Universidade Vigo

IDENTIFYING DATA				
Physics Extended				
Subject	Physics Extended			
Code	V04M141V01104			
Study programme	(*)Máster Universitario en Enxeñaría Industrial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	1st	1st
Teaching language	English			
Department				
Coordinator	Fernández Fernández, José Luís López Vázquez, José Carlos			
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General description	The main goals of Physics Extended are: a) To get a deeper understanding of the physical foundations of engineering, specifically those related to electromagnetic and wave phenomena. b) To introduce the use of mathematical tools, in particular vector analysis and differential equations and their associated boundary value problems, within the framework of problems and models in Physics. c) To combine theoretical education and a practical engineering approach, stressing the relevance of fundamentals to deal with problem analysis and synthesis of solutions in real-life situations. d) To relate the topics in the fundamentals of electromagnetism and wave phenomena to the contents of other more technological subjects included in the curriculum for the Degree. The topics of Physics Extended are, essentially, an introduction to wave phenomena in general (three units) and the study of classical electromagnetism using an axiomatic approach employing a mathematical treatment based on differential vector operators (four units).			

Training and Learning Results	
Code	
A1	Knowledge and understanding that provide a basis or opportunity for originality in developing and / or applying ideas, often in a research context.
A3	That students are able to integrate knowledge and handle complexity and formulate judgments based on information that was incomplete or limited, include reflecting on social and ethical responsibilities linked to the application of their knowledge and judgments.
C7	CET7. Apply their knowledge and solve problems in new or unfamiliar environments within broader contexts and multidisciplinary environments.
C10	CET10. Possess learning skills that will allow further study of a self-directed or autonomous mode.

Expected results from this subject	
Expected results from this subject	Training and Learning Results
To know and to understand the physical foundations of mechanical vibrations and waves, as well as of electricity and magnetism	A1 A3 C7
To know and to be skilled in the application of vector analysis and differential equations of mathematical physics, as problem solving tools within the framework of fundamentals of physics	A1 A3 C7

To be able to establish efficient strategies and procedures for solving problems in fundamentals of physics related to industrial technologies	A1 A3 C7
To be able to implement specific solutions in the laboratory to experimental problems in fundamentals of physics	A1 A3 C7 C10

Contents

Topic	
I.1. WAVE MOTION	1.1. Wave phenomena 1.2. Fundamental characteristics of waves 1.3. The wave equation 1.4. Plane waves 1.5. Wavefront and wavevector 1.6. Cylindrical and spherical waves 1.7. Longitudinal and transverse waves 1.8. Huygens' principle 1.9. Reflection and refraction of waves
I.2. MECHANICAL WAVES	2.1. The nature of mechanical waves 2.2. Longitudinal waves in thin rods 2.3. Longitudinal waves in springs 2.4. Transverse waves in strings 2.5. Power flow and intensity of a wave 2.6. Longitudinal waves in fluids
I.3. DESCRIPTION OF PHYSICAL QUANTITIES BY MEANS OF VECTOR ANALYSIS	3.1. Differential of arc of a curve 3.2. Scalar fields 3.3. Directional derivative 3.4. Gradient 3.5. Vector fields 3.6. Flux of a vector field 3.7. Solenoidal fields 3.8. Divergence of a vector field 3.9. Ostrogradski-Gauss' theorem or divergence theorem 3.10. Divergence of a solenoidal field 3.11. Circulation of a vector field 3.12. Rotation or curl of a vector field 3.13. Stokes' theorem 3.14. Conservative fields
II.1. GENERAL EQUATIONS OF ELECTROMAGNETISM	1.1. Definition of electric and magnetic fields 1.2. Field sources: macroscopic electric charges and currents 1.3. Relations among fields E and B and their sources: Maxwell's equations 1.4. Free charge 1.5. Polarization charge 1.6. Electric current 1.7. Polarization current 1.8. Magnetization current 1.9. Maxwell's equations as a function of fields E, D, B, and H 1.10. Boundary conditions for electromagnetic fields 1.11. Electrodynamic potentials 1.12. The energy law of the electromagnetic field
II.2. TIME-INDEPENDENT FIELDS: ELECTROSTATICS, STEADY ELECTRIC CURRENT AND MAGNETOSTATICS	2.1. Fundamental equations of electrostatics 2.2. Electric dipole 2.3. Fundamental equations for steady electric current 2.4. Equations including media properties 2.5. Electrical resistance 2.6. Joule's law 2.7. Electromotive forces and generators 2.8. Potential distribution in a resistor 2.9. Fundamental equations of magnetostatics 2.10. Equations including media properties 2.11. Magnetic forces 2.12. Magnetic circuit 2.13. Magnetic dipole

II.3. ELECTROMAGNETIC INDUCTION AND QUASISTATIC FIELDS	3.1. Electromagnetism in moving media 3.2. Galilean transformation of electric and magnetic fields 3.3. Electromotive force around a circuit 3.4. Faraday's law of electromagnetic induction 3.5. Definition of quasistatic fields 3.6. Self-inductance and mutual inductance 3.7. Magnetic energy
II.4. ELECTROMAGNETIC WAVES	4.1. Wave equations for fields E and H 4.2. E.M. monochromatic plane waves in lossless media 4.3. E.M. monochromatic plane waves in lossy media 4.4. Incidence of a plane wave on an interface between two perfect dielectrics 4.5. Incidence of a plane wave on an interface between a perfect dielectric and a conductor
III.1 LABS: STRUCTURED ACTIVITY SESSIONS	1.1 Structured activity sessions: - Experimental data processing (approximate quantities, measurement of physical magnitudes, error estimation) - Adequate operation with basic measurement instruments (flex-meter, micrometer, multimeter (analog and digital), oscilloscope) - Laboratory experiments with mechanical or electromagnetic waves (emission and reception of ultrasonic waves, microwaves or light waves, standing waves along one direction, Michelson interferometer)
III.2 LABS: UNSTRUCTURED ACTIVITY (OPEN LAB) SESSIONS	2.1. Unstructured activity (open lab) sessions: - A practical problem, formulated with basic initial data, will be assigned to each working team. Then, under the teacher's supervision, each team must analyze the problem, select a possible solution and carry it out in the lab - For the open lab problems, a diversity of topics and experimental techniques are considered within the field of wave and electromagnetic phenomena, in particular, electric current conduction and electromagnetic induction in quasistatic regime - As a reference, some open lab problems that can be proposed are: measuring the electric field on a weakly conducting sheet, numerical solution of the Laplace equation, measuring the self-inductance of a coil or a solenoid, measuring the mutual inductance of two coils or two solenoids - As an option, the open lab sessions may be replaced by a well-documented piece of work reporting some topic/technique/process/device related to science or technology where wave or electromagnetic phenomena play an essential role. The report must include a model of the problem, clearly identifying the relevant quantities and physical laws

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	20	30	50
Problem solving	9	33	42
Laboratory practical	18	18	36
Problem and/or exercise solving	2	0	2
Essay questions exam	2	0	2
Report of practices, practicum and external practices	0	18	18

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

Methodologies

	Description
Lecturing	The main topics of the subject are introduced by the teacher using projected presentations and the chalkboard, emphasizing the theoretical basis and fundamentals and stressing the critical or key points. Occasionally, demonstrative experiments or audiovisual material may be employed
Problem solving	Academic problems related to the topics of the subject are formulated and worked out at the chalkboard by the teacher or the students. By practicing standard schemes, formulas or algorithms and by analyzing the results, the student must develop adequate skills to be able to obtain the correct solution to the problem on his/her own at the end of the course
Laboratory practical	Activities for applying the knowledge to particular situations and for developing basic and procedural skills related to the subject. These activities will be held in specific rooms with specialized equipment (laboratories and computer rooms)

Personalized assistance

Methodologies	Description
Lecturing	In tutoring hours
Problem solving	In tutoring hours
Laboratory practical	In tutoring hours

Assessment			
	Description	Qualification	Training and Learning Results
Problem and/or exercise solving	Test in which the student must solve a series of problems and / or exercises in a time / conditions set by the teacher	40	A1 C7 A3 C10
Essay questions exam	Test that includes open questions on a topic. Students should develop, relate, organize and present knowledge on the subject in an argued response	50	A1 C7 A3
Report of practices, practicum and external practices	Each team should write a report on the activities carried out. The report must include the tasks and procedures developed, the results obtained or the observations taken, as well as a detailed description of the data processing and analysis	10	A1 C7 A3 C10

Other comments on the Evaluation

1. Ordinary call (December-January)
1.1 Continuous assessment
- The final mark G0 results from the classroom mark A0 (80% of the final mark), on topics of Parts I and II, and the lab mark L0 (20% of the final mark), on topics of Part III.
- Mark A0 combines the classroom mark C0 (40% of the final mark), that is obtained from theoretical-practical tests (essay-questions and problem/exercise solving) to be developed during the term, and the classroom mark F0 (40% of the final mark), that is obtained from an end-of-term theoretical-practical test to be held on the same date that the exam of the ordinary call.
- Mark L0 combines the mark L01 (10% of the final mark), that is obtained from theoretical-practical tests to be developed during the term (essay-questions and problem/exercise solving) on topics of Part III.1, and the mark L02 (10% of the final mark) that is obtained from a lab report corresponding to topics of Part III.2. Only students that have regularly attended the lab sessions can obtain a mark L0 different form "0.0".
- The final mark of the continuous assessment in the ordinary call is obtained as
G0 = A0 (80%) + L0 (20%) = C0 (40%) + F0 (40%) + L01 (10%) + L02 (10%)
- To pass the course, a student must obtain a final mark G0 equal to or higher than 5.
1.2 Global assessment
- Those students who have been granted the waiver of the continuous assessment in the ordinary call will obtain 100% of their final mark G1 from a exam corresponding to the ordinary call.
- The final mark G1 results from the classroom mark A1 (80% of the final mark), on topics of Parts I and II, and the lab mark L1 (20% of the final mark), on topics of Part III.1.
- Mark A1 combines marks C1 (40% of the final mark) and F1 (40% of the final mark), that are obtained from theoretical-practical tests (essay-questions and problem/exercise solving).
- Mark L1 (20% of the final mark) is obtained from a theoretical-practical test (essay-questions and problem/exercise solving).
- The final mark of the global assessment in the ordinary call is obtained as
G1 = A1 (80%) + L1 (20%)= C1 (40%) + F1 (40%) + L1 (20%)
- To pass the course, a student must obtain a final mark G1 equal to or higher than 5.
2. Extraordinary call (June-July)
- All students, whether they have waived continuous assessment or not, will obtain 100% of their final mark G2 from an exam corresponding to the extraordinary call.
- The final mark G2 results from the classroom mark A2 (80% of the final mark), on topics of Parts I and II, and the lab mark L2 (20% of the final mark), on topics of Part III.1.
- Mark A2 combines marks C2 (40% of the final mark) and F2 (40% of the final mark), that are obtained from theoretical-practical tests (essay-questions and problem/exercise solving).
- Mark L2 (20% of the final mark) is obtained from a theoretical-practical test (essay-questions and problem/exercise solving).
- The final mark of the continuous or global assessment in the extraordinary call is obtained as
G2 = A2 (80%) + L2 (20%)= C2 (40%) + F2 (40%) + L2 (20%)
- To pass the course, a student must obtain a final mark G2 equal to or higher than 5.
3. Common features and interconnection among the assessment alternatives
- In the continuous and global assessment modalities for the ordinary and extraordinary calls that have been defined in the previous sections, we can classify marks that are equivalent to each other in three sets with three elements each: classroom

marks C0, C1 and C2, classroom marks F0, F1 and F2 and lab marks L0, L1 and L2. If C is the most recent valid mark from C0, C1 and C2, F is the most recent valid mark from F0, F1 and F2 and L is the most recent valid mark from L0, L1 and L2, the final mark G in the ordinary or the extraordinary call, either for continuous or global assessment, is obtained as
G =C(40%) + F (40%) + L(20%)
To pass the course, a student must obtain a final mark G equal to or higher than 5 in any of the assessment alternatives.
- To obtain the final mark G2 in the extraordinary call the students, whether they have waived continuous assessment or not, can choose between:
a) answering the part of the exam of the extraordinary call corresponding to marks C2, F2, and/or L2, that will be used in the formula of the final mark of the extraordinary call G2.
b) use the most recent valid mark of each type (C0 or C1, F0 or F1 and/or L0 or L1) to be used instead of marks C2, F2 and/or L2, respectively, in the formula of the final mark of the extraordinary call G2, not taking the corresponding part of the exam of this call.
4. End-of-degree call
- The end-of-degree call follows the same assessment scheme as the extraordinary call.
- The end-of-degree assessment is completely independent of the assessments in the ordinary and extraordinary calls (in particular, the features and interconnections described in the previous section do not apply).
5. Supplementary assessment rules
- Students should not have access to or use any electronic device during the tests and exams, unless specifically authorized. The mere act of taking an unauthorized electronic device into the examination room will result in the student failing the subject and the final mark in the corresponding call will be "suspenso (0.0)".
- The tests and exams will be jointly set and assessed by the teaching team of the subject.
- The dates for the exams in each call will be assigned by the board of directors of the School of Industrial Engineering (E.E.I.).
6. Ethical commitment
Every student is expected to behave in an appropriate ethical manner. Should unethical conduct be detected (copying, plagiarism, utilization of unauthorized electronic devices, or others), the student will be considered not to have fulfilled the necessary requirements to pass the subject. In this case, the final mark in the corresponding call will be "suspenso (0,0)".

Sources of information

Basic Bibliography

Fernández, José L. , Pérez-Amor, Mariano J., **Guía para la resolución de problemas de electromagnetismo. Compendio de teoría**, Reverté, 2012

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Alonso, M y Finn, E. J., **Física**, Addison-Wesley Iberoamericana, 2000

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Complementary Bibliography

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Bronshtein, I. N., **Manual de matemáticas para ingenieros y estudiantes**, MIR 1982, MIR-Rubiños 1993

Spiegel, M. R., **Fórmulas y tablas de matemática aplicada**, McGraw-Hill, serie Schaum, 2014

Spiegel, M. R., **Schaum's Outline of Vector Analysis**, McGraw-Hill, Schaum's Outline Series, 2009

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Bronshtein, I. N. and Semendyayeb K. A., **Handbook of Mathematics**, Springer, 2007

Spiegel, M. R., Lipschutz, S., Liu J., **Schaum's Outline of Mathematical Handbook of Formulas and Tables**, McGraw-Hill, Schaum's Outline Series, 2011

Recommendations

Other comments

It is highly recommended to have reviewed the fundamental topics in Physics and Mathematics included within the basic subjects in a standard degree in engineering.
In the event of discrepancy, the Spanish version of this syllabus prevails