Universida de Vigo

IDENTIFYING DATA				
Physics 3				
Subject	Physics 3			
Code	V12G360V01503			
Study programme	Degree in Industrial Technologies Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish Galician English			
Department				
Coordinator	López Vázquez, José Carlos			
Lecturers	Fernández Fernández, José Luís López Vázquez, José Carlos Pou Álvarez, Pablo Quintero Martínez, Félix			
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General description	The main goals of Physics III 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 III 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).			

Competencies	
Code	
B10	CG10 Ability to work in a multidisciplinary and multilingual environment.
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.
D10	CT10 Self learning and work.

Learning outcomes			
Expected results from this subject	Training and Learning Results		
To know and to understand the physical foundations of electricity and magnetism as well as of vibrations and waves.	B10	C2	
To know and to be able to apply, in simple cases, vector analysis and differential equations of mathematical physics, as problem solving tools within the framework of fundamentals of physics.	B10	C2	
To be able to establish efficient strategies and procedures for solving problems in fundamentals of physics related to industrial technologies.	B10	C2	
To be able to implement specific solutions in the laboratory to experimental problems in fundamentals of physics.	B10	C2	D10

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 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. 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, 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 quasi-static 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 session 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	11.5	30.5	42
Laboratory practical	18	18	36
Essay questions exam	2	0	2
Problem and/or exercise solving	2	0	2
Practices report	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 blackboard, emphasizing the theoretical basis and fundamentals and stressing the critical or key points. Eventually, demonstrative experiments or audiovisual material could be employed
Problem solving	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 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 (hardware and computer labs)

Personalized assistance

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

Assessment

	Description	Qualification	Training and Learning Results	
Essay questions exam	Test that include open questions on a topic. Students should develop, relate, organize and present knowledge on the subject in an argued response	50	B10	C2

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	B10	C2	D10
Practices report	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	B10	C2	D10

Other comments on the Evaluation

1. CONTINUOUS ASSESSMENT

CONTINUOUS ASSESSMENT TESTS (40%)

- Mark A0 (20%) will be obtained from essay questions exams on topics of Parts I and II

- Mark L0 (20%) will be obtained from a problem solving exam 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 an essay questions exam on topics of Parts I and II

- Mark P1 (30%) will be obtained from a problem solving exam 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 on the same date as the final exam in the December-January call

- Mark A1 (20%) will be obtained from essay questions exams on topics of Parts I and II

- Mark L1 (20%) will be obtained from a problem solving exam 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 exam(s) 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 exam(s) 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 an essay questions exam on topics of Parts I and II

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

EXAM THAT REPLACES CONTINUOUS ASSESSMENT TESTS (40%)

- It is held on the same date as the final exam in the June-July call

- Mark A2 (20%) will be obtained from essay questions exams on topics of Parts I and II

- Mark L2 (20%) will be obtained from a problem solving exam 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 exam(s) 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 exam(s) 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 exams 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 user of any workbooks or collections 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 global mark for students not attending the final exam will be "non presentado"

- 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 exams corresponding to the end-of-degree call, as well as any exam held on date and time other than the dates and times stated by the E.E.I. for official exams, could have a different format than the one described above. Nevertheless, each mark (L, A, T and P) will hold its value to calculate the global mark G

- The date and hours for revision of marks and tests and exams results will be announced in advance. Revision out of this date and 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
Basic Bibliography
J. L. Fernández, M. J. Pérez-Amor, **Guía para la resolución de problemas de electromagnetismo. Compendio de teoría**, Reverté, 2012
J. L. Fernández, M. J. Pérez-Amor, **Guía para la resolución de problemas de electromagnetismo. Problemas resueltos**, Reverté, 2012
M. Alonso y E. J. Finn, **Física**, Addison-Wesley Iberoamericana, 2000
M. Alonso and E. J. Finn, **Physics**, Pearson, 1992
Complementary Bibliography
M. R. Spiegel, **Análisis vectorial**, McGraw-Hill, serie Schaum, 2011
M. R. Spiegel, **Schaum's Outline of Vector Analysis**, McGraw-Hill, Schaum's Outline Series, 2009
D. K. Cheng, **Fundamentos de electromagnetismo para ingeniería**, Addison-Wesley, 1997
D. K. Cheng, **Fundamentals of Engineering Electromagnetics**, Prentice Hall, 1993
J. A. Edminister, **Electromagnetismo**, McGraw-Hill, serie Schaum, 1992
J. A. Edminister, M. Nahvi, **Schaum's Outline of Electromagnetics**, McGraw-Hill, Schaum's Outline Series, 2013
I. Bronshtein, **Manual de matemáticas para ingenieros y estudiantes**, MIR 1982, MIR-Rubiños 1993,
I. N. Bronshtein, K. A. Semendyayeb, **Handbook of Mathematics**, Springer, 2007
M. R. Spiegel, **Fórmulas y tablas de matemática aplicada**, McGraw-Hill, serie Schaum, 2014
M. R. Spiegel, S. Lipschutz, J. Liu, **Schaum's Outline of Mathematical Handbook of Formulas and Tables**, McGraw-Hill, Schaum's Outline Series, 2011

Recommendations

Subjects that it is recommended to have taken before

Physics: Physics 1/V12G360V01102
Physics: Physics 2/V12G360V01202
Mathematics: Algebra and statistics/V12G360V01103
Mathematics: Calculus 1/V12G360V01104
Mathematics: Calculus 2 and differential equations/V12G360V01204

Other comments

Requirements: To register in this subject, it is mandatory to have been registered or to be registered in all the subjects corresponding to the first and second years of the curriculum of the Degree in Industrial Technologies Engineering

In particular, it is highly recommended reviewing the topics in Physics and Mathematics included within the subjects that should have been passed previously

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