW	<ul style="list-style-type: none"> <li>2.1.- Charge and Electric Flux.</li> <li>2.2.- Calculating Electric Flux.</li> <li>2.3.- Gauss's Law.</li> <li>2.4.- Applications of Gauss's Law.</li> <li>2.5.- Conductors in Electrostatic Equilibrium.</li> </ul>
3.- ELECTRIC POTENTIAL	<ul style="list-style-type: none"> <li>3.1.- Electric Potential Energy.</li> <li>3.2.- Electric Potential.</li> <li>3.3.- Calculating Electric Potential.</li> <li>3.4.- Equipotential Surfaces.</li> <li>3.5.- Potential Gradient.</li> </ul>
4.- CAPACITANCE AND DIELECTRICS	<ul style="list-style-type: none"> <li>4.1.- Capacitors and Capacitance.</li> <li>4.2.- Capacitors in Series and Parallel.</li> <li>4.3.- Energy Storage in Capacitors and Electric-Field Energy.</li> <li>4.4.- Dielectrics, Molecular Model of Induced Charge, and Polarization Vector.</li> <li>4.5.- Gauss's Law in Dielectrics.</li> <li>4.6.- Dielectric Constant and Permittivity.</li> </ul>
5.- CURRENT, RESISTANCE, AND ELECTROMOTIVE FORCE	<ul style="list-style-type: none"> <li>5.1.- Electric Current.</li> <li>5.2.- Current and Current Density.</li> <li>5.3.- Ohm's Law and Resistance.</li> <li>5.4.- Electromotive Force and Circuits.</li> <li>5.5.- Energy and Power in Electrical Circuits.</li> <li>5.6.- Basic Theory of Electrical Conduction.</li> </ul>
6.- MAGNETIC FIELD	<ul style="list-style-type: none"> <li>6.1.- Magnetic Field.</li> <li>6.2.- Motion of Charged Particles in a Magnetic Field.</li> <li>6.3.- Magnetic Force on a Current-Carrying Conductor.</li> <li>6.4.- Force and Torque on a Current Loop.</li> <li>6.5.- Biot-Savart's Law.</li> <li>6.6.- Magnetic Field Lines and Magnetic Flux.</li> <li>6.7.- Ampère's Law.</li> </ul>
7.- MAGNETIC FIELD IN MATTER	<ul style="list-style-type: none"> <li>7.1.- Magnetic Substances and Magnetization Vector.</li> <li>7.2.- Ampère's Law in Magnetic Media.</li> <li>7.3.- Magnetic Susceptibility and Permeability.</li> <li>7.4.- Paramagnetism and Diamagnetism.</li> <li>7.5.- Ferromagnetism.</li> </ul>
8.- ELECTROMAGNETIC INDUCTION	<ul style="list-style-type: none"> <li>8.1.- Induction Experiments.</li> <li>8.2.- Faraday-Lenz's Law.</li> <li>8.3.- Induced Electric Fields.</li> <li>8.4.- Eddy Currents.</li> <li>8.5.- Mutual Inductance.</li> <li>8.6.- Self-Inductance and Inductors.</li> <li>8.7.- Magnetic-Field Energy.</li> </ul>
9.- THERMODYNAMIC SYSTEMS	<ul style="list-style-type: none"> <li>9.1.- Classical Thermodynamics.</li> <li>9.2.- Thermodynamic Systems and Classification.</li> <li>9.3.- State Variables and State of a System.</li> <li>9.4.- Equations of State.</li> <li>9.5.- Thermodynamic Equilibrium.</li> <li>9.6.- Change of State, Transformation or Process.</li> <li>9.7.- Quasi-static Processes.</li> <li>9.8.- State and Process Functions.</li> </ul>
10.- TEMPERATURE AND HEAT	<ul style="list-style-type: none"> <li>10.1.- Thermal Equilibrium, The Zeroth Law of Thermodynamics, and Temperature.</li> <li>10.2.- Thermometers and Temperature Scales.</li> <li>10.3.- Ideal Gas Thermometers and the Kelvin Scale.</li> <li>10.4.- Heat.</li> <li>10.5.- Calorimetry and Heat Capacities.</li> </ul>

11.- THE FIRST LAW OF THERMODYNAMICS	11.1.- Work. 11.2.- Work Done During Volume Changes. 11.3.- Internal Energy. 11.4.- The First Law of Thermodynamics. 11.5.- Internal Energy of an Ideal Gas. 11.6.- Molar Heat Capacities of an Ideal Gas. 11.7.- Adiabatic, Isothermal, Isobaric and Isochoric Processes for an Ideal Gas. 11.8.- Enthalpy.
12.- THE SECOND LAW OF THERMODYNAMICS	12.1.- Directions of Thermodynamic Processes. 12.2.- Heat Engines, Refrigerators, and Heat Pumps. 12.3.- The Second Law of Thermodynamics: Clausius and Kelvin-Planck Statements. 12.4.- Carnot Engine. 12.5.- Carnot Theorems. 12.6.- Thermodynamic Temperature. 12.7.- Entropy. 12.8.- Increase of Entropy Principle. 12.9.- Entropy Change of an Ideal Gas.
LABORATORY	1.- How to Use a Multimeter. Ohm's Law. Direct Current. Circuit with Resistors. 2.- Linear and Non-Linear Conductors. 3.- Charge and Discharge of a Capacitor. 4.- Analysis of a Parallel Plate Capacitor with Dielectrics. 5.- Utilization of an Oscilloscope to Analyze Charge and Discharge Processes. 6.- Study of the Magnetic Field. Helmholtz Coils. Magnetic Moment. Hall Effect. 7.- Calorimetry. Water Equivalent of Calorimeter. Latent Heat of Fusion. 8.- Thermodynamics of the Ideal Gas. Heat Capacity Ratio. Adiabatic Work.
LABORATORY: UNSTRUCTURED ACTIVITY (OPEN LAB) SESSIONS	Unstructured activity (open lab) sessions that cover the topics of the above cited regular laboratory sessions. A practical problem will be assigned to each team. Then, under the teacher's supervision, each team must analyse the problem, select a theoretical model and experimental means to obtain a solution.

### Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	24.5	45	69.5
Problem solving	8	20	28
Laboratory practical	18	18	36
Objective questions exam	1	0	1
Problem and/or exercise solving	3.5	0	3.5
Essay questions exam	3	0	3
Report of practices, practicum and external practices	0	9	9

\*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

### Methodologies

	Description
Lecturing	Lectures are given by the teacher on the contents of the subject, theoretical bases and / or guidelines of a work, exercise or project to be performed by the students.
Problem solving	Activity in which problems and / or exercises related to the subject are formulated. The student must develop the appropriate or correct solutions through the repetition of routines, the application of formulas or algorithms, the application of procedures for transforming the available information and the interpretation of the results. It is usually used as a complement to the lecture sessions.
Laboratory practical	Activities for applying the knowledge to particular situations and for the acquisition of basic and procedural skills related to the subject. They are developed in dedicated rooms with specialized equipment (laboratories, computer rooms, etc.).

### Personalized assistance

Methodologies	Description
Lecturing	In office hours.
Laboratory practical	In office hours.
Problem solving	In office hours.

Tests	Description
Objective questions exam	In office hours.
Problem and/or exercise solving	In office hours.
Essay questions exam	In office hours.
Report of practices, practicum and external practices	In office hours.

### Assessment

Description	Qualification	Training and Learning Results
Objective questions exam	10	B3 C2
Problem and/or exercise solving	40	B3 C2 D2
Essay questions exam	40	B3 C2
Report of practices, practicum and external practices	10	B3 C2 D9 D10

### Other comments on the Evaluation

Continuous assessment (denoted EC) will have a weight of 40% in the final mark, and will include the lab mark (20%, denoted ECL) and the class mark (20%, denoted ECA).

The mark ECA will be evaluated by means of tests on the topics covered in the lectures. These tests will comprise objective questions and/or essay questions.

The mark ECL will be evaluated by the lab reports and tests on the topics covered in the laboratory sessions.

Those students unable to attend the continuous assessment and who have been granted the waiver of the continuous assessment have the possibility of taking a final test to obtain a REC mark with a weight of 40% of the final mark. This test will include the contents of the lab sessions (weight of 20%, denoted RECL) and the topics covered in the lectures (weight of 20%, denoted RECA).

The remaining 60% of the final mark will be obtained by taking a final exam. This will consist of two parts: a theoretical part (denoted T) with a weight of 20% of the final mark, and another part on problem solving (denoted P) with a weight of 40% of the final mark. The theoretical part will consist of a test comprising objective questions and/or essay questions. Those students not attending the final exam will obtain a mark of non-presented.

Both the "fin de carrera" exam and any other ones held on dates and/or times different from those officially set by the School of Industrial Engineering (E.E.I.), could have an exam format different from the one previously described, although each part of the exam (EC or REC, T and P) will hold its weight in the final mark.

Final mark G for the continuous assessment modality:

$$G = ECL + ECA + T + P.$$

Final mark G for the assessment at the end of the course and July (RECL and RECA only for those students who have been granted the waiver of the continuous assessment):

$$G = ECL \text{ (or RECL)} + ECA \text{ (or RECA)} + T + P.$$

To pass the course, a student must obtain a final mark G equal to or higher than 5.

Ethical commitment: Every student is expected to follow an appropriate ethical behaviour. In the case that unethical conduct is detected (copy, plagiarism, utilisation of unauthorised electronic devices, or others), it will be considered that the student does not fulfil the necessary requirements to pass the subject. In this case, the final mark in the present academic year will be "suspenso" (0.0).

Students should not possess or use any electronic device during the tests and exams, unless specifically authorised to do so. The mere fact that a student carries an unauthorised electronic device into the examination room will result in failing the subject in the present academic year and the final mark will be [suspense] (0.0).

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## Sources of information

### Basic Bibliography

1. Young H. D., Freedman R. A., **Física Universitaria, V1 y V2**, 13ª ed., Pearson,
- 1en. Young H. D., Freedman R. A., **University physics: with modern physics**, 14th ed., Pearson,

### Complementary Bibliography

2. Tipler P., Mosca G., **Física para la ciencia y la tecnología, V1 y V2**, 5ª ed., Reverté,
- 2en. Tipler P., Mosca G., **Physics for Scientists and Engineers, V1 and V2**, 6th ed., W. H. Freeman and Company,
3. Serway R. A., Jewett J. W., **Física para ciencias e ingeniería, V1 y V2**, 9ª ed., Cengage Learning,
- 3en. Serway R. A., Jewett J. W., **Physics for Scientists and Engineers**, 9th ed., Brooks/Cole,
4. Juana Sardón, J. M., **Física general, V1 y V2**, 2ª ed., Pearson Prentice-Hall,
5. Bronshtein, I., Semendiaev, K., **Manual de matemáticas para ingenieros y estudiantes**, 4ªed., MIR 1982; MIR-Rubiños 1993,
- 5en. Bronshtein, I., Semendiaev, K., **Handbook of Mathematics**, 5th Ed., Springer Berlin,
6. Jou Mirabent, D., Pérez García, C., Llebot Rabagliati, J. E., **Física para ciencias de la vida**, 2ª ed., McGraw-Hill Interamericana de España S.L.,
7. Cussó Pérez, F., López Martínez, C., Villar Lázaro, R., **Fundamentos Físicos de los Procesos Biológicos**, 1ª ed., ECU,
8. Cussó Pérez, F., López Martínez, C., Villar Lázaro, R., **Fundamentos Físicos de los Procesos Biológicos, Volumen II**, 1ª ed., ECU,
9. Villar Lázaro, R., López Martínez, C., Cussó Pérez, F., **Fundamentos Físicos de los Procesos Biológicos, Volumen III**, 1ª ed., ECU,
- 10en. Villars, F., Benedek, G. B., **Physics with Illustrative Examples from Medicine and Biology**, 2nd ed., AIP Press/Springer-Verlag,

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## Recommendations

### Other comments

Basic recommendations:

1. Basic knowledge acquired in the subjects of Physics and Mathematics in previous courses.
2. Oral and written comprehension.
3. Capacity for abstraction, basic calculus, and synthesis of information.
4. Skills for group work and communication.

In the event of discrepancy, the Spanish version of this syllabus prevails.

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## Contingency plan

### Description

=== EXCEPTIONAL PLANNING ===

Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===

\* Teaching methodologies maintained

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\* Teaching methodologies modified

All the methodologies (lecturing, problem solving and laboratory practical): in the blended learning regime face-to-face classroom activities will be combined with online lecturing through the virtual campus ([Campus Remoto]), using FAITIC platform as an additional support. In the distance learning regime, online lecturing will take place through virtual campus ([Campus Remoto]), using FAITIC platform as an additional support as well. To guarantee the access of the students to the materials and resources of the course other methodologies and media could be implemented if needed.

Laboratory practicals: in blended learning, the operation of experimental devices by the students and the associated data acquisition activities could suffer major restrictions. These activities will be mostly replaced by demonstrations developed by

the lecturer in the lab and watched by the students attending the lab session. These demonstrations could be followed online by the rest of the students. Data processing and analysis are greatly independent of the operation of experimental devices and can be developed outside the laboratory (in another classroom, at home, etc.), so such activities could be realized by students attending the lab as well as by students participating online. In the distance learning regime, the laboratory practicals will be developed entirely online and the operation of experimental devices and data acquisition activities to be done by the students will be completely replaced by demonstrations developed by the lecturer and/or specific audiovisual materials.

\* Non-attendance mechanisms for student attention (tutoring)

Office hours and tutoring could be developed both face-to-face (provided that safety can be guaranteed) or online, by using asynchronous media (email, forum, etc.) or by videoconference (by making an appointment).

\* Modifications (if applicable) of the contents

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\* Additional bibliography to facilitate self-learning

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\* Other modifications

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=== ADAPTATION OF THE TESTS ===

\* Tests already carried out

Test XX: [Previous Weight 00%] [Proposed Weight 00%]

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\* Pending tests that are maintained

Test XX: [Previous Weight 00%] [Proposed Weight 00%]

Final exam, part P 40%, the weight of the exam is maintained.

Final exam, part T 20%, the weight of the exam is maintained.

\* Tests that are modified

[Previous test] => [New test]

ECA 20%, types of tests may include: objective questions exam, essay questions exam => ECA 20%, types of tests may include: objective questions exam, essay questions exam, problem and/or exercise solving.

ECL 20%, types of tests may include: essay questions exam, practices report 10% => ECL 20%, types of tests may include: essay questions exam, problem and/or exercise solving, practices report 10%.

\* New tests

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\* Additional Information

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