UNIVERSITÀ DEGLI STUDI DI PALERMO

SCHOOL	POLYTECHNIC SCHOOL
ACADEMIC YEAR	2016/2017
FIRST CYCLE COURSE	CIVIL AND BUIDING ENGINEERING
SUBJECT	PHYSICS II
TYPE OF EDUCATIONAL ACTIVITY	A
AMBIT	50280-Fisica e chimica
CODE	07870
SCIENTIFIC SECTOR(S)	FIS/01
HEAD PROFESSOR(S)	VALENTI DAVIDE Ricercatore Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54
PROPAEDEUTICAL SUBJECTS	
YEAR	2
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**VALENTI DAVIDE** Thursday 15:00 17:00 Dipartimento di Fisica e Chimica (DiFC), Viale delle Scienze, Edificio 18, 90128 Palermo

DOCENTE: Prof. DAVIDE VALENTI

TEACHING METHODS	The course takes place during the second semester of the second year of two degree courses: Engineering for Environment and Territory and Civil and Construction Engineering and consists of two modules (3rd and 4th). The course consists of lectures and tutorials during which are proposed and solved exercises and problems whose difficulty increases gradually up to reach the level of the exam tests. The exercises tend to verify both the knowledge gained and the problem solving skills, and to train students for the examinations.
ASSESSMENT METHODS	The exam is divided into two phases: a written test, lasting two hours, and an oral examination. The written test consists in the resolution, without the aid of textbooks or notes, of six multiple-choice exercises and two problems, related to laws and phenomena of the classic Electromagnetism. The written test allows to verify, under equal conditions for all candidates, not only the level of knowledge of the Electromagnetism laws, but also the ability to apply them to specific situations (problem solving). In particular, through the resolution of the exam problems the student may demonstrate his ability to analyze a physical phenomenon and to give a mathematical description by writing equations that, once they are solved, allow to achieve quantitative results. The oral test consists of an examination-interview, based on the enunciation and discussion of the physical laws studied during the course and the use of these laws to solve simple problems. The examination-interview allows to evaluate the candidate's knowledge, his ability to apply that knowledge (problem solving), clarity in exposing the concepts and properties of scientific language used. The final evaluation, properly graded, will take into account the following conditions: a) Basic knowledge of the studied physical laws and ability to apply them to some new situations, sufficient ability to analyze the phenomena considered and to describe the procedures followed (18-21 mark); b) Good knowledge of the physical laws studied and ability to apply them to situations similar to those studied, quite good abilities to analyze the phenomena considered and to describe the procedures followed (22-25 mark); c) Deep knowledge of the studied physical laws and ability to apply them to any proposed physical phenomenon, but not always promptly and following a linear approach, good ability to analyze the phenomena considered and to describe the procedures followed (26-28 rating); d) Deep and wide knowledge of the studied physical laws and ability to apply them promptly and correctly to any proposed physical phenomenon, excellent skills to analyze the phenomena considered and excellent communication skills (29-30 cum laude).
LEARNING OUTCOMES	Knowledge and understanding The student will have learned how to build a physical model for the description of the phenomena in which electric and magnetic forces are involved. In particular, at the end of the course the student will possess knowledge of issues relating to both the electrostatic (charge concept, electric field, electrostatic potential, Coulomb law, Gauss theorem) and electromagnetism (Ampere circuital law and Faraday-Lenz law). The student will have finally realized the importance of Maxwell equations as an essential tool for the description and quantification of all electrical and magnetic phenomena observable in classical physics. Abilities to apply knowledge and understanding The student will have acquired the ability to identify the symmetry in a physical problem and to outline the electromagnetic phenomena, describing them quantitatively by Maxwell equations. He will be able to solve problems related to electric and magnetic phenomena, by using symmetry arguments and applying the superposition principle and the principles of conservation. Independent judgment The student will be able to determine whether in a given problem one has to use a dynamic "approach" (analysis of the system in terms of electric and magnetic forces) or, otherwise, an "energy" approach (analysis of the system by applying the principle of energy conservation). Communication skills The student will have acquired skills in communicating and expressing issues concerning the topics of the course. He will be able to address topics of Electromagnetism, referring to related principles and laws and making qualitative considerations on specific issues. Learning ability The student will have acquired and honed the ability to see books and scientific journals. This will allow the student to continue his studies with greater intellectual

	independence and increased ability of assessment and making decisions.
EDUCATIONAL OBJECTIVES	LEARNING TASKS OF MODULE 1 The learning tasks of this module are the study of the phenomena in which electric and magnetic forces due to steady currents are present, the construction of an adequate physical model and the ability to apply the laws of Coulomb, Gauss and Ampère to specific cases. Using principles of conservation, laws of electrostatics and Ampère law is a fundamental task not only to understand the meaning of charge, electric field, magnetic field and electric current, but also to realize which is the role played by these quantities in the functioning of the real world. It will be also introduced the concept of electrostatic potential, with the goal of providing the student an essential conceptual tool for the description of an electrostatic system in terms of energy changes. The student will become able to deal with physical situations in which there are motionless charges or steady currents, to describe qualitatively what occurs in the system considered, to choose the correct way to quantitatively analyze the dynamics of the system by applying laws and principles, and to resolve finally the equations, in view of finding the mathematical solution of the problem. This will be followed by a comparison between physical aspect of the problem and mathematical description. LEARNING TASKS OF MODULE 2 The learning tasks of this module are the study and understanding of the phenomena and laws related to time varying electric and magnetic fields. Through the study of electromagnetic induction (Faraday-Lenz law) and displacement currents (Maxwell induction law) the student will learn how to treat systems in which fields variable in time and space are present. At the same time the student will understand the electromagnetic nature of light and radio waves, while learning to qualitatively describe the electromagnetic phenomena. Finally, by choosing the appropriate tools to quantitatively analyze the dynamics of the system considered, he will be able to solve equations to obtain the mathematical solution of a given problem. The comparison between the physical point of view of the problem, qualitatively discussed, and its mathematical description will allow the student to get a complete understanding of the phenomena analyzed.
PREREQUISITES	The prerequisites for successfully attending the course and achieving the tasks are to be familiar with real-valued functions of a real variable, including derivatives and integration, knowledge of the conservation principles of energy, momentum and angular momentum, ability to describe a physical phenomenon through equations of motion, and finally ability to solve a specific problem, detecting and using appropriately symmetries eventually present in the physical system considered.
SUGGESTED BIBLIOGRAPHY	1 - R. A. Serway, R. J. Beichner, Fisica per Scienze e Ingegneria (vol. 2), EdiSES, 3a edizione, Napoli. 2 - D. Halliday, R. Resnick, J. Walker, Fondamenti di Fisica: Elettrologia, Magnetismo, Ottica (vol. 2), Casa Editrice Ambrosiana, 6a edizione, Milano. 3 - P. Pavan, P. Sartori, Problemi di Fisica risolti e commentati (vol. 2), Casa Editrice Ambrosiana, 3a edizione, Milano. 4 - L. Lovitch, S. Rosati, Problemi di Fisica Generale (vol. 2), Casa Editrice Ambrosiana, 2a edizione, Milano. 5 - M. Bruno, M. D'Agostino, R. Santoro, Esercizi di Fisica - Elettromagnetismo, Casa Editrice Ambrosiana, 1a edizione, Milano.

SYLLABUS

Hrs	Frontal teaching
3	Electric charge. Conductors and insulators. Coulomb law. Charge conservation principle. Electric field. Electric field lines and their meaning. Electric field generated by a point charge. Electric field generated by an electric dipole. Electric field generated by a linear charge distribution and by a disc with a homogeneous charge distribution. Electric charge immersed in electric field. Electric dipole immersed in electric field: torque on the dipole and potential energy of the dipole p within the field.
2	Vectorial quantities and flow through a surface. Flow of electric field and Gauss law. Relationship between Gauss law and Coulomb law. Charge distribution on an isolated conductor. Gauss law in a system with spherical, cylindrical and flat symmetry. Electric field generated by an insulating foil and by two conducting sheets with uniform charge distributions.
3	Electric potential energy of a system of charges. The electric potential: concept and physical meaning. Equipotential surfaces. Zero of electric potential: its meaning and importance for the calculation of the electric potential in different space points. Potential due to a point charge. Potential due to a system of charges. Potential due to an electric dipole. Potential due to a continuous charge distribution. Calculation of the electric field for a given potential. Electric potential energy for a given potential: the case of a system of charges. Electric potential of an isolated charged conductor.

SYLLABUS

Hrs	Frontal teaching
2	Electrical capacitance. The capacitor. Relationship between capacitance and electrical charge on a capacitor. Calculation of the electric capacitance for a plane, spherical and cylindrical capacitor. Capacitors in series and in parallel. Energy stored inside a parallel plate capacitor. Energy stored in the electric field: electric energy density. Definition of dielectric material and its characteristics. Capacitor with a dielectric. The Gauss law in the presence of a dielectric.
2	Electric current. Electric current density and drift velocity: the microscopic point of view. Resistivity and electrical resistance. Electrical conductivity: relationship between electric field and density of current. Calculation of resistance for a given resistivity. Temperature dependence of the resistance. Ohm law: phenomenological and microscopic point of view. Power in electric circuits.
2	Electromotive force. Second Kirchoff's law. Calculation of the electric current in a single mesh circuit by applying the principle of energy conservation (potential method). Other single mesh circuits. Resistors in series. Potential difference between two points of a circuit. Relationship between power, potential, and electromotive force in a circuit. Multi-mesh circuits. First Kirchoff's law. Resistors in parallel. RC circuits. Charge and discharge of a capacitor.
3	Natural magnetism and definition of magnetic field: Lorentz law. Magnetic field lines. Hall Effect. Charge in circular motion. Helicoidal trajectory of a charge: the cyclotron. Magnetic force acting on an electric wire. Torque on a coil traversed by electric current in the presence of magnetic field. Magnetic dipole moment.
2	Magnetic fields generated by current: Biot-Savart law. Force between two parallel conductors. Ampere law. Magnetic field generated by a long straight current-carrying wire. Magnetic fields generated by a solenoid and a toroid. Magnetic dipole generated by current-traversed coil.
2	Experiments on electromagnetic induction: Faraday law and Lenz law. Electromagnetic induction and energy balances. Flow of the magnetic field and inductance. Self-induction. RL circuits. Energy stored in a magnetic field. Mutual inductance.
3	Damped mechanical oscillator driven by a periodic force. LC circuit: analysis of the circuit and analogy with the mechanical oscillator. RLC circuit and damped oscillations: analogy with the mechanical case. RLC circuit in the presence of alternating current: driven oscillations and resonance.
2	Gauss law for magnetism. Displacement current and Maxwell induction law. Generalization of Ampère law: Ampère-Maxwell law. Spin and orbital magnetic dipole moment. Diamagnetism, paramagnetism, and ferromagnetism.
2	Maxwell equations. Light as a wave phenomenon. Electromagnetic waves and their equation obtained starting from Maxwell equations. Energy carried by an electromagnetic wave and Poynting vector.

Hrs	Practice
5	Exercises on Coulomb law and Gauss law: calculation of electric field and flow of electric field due to point charges and continuous charge distributions. Exercises on conductors: calculation of charge distribution, electric field and electric potential. Electric field generated by particular charge distributions (linear, homogeneous on a flat surface, homogeneous on a spherical surface, homogeneous and non-homogeneous within spherical volume, homogeneous on a cylindrical surface).
4	Exercises on capacitors: calculation of the charge on a capacitor, calculation of the electric field and potential difference between the plates of capacitors of different type (parallel, spherical, and cylindrical plates). Exercises on dielectrics: calculation of electric field and potential difference. Exercises on the variation of the capacitance in the presence of a dielectric. Calculation of electrostatic energy in a vacuum and in a dielectric.
4	Exercises on direct current circuits. Applications of Ohm's law and Kirchhoff's laws. Calculation of power in electrical circuits. Study of the RC circuit in various conditions.
4	Exercises on Biot-Savart law and Ampère law. Calculation of the magnetic field generated by currents in various conditions. Exercises on magnetic field and currents in solenoids and toroids. Exercises on magnetic dipoles (coils and multi-coil circuits traversed by current).
5	Exercises on Faraday's magnetic induction law: electric fields induced by changes in magnetic flux. Exercises on magnetic fields, multi-coil circuits and inductance. Exercises on RL circuit. Calculation of the energy stored in a magnetic field in various systems.
4	Exercises on LC circuits (oscillations) and RLC circuits (damped and driven oscillations). Calculation of power in alternating current circuits. Exercises on electromagnetic waves: calculation of electric field, magnetic field, wave amplitude and Poynting vector.