FISICA II E LABORATORIO A - L

FIS/01 - 10 CFU - 1° Semester

Teaching Staff

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Office Hours: Lunedi e Mercoledi 15.30-18. Il docente garantisce la sua presenza per tutto il tempo necessario ai colloqui con gli studenti che si presenteranno entro le 15.45. Se non si sarà presentato alcuno studente, alle 15.45 il ricevimento sarà chiuso.

LEARNING OBJECTIVES

The main objective of the Physics II course is the basic knowledge of:

- classical electromagnetism, both in the vacuum and in the isotropic and homogeneous media;

- geometric and physical optics;

combined with the acquisition of the ability to solve problems of electromagnetism.

Another basic objective is the learning of the experimental method for the measurement of physical quantities in the laboratory and the check of physical laws.

DETAILED COURSE CONTENT

ELECTROSTATICS
1.1 - Electrostatic force. Electrostatic field.
The composition of matter and the presence of electrical interactions between its charged constituents. Quantization and conservation of the electric charge. Insulating materials and conductors. Force between electric charges. Coulomb's law. The electrostatic field. Calculation of electrostatic fields for discrete and continuous distributions. The field map. Motion of a charge in an electrostatic field. Millikan experience.
1.2 - Electrical work. Electrostatic potential.
The electric work. The electric voltage. The electrostatic potential. The electrostatic energy. Calculation of potential and electrostatic energy: for a point charge and for discrete and continuous charge distributions. Potential energy of a charged system. Motion of a charge in an electrostatic field. Energy conservation. Motion in a central field. Classic model of hydrogen atom. Electrostatic separator and

cathode ray tube. The electrostatic field as a potential gradient. Calculation of electrostatic fields from the potential for continuous charge distributions. The rotor of the electric field. Equipotential surfaces. Electric field and potential generated by a dipole. Motion of a dipole in a uniform electric field. Potential energy of a dipole placed in a field. Polar molecules.

1.3 - The law of Gauss.

Electrostatic flow. The Gauss law. Applications of the Gauss law: spherical shell, sphere, wire and uniformly loaded plane. The Gauss law in local form; Poisson and Laplace equations.

1.4 - Conductors. Dielectrics. Electrostatic energy.

Conductors. Electrostatic induction. Cable conductor. Electrostatic screen. Capacitors. Electrostatic energy.

Dielectrics. Relative dielectric constant, absolute, electrical susceptibility. Polarization of dielectrics. Definition of the vector D (dielectric induction). Gauss and Poisson laws in dielectrics.

STATIONARY CORRENTS AND MAGNETOSTATIC FIELDS

2.1 - Electric current.

Electrical conduction. Average and instant current, current density. Ohm's law for ohmic conductors. Conductivity and resistivity. Classical model of conduction. Electrical resistance. Temperature dependence. Superconductors. Electricity and absorbed power. Generators of f.e.m. Resistors in series and in parallel. Kirchhoff's laws. Charge and discharge of an RC circuit.

2.2 - Magnetic field.

Properties of magnets. Magnetic field. Lorentz force.

Magnetic force on a wire drawn by current: the second elementary law of Laplace. Torque agent on a current loop in a uniform magnetic field. Magnetic moment of astationary current loop. Hall effect. Motion of a particle in a uniform magnetic field. The speed selector. The mass spectrometer. The cyclotron.

2.3 - Sources of the magnetic field. Ampère's law. Magnetic properties of matter.

Magnetic field produced by a current element - first elementary Laplace law.

Magnetic permeability of the vacuum. Ampere-Laplace law for the magnetic field generated by a closed current circuit. Magnetic field produced by a rectilinear wire (Biot-Savart law), by a circular coil, by an ideal solenoid. Forces acting on parallel wires driven by current. Ampère law. Gauss law for the magnetic field.

Displacement current. Ampère-Maxwell law. Magnetic properties of matter. Permeability and magnetic susceptibility. Magnetization mechanisms and Amperian currents.

CURRENTS AND VARIABLE FIELDS

3.1 - Variable electric and magnetic fields over time.

Faraday law. Lenz law. Current generators. Foucault currents. Self-induction.

Circuits RL. Magnetic energy. Density of magnetic energy. Mutual induction. Maxwell equations.

3.2 - Electrical oscillations. Alternating currents.

Electrical oscillations. Ideal LC circuit. Discharge of a capacitor in an inductive loop.

Resistors, capacitors and inductors in AC. Reactances and impedance. RLC circuits in AC. Resonance. Power in AC. Power factor. Merit factor of an RLC circuit. Ideal transformer.

ELECTROMAGNETIC WAVES

4.1 - Electromagnetic waves.

Electromagnetic waves. Harmonic electromagnetic waves. Linear, circular and elliptical polarization. Poynting vector. Intensity of a wave e.m. Radiation pressure. Electromagnetic spectrum. Spherical waves.

OPTICS

5.1 - Reflection and refraction of light.

Speed of light in a medium. Index of refraction. Cauchy formula. Principle of Huygens-Fresnel. Reflection and refraction. Limit angle. Total reflection. Chromatic dispersion. Prism. Fresnel coefficients. Brewster angle. Polarization by reflection. Polarization by selective absorption and diffusion. Malus law.

Birefringence. Optical activity.
5.2 - Geometric optics.
Image construction in geometric optics. Spherical and flat mirrors. Focal distance. Magnification. Spherical and flat diopters. Dioptric power. Front and rear focal distances. Magnification. Thin lenses. Convergent power. Focal distance. Lens builder equation. Magnification. Optical microscope. Visual enlargement.
5.3 - Interference.
Interference from two slits. Minimum and maximum interference position. Intensity distribution between the fringes. Phase method for calculating intensities.
5.4 - Diffraction.
Fraunhofer diffraction from a single rectilinear slit. Diffraction minima position. Minimum resolution angle. Rayleigh criterion. Resolving power of a lens. Linear resolution power of a microscope.
ELEMENTS OF THEORY OF ERRORS
Uncertainty of a measure. Error sources. Estimate of the uncertainty in the reading of scales. Random errors and systematic errors. Representation of experimental data. Significant figures. Discrepancy between two measures. Graph representation. Verifying relationships with a chart. Relative error or accuracy. Propagation of errors in indirect measures (maximum limit of uncertainty). Propagation of errors in indirect measures (random uncertainties and independent measures).
Statistical analysis of a set of measures: mean and standard deviation. Error on the average. Frequency histograms. Probability distribution of Gauss. Linear best-fit and its uncertainty. Chi-square test.

LABORATORY ACTIVITY

Measurement of reaction time to light and sound stimuli.

Measurement of the elastic constant of a spring.

Measurement of gravity acceleration with the simple pendulum.

Measurement of the viscosity coefficient of glycerine.

Resistance measurement with the voltamperometric method.

Measurement of resistances of high value, by means of the discharge of the capacitor.

Measurement of the ratio e / m by magnetic deflection.

Measurement of the focal distance of a converging lens.

Verification of the Malus law and measurement of concentrations of optically active solutes.

TEXTBOOK INFORMATION

1. P.Mazzoldi, N.Nigro, C.Voci: ELEMENTI DI FISICA, Vol.II - Elettromagnetismo e Onde, EdiSES Napoli

2. D. Halliday, R.Resnick: FISICA 2, Ed. Ambrosiana

3. R.A.Serway – Fisica Vol.II - ed.EdiSES

4. P.A.Tipler, G.Mosca - Physics for scientists and engineering, W.H.Freeman and Company

5. J. Taylor: Introduzione all'analisi degli errori. Lo studio delle incertezze nelle misure fisiche, Zanichelli