Course	**General Physics II**
Degree Level and Course:	Bachelor's Degree in Industrial Engineering (L-9)
Scientific-Disciplinary Sector (SSD)	FIS/01
Academic Year	2024-2025
Year of Course:	**2**
Total Credits	**6**
Prerequisites	**For the course "General Physics II,"** it is required to have passed the courses in Calculus I and General Physics I. However, it is strongly recommended that students have at least attended the courses in Calculus II and Geometry, as electromagnetism is the first example of field theory that students encounter, and fields are structures that exist in multiple dimensions. Without a solid understanding of Geometry and Calculus I & II, it is nearly impossible to deeply understand the behavior of electromagnetic fields.
Instructor	**Pietro Oliva** **Assistant: Dr. Cristina Martellini** *Platform Nickname*: *oliva.pietro.* *Platform Nickname*: *cristina.martellini* *Course of Study*: Ingegneria *E-mail: pietro.oliva@unicusano.it* (to be used only for internal communications, thesis, internships, and administrative matters). For questions about the program, use messages on the platform. Office Hours: Check the video conference calendar on the university website.
Knowledge Prerequisites	**Knowledge of the fundamentals of Mathematical Analysis I and II** and vector functions of multiple variables. Specifically, it is recommended to approach this exam only if you are proficient in: • Basic Trigonometry. • Equations and inequalities of first and second degree. • Exponentials and logarithms. • Real variable functions. Directional derivatives and integrals in multiple dimensions (circulations and fluxes). • Second-degree linear non-homogeneous differential equations with non-constant parameters. • Basics of General Physics: Kinematics, Dynamics, and Thermodynamics. • Matrix manipulation. Determinants and row-column products.
Learning Objectives	The typical goal of the General Physics II course is to teach the fundamentals of classical electromagnetism, which is a gauge (field) theory. The course focuses on propagation in a vacuum but also addresses propagation in isotropic and homogeneous media. By the end of the course, students will be able to apply the fundamental laws governing electromagnetic interactions and the electrical and magnetic properties of matter. *Knowledge and understanding* The course aims to introduce students to the field of electronics, describing the main methods of data acquisition and immediate analysis, as well as appropriate communication methods. • Understanding and technical terminology in the field of electromagnetism. • Knowledge of the basic principles of electromagnetism. • Understanding typical problems in electrostatics, magnetostatics, and induction phenomena through developed inductive and deductive reasoning skills. • Ability to model a natural phenomenon in terms of scalar and vector physical quantities, set up a problem using appropriate relationships between physical quantities, and solve it using analytical or numerical methods. • Ability to set up simple experimental configurations for didactic demonstrations. *Applying knowledge and understanding* Among the key skills that students should have acquired by the end of the course is proficiency in Maxwell's equations. Specifically, they should be able to: • Apply acquired knowledge to describe physical phenomena rigorously using the scientific method. • Develop theoretical models and design simple experiments in the field of electromagnetism. • Independently apply the principles and methods learned in laboratory activities, solving specific problems similar to those addressed during exercises and tutorials. *Communication skills* By the end of the course, students should possess a correct and understandable scientific language, integrating this knowledge with the equivalent terminology in English. For this purpose, relevant Anglo-Saxon terminology in the field of electromagnetism will be highlighted where possible. Students should be able to write and/or understand a brief exercise with its corresponding solution without ambiguity. *Learning skills* Students should be able to independently solve original electromagnetism problems, develop their own methods for solving standard exercises, and search for and find new problems by consulting external international sources.

Course Organization	Study Load: *Interactive Learning (IL) for students: 25 hours; 1 ECTS* *Lectures (Theory Teaching, LT): 105 hours (including 20 hours of exercises).* The recommended time for studying the entire course is 8-9 weeks. The course is delivered through pre-recorded audio-video lectures, along with slides and handouts, which form the study materials available on the platform. Self-assessment tests are also provided, in asynchronous format, to help students check both their understanding and the level of knowledge acquired in each lesson. Interactive teaching is carried out on the "virtual classroom" forum and includes two Etivity tasks that apply the knowledge acquired in the theory lessons to solve problems typical of the topics covered in the course, using circuits developed in Java by the students. In particular, the General Physics II course consists of 6 ECTS credits. The total study load for this module is about 150 hours, divided as follows: About 100 hours for viewing and studying the recorded material and applying the knowledge to exercises (approximately 23 hours of Theory videos and a minimum of 3 hours of exercises). About 50 hours of Interactive Teaching, which includes preparing and submitting 2 Etivity tasks, as well as any homework and self-assessment tests. It is recommended to distribute the study of the material evenly over a period of 8-9 weeks, dedicating approximately 20 hours per week (3-4 hours per day, excluding weekends). The course is developed through pre-recorded audio-video lectures, which, along with slides and handouts, form the study materials available on the platform. Solving exercises and self-assessment tests are provided asynchronously, accompanying the pre-recorded lessons and enabling students to assess both their comprehension and knowledge of each lesson's content. Additionally, scheduled web-conference lessons are available during the academic terms, along with previous exam papers, which help students become familiar with the written exam format. The teaching also makes use of forums (virtual classrooms) available on the platform, which serve as an asynchronous discussion space where the instructor identifies significant topics from each module and interacts with students, proposing exercises for them to complete.
Expected Learning Outcomes	At the end of the course, the student will have demonstrated the ability to: **[Knowledge and Understanding]** • Understand the terminology used in electrodynamics. • Knowledge of the fundamental laws governing electromagnetic fields. • Knowledge of the fundamental laws for the design of lumped-parameter circuits. **[Application of Knowledge]** • Identify specific solutions to an electromagnetism problem. • Understand the theories related to classical physics. • Extract a conceptual model from a real-world problem. **[Ability to Draw Conclusions]** • Solve analytical and numerical problems related to electromagnetism in a vacuum and in homogeneous, isotropic, and linear materials. **[Communication Skills]** • Develop correct, rigorous, and understandable scientific language that allows clear and complete presentation of the knowledge and techniques acquired during the course. **[Learning Skills]** • Apply acquired knowledge to solve original problems related to electromagnetism. • Know how to search for and find answers (or the right questions) in the literature for original problems that arise in a professional context.
Materials	While the course handouts provided by the instructor are sufficient, a fundamental and complex course like General Physics II should seriously consider purchasing essential textbooks, which should be part of the library of every engineer. Therefore, it is recommended to have at least one of the following texts, all of which are considered optimal for preparing for this exam: • David Halliday, Robert Resnick, Jearl Walker. Fundamentals of Physics – Mechanics, Waves, Thermodynamics, Electromagnetism, Optics. Eighth Italian Edition, Ambrosiana Publishing House, exclusive distribution by Zanichelli. • For foreign, ERASMUS, and English-speaking students: Halliday, Resnick – Fundamentals of Physics, 10th Edition.

Course Content	**First Part (Weeks 1 - 3; Modules 1-3; Self-Assessment Test)** Estimated time: 20 hours Review of basic Physics and Mathematics. Gradient, divergence, and curl. Introduction to Maxwell's Equations. **Second Part (Weeks 4 - 5; Modules 4-7; Self-Assessment Test)** Estimated time: 30 hours Electrostatics in a vacuum. Electric charge and Coulomb's law. Electric field. Gauss's Theorem. Electric potential. First Maxwell equation. Electric dipole. Systems of conductors and electrostatic fields. Electric capacitance. Capacitors. Electrostatic field energy. Electrostatic energy density. Steady-state electric current. Conductors. **Third Part (Weeks 6 - 8; Modules 8-10; Self-Assessment Test)** Estimated time: 25 hours Current density and continuity equation. Electrical resistance and Ohm's law. DC circuits. Circuits with almost steady current: charging RC circuit, discharging RC circuit, energy balance. Magnetic phenomena in a vacuum. **Fourth Part (Weeks 9 - 12; Modules 11-27; Self-Assessment Test)** Estimated time: 30 hours Lorentz force and magnetic induction vector B. Ampere's circuital theorem. Time-varying electric and magnetic fields: third and fourth Maxwell equations. Electromagnetic induction. Faraday-Neumann-Lenz law. Electromagnetic field energy density. Alternating currents. AC quantities. RLC circuit. Students who, following the recognition of a similar exam taken in a previous academic career, need to take a reduced exam (e.g., 3 CFU instead of 6) will be examined on topics from the First and/or Second and/or Third Part (depending on what has been recognized).
Teaching Organization	***Teaching and Learning Activities*** The course consists of both teaching activities and learning activities. The teaching activities include pre-recorded lectures and/or synchronous lessons via web conference. The learning activities include both independent study of the handouts and exercises provided by the instructor, as well as the study required to complete the self-assessment tests and E-tivity tasks. The exercises in the modules are essential for quickly verifying comprehension of the topic being studied. These exercises can be submitted to the instructor through the platform messaging system to ask for clarifications on topics that are not fully understood or to raise any doubts that arise during preparation. The E-tivities must be done independently and sent with clear and complete solutions to the instructor via private message on the platform. It is recommended to submit scanned PDF files. ***Study Schedule*** The course is organized to be completed in approximately two months, with a weekly commitment of at least 25 hours. However, if the proposed schedule is not followed, it is likely that two months will not be enough for adequate preparation. The course is designed for autonomous learning, which is also suitable for working students. It is recommended to plan the final exam no less than two months after starting the study. ***Virtual Classroom*** The course includes a virtual classroom. Communications with the instructor regarding course topics should occur in the virtual classroom forum. ***Study Load*** The total study load for the course is 220 hours, divided approximately as follows: • 25 hours to watch the recorded study material. • 175 hours for independent study. • Approximately 20 hours for E-tivity tasks.
Assessment Method	The exam typically consists of a written test aimed at assessing the ability to analyze and rework the concepts acquired. This test is composed of 3-5 exercises (each with a partial score indicated next to it on the exam paper) and lasts 90 minutes. The grade is given on a scale of 30. The minimum passing grade is 18/30. If the E-tivity tasks have been submitted, ticking the appropriate boxes at the bottom of the questions will result in a higher evaluation. Grade Composition: • Knowledge and Understanding: 80% from the written test; 20% from interactive activities (e.g., forum participation, e-tivity, etc.). • Applying Knowledge and Understanding: 80% from the written test; 20% from homework. • Communication Skills: 50% from interactive activities (e.g., forum participation, e-tivity, etc.); 50% from the written test. • Learning Skills: 40% from the written test; 60% from interactive activities (e.g., forum participation, e-tivity, etc.).
Criteria for the Final Thesis Assignment	The final thesis will be assigned based on an interview with the instructor, in which the student will express their specific interests related to a topic they wish to explore further. There are no restrictions on requesting a thesis assignment, and no specific average grade is required to make the request.
Reduced Program	Students who, following the recognition of a similar exam taken in a previous academic career, need to take the General Physics 2 exam, are invited to contact the instructor by sending the program of the exam already taken. In this way, the modules required for the reduced exam (< 9 CFU) can be determined.