Course guide
2500002 - GECFISAPLI - Applied Physics

Last modified: 01/10/2023

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 748 - FIS - Department of Physics.

Degree: BACHELOR'S DEGREE IN CIVIL ENGINEERING (Syllabus 2020). (Compulsory subject).

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

LECTURER

Coordinating lecturer: DANIEL CALVETE MANRIQUE

Others: DANIEL CALVETE MANRIQUE, ALBERTO FALQUES SERRA, GRECIA GUIJARRO, ALVARO MESEGUER SERRANO, JUAN JOSE SANCHEZ UMBRIA

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
14395. Understanding and mastery of the basic concepts about the general laws of mechanics, thermodynamics, fields and waves and electromagnetism and their application for solving engineering problems. (Basic training module)

TEACHING METHODOLOGY

The course consists of 4 hours per week of classroom classes. Each week, 2 hours are dedicated to theory classes, in which the teacher explains the basic concepts and materials of the subject, presents examples and carries out exercises; and 2 hours are dedicated to problem solving with greater interaction with the students. Practical exercises are carried out to consolidate the general and specific learning objectives. The remaining weekly hours are devoted to laboratory practices.

As a complement to the theory and problem classes, a 2-hour workshop is held every week. The workshops work both on the previous knowledge of the baccalaureate necessary for the subject and the reinforcement of concepts specific to the subject.

Support material is used in a detailed teaching plan format via the ATENEA virtual campus: contents, schedule of assessment and directed learning activities and bibliography.

The language of instruction of each group indicates the language that the teaching staff will use in the theory and problem sessions. In laboratory sessions and workshops, the language used by the teacher may be different. Also in the case of occasional substitutions of the teaching staff, the language may be different from the reference language of the group.

Practice sessions may be scheduled outside of school hours in the following weeks:
- Calorimetry: 2-6 October (week 40)
- Hooke's Law: November 6-10 (week 45)
- Speed of sound: November 27-December 1 (week 48)

Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.

LEARNING OBJECTIVES OF THE SUBJECT

Knowledge of heat and thermodynamics; Oscillations and waves; Electricity and Magnetism.

1 Ability to apply the general principles of thermodynamics to basic engineering problems.
2 Ability to apply the concepts of fields and waves in engineering.
3 Ability to solve simple electromagnetism problems.

Understanding and mastering the basic concepts of physics on the general laws of thermodynamics, fields and waves, and electromagnetism and their application to the resolution of engineering problems. Knowledge of thermodynamics including the first and second principles, heat transfer, and the foundations of kinetic theory. Knowledge of wave propagation, and in particular acoustic problems. Knowledge of electromagnetism, including engineering-type applications. Basic knowledge about continuum mechanics.

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	20.00
Hours medium group	24,0	16.00
Hours small group	6,0	4.00
Guided activities	6,0	4.00
Self study	84,0	56.00

Total learning time: 150 h

CONTENTS

Continuum Mechanics

Description:
Efforts. Deformation. Tension. Modules of elasticity. Elasticity and plasticity. Molecular model of elasticity
Examples and problem solving.
Density. Pressure in a fluid. Forces on a dam wall. Principle of Archimedes. Flotation.
Examples and problem solving.
Laminar and turbulent flow. Stationary flow: continuity equation. Energy conservation: Bernoulli equation. Applications of the Bernoulli equation. Viscosity. Reynolds name. Poiseuille law. Stokes law.
Examples and problem solving

Specific objectives:
Know the elastic properties of materials. Acquire the concepts of stress, deformation and modulus of elasticity. Know the validity ranges of Hooke's law.
Practical exercises to consolidate learning.
Know the properties of fluids. Acquire the concepts of density, pressure and surface tension. Know how to use the Archimedean principle.
Practical exercises to consolidate learning.

Full-or-part-time: 21h 36m
Theory classes: 4h
Practical classes: 4h
Laboratory classes: 1h
Self study : 12h 36m

Heat and Thermodynamics

Description:
Thermal and temperature balance. Zero principle of thermodynamics. Thermometers and temperature scales. Amount of heat. Heat capacity. Phase changes and latent heat.
Examples and problem solving.
Phases of matter. Phase diagrams. Equations of state. Ideal gas equation. Dilation and thermal stress. Molecular properties of matter.
Examples and problem solving.
Heat transfer. Conduction: Fourier's law, thermal resistance. Convection. Radiation: Stefan-Boltzmann law.
Examples and problem solving.
Thermodynamic systems and processes. Work, internal energy and heat. First principle. Types of thermodynamic processes: adiabatic, isochoric, isothermal and isobaric. Ideal gases: internal energy, heat capacity and adiabatic processes.
Examples and problem solving.
Entropy Microscopic interpretation of entropy. Irreversibility.
Exemples and problem solving.
Thermal machines and coolers. Heat pumps. Second principle of thermodynamics. Carnot cycle. Conversion of energy and usable energy.
Examples and problem solving.
Specific heat and heat transfer.

Specific objectives:
Acquire the Concepts of temperature and heat, and add microscopic significance. Know the different temperature scales. Know the thermal properties and phases of matter. Acquire the concepts of phase, phase change, heat capacity and latent heat.
Practical exercises to consolidate learning.
Know the thermal properties and phases of matter. Acquire the concepts of thermal expansion and thermal stress. Acquire the concepts of phase and phase change.
Practical exercises to consolidate learning.
Acquire the concept of heat transfer. Know the heat transfer mechanisms. Acquire the concepts of thermal resistance, emissivity and radiant power.
Practical exercises to consolidate learning.
Acquire the concept of internal energy. Know the relationship between work, internal energy and heat. Know how to use the first principle of thermodynamics. Acquire the concept of internal energy and its microscopic meaning. Know the relationship between work, internal energy and heat. Know how to use the first principle of thermodynamics.
Practical exercises to consolidate learning.
Acquire the concept of entropy. Acquire the concepts of entropy and irreversibility, as well as their microscopic meaning. Calculate the change of entropy in a thermodynamic system.
Exercicis pràctics per tal de consolidar l'aprenentatge.
Acquire the concept of thermal machine and thermal performance. Know the energy balances in a thermal machine.
Practical exercises to consolidate learning.
Familiarize yourself with various laboratory instruments: balance and thermometer. Calculate and represent measures and their errors.

Full-or-part-time: 45h 36m
Theory classes: 8h
Practical classes: 8h
Laboratory classes: 3h
Self study : 26h 36m

Oscillations and Waves

Description:
Balance and restoration forces. Small amplitude oscillations. Simple harmonic movement. Damped, forced oscillations and resonance
Examples and problem solving.
Mechanical waves. Types of mechanical waves. Pulses, periodic waves and speed of propagation. Mathematical representation of a wave. Wave equation. Principle of superposition and Fourier Analysis of wave motion. Transverse waves: waves on a wire, waves on a rope. Longitudinal waves: Pressure waves in a solid, a fluid and a gas.
Examples and problem solving.
Energy, power and intensity of a wave. Spherical waves. Acoustics.
Examples and problem solving.
Reflection and refraction. Propagation by non-homogeneous means.
Examples and problem solving.
Interference. Standing waves and normal modes.
Examples and problem solving.
Wave interference. Wave bundles. Wave groups. Group speed and dispersion. Doppler effect.
Examples and problem solving.
Proof of Hookess Law by measuring elongations and periods of oscillation.
Acoustic waves, wavelength, frequency and speed of sound.

Specific objectives:
Acquire the concepts of balance, restoring strength and periodic movement. Know the terms to characterize a periodic movement. Acquire the concept of simple harmonic motion. Acquire the concepts of damped oscillation, forced oscillation and resonance.
Practical exercises to consolidate learning.
Acquire the concept of mechanical wave. Know the different types of mechanical waves. Acquire the concept of wave function, sine wave function, propagation speed, wavelength and period. Know the wave equation. Know the principle of superposition and harmonic analysis. Know how to describe different types of waves in different media in the wave equation.
Practical exercises to consolidate learning.
Know the properties of wave energy.
Practical exercises to consolidate learning.
Know the phenomena of reflection and refraction.
Practical exercises to consolidate learning.
Know the phenomenon of interference. Acquire the concept of standing wave, normal mode and resonance.
Practical exercises to consolidate learning.
Acquire the concept of wave packet, group, group speed and dispersive medium. Know the phenomenon of the Doppler effect.
Practical exercises to consolidate learning.
Measurement of masses, lengths and time. Calculation and propagation of errors. Calculation of linear regressions.
Familiarize yourself with various laboratory instruments: function generator, multimeter and oscilloscope. Calculate and represent measures and their errors.

Full-or-part-time: 76h 48m
Theory classes: 13h
Practical classes: 13h
Laboratory classes: 6h
Self study : 44h 48m

GRADING SYSTEM

The final mark is the sum of the following partial marks:

Nel: laboratory teaching qualification
Nps: mark from summary exmans

Nfinal= 0.10 * Nel + 0.90 * Nps

The laboratory teaching grade is the average of the laboratory activities. The synthesis tests consist of two mid-term exams. In the second midterm, students have the option of taking a final exam to evaluate the whole course. The grade of the synthesis tests is the average of both mid-term exams or the grade of the final exam.

Criteria for re-evaluation qualification and eligibility: Students that failed the ordinary evaluation and have regularly attended all evaluation tests will have the opportunity of carrying out a re-evaluation test during the period specified in the academic calendar. Students who have already passed the test or were qualified as non-attending will not be admitted to the re-evaluation test. The maximum mark for the re-evaluation exam will be five over ten (5.0). The non-attendance of a student to the re-evaluation test, in the date specified will not grant access to further re-evaluation tests. Students unable to attend any of the continuous assessment tests due to certifiable force majeure will be ensured extraordinary evaluation periods.

These tests must be authorized by the corresponding Head of Studies, at the request of the professor responsible for the course, and will be carried out within the corresponding academic period.

EXAMINATION RULES.

Failure to perform a laboratory or continuous assessment activity in the scheduled period will result in a mark of zero in that activity.At the end of semester examinations are scheduled for those who have not made any final exams due to a number of reasons verifiable.

BIBLIOGRAPHY

Basic:

- Young, H.D; Freedman, R.A. Fisica universitaria. 13a ed. México D.F.: Pearson Educación, 2013. ISBN 9786073221245.
- Tipler, P.A.; Mosca, G. Física para la ciencia y la tecnología. 6a ed. Barcelona: Reverté, 2010. ISBN 9788429144284.

Complementary:

- Burbano de Ercilla, S. Problemas de física. 27a ed. Madrid: Tebar, 2006. ISBN 8473602374.
- Roller, D.E.; Blum, R. Física. Reverté. Barcelona: Reverté, 1986-1990. ISBN 8429143378.
- Giancoli, D.C. Física para ciencias e ingeniería. 4a ed. México: Pearson Education, 2008. ISBN 9789702612254.
- Juana Sardon. J.M de. Física general. 2a ed. Madrid: Pearson Educación, 2003. ISBN 420533424.
- Alonso, M.; Finn, E.J. Física, Vol.1: Mecánica. México: Addison-Wesley, 1986. ISBN 9686630007.
- Alonso, M.; Finn, E.J. Física, Vol.2: Campos y ondas. México: Addison Wesley Longman, 1986. ISBN 9684444265.