Universidade 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			
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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: 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. 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. Joules 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. Faradays 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 waves on an interface between two perfect dielectrics 4.5. Incidence of a plane waves 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 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 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
Master Session	20	30	50
Troubleshooting and / or exercises	11.5	30.5	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
Laboratory practises	In office hours
Troubleshooting and / or exercises	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	B10 C2
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	B10 C2 D10
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	B10 C2 D10

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 on the same date as the final exam in the December-January call

- Mark ***A1*** **(20%)** will be obtained from a short answer test on topics of Parts I y 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 on the same date as the final exam in the June-July call

- Mark ***A2* (20%)** will be obtained from a short answer test on topics of Parts I y 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 test 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 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 “fin de carrera” 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 (***T***, P, ***L***, ***A***) will hold its value to calculate the global mark G

- The date and hours for revision of marks and tests 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, 1992

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 is mandatory to have passed, or at least to be register in, all the subjects corresponding to the first and second years of the curriculum of the Engineering Degree in Industrial Technologies

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