IDENTIFYING DATA				
Advanced Physics				
Subject	Advanced Physics			
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			
Lecturers	Fernández Fernández, José Luís López Vázquez, José Carlos			
E-mail	jlfdez@uvigo.es			
Web	http://faitic.uvigo.es			
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 electromagnetism and wave phenomena fundamentals 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 a step-by-step axiomatic approach employing a mathematical treatment based on differential vector operators (seven units)			

Competencies	
Code	
A1	CB6. Knowledge and understanding that provide a basis or opportunity for originality in developing and / or applying ideas, often in a research context.
A3	CB8. 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.

Learning outcomes	
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: Maxwells equations 1.4. Free charge 1.5. Polarization charge 1.6. Electric current 1.7. Polarization current 1.8. Magnetization current 1.9. Maxwells equations in 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. ELECTROSTATICS	2.1. General equations
II.3. STEADY ELECTRIC CURRENT	3.1. General equations 3.2. Equations including media properties 3.3. Electrical resistance 3.4. Joules law 3.5. Electromotive forces and generators 3.6. Potential distribution in a resistor
II.4. MAGNETOSTATICS	4.1. General equations 4.2. Equations including media properties 4.3. Magnetic forces 4.4. Magnetic circuit 4.5. Magnetic dipole
II.5. ELECTROMAGNETIC INDUCTION	5.1. Electromagnetism in moving media 5.2. Galilean transformation of electric and magnetic fields 5.3. Electromotive force around a circuit 5.4. Faradays law of electromagnetic induction

II.6. ELECTROMAGNETIC WAVES	6.1. Wave equations for fields E and H 6.2. E.M. monochromatic plane waves in lossless media 6.3. E.M. monochromatic plane waves in lossy media 6.4. Incidence of plane waves on the boundary between two perfect dielectrics 6.5. Incidence of plane waves on the boundary between a perfect dielectric and a conductor
II.7. QUASISTATIC FIELDS	7.1. Definition 7.2. Self-inductance and mutual inductance 7.3. Magnetic energy
III.1 LABS	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	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 at the lab - For the open lab problems, 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
Master Session	20	30	50
Troubleshooting and / or exercises	9	33	42
Laboratory practises	18	18	36
Short answer tests	2	0	2
Troubleshooting and / or exercises	2	0	2
Reports / memories of practice	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
Master Session	The main topics of the subject are introduced by the teacher using projected presentations and the blackboard, emphasizing the theoretical basis and fundamentals and stressing the critical or key points. Eventually, demonstrative experiments or audiovisual material could be employed
Troubleshooting and / or exercises	Academic problems related to the topics of the subject are formulated and worked out at the blackboard 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 practises	Practical activities are developed for applying the theoretical knowledge to particular situations and for developing adequate skills to carry out experimental procedures related to the topics. These activities will be held in specific rooms with specialized equipment (hardware and computer labs)

Personalized attention

Methodologies	Description
Master Session	In office hours
Troubleshooting and / or exercises	In office hours

Laboratory practises	In office hours

Assessment

	Description	Qualification	Training and Learning Results
Short answer tests	The questions are related to a particular fundamental point or basic topic for the assessment of the associated learning outcomes. The student must be able to answer them in a direct and clear way showing or revealing its knowledge about fundamentals	50	A1 C7 A3
Troubleshooting and / or exercises	The student must solve problems or exercises on his/her own in a prescribed period of time and previously established conditions. This test could be face-to-face or virtual (using chat, email, forum, audio-conference, etc.)	40	A1 C7 A3 C10
Reports / memories of practice	Each team should write a report on the activities carried out. The report must include the developed tasks and procedures, the obtained results or taken observations, as well as a detailed description of the data processing and analysis	10	A1 C7 A3 C10

Other comments on the Evaluation

1. CONTINUOUS ASSESSMENT

CONTINUOUS ASSESSMENT TESTs (40%)

- Mark *A0* (20%) will be obtained from short answer tests on topics of Parts I and II

- Mark *L0* (20%) will be obtained from a problem solving test on topics of Part III.1 (10%) and from the open lab report (or the topic report) corresponding to Part III.2 (10%). Only students that have regularly attended the lab sessions can obtain the mark *L0*

Final EXAM (60%)

- It is held in the December-January call

- Mark *T1* (30%) will be obtained from a short answer test on topics of Parts I and II

- Mark *P1* (30%) will be obtained from a problem solving test on topics of Parts I and II

GLOBAL MARK

- The global mark *G1* is obtained as

G1 = T1 + P1 + L0 + A0

- To pass the course, a student must obtain a global mark ***G1* equal to or higher than 5**

2. END-TERM ASSESSMENT

EXAM THAT REPLACES CONTINUOUS ASSESSMENT TESTS (40%)

- It is held in the December-January call

- Mark *A1* (20%) will be obtained from a short answer test on topics of Parts I and II

- Mark *L1* (20%) will be obtained from a problem solving test on topics of Part III.1

GLOBAL MARK

- In this case the global mark *G1* is obtained as

G1 = T1 + P1 + L1 + A1

- To pass the course, a student must obtain a global mark ***G1* equal to or higher than 5**

- A student that had previously obtained marks *L0* or *A0* (or both) would choose between:

a) answering the test corresponding to mark *L1* and/or mark *A1*, in such a way that the new mark *L1* replaces *L0* and/or the new mark *A1* replaces *A0*

b) holding mark *L0* and/or mark *A0* instead of answering the test corresponding to mark *L1* and/or mark *A1*, respectively

3. ASSESSMENT in the SECOND CALL (JUNE-JULY)

FINAL EXAM (60%)

- It is held in the June-July call

- Mark *T2* (30%) will be obtained from a short answer test on topics of Parts I and II

- Mark *P2* (30%) will be obtained from a problem solving test on topics of Parts I and II

EXAM THAT REPLACES CONTINUOUS ASSESSMENT TESTS (40%)

- It is held in the June-July call

- Mark *A2* (20%) will be obtained from a short answer test on topics of Parts I and II

- Mark *L2* (20%) will be obtained from a problem solving test on topics of Part III.1

GLOBAL MARK

- In this case the global mark *G2* is obtained as

G2 = T2 + P2 + L2 + A2

- To pass the course, a student must obtain a global mark ***G2* equal to or higher than 5**

- A student that had previously obtained marks *L0, L1, A0 or A1 would choose between:*

a) answering the test corresponding to mark *L2* and/or mark *A2*, in such a way that the new mark *L2* and/or the new mark *A2* will replace the marks of the same type (*L0* or *L1* and/or *A0* or *A1*, respectively)

b) holding the most recent marks of each type (*L0* or *L1* and/or *A0* or *A1*) instead of answering the test corresponding to mark *L2* and/or mark *A2*, respectively

4. NOTATION FOR MARKS

L = the latest mark among *L0*, *L1* and *L2*

A = the latest mark among *A0*, *A1* and *A2*

T = T1 in December-January call (1st edition) or *T2* in June-July call (2nd edition)

P = P1 in December-January call (1st edition) or *P2* in June-July call (2nd edition)

G = G1 in December-January call (1st edition) or *G2* in June-July call (2nd edition)

In any of the calls, the global mark *G* is obtained as

G = T* + P+*L* + *A

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

5. SUPPLEMENTARY ASSESSMENT RULES

- Presentation of DNI or any other identification document is compulsory during tests and exams

- Resources and material that can be used in the tests and final exams:

a) In problem solving tests on topics of Parts I and II (corresponding to marks *P1* and *P2*) it is allowed to employ notes about theory adequately bound (this includes both the Department lecture notes on the subject and the handwritten notes of the student, exclusively about theory), one textbook and one mathematics handbook (Bronshtein or similar). It is forbidden the use of any workbook or collection of worked out problems

b) In any other case, the use of any additional resources is forbidden

c) 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 global mark will be "suspenso" (0.0)

- The tests and exams will be jointly defined and assessed by the teaching team of the subject

- The dates for the final exams at each call will be assigned by the board of directors of the School of Industrial Engineering

(E.E.I.)

- The date and hours for revision of marks and tests results will be announced in advance. Revision out of this date and these hours will be possible only if a reasonable reason for non-attendance is documented

6. 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 global mark in the present academic year will be "suspenso" (0.0)

Sources of information
1. J. L. Fernández, M. J. Pérez-Amor, **"Guía para la resolución de problemas de electromagnetismo. Compendio de teoría"**, Reverté (2012),
2. J. L. Fernández, M. J. Pérez-Amor, **"Guía para la resolución de problemas de electromagnetismo. Problemas resueltos"**, Reverté (2012),
3. M. Alonso y E. J. Finn, **"Física"**, Addison-Wesley Iberoamericana (2000),
4. M. R. Spiegel, **"Análisis vectorial"**, McGraw-Hill, serie Schaum (2011),
5. D. K. Cheng, **"Fundamentos de electromagnetismo para ingeniería"**, Addison-Wesley (1997),
6. J. A. Edminister, **"Electromagnetismo"**, McGraw-Hill, serie Schaum (1992),
7. I. N. Bronshtein, **"Manual de matemáticas para ingenieros y estudiantes"**, MIR (1982),
8. M. R. Spiegel, **"Fórmulas y tablas de matemática aplicada"**, McGraw-Hill, serie Schaum (2014),

Basic:

1. J. L. Fernández, M. J. Pérez-Amor, "Guía para la resolución de problemas de electromagnetismo. Compendio de teoría", Reverté (2012) For Parts II and III (although the text is in Spanish, translation of some sections will be made available)

2. J. L. Fernández, M . J. Pérez-Amor, "Guía para la resolución de problemas de electromagnetismo. Problemas resueltos" Reverté (2012) - For Parts II and III (although the text is in Spanish, translation of some sections will be made available)

3. M. Alonso and E. J. Finn, "Physics", Pearson (1992) For Parts I and III

Supplementary:

4. M. R. Spiegel, "Schaum's Outline of Vector Analysis", McGraw-Hill, Schaums Outline Series (2009)

5. D. K. Cheng, "Fundamentals of Engineering Electromagnetics", Prentice Hall (1993) or Pearson (2014)

6. J. A. Edminister, M. Nahvi, "Schaum's Outline of Electromagnetics", McGraw-Hill, Schaums Outline Series (2013)

7. I. N. Bronshtein, K. A.Semendyayeb, "Handbook of Mathematics", Springer (2007)

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

Recommendations

Other comments

It is highly recommended reviewing the fundamental topics in Physics and Mathematics included within the basic subjects in a standard degree in engineering