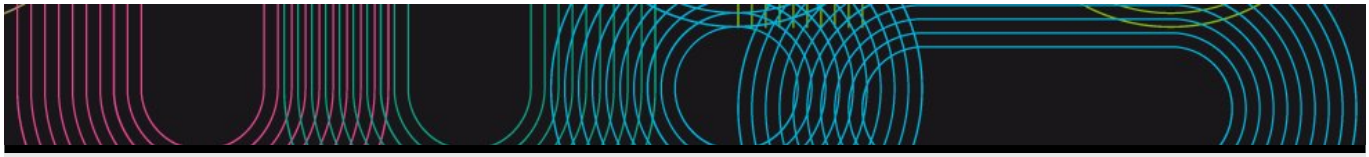

IDENTIFYING DATA				
Physics: Fields and Waves				
Subject	Physics: Fields and Waves			
Code	V05G301V01202			
Study programme	Grado en Ingeniería de Tecnologías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Basic education	2nd	1st
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Fraile Peláez, Francisco Javier			
Lecturers	Fraile Peláez, Francisco Javier Obelleiro Basteiro, Fernando Rubiños López, José Óscar			
E-mail	fj_fraile@com.uvigo.es			
Web	http://moovi.uvigo.gal/			
General description	Fields and Waves presents the first contact in the student's degree with the phenomena of electromagnetic waves, which are the physical medium for transmission of information at almost instantaneous speed. Mathematical modeling of electromagnetic fields that provide insights into the behavior of electromagnetic waves in real environments will be introduced. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results	
Code	
B3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
C1	CE1/FB1: The ability to solve mathematical problems in Engineering. The aptitude to apply knowledge about linear algebra, geometry, differential geometry, differential and integral calculus, differential and partial differential equations; numerical methods, numerical algorithms, statistics and optimization
C3	CE3/FB3: Comprehension and command of basic concepts about the general laws of mechanics, thermodynamics, electromagnetic fields and waves and electromagnetism and their application to solve Engineering problems.
D3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.

Expected results from this subject	Training and Learning Results		
New	B3	C1 C3	D3
Solve electrostatic and magnetostatic problems: capacity and self-induction.	B3	C1 C3	D3
Calculate the main parameters of electromagnetic waves: frequency, wavelength, propagation constant, polarization, Poynting vector, phase constant, attenuation constant	B3	C3	D3
Analyze the propagación of waves in media with and without losses.	B3	C3	D3
Analyze the incidence of waves over obstacles or discontinuities: decomposition in incident, reflected and transmitted waves.	B3	C3	D3

Contents
Topic

1. Vector and differential analysis of fields	1.1 Scalar and vector fields 1.2 Systems of coordinates in space 1.3 Vector Algebra 1.4 Integral operators 1.5 Differential operators 1.6 Properties of operators
2. Electrostatics	2.1 Electric charge 2.2 Electric field and its properties 2.3 Electric potential 2.4 Electric permitivity 2.5 Gauss law 2.6 Equations of Poisson and Laplace. Capacitance
3. Magnetostatics	3.1 Electric current 3.2 Magnetic field and its properties 3.3 Magnetic permeability 3.4 Ampere's Law 3.5 Self-induction
4. Maxwell model	4.1. Maxwell's equations in integral form 4.2. Differential form of Maxwell's equations 4.3. Boundary conditions 4.4. Harmonic time variation and phasor notation 4.5. Energy and power density
5. Fundamentals and characteristics of waves	5.1 Wave equation in the phasor domain 5.2 Solutions in rectangular coordinates 5.3 Wave parameters: frequency, wavelength, propagation constant and impedance of the medium. 5.4 Poynting vector and average power density 5.5 Progressive waves on lossy and lossless media 5.6 Polarization
6. Waves in the presence of obstacles	6.1 Wave incidence on conductors 6.2 Incidence on discontinuity between two media 6.3 Incident, reflected and transmitted wave 6.4 Standing wave diagram 6.5 Power transmission
P1. Vector algebra and coordinate systems.	Review of operations with vectors in space. Vector representation in the Cartesian, cylindrical and spherical systems. Differential elements of length, area and volume in the three systems.
P2. Electrostatics-I.	Integral of circulation of the electric field. The electric dipole. Linear, surface and volume densities of charge. Potential and electric field of charge distributions. Principle of superposition of sources Far field.
P3. Electrostatics-II.	Electric displacement vector flow. Application of Gauss's integral and differential theorem. Capacitors. Image theory.
P4. Magnetostatics.	Integration of surface and volumetric current densities. Magnetic field of current distributions. Principle of superposition of sources. Applications of Ampere's Law integral and differential. Self-induction Imaging theory.
P5. Maxwell's model.	Application of Faraday's and Ampere-Maxwell's laws. Phasor and time domain representation of electromagnetic fields. Application of Maxwell's laws.
P6. Fundamentals and characteristics of waves.	Plane wave propagation. Wave parameters. Determination of wave polarisation. Phasor and time domain representation of plane waves.
P7. Waves in the presence of obstacles	Incidence of a wave on a metallic plane. Incidence of a plane wave on a discontinuity between two dielectric media. Standing wave.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	18	24	42
Case studies	27	36	63
Problem solving	12	16	28
Essay questions exam	2	4	6
Case studies	2	4	6
Problem and/or exercise solving	2	3	5

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

Methodologies

	Description

Lecturing	Exhibition by the professor of the contents on the matter object of study, theoretical bases and/or guidelines of a work, exercise or project to develop by the student. Through this methodology the competencies B3, C1, C3 and D3 are developed.
Case studies	Analysis of a fact, problem or real event with the purpose to know it, interpret it, resolve it, generate hypothesis, contrast data, think about it, complete knowledges, diagnose it and train in alternative procedures of solution. This metodology will be used both in large and medium size groups. Through this methodology the competencies B3, C1, C3 and D3 are developed.
Problem solving	Activities application of knowledge to specific situations, and the acquisition of basic skills and procedural matters related to the object of study, which are held in computer rooms. Electromagnetic simulators will be used. Through this methodology the competencies B3, C1, C3 and D3 are developed.

Personalized assistance

Methodologies	Description
Lecturing	The student will receive personalized attention during the tutoring hours (https://moovi.uvigo.gal/)
Problem solving	The student will receive personalized attention during the tutoring hours (https://moovi.uvigo.gal/)
Case studies	The student will receive personalized attention during the tutoring hours (https://moovi.uvigo.gal/)
Tests	**Description**
Essay questions exam	The student will receive personalized attention during the tutoring hours (https://moovi.uvigo.gal/)
Case studies	The student will receive personalized attention during the tutoring hours (https://moovi.uvigo.gal/)
Problem and/or exercise solving	The student will receive personalized attention during the tutoring hours (https://moovi.uvigo.gal/)

Assessment

	Description	Qualification	Training and Learning Results
Essay questions exam	Proof for individual evaluation of the skills that includes open questions on a subject. The students have to develop, relate, organise and present their knowledge about the subject in an extensive answer.	35	B3 C1 C3 D3
Case studies	Test for individual evaluation of the competences that includes the approach of a practical case. Students develop the analysis of the situation in order to know it, interpret it, solve it, generate hypothesis, contrast data, reflect, complete knowledge, diagnose it and train in alternative solution procedures.	35	B3 C1 C3 D3
Problem and/or exercise solving	Individual proof where students must develop appropriate or correct solutions through the exercise of routines, the application of formulas or algorithms, the application of procedures for transforming available information and the interpretation of results	30	B3 C1 C3 D3

Other comments on the Evaluation

Following the policy guidelines of the Center, the students can choose between two systems of evaluation: continuous evaluationand evaluation at the end of the term.

In all the evaluation tests, the competences B3, C1, C3 and D3 will be evaluated.

1. CONTINUOUS ASSESSMENT.

- The system of continuous assessment (EC) will consist of:
    - a) A problem solving deliverables or worked in practical classes. The qualification will be ECa, with maximum score of 1.5 points. It will be necessary to reach 40% of the maximum for this test to have an impact on the final grade.
    - b) A problem solving session on topics 1, 2 and 3. The score will be ECb, and the subtotal EC1 = ECa + ECb can have a maximum value of 5 points.
    - c) A problem solving deliverables or worked in practical classes. The qualification will be ECc, with maximum score of 1.5 poins. It will be necessary to reach 40% of the maximum for this test to have an impact on the

final grade.

- d) A problem solving sessionon topics 4, 5 and 6. The score will be ECd, and the subtotal EC2 = ECc + ECd can have a maximum value of 5 points.

- The final score of the ordinary exam for students who follow continuous assessment (CE) is obtained by adding the two previous subtotals: EC = EC1 + EC2, unless one of the two subtotals is less than 1.5 (30% of the maximum), in which case the final grade will be limited to a maximum of "Suspense (4.0)".
- The planning of the different intermediate assessment tests will be approved by an Academic Committee of Degree (CAG) and will be available at the beginning of the semester.
- Before the completion or delivery of each test, the date and procedure for reviewing the grades obtained will be indicated, which will be public within a reasonable period of time.
- The continuous assessment tests are not recoverable, that is, if a student cannot meet them within the stipulated period, the teacher does not have to repeat them.
- The qualification obtained in the continuous assessment tests (EC1 and EC2) will be valid only for the current academic year.
- It will be understood that a student accepts this system if he/she presents to take the "ECb" test for continuous assessment.

2. EXAM-ONLY ASSESSMENT

- It will be mandatory for students who do not follow continuous assessment to be able to pass the subject at the ordinary exam.
- It will consist of a problem solving session on topics 1 to 6. The score will be EF, and will have the same requirement of achieving 30% of the maximum possible in each of the two parts corresponding to topics 1 to 3 (part 1) and 4 to 6 (part 2).

3. EXTRAORDINARY EXAM.

- Students who followed the continuous assessment:
  - The extraordinary exam will be divided into two parts: EX1 (items 1 to 3) with a maximum value of 5 points, and EX2 (items 4 to 6) with a maximum value of 5 points.
  - The students who followed the continuous evaluation will choose if to do: only EX1, only EX2 or both parts. The final note will be: EF = max (EX1, EC1) + max (EX2, EC2).
- Students who did not follow the continuous evaluation. It consists of a single evaluation with the same format as the first opportunity (a problem solving session on topics 1 to 6).The score will be EF, and will have the same requirement of achieving 30% of the maximum possible in each of the two parts corresponding to topics 1 to 3 (part 1) and 4 to 6 (part 2).

4. END OF PROGRAM EXAM

- It will have the same format as the global assesment.

5. OBSERVATIONS.

- Student who chose continuous assessment or takes any of the two final global exams of first or second opportunity are considered as presented.
- It is considered that the subject is approved if the final grade is equal to or greater than 5 and in each part at least 30% of the maximum possible is reached. If any of the two subtotals is less than 30% of the maximum, the final grade will be limited to a maximum of "Suspenso (4.0)".
- In case of detection of plagiarism in any of the tests, the final grade will be SUSPENSO (0) and the fact will be communicated to the Center Head for the appropriate purposes.
- English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.

Sources of information

Basic Bibliography

F. T. Ulaby, U. Ravaioli, **Fundamentals of Applied Electromagnetics**, Global Edition 7/e, Pearson Education Limited, 2015

D. K. Cheng, **Fundamentos de Electromagnetismo para Ingeniería**, Addison Wesley, 1998
Antonio Pino, F. Obelleiro, **Apuntes de clase**, (moovi.uvigo.gal/), 2020

Complementary Bibliography

D. K. Cheng, **Fundamentals of Engineering Electromagnetics**, New International Edition, Pearson, 2013
David J. Griffiths, **Introduction to Electrodynamics**, 4ª Edición, Pearson Education Limited, 2012
Javier Fraile Peláez, **Apuntes de Electromagnetismo Báscio**, moovi.uvigo.gal, 2023
J. R. Reitz, F. J. Milford, R. W. Christy, **Fundamentos de la Teoría Electromagnética**, 4ª Edición, Addison Wesley, 1996
F. Dios, D. Artigas, et all., **Campos Electromagnéticos**, Ediciones UPC, 1998
W. H. Hayt, J. A. Buck, **Teoría Electromagnética**, 8ª Edición, Mc Graw Hill, 2012
D. K. Cheng, **Field and Wave Electromagnetics**, 2ª Edición, Addison Wesley, 1998
M. F. Iskander, **Electromagnetic Fields and Waves**, 2ª Edición, Prentice Hall, 2012

Recommendations

Subjects that it is recommended to have taken before

Mathematics: Calculus 1/V05G301V01101
Mathematics: Calculus 2/V05G301V01106