UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Course guide
300011 - FIS - Physics

Last modified: 01/06/2023

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

Degree:	BACHELOR'S DEGREE IN NETWORK ENGINEERING (Syllabus 2009). (Compulsory subject).
	BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING (Syllabus 2009). (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

Students should be familiar with the concepts of physical magnitude, units and unit conversion, and with the concepts of force, work, energy and fields. They should know how to use scientific notation in basic calculations. They should be able to apply fundamental aspects of trigonometry and differential, integral and vector calculus and of 1- and 2-dimensional kinematics.

REQUIREMENTS

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. CE 3 TELECOM. Students will acquire a detailed understanding of the basic concepts in the general laws of mechanics, thermodynamics, fields, waves and electromagnetism and their application to engineering problems. (CIN/352/2009, BOE 20.2.2009)

Transversal:
2. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.
3. 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.
4. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

TEACHING METHODOLOGY

Students of this course will acquire a solid understanding of the key physical concepts used in engineering and develop the capacity to make accurate predictions and solve complex problems by relating diverse concepts and applying the appropriate mathematical techniques. The learning objectives will be assessed on an individual basis, although students will also work in groups to defend and discuss their solutions to the problems studied and to suggest possible areas for improvement.

The lectures will mainly follow expository, model where the teacher will introduce the concepts and basic laws of physics and solve application examples of these concepts. Guided activities aimed a consolidating the knowledge of these concepts and laws, and use them to solve problems and applications.
These classes encourage students to take a more active role and to develop individual and group work concerning theoretical concepts. Guided activities will consist mainly:
- Using audiovisual and laboratory materials to demonstrate the correlations between the theory content of the course, the experiments conducted and the technological applications considered.
- Discussing solutions to a series of problems prepared individually prior to each class and considering the merits of different approaches.
- Taking tests designed to reflect individual progress towards achieving the learning objectives. In most directed activities, each group will submit a brief document for assessment, which will count for 1% of the final mark (although this percentage may vary in specific cases).

Finally, students will be expected to carry out independent learning by reading texts or watching videos on the key theoretical concepts covered in the course. Background reading should be completed before each topic is introduced in the corresponding class. In addition, students will be given a set of problems to complete individually for subsequent discussion during the directed activities, and a series of multiple-choice questions to be completed for self-assessment.

Lecturers and students will use the digital campus to exchange documentation and to monitor the assessment process. It also introduces texts and videos related to the agenda, to guide students' independent learning. In each issue there will be a questionnaire with test questions for self assessment. Although the use of a third language will not be assessed, some of the teaching materials will be written in English so that students can familiarise themselves with common scientific and technical vocabulary.

A general glossary of terms in English, Spanish and Catalan will be made available at the start of the course.

LEARNING OBJECTIVES OF THE SUBJECT

On completing the Physics course, students will be able to:

- Define the fundamental concepts in mechanics and electromagnetism.
- Explain the meaning and implications of Newton's Laws, the principle of conservation of energy, Coulomb's laws, electric fields, Gauss's law, the concepts of potential and electrostatic potential energy, the concept of current, Ohm's law and Kirchhoff's laws, magnetic fields and forces, the Biot-Savart law, Ampere's law and the Faraday-Lenz law, Maxwell's laws as a synthesis of the laws of electromagnetism and the concept of electromagnetic waves.
- Identify the physical magnitudes, principles and laws with which real situations can be modelled and understood, determine their quantitative consequences, and draw conclusions.
- Apply physical concepts and laws and the appropriate mathematical strategies to complex mechanics and electromagnetism problems and interpret the results.
- Use clear and effective spoken and written communication to present qualitative and quantitative arguments in support of scientific reasoning.
- Work independently with the suggested materials and following the course guidelines to acquire new knowledge and identify possible areas for improvement.
- Read and correctly interpret physics-related materials written in English.

STUDY LOAD

Type	Hours	Percentage
Guided activities	24,0	16.00
Self study	84,0	56.00
Hours large group	42,0	28.00

Total learning time: 150 h

CONTENTS

MECHANICS

Description:

- Kinematics and Newton's laws

Theoretical concepts: two-dimensional kinematics; Newton's first law, inertial and non-inertial reference systems; Newton's second law, inertial mass and gravitational mass; Newton's third law, action and reaction, internal and external forces; types of forces: weight, normal, frictional, elastic, tension.

Examples and applications of kinematics and Newton's laws: massless pulleys, inclined planes, bodies following curvilinear trajectories, simple pendulums.

- Work and energy

Theoretical concepts: definition of work by constant and variable force, in 1 and 3 dimensions; kinetic energy; work-kinetic energy theorem; conservative forces and potential energy; differential relationship between force and potential energy/work; theorem of conservation of mechanical energy.

Examples and applications of conservation of mechanical energy: massless pulleys, inclined planes, simple pendulums, vertical loops.

- Rotation on a fixed axis

Theoretical concepts: kinematics of circular movement; moment of force; Newton's second law for rotation; moment of inertia; kinetic energy of rotation.

Examples and applications of Newton's second law for rotation and of the conservation of mechanical energy in rotational systems: pulleys with mass, bodies that roll without sliding, physical pendulums.

Related activities:

Directed activities (4 sessions). Below are examples of the types of activities that the lecturer may decide to use, although these can be adapted according to the specific requirements and progress of each class.

- AV 1: Classroom-based activity in which the interactive blackboard will be used to solve complex problems involving the application of Newton's laws and the concepts of work and energy. Students will use Java animations and applets to demonstrate numerical experiments (for example, applying the Euler method to movement with velocity-dependent friction).

- AV 2: Classroom-based activity for discussing the students' solutions to the scientific problems set and suggesting possible corrections.

- AV3: Classroom-based activity for discussing the students' solutions to the scientific problems set and suggesting possible corrections.

- AV 4: Problem-based tests completed individually.

Full-or-part-time: 39h
Theory classes: 11h
Guided activities: 6h
Self study : 22h

ELECTRICITY

Description:
- Electric fields (I): Discrete distributions
Theoretical concepts: intuitive definition of electric charge; quantisation of electric charge; electric force and Coulomb's law; conductors and dielectrics; principle of superposition; concept of electric field.
Examples and applications: movement of charge in the presence of electric fields, operation of a photocopier.
- Electric fields (II): Continuous distributions
Theoretical concepts: concept of electric field for a continuous charge distribution; calculation of electric fields; electric field flow; Gauss's law.
Examples and applications: calculation by integration of the magnetic field generated by a current-carrying wire, ring and disc; calculation of electric fields using Gauss's law in problems with spherical and cylindrical symmetry.
- Electric potential
Theoretical concepts: displacement of a point charge in the presence of an electric field; electric potential energy; concept of electric potential; electric potential of a system of point charges; electric potential of charge distributions; calculation of potential by direct integration; relationship between field and electric potential; calculation of potential from an electric field; calculation of an electric field from potential.
Examples and applications: calculation by integration of the potential due to an infinite current-carrying wire, ring and disc; calculation of potential from the electric field obtained in the previous topic.
- Capacity and condensers
Theoretical concepts: formation energy of a system of charges (discrete and continuous cases); definition of capacity; capacity of flat-parallel, cylindrical and spherical condensers; energy of a condenser; dielectrics; molecular description of dielectrics.
Examples and applications: condenser combinations, condensers with dielectrics.
- Electric current
Theoretical concepts: concept of electric current; resistance and resistivity; resistor combinations; Ohm's law; power dissipation in a circuit; Joule's law; Kirchhoff's laws. Examples and applications: study of simple circuits, charge and discharge of a condenser.

Related activities:
Directed activities (5 sessions). Below are examples of the types of activities that the lecturer may decide to use, although these can be adapted according to the specific requirements and progress of each class.
- AV 5: Classroom-based activity in which the interactive blackboard will be used to study the movement of charged particles that follow Newton's laws and Coulomb's law. Students will compare the simulation results with theory-based calculations
- AV 6: Classroom-based activity for discussing and correcting the proposed solutions to discrete and continuous charge problems.
- AV 7: Classroom-based activity for discussing and correcting the proposed solutions to electric potential and condenser problems.
- AV 8: Classroom-based activity in which students will use specific software to analyse the behaviour of commutation circuits with condensers and compare their findings with theory-based solutions to specific problems.
- AV 9: Problem-based tests completed individually.

Full-or-part-time: 62h
Theory classes: 16h 30m
Guided activities: 9h 30m
Self study : 36h

MAGNETISM

Description:
- Magnetic fields
Theoretical concepts: magnetic force and Lorentz's force law, magnetic force due to a current-carrying wire, movement of charge in the presence of a magnetic field; Hall effect.
Examples and applications: movement of a current coil; movement of a current coil in the presence of a magnetic field; velocity selector, synchrotron and mass spectrometer.
- Sources of magnetic fields
Theoretical concepts: magnetic field generated by a point charge and magnetic field of a current distribution (Biot-Savart law); magnetic field generated by a rectilinear current-carrying wire, by a current coil and by a solenoid; Gauss's law for magnetism; Ampere's law.
Examples and applications: definition of an ampere; calculation of the magnetic field due to an infinite current-carrying wire, infinite current-carrying cylinder or toroid using Ampere's law.
- Magnetic induction
Theoretical concepts: concept of flow of magnetic fields, magnetic induction, Faraday's law, Lenz's law, self and mutual inductance.
Examples and applications: electromotive force, Foucault currents.

Related activities:
Directed activities (3 sessions). Below are examples of the types of activities that the lecturer may decide to use, although these can be adapted according to the specific requirements and progress of each class.
- AV 10: Classroom-based activity in which the interactive blackboard will be used to study the movement of charges within magnetic fields.
- AV 11: Classroom-based activity for discussing and correcting the proposed solutions to magnetism problems.
- AV 12: Classroom-based activity in which students will use laboratory material to produce a practical demonstration of the Faraday-Lenz law using coils, multimeters and magnets.

Full-or-part-time: 34h
Theory classes: 10h 30m
Guided activities: 5h 30m
Self study : 18h

MAXWELL'S LAWS AND ELECTROMAGNETIC WAVES

Description:
- Maxwell's laws
Theoretical concepts: displacement current, relationships between electric and magnetic fields, Maxwell's equations as a synthesis of electromagnetism laws. Electromagnetism spectrum. Relation with the Maxwell equations. The wave equation of an electromagnetical wave.

Related activities:
Directed activities (1 sessions). Below are examples of the types of activities that the lecturer may decide to use, although these can be adapted according to the specific requirements and progress of each class.
- AV 13: Students will work together in a computer room to discuss and correct their solutions to the coursework problems and to produce computer simulations by completing a tutorial on electromagnetic waves.

Full-or-part-time: 15h
Theory classes: 4h
Guided activities: 3h
Self study : 8h

ACTIVITIES

First Test

Description:
Students will work in groups of ten to complete and discuss a series of kinematics and mechanics exercises and problems using the animation tool provided by the interactive blackboard.

Specific objectives:
To acquire a solid understanding of kinematics and mechanical laws, identify the relationships between real situations and simplified models, and develop the capacity to make quantitative predictions using physical laws.

Material:
Users' guide to the interactive blackboard (digital). Copy of the descriptions of the kinematics exercises (digital and paper) and completed examples (digital: explanatory video and document containing screen captures). Descriptions of the exercises (digital and paper) and completed examples (digital: explanatory video and document containing screen captures)

Delivery:
Students will submit their calculations and discuss the results using the interactive blackboard. This assignment will count for 1% of the final mark.

Full-or-part-time: 3h
Theory classes: 1h
Self study: 2h

ACTIVITY 3: MECANICAL APPLICATIONS

Description:
Groups of 20 students will discuss a series of exercises and problems, which will require them to relate different concepts covered during the course and to apply basic calculus operations (differential, integral and vector). The exercises should be completed prior to each class in preparation for group discussion. Students will also be expected to relate the content of the exercises to real situations and discuss the implications of their results.

Specific objectives:
To obtain a solid understanding of the basic elements of mecanical's laws, develop the capacity to solve complex physical and mathematical problems, and provide sound arguments to justify different potential strategies.

Material:
Students will be given a series of problems in digital format, some of which may be written in English to help students become accustomed to working with a third language.

Delivery:
Students will submit their solutions to some of the group exercises completed in class. The marks awarded will count for 2% of the final mark.

Full-or-part-time: 3h
Theory classes: 1h
Self study: 2h

second test

Description:
Groups of 20 students will be set problem-based tests covering the topics studied up to that point in the course.

Specific objectives:
The tests are designed to reflect the students progress towards achieving the course objectives and learning outcomes.

Material:
Problem-based test (paper).

Delivery:
Students will submit the completed individual tests, which will count for 15% of the final mark.

Full-or-part-time: 3h
Theory classes: 1h
Self study: 2h

ACTIVITY 5: ELECTRIC FIELDS (INTERACTIVE BLACKBOARD)

Description:
Students will work in groups of ten to complete and discuss a series of exercises and problems involving Coulomb's law and mechanical laws, using the animation tool provided by the interactive blackboard.

Specific objectives:
To acquire a solid understanding of the concept of electric field, Coulomb's law and mechanical laws, identify the relationships between real situations and simplified models, and develop the capacity to make quantitative predictions using physical laws.

Material:
Students will be given a series of problems in digital format, some of which may be written in English to help students become accustomed to working with a third language.

Delivery:
Students will submit their calculations and discuss the results using the interactive blackboard. This assignment will count for 2% of the final mark.

Full-or-part-time: 2h
Self study: 2h

ACTIVITY 6: APPLICATIONS OF ELECTRIC FIELDS

Description:
Groups of ten students will discuss a series of exercises and problems, which will require them to relate different concepts covered during the course and to apply basic calculus operations (differential, integral and vector). The exercises should be completed prior to each class in preparation for group discussion. Students will also be expected to relate the content of the exercises to real situations and discuss the implications of their results.

Specific objectives:
To acquire a solid understanding of electric fields, Coulomb's law, Gauss's law and their applications, develop the capacity to solve complex physical and mathematical problems, and provide sound arguments to justify different potential strategies.

Material:
Students will be given a series of problems in digital format, some of which may be written in English to help students become accustomed to working with a third language.

Delivery:
Students will submit their solutions to some of the group exercises completed in class. The marks awarded will count for 2% of the final mark.

Full-or-part-time: 2h
Self study: 2h

ACTIVITY 7: APPLICATIONS OF ELECTRIC POTENTIAL AND CONDENSERS

Description:
Groups of ten students will discuss a series of exercises and problems, which will require them to relate different concepts covered during the course and to apply basic calculus operations (differential, integral and vector). The exercises should be completed prior to each class in preparation for group discussion. Students will also be expected to relate the content of the exercises to real situations and discuss the implications of their results.

Specific objectives:
To acquire a solid understanding of electric potential, capacity and condensers and their applications, develop the capacity to solve complex physical and mathematical problems, and provide sound arguments to justify different potential strategies.

Material:
Students will be given a series of problems in digital format, some of which may be written in English to help students become accustomed to working with a third language.

Delivery:
Students will submit their solutions to some of the group exercises completed in class. The marks awarded will count for 2% of the final mark.

Full-or-part-time: 92h
Guided activities: 20h
Self study: 72h

GRADING SYSTEM

The final mark will be obtained from the marks for the following activities, according to the percentage weighting shown below.
- Two theory-based/applied examinations: 50% (25% end of first semester, 25% end of course)
- Two theory-based/applied tests: 30% (15% each)
- Directed activities: 20%.
Students will receive a mark of zero for any examination, test or directed activity they do not attend or for any exercise they fail to submit.

EXAMINATION RULES.

All teaching activities are compulsory. Students will receive a mark of zero for any activity they fail to attend/submit. Examinations and tests will be completed individually. Directed activities may be carried out individually or in groups, as indicated in each case.

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: 26/07/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=10373. ISBN 9788429144307.

Complementary:
- Feynman, Richard P.; Leighton, Robert B.; Sands, Matthew. Física. México: Pearson Educación, 1998. ISBN 9684443501.
- Fleisch, D.A. A Student's guide to Maxwell's equations. Cambridge: Cambridge University Press, 2008. ISBN 9780521701471.

RESOURCES

Other resources:
Internet: specific websites accessed from the website of Athena of the subject.