COURSE OF STUDY *L30 Fisica*

ACADEMIC YEAR *2023-2024*

ACADEMIC SUBJECT General *Physics, mod. A*

General information	
Year of the course	Second
Academic calendar (starting and ending date)	Second semester, from September 18, 2023 to December 22, 2023
Credits (CFU/ETCS):	9
SSD	FIS-**01**
Language	Italian
Mode of attendance	Not mandatory

Professor/ Lecturer	
Name and Surname	Roberto Bellotti, Marcello Abbrescia, Antonio Palazzo
E-mail	
Telephone	roberto.bellotti@uniba.it, marcello.abbrescia@uniba.it, palazzo@ba.infn.it
Department and address	Interateneum Physics Department
Virtual room	
Office Hours (and modalities: e.g., by appointment, on line, etc.)	By appointment, to be fixed via email or phone call to the course professors

Work schedule			
Hours			
Total	Lectures	Hands-on (laboratory, workshops, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
225	48	45	132
CFU/ETCS			
9	6	3	

Learning Objectives	This course aims at providing a basic knowledge of electromagnetism.
Course prerequisites	Understanding of a text, notions of geometry, algebra and elementary trigonometry. Differential and integral calculus of functions with one variable. Differential equations of the first and second order. Scalar and vector quantities. Newton's laws and motion equations. Kinetic and potential energy.

Teaching strategies	Lectures and exercises
Expected learning outcomes in terms of	
Knowledge and understanding on:	The goal of this course is to provide students with basic knowledge of electromagnetism (in static and dynamic conditions, in vacuum or in matter). At the end of the course the student will have acquired this knowledge and will be able to solve simple problems on electromagnetism. Understanding how the laws of Physics are verified through famous examples and experiments.
Applying knowledge and understanding on:	Ability to set up and solve problems relating to classical electromagnetism. Ability to identify essential elements of a phenomenon, in terms of order of magnitude and necessary level of precision.

Soft skills	• *Making informed judgments and choices* Development of the critical sense necessary to discern significant aspects from marginal ones, to evaluate the correctness of the assumptions and approximations adopted. Development of analysis skills aimed at identifying inconsistencies and possible sources of error, including dimensional checks. • *Communicating knowledge and understanding* Acquisition of competence in communication in Italian, and of the rigor necessary for the topics covered. Ability to evaluate the logical structure in the presentation (formal or informal, written or oral) of physics topics. This self-evaluation ability is required in the various tests that the student must pass. • *Capacities to continue learning* Ability to recognize the variety and beauty of discoveries and electromagnetism.
Syllabus	
Content knowledge	**1) Electrostatic force and electrostatic field.** Introduction to electromagnetism: relationship between sources and fields by means of the Lorentz force. Electrical Charges. Insulators and Conductors. Electrical structure of matter. Coulomb's law. Electrostatic Field. Electrostatic field produced by a continuous distribution of charges. Linear, surface and volumetric charge density. Lines of force of the electrostatic field. Examples: electrostatic field of a charged wire, of a charged ring, of a charged disk, of an indefinite plane, of two indefinite planes. Reasoned problem solving. **2) Electrical work and electrostatic potential.** Work of the electric force. Electrostatic potential. Electrostatic potential energy. Electrostatic field as a gradient of the electrostatic potential. Equipotential surfaces. Rotor of a vector field. Stokes' theorem. Application to the electrostatic field. Electric dipole. Examples: electrostatic energy of three charges. Reasoned problem solving. **3) Gauss's law.** Electrostatic field flow. Gauss's law. Proof of Gauss's law. Applications and consequences of Gauss' law. Electrostatic field around a surface layer of charge. Discontinuity of the normal component of the electrostatic field. Gauss' law in differential form. Divergence of a vector field. Solenoidal vector fields. Maxwell equations for electrostatics. Examples: electrostatic field of a spherical surface charge distribution, electrostatic field produced by a uniformly charged sphere and a flat surface charge distribution. Reasoned problem solving. **4) Conductors.** Electrostatic energy. Balanced in equilbrium. Capacitance of an insulated conductor. Persimmon conductor. Electrostatic screen. Hollow conductors with electrical charges inside. Capacitors. Connection of capacitors. Capacitors in series and parallel. Energy of the electrostatic field. Electrostatic energy density. Electrostatic potential energy of a system of charges. Examples: capacitance of an insulated spherical conductor, relationship between density and radius of two contacting conducting spheres, field and potentials of two concentric spherical conductors in various charge configurations, capacitance of a spherical capacitor, capacitance of a flat capacitor, electrostatic energy of a spherical capacitor, electrostatic energy of a charged sphere. Reasoned problem solving. **5) Dielectrics.** Dielectric constant. Polarization of dielectrics. Relative dielectric constant. Electrical susceptibility. Capacitance of capacitor with dielectric. Absolute

	dielectric constant of the dielectric. Dielectric strength. Polarization of dielectrics. Electrostatic field produced by a polarized dielectric. Electrostatic field inside a polarized dielectric. General equations of electrostatics in the presence of dielectrics. Dielectric induction vector. Gauss's law for the dielectric induction vector. Reasoned problem solving. **6) Electric current** Electrical conduction. Electric current. Law of conservation of charge. Stationary current regime. Classical model of electrical conduction. Ohm's law. Ohm's law for metallic conductors. Electrical resistance. Joule effect. Thermal effects. Power. Joule effect. Superconducting materials. Resistors in series and parallel. Resistors in series. Resistors in parallel. Electromotive force. Electromotive field of a generator. Van de Graaf generator. Charging and discharging a capacitor through a resistor. Charging a capacitor. Discharge of a capacitor. Kirchhoff laws for electrical networks. Calculation of the resistance of three-dimensional conductors. Examples: Speed of conduction electrons in a metal. Current density and drift speed. Reasoned problem solving. **7) Magnetic field and magnetic force** First experimental facts on magnetic interaction; electricity and magnetism. Magnetic field lines. Gauss's law for the magnetic field; electrostatic field and magnetic field. Magnetic force on a moving charge: motion of a particle in a magnetic field, motion in a uniform magnetic field, $\theta=\pi/2$, motion in a uniform magnetic field, generic θ. Magnetic force on a current carrying conductor. Mechanical moments on flat circuits. Ampère's equivalence principle. Expressions of force, momentum and work via magnetic flux. Hall effect. Examples of motions of charged particles in a uniform magnetic field. Mass spectrometers. Bainbridge speed selector and spectrometer. Cyclotron. Examples: Flat loop in a magnetic field. Force on a circular coil in a magnetic field. Reasoned problem solving. **8) Magnetic field sources and Ampère's law** Magnetic field produced by a current, magnetic field produced by a moving charge. Magnetic fields produced by particular circuits: indefinite straight wire and Biot-Savart law, circular loop, magnetic dipole-magnetic dipole mutual interaction, rectilinear solenoid. Electrodynamic actions between current-carrying circuits. Ampère's law. Properties of the magnetostatic field in vacuum. Discontinuity of the magnetic field. Relativity of electric and magnetic fields. Examples: magnetic field produced by a square loop. Rowland record. Action and reaction principle for two current-carrying circuits. Magnetic field of an undefined straight conductor. Magnetic field of an undefined rectilinear solenoid. Magnetic field of a toroidal solenoid. Magnetic field of an indefinite plane current. Reasoned problem solving. 9) Electric and magnetic fields varying over time Introductory concepts: electromotive force of an electric field, flux of the magnetic field. Faraday's law of electromagnetic induction. Lenz's law. Physical origin of the induced electromotive force. Translational motion of a conductor in a magnetic field. Electric fields induced by temporal variations of a magnetic field. Applications of Faraday's law: electromagnetic friction, generators, sinusoidal current generator, electric motors, eddy currents. Felici's law and magnetic field measurements. Self-induction. Series RL circuits. Magnetic energy. Mutual induction. Magnetic energy of coupled circuits. Magnetic energy of two coupled circuits. Displacement current and Ampère-Maxwell law. Maxwell's equations. Equation of electromagnetic waves. Examples: Conductive circuit with moving side in a magnetic field. Electromotive force induced by temporal

	variations of a magnetic field. Palmieri circle. Inductance of a toroid and a solenoid. Magnetic energy in a toroidal solenoid, in a coaxial cable. Mutual induction between coaxial solenoids and between coupled circuits. . Magnetic energy of two coupled circuits. Mutual induction between two solenoids. Oscillations of a coil. Displacement current in a flat capacitor. Reasoned problem solving.
Texts and readings	*P. Mazzoldi - N. Nigro - C.Voci - (Vol. 2) Elettromagnetismo e Onde, Third edition*
Notes, additional materials	
Repository	

Assessment	
Assessment methods	
Assessment criteria	The final grade is evaluated by the Commission based on the outcome of the written test and the oral test. The written test is passed if: • Both required exemptions are passed (generally the first exemption is carried out during the teaching break of the first semester, and the other immediately after the end of the course), or • You pass the written test in one of the scheduled sessions The written test is considered passed when the student has achieved at least a sufficient score (15/30). If the written test is passed, the oral test can be taken in any session scheduled during the same exam session (summer or winter). If the oral test is not passed, then it will be necessary to take the written test again.
Final exam and grading criteria	The written test constitutes an access test to the oral exam and is intended to verify the ability to solve problems related to the topics of the course. The oral test evaluates the ability to illustrate the topics to other people, connect different parts of the program, use the scientific language introduced in the course and the mathematical formalism in a manner appropriate to the level of the course.
Further information	
	.