Course guide
300201 - FF - Fundamentals of Physics

Last modified: 31/01/2024

Unit in charge: Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 748 - FIS - Department of Physics.

Degree: BACHELOR'S DEGREE IN AEROSPACE SYSTEMS ENGINEERING (Syllabus 2015). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: Definit a la infoweb de l'assignatura.

Others: Definit a la infoweb de l'assignatura.

PRIOR SKILLS

Post-compulsory secondary education mathematics and physics.
- Operability with the basics of trigonometry, vector calculus and differential and integral calculus.
- Familiarity with the concepts of physical quantity, unit and unit conversion.
- Familiarity with the use of scientific notation in basic calculation.
- Operability with the basics of kinematics in one and two dimensions.
- Familiarity with the concepts of force, work, energy and field.

It is recommended to have passed or taken Calculus and Algebra and Geometry simultaneously.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE2. CE 2 AERO. Comprensión y dominio de los conceptos básicos sobre las leyes generales de la mecánica, termodinámica, campos y ondas y electromagnetismo y su aplicación para la resolución de problemas propios de la ingeniería. (CIN/308/2009, BOE 18.2.2009)

Transversal:
CT6. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.
CT3. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 1. Planning oral communication, answering questions properly and writing straightforward texts that are spelt correctly and are grammatically coherent.

Basic:
CB5. (ENG) CB5 - Que los estudiantes hayan desarrollado aquellas habilidades de aprendizaje necesarias para emprender estudios posteriores con un alto grado de autonomíA
CB2. (ENG) CB2 - Que los estudiantes sepan aplicar sus conocimientos a su trabajo o vocación de una forma profesional y posean las competencias que suelen demostrarse por medio de la elaboración y defensa de argumentos y la resolución de problemas dentro de su área de estudio

TEACHING METHODOLOGY

The subject aims to introduce and consolidate physics concepts that an engineer must know and develop their ability to solve problems that involve relating different concepts and reasoning using equations and mathematical calculations, to make predictions in different situations. This ability must be developed and assessed individually, but the advantages of group work will also be used so that students are able to defend their proposed solutions to problems and cooperate with their peers.

The Theory Group classes will mainly follow the expository model, where the teacher will introduce the basic concepts and laws of physics. The problem classes will allow the consolidation of knowledge and how to use these concepts and laws to solve problems. These problems will be solved by the students themselves at home and by teachers and students later in class.

Finally, independent learning will be guided by texts with theoretical concepts of the subject and/or explanatory videos, which students will have to read and/or view before starting each of the topics and the collection of problems that students they will have to solve individually at home to be able to discuss them later during the problems sessions.

The Atenea Digital Campus will be used regularly for the exchange of documentation between students and teachers and to keep the evaluation process up to date. Texts and videos related to the syllabus and problem collection will be introduced to guide students' independent learning.

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the Fundamentals of Physics subject, the student must be able to:

· Define the fundamental concepts and quantities of mechanics, fields and waves, and electromagnetism: force, mass, work, power, kinetic energy, potential energy, center of mass, linear moment, moment of a force, moment of inertia, angular momentum, simple harmonic motion, wave motion, sound intensity, electric charge, electric force and field, electric dipole moment, electric field flux, electric potential, electrostatic potential energy, electric current, magnetic force and field, dipole moment magnetic, magnetic field flux, induced electromotive force and electromagnetic waves.

· Explain the meaning and implications of Newton's laws, the work-kinetic energy theorem, the principle of conservation of energy, the principle of conservation of linear momentum, the principle of conservation of angular momentum, the equation of waves, Coulomb's law, Gauss's law, Biot and Savart's law, Gauss's law for magnetism, Ampère's law, Faraday-Lenz's law, and Maxwell's laws as a synthesis of the laws of electromagnetism.

· Identify the magnitudes, principles, and physical laws that allow modeling and understanding of real situations and reach quantitative conclusions and consequences about them.

· Apply the concepts and physical laws acquired and the mathematical tools necessary to solve problems of a certain level of complexity in mechanics, fields, waves, and electromagnetism and interpret the results obtained.

· Communicate clearly and effectively orally and in writing to justify scientific reasoning with qualitative and quantitative arguments.

· Acquire knowledge independently, using the sources of information and the indicated guidelines and identifying learning gaps.

STUDY LOAD

Type	Hours	Percentage
Hours medium group	6,0	4.00
Guided activities	18,0	12.00
Self study	84,0	56.00
Hours large group	42,0	28.00

Total learning time: 150 h

CONTENTS

MECHANICS

Description:
- Kinematics
Theoretical concepts: Position, speed and acceleration. Kinematics in 2 dimensions. Normal and tangential acceleration. Kinematics of circular motion.
Examples and applications: Movement in 1 dimension with non-uniform acceleration. parabolic shot

- Newton's laws
Theoretical concepts: Reference systems and Newton's first law. Newton's second law. Force, linear momentum and mass. Newton's third law. Internal and external forces. Types of forces: weight, normal, friction, elastic force and tension. - Oscillatory movement, Restoration forces and small-amplitude oscillations. Simple harmonic motion.
Examples and applications: Massless pulleys, inclined planes, curvilinear trajectories, simple pendulum.

- Work and Energy
Theoretical concepts: Work by constant and variable force, in 1 and 2 dimensions. Power. kinetic energy Work-Kinetic Energy Theorem. Conservative forces and potential energy. Differential relationship between force and potential energy. Theorem of conservation of mechanical energy. Total energy of simple harmonic motion.
Examples and applications: Massless pulleys, inclined planes, simple pendulum, vertical loop, energy diagrams.

- Rotation around a constant axis
Theoretical concepts: Center of mass of a system of particles. Linear momentum conservation theorem. Rigid solid: motion of its center of mass and kinematics of rotation. angular momentum A moment of strength. Newton's second law of rotation by a rigid solid. Scalar moment of inertia. Work and energy of rotating systems. Theorem of conservation of angular momentum.
Examples and applications: Calculation of centers of mass and angular momentum for discrete distributions. Externally fixed shaft rotation. Pulleys with mass. Sliding and non-sliding rolling bodies (yo-ios and undercarriage wheels). Physical and ballistic pendulum.

Related activities:
· AV1: Control of problems 1.
· AV2: Theory control 1.
· AV4i5: Mid-term and end-of-term exams.
· AV6: Problem solving of the collection outside the classroom by the student.

Full-or-part-time: 57h
Theory classes: 28h
Self study : 29h

(ENG) ELECTRIC FIELDS

Description:
- Electric field.
Theoretical concepts: Electric charge. Conductors and dielectrics. Electric force and Coulomb's law. Principle of overlap. Electric field concept. Electric field calculation for discrete and continuous charge distributions. Electric field flow. Gauss's law. Flat and spherical capacitors.
Examples and applications: Movement of charges and dipoles in the presence of electric fields. Electric field of the dipole. Electric field generated by capacitors. Calculation by integration of the electric field generated by a ring and a load disk. Calculation by Gauss's Law of the electric field in problems with spherical, cylindrical and planar symmetry. Electric field discontinuity in conductors, spike effect

- Electric potential
Theoretical concepts: Electric field work and potential difference. Electric potential energy. Conductors in electrostatic balance and shielding. Calculation of the electric potential for discrete and continuous distributions. Differential relationship between field and potential.
Examples and applications: Calculation of potential by ring integration. Calculation of the potential from the electric field with path integrals.

- Capacitors
Capacitance of a capacitor. Energy stored in a capacitor. Dielectric effects in capacitors, dielectric constant.
Examples and applications: Capacitance of parallel plate capacitor and cylindrical capacitor. Charge energy of a capacitor by batteries.

Related activities:
· AV3: Control in waves and electrostatic
· AV5: End-of-semester exam.
· AV6: Problem solving of the collection outside the classroom by the student.

Full-or-part-time: 35h
Theory classes: 15h
Self study : 20h

(ENG) MAGNETOSTATIC FIELD. INDUCTION.

Description:
- Magnetic field.
Theoretical concepts: Pila de Volta. Electric current and stationary closed circuits. Ohm's Law magnets Lorentz force for a point charge and for an electric current element. Forces and moments on closed circuits. Magnetic dipole moment. Magnetic field by a closed circuit from current element (Biot and Savart Law). Magnetic field created by a straight current thread, by a current loop and by a coil. Forces between current elements. Magnetic field flux and Gauss's law for magnetism. Ampère's law.
Examples and applications: Movement of charges and current loops in the presence of magnetic fields. Calculation by integration of the electric field generated by a loop. Calculation with Ampère's law of the magnetic field of the infinite wire, the coil and the toroid.

- Magnetic induction.
Theoretical concepts: Generalized electromotive force. Magnetic induction. Faraday's law. Lenz's law. Electric field circulation. Self-induction Coefficient of self-induction. General structure of an RLC circuit. Mutual induction.
Examples and applications: Induced electromotive force and motion. Movements of a magnet on a circuit. Generators at power stations - alternating current. engines Coefficient of self-induction in coils. Mutual induction between two coils.

Related activities:
· AV5: End-of-term exam.
· AV6: Solving problems of the collection outside the classroom by the student.

Full-or-part-time: 34h
Theory classes: 14h
Self study : 20h

(ENG) ONDAS

Description:
Wave motion
Theoretical concepts: Types of waves. Wave pulses and speed of propagation. Harmonic waves and wave equation in 1 dimension. Longitudinal waves: sound waves. Sound waves in 3 dimensions. Energy, power and intensity of a sound wave. decibels
Examples and applications: Characteristics and propagation of harmonic waves, sound hearing and intensity level, wave phenomena.

- Maxwell's laws and electromagnetic waves.
Theoretical concepts: Displacement current. Maxwell's equations as a synthesis of the laws of electromagnetism. Electromagnetic waves. The electromagnetic spectrum.

Related activities:
AV3: Control waves and electrostatics
AV5: Final semester exam.
AV6: Problem solving of the collection outside the classroom by the student.

Full-or-part-time: 17h
Theory classes: 2h
Self study : 15h

ACTIVITIES

(ENG) TEST PROBLEMS OF MECHANICS

Description:
In the Theory Group, students carry out a problem check with the content worked up to the time of mechanics.

Specific objectives:
Check the knowledge achieved on the contents of the control, by teachers and students. Develop the ability to communicate clearly and effectively in writing, justifying the resolution of problems.

Material:
Statement of control on paper and calculator.

Delivery:
The individually solved control is delivered.

Related competencies :
CB2. (ENG) CB2 - Que los estudiantes sepan aplicar sus conocimientos a su trabajo o vocación de una forma profesional y posean las
competencias que suelen demostrarse por medio de la elaboración y defensa de argumentos y la resolución de problemas dentro de
su área de estudio
CB5. (ENG) CB5 - Que los estudiantes hayan desarrollado aquellas habilidades de aprendizaje necesarias para emprender estudios posteriores con un alto grado de autonomíA

Full-or-part-time: 1h
Practical classes: 1h

(ENG) THEORETICAL TEST MECHANICS

Description:
In the Theory Group, students carry out a theory test with the content worked on so far (typically the topics of the Mechanics block).

Specific objectives:
Check the knowledge achieved on the contents of the control, by teachers and students. Develop the ability to communicate clearly and effectively in writing.

Material:
Statement of control on paper and calculator.

Delivery:
The control is delivered and must be solved individually

Related competencies :
. CE 2 AERO. Comprensión y dominio de los conceptos básicos sobre las leyes generales de la mecánica, termodinámica, campos y ondas y electromagnetismo y su aplicación para la resolución de problemas propios de la ingeniería. (CIN/308/2009, BOE 18.2.2009)

Full-or-part-time: 1h
Practical classes: 1h

SHORT EXAM ON WAVES AND ELECTROSTASTIC

Description:
In the Theory Group, students will answer a series of questions/problems about mechanic waves, electric fields, and electric potential.

Specific objectives:
Check the knowledge achieved on the contents of the control, by teachers and students. Develop the ability to communicate clearly and effectively in writing.

Material:
Statement of the questions

Delivery:
The individually solved control is delivered.

Related competencies :
. CE 2 AERO. Comprensión y dominio de los conceptos básicos sobre las leyes generales de la mecánica, termodinámica, campos y ondas y electromagnetismo y su aplicación para la resolución de problemas propios de la ingeniería. (CIN/308/2009, BOE 18.2.2009)
04 COE N1. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 1. Planning oral communication, answering questions properly and writing straightforward texts that are spelt correctly and are grammatically coherent.
07 AAT N1. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.
CB2. (ENG) CB2 - Que los estudiantes sepan aplicar sus conocimientos a su trabajo o vocación de una forma profesional y posean las
competencias que suelen demostrarse por medio de la elaboración y defensa de argumentos y la resolución de problemas dentro de
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CB5. (ENG) CB5 - Que los estudiantes hayan desarrollado aquellas habilidades de aprendizaje necesarias para emprender estudios posteriores con un alto grado de autonomíA

Full-or-part-time: 1h
Practical classes: 1h

MID-TERM EXAM

Description:
During the week of midterm exams, there will be an individual exam on theory and problems of the content worked on so far.

Specific objectives:
Check the knowledge achieved on the contents included, by teachers and students. Develop the ability to communicate clearly and effectively in writing, justifying the resolution of problems and answering theoretical questions.

Material:
Statement of the paper exam, calculator

Delivery:
The exam will be delivered individually.

Full-or-part-time: 2h
Practical classes: 2h

FINAL EXAM

Description:
During the week of end-of-semester exams, there will be an individual exam on theory and problems of all the content covered in the subject.

Specific objectives:
Check the knowledge achieved on the contents of the subject, by teachers and students. Develop the ability to communicate clearly and effectively in writing, justifying the resolution of problems and answering theoretical questions.

Material:
Statement of the exam on paper, calculator and form.

Delivery:
The exam will be delivered individually.

Related competencies :
. CE 2 AERO. Comprensión y dominio de los conceptos básicos sobre las leyes generales de la mecánica, termodinámica, campos y ondas y electromagnetismo y su aplicación para la resolución de problemas propios de la ingeniería. (CIN/308/2009, BOE 18.2.2009)
04 COE N1. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 1. Planning oral communication, answering questions properly and writing straightforward texts that are spelt correctly and are grammatically coherent.
07 AAT N1. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.
CB2. (ENG) CB2 - Que los estudiantes sepan aplicar sus conocimientos a su trabajo o vocación de una forma profesional y posean las
competencias que suelen demostrarse por medio de la elaboración y defensa de argumentos y la resolución de problemas dentro de
su área de estudio
CB5. (ENG) CB5 - Que los estudiantes hayan desarrollado aquellas habilidades de aprendizaje necesarias para emprender estudios posteriores con un alto grado de autonomíA

Full-or-part-time: 2h
Practical classes: 2h

GRADING SYSTEM

The evaluation criteria defined on the subject's infoweb will be applied.

EXAMINATION RULES.

All proposed activities are mandatory. An exam, control, exercise or project not submitted will be scored with a grade of zero. Examinations and controls will be carried out individually.

BIBLIOGRAPHY

Basic:
- Walker, Jearl; Resnick, Robert; Halliday, David. Fundamentals of physics [on line]. 8th ed. extended. Hoboken, NJ: John Wiley & Sons, 2008 [Consultation: 26/07/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=3059079. ISBN 9780471758013.
- Tipler, Paul Allen; Mosca, Gene. Física para la ciencia y la tecnología(VOL. 1) [on line]. 6a ed. Barcelona [etc.]: Reverté, 2010 [Consultation: 26/07/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=10372. ISBN 9788429144291.
- Tipler, Paul Allen; Mosca, Gene. Física para la ciencia y la tecnología(VOL. 2) [on line]. 6a ed. Barcelona [etc.]: Reverté, 2010 [Consultation: 17/04/2020]. Available on: http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=6537. ISBN 9788429144307.

Complementary:
- Feynman, R.P. Física. Argentina: Addison-Wesley Iberoamericana, 1987. ISBN 0201066211.
- Fleisch, D.A. A student's guide to Maxwell's equations. Cambridge: Cambridge University Press, 2008. ISBN 9780521701471.

RESOURCES

Hyperlink:
- Curs general de Física amb applets de java. http://www.sc.ehu.es/sbweb/fisica/- Cursos generals de mecànica i d'electromagnetisme del MIT. http://ocw.mit.edu/courses/physics/8-01-physics-i-classical-mechanics-fall-1999/ />http://ocw.mit.edu/courses/physics/8-02-electricity-and-magnetism-mechanics-spring-2002/