Universidad Zaragoza

Year : 2019/20

27203 - Physics

Syllabus Information

Academic Year: 2019/20
Subject: 27203 - Physics
Faculty / School: 100 -

Degree: 452 - Degree in Chemistry

ECTS: 12.0
Year: 1
Semester: Annual
Subject Type: Basic Education
Module:

1.General information

1.1.Aims of the course

1.2.Context and importance of this course in the degree

1.3.Recommendations to take this course

2.Learning goals

2.1.Competences

2.2.Learning goals

2.3.Importance of learning goals

3.Assessment (1st and 2nd call)

3.1.Assessment tasks (description of tasks, marking system and assessment criteria)

The course will be passed with a mark equal or greater than 5.0 at any of the two official calls (in June or in September).

- The grade (C) will be obtained as:

C = 0.1*L+0.9*(P1+P2)/2

being:

L = laboratory mark (from reports or a laboratory exam).

P1 = exam mark for the first half of the subject.

P2 = exam mark for the second half of the subject.

- Alternatively, the grade can be obtained (if the final result is better) as:

C = 0.1*L+0.2*T+0.7*(P1+P2)/2

being:

T = mark for continuous assessment from different works proposed by the professor.

Maximum values of C, L, P1, P2 and T are 10. To apply any formula L must be greater than 3.0 and P1 and P2 greater than 4.5. Each exam includes theory and problems and the mark is the average of those from each part provided they are greater than 3.0.

In February there will be a non-official exam for the first half of the subject (P1).

All marks are conserved along the whole course.

4.Methodology, learning tasks, syllabus and resources

4.1.Methodological overview

The methodology followed in this course is oriented towards the achievement of the learning objectives. A wide range of teaching and learning tasks are implemented, such as:

- Lectures for the whole group and (individual and/or small group) tutorials for activity 1 (see section 5.2).
- Problem-based learning and team and individual work for activity 2.
- Laboratory work and elaboration of reports for activity 3.
- Case-based learning, search for information from different sources, team and individual work for activity 4.

4.2.Learning tasks

The following activities are programmed to help students reach the learning outcomes:

- ACTIVITY 1: Lectures (8 ECTS. 80 hours onsite in the classroom) are used to explain the fundamental concepts of Physics, subsequent autonomous work (120 hours) is required to work on such concepts, using personal notes and recommended bibliographic resources.
- ACTIVITY 2: Problem-solving activities and case analysis in small groups (2.2 ECTS. 30 hours for onsite work in the classroom plus 25 hours of autonomous work).
- ACTIVITY 3: Laboratory work to observe physical phenomena (0.6 ECTS. 5 sessions x 2 hours each at the Physics Laboratory + 5 hours for autonomous elaboration of reports). The goals of the laboratory sessions are:
    1. Study of damped and driven oscillations and mechanical resonance.
    2. Determination of thermal properties: specific heat capacity of metals, fusion latent heat of water.
    3. Determination of electrical magnitudes. Verification of Ohm's law. Analysis of resistors in series and in parallel. Measurement of resistivity of different materials.
    4. Measurement of the magnetic field created by coils and solenoids. Determination of the horizontal component of the Earth's magnetic field. Measurement of magnetic forces on a current element.
    5. Observation of wave properties of light: polarization, interference and diffraction. Verification of Malus' law and characterization of the optical activity in sugar solutions.
- ACTIVITY 4: Guided and collaborative assignments in small groups on specific topics (1.2 ECTS. 30 hours of autonomous work, including 3 hours for tutorials).

4.3.Syllabus

The course will address the following topics:

I. CLASSICAL MECHANICS

- Topic 1. KINEMATICS. Quantities and units. Velocity and acceleration. Vectors. Relative velocity. Circular motion.
- Topic 2. FORCES AND NEWTONS'S LAWS. Newton's laws of motion. Examples of forces. Systems of particles. Center of mass. Rotation and moment of a force. Moment of inertia.
- Topic 3. LINEAR MOMENTUM AND ANGULAR MOMENTUM. Linear momentum of a system of particles and conservation law. Angular momentum of a system of particles and conservation law.
- Topic 4. WORK AND KINETIC ENERGY. Work definition. Kinetic energy of a system of particles. Rotational kinetic energy. Collisions.
- Topic 5. CONSERVATIVE FORCES AND POTENTIAL ENERGY. Potential energy. Principle of conservation of mechanical energy. Force and potential energy: equilibrium points. Central forces. Effective potential energy: the two-body problem.
- Topic 6. OSCILLATIONS. Simple harmonic oscillator. Energy for the simple harmonic motion. Motion near an equilibrium point. Simple pendulum. Damped and driven oscillations.

II. THERMODYNAMICS

- Topic 7. STATISTICAL MECHANICS AND THE KINETIC THEORY OF GASES. Microscopic and macroscopic descriptions of an ideal gas. Equation of state for an ideal gas. Definition of temperature. Theorem of equipartition. Distribution of molecular velocities.
- Topic 8. HEAT AND THE FIRST LAW OF THERMODYNAMICS. Heat. Heat capacity and specific heat capacity. Phase transition and latent heat. Thermal equilibrium. Heat transfer: conduction, convection and radiation. First law of thermodynamics. Internal energy. Heat capacity of solids and gases. Failures of the equipartition theorem: energy quantization.
- Topic 9. THERMODYNAMIC PROCESSES AND STATE EQUATIONS. Quasi-static processes. Work and *PV*

diagram for a gas. Quasi-static adiabatic expansion of an ideal gas. Van der Waals equation. Phase diagrams. Reversible and irreversible processes.

- Topic 10. THERMODYNAMIC CYCLES AND THE SECOND LAW OF THERMODYNAMICS. Heat engines: second law of thermodynamics. Refrigerators and heat pumps. The Carnot cycle. Other relevant cycles. Entropy definition. Entropy of an ideal gas. Entropy and disorder.

III. ELECTROSTATICS

- topic 11. ELECTROSTATIC FIELD. Conservation of the electric charge. Coulomb's law. Electrostatic field. Field calculation for point charges and continuous charge distributions. Gauss's theorem: application examples.
- Topic 12. ELECTROSTATIC POTENTIAL. Potential difference. Field and potential. Examples of calculation of the electrostatic potential. Electrostatic potential energy. Electric dipoles and motion inside a uniform electric field.
- Topic 13. DIELECTRICS AND CONDUCTORS. Charge and field for conductors in electrostatic equilibrium. Capacity and capacitors. Storage of electric energy. Capacitor combinations. Polarization: free and bound charges. Polarization vector and displacement vector. Gauss's theorem in a dielectric medium.

IV. ELECTROMAGNETISM

- Topic 14. ELECTRIC CURRENT. Current density and intensity. Electrical resistance and Ohm's law. Electric power. Electromotive force and batteries. Resistors in series and in parallel. Instruments for electrical measurements: ammeter and voltmeter. Charge and discharge of a capacitor.
- Topic 15. MAGNETIC FIELD. Lorentz force on electric charges. Motion of charged particles inside a magnetic field: velocity selector and mass spectrometer. Force on a current element. Torque on a current loop: magnetic dipole moment and the potential energy of a magnetic dipole. The Hall effect.
- Topic 16. SOURCES OF MAGNETIC FIELD. Field created by moving electric charges. Field created by currents: law of Biot and Savart. Gauss's law for magnetism. Law of Ampère.
- Topic 17. MAGNETIC INDUCTION. Law of Faraday and law of Lenz. Inductance and RL circuits. Magnetic energy. Generation of alternating current.
- Topic 18. MAGNETIC PROPERTIES OF MATERIALS. Atomic magnetic moment. Magnetization and magnetic susceptibility. Paramagnetism. Ferromagnetism. Diamagnetism.
- Topic 19. ELECTROMAGNETIC FIELD AND ELECTROMAGNETIC WAVES. Displacement current. Maxwell's equations. Wave equation. Plane and spherical electromagnetic waves. Energy of an electromagnetic wave and the Poynting vector. Electromagnetic spectrum.

V. OPTICS

- Topic 20. LIGHT: PROPAGATION IN ISOTROPIC MEDIA. The nature of light. Light propagation: wavefront and Huygens's principle. Reflection and refraction: Snell's law, total internal reflection, continuous refractions and mirages. Absorption, dispersion and diffusion.
- Topic 21. POLARIZATION OF LIGHT. PROPAGATION IN ANISOTROPIC MEDIA. Polarization of a wave. Polarization by absorption and by reflection. Light propagation in anisotropic media. Birefringence. Optical activity.
- Topic 22. INTERFERENCE AND DIFFRACTION. Phase difference and coherence. Interference between light waves. Interference pattern from two slits. Diffraction pattern from one slit. Fraunhofer and Fresnel diffraction. Diffraction and resolution. Diffraction gratings: spectroscope and X-ray diffraction.
- Topic 23. FORMATION OF OPTICAL IMAGES (GEOMETRICAL OPTICS). Formation of images at the paraxial approximation: definitions and rules, the Abbe invariant, focuses and focal planes. Thin lenses. The human eye.

Practical sessions

There will be five laboratory sessions (two hours each) during the course:

1. Driven oscillations. Mechanical resonance (in November)
2. Measurement of thermal properties of materials (in December)
3. Measurement of electrical quantities (in March)
4. Measurement of magnetic fields and effects of magnetic fields on conductors (in April)
5. Observation of wave properties of light: polarization, interference and diffraction (in May)

4.4.Course planning and calendar

For further details concerning the timetable, the classroom assigned for the lectures and further information regarding this course, please refer to the "Facultad de Ciencias" website (https://ciencias.unizar.es/node/7073).

Particular dates for each session and distributions of groups will be announced well in advance.

4.5.Bibliography and recommended resources