UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

CONSIGLIO INTERCLASSE IN MATEMATICA

COURSE OF STUDY THREE-YEAR BACHELOR PROGRAMME IN MATHEMATICS

ACADEMIC YEAR 2024-2025

ACADEMIC SUBJECT PHYSICS 1

General information	
Programme year	First
Term	Second semester (February 24, 2025 – May 30, 2025)
European Credit Transfer and Accumulation System credits (ECTS)	9
SSD	FIS/01
Language	Italian
Mode of attendance	Not mandatory but strongly recommended

Lecturers		
Name and surname	Piergiorgio Fusco (instructor of record)	Domenico Colella
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Telephone	+39 080 544 3174	+39 080 544 2344
Department and office	Department of Physics mezzanine, room R77	Department of Physics mezzanine, room R38
Virtual meeting room	Microsoft Teams, code cnrvmay	
Web page	https://www.ba.infn.it/~fusco/f1mat.html	
Office hours	Tuesday 17:00-19:00, Thursday 11:00-13:00, or by appointment	Monday 14:00-16:00

Work schedule	Total	Lectures	Hands-on learning (recitations/laboratories)	Self-study
Hours	225	48	24	153
ECTS credits	9	6	3	

Learning objectives	
	Knowledge of the main topics of Mechanics, Fluid Dynamics, Thermodynamics and Gravitation. Consolidation of a logical and scientific way of thinking. Ability to solve problems with a rational and scientific approach.

Course prerequisites	
	Very good knowledge of high school Algebra and Geometry. Knowledge of the fundamentals of Trigonometry. Knowledge of the basics of Mathematical Analysis is helpful.

Syllabus	
Course contents	**Vector calculus** Scalar and vector quantities. Product of a scalar times a vector. Vector addition and subtraction. Cartesian components of vectors. Unit vectors. Scalar product. Vector product. Derivative of a vector and of a unit vector.

	Intrinsic derivative of a vector. **Physics and the experimental method** Measurement of physical quantities. Units of measure. Measurement errors and an overview of their treatment. Representation of physical quantities, scientific notation, dimensional analysis. **Particle kinematics** Reference frames. Position, displacement, velocity, acceleration. Uniform linear motion and uniformly accelerated motion. Velocity and acceleration with respect to position. Free fall motion. Simple harmonic motion. Motion in the plane. Polar components. Acceleration in plane motion. Uniform and uniformly accelerated circular motion. Angular velocity and angular acceleration. Centripetal and tangential acceleration. Vector notation in circular motion. Rotation of a unit vector. Projectile motion in two dimension. **Kinematics of relative motion** Theorem of relative velocities. Theorem of relative accelerations. Examples. **Particle Dynamics** Newton's First Law. Forces. Acceleration and mass. Newton's Second Law. Newton's Third Law. Weight, tension, contact forces, static friction, kinetic friction, elastic force, drag force. Linear momentum. Theorem of linear momentum. Centripetal force. Pendulum. Angular momentum of a particle. Torque. Angular momentum theorem. Conservation of angular momentum. **Dynamics of relative motion** Inertial and non-inertial reference frames. Straight relative motion. Rotational relative motion. Motion relative to the Earth. **Work and energy** Work. Power. Kinetic energy. Work-energy theorem. Conservative forces. Potential energy. Work and potential energy of weight force and of an elastic force. Mechanical energy and its conservation. Kinetic friction. Work of non-conservative forces. Conservation of energy. Energy of a pendulum. **Dynamics of systems of particles** Systems of particles. Internal and external forces. Center of mass: position, velocity, acceleration and Newton's Second Law. Conservation of linear momentum. Angular momentum for systems of particles. Conservation of angular momentum. Center-of-mass reference frame. Momentum in the center-of-mass frame. König's theorem for angular momentum. König's theorem for kinetic energy. Energy and work for a system of particles. **Dynamics of rigid bodies** Rigid bodies. Density. Center of mass of a body. Motions of a body. Degrees of freedom. Linear motion of a body. Rotation of a body about a fixed axis. Angular momentum of a body. Newton's Second Law in angular form. Kinetic energy in rotation. Precession of angular momentum. Rotation of the rotation axis. Axes of inertia. Rotational inertia. Huygens-Steiner's theorem. Compound pendulum. Rolling motion. Instantaneous axis of rotation. Conservation of energy in rolling motion. Angular momentum and linear

	momentum. Conservation laws for rigid bodies. Conservation of angular momentum. Statics and equilibrium. **Collisions** Collision between two particles. Laboratory frame and center-of-mass frame. Momentum and kinetic energy in collisions. Inelastic and elastic collisions. Collisions between a particle and a rigid body, or between rigid bodies. **Fluids** Force and pressure in fluids. Measurement of pressure. Work in fluids. Static equilibrium and weight. Stevin's Law. Equilibrium in fluids. Archimedes' Principle. Internal friction and viscosity. Motion of an ideal fluid. Steady flow. Flow rate. Equation of continuity. Bernoulli's theorem. Laminar flow. Turbulent flow. Fluid resistance. **The First Law of Thermodynamics** Thermodynamic systems. Thermodynamic and thermal equilibrium. Thermometric characteristics. Empirical measurement of temperature. Thermometric scales. Joule's experiments. Work and energy of a thermodynamic system. Heat and work. The First Law of Thermodynamics. Thermodynamic processes. Reversible and irreversible processes. Calorimetry. Mole. Molar specific heat. State changes. Heat of transformation. Heat sources. Heat conduction. Heat convection. Thermal radiation. Thermal expansion. **Ideal gases** Boyle's isothermal law. Volta–Gay-Lussac's isobaric and isochoric laws. Avogadro's Law. Equation of state for ideal gases. Constant volume gas thermometer. Transformations of a gas and work. Specific heat at constant volume and constant pressure. Joule's free expansion. Internal energy of a gas. Mayer's formula. Specific heat of ideal gases. Adiabatic, isothermal, isochoric, isobaric, generic, cyclic processes. Efficiency of a heat engine. Carnot's cycle. Refrigerating cycles. **The Second Law of Thermodynamics** Kelvin-Planck's and Clausius' statements of the Second Law of Thermodynamics. Carnot's theorem. Carnot's engine. Efficiency of heat engines. Absolute thermodynamic temperature. Clausius' Theorem. Entropy. Entropy increase. Entropy of the universe. Variation of entropy in adiabatic processes, in heat exchanges, in phase changes, in ideal gases processes. Third Law of Thermodynamics. Entropy and statistics. Macrostates, microstates, thermodynamic probabilities. Boltzmann's equation. Entropy and disorder. **Gravitation** Central force. Angular momentum. Areal velocity. Kepler's Laws. Newton's Law of Gravitation. Gravitational field and potential energy.
Reference books	Textbook: Mazzoldi, Nigro, Voci, "Elementi di Fisica Vol. I – Meccanica e Termodinamica", Edises Supplementary textbook: Halliday, Resnick, Walker, "Fundamentals of Physics Extended", Wiley & Sons
Additional course materials	Prof. Fusco provides detailed handouts on all course topics (approximately 750 pages) available on his web pages.

Repository	

Expected learning outcomes	
Knowledge and understanding	Knowledge and understanding of the main topics of Mechanics, Fluid Dynamics, Thermodynamics and Gravitation. Consolidation of a logical and scientific way of thinking.
Applying knowledge and understanding	Ability to apply the knowledge of Physics to understanding, analyze and solve problems and phenomena, both in physics and in general scientific and technological contexts.
Soft skills	*Making judgements*: Ability to organize knowledge and interpret data in order to deal with scientific and technological problems and situations in a rational and effective manner.
	Communication skills: Ability to discuss and present scientific and technological subjects in a professional manner, with particular reference to physical sciences.
	Learning skills: Capacity to delve into further studies in Physics and, in general, in scientific and technological fields.

Teaching methods	
	Face-to-face lectures will explain all the topics of the course and consolidate their knowledge, also through active student participation. Exercises will be done in order to develop and improve the students' ability to solve problems with a rational and scientific approach.

Assessment	
Assessment methods	Written test, lasting two and a half hours, consisting of problems and questions on the topics covered in the syllabus, to assess the ability to understand the questions, to correctly set solutions using the physical laws and procedures taught, and to obtain the exact results. The grades are published on the professor's web pages. If the written exam is passed, students proceed to the oral examination, which assesses the knowledge of the syllabus topics and the ability to reason about physical laws and phenomena.
Evaluation criteria	• *Knowledge and understanding*: The level of knowledge and understanding of the physical laws and phenomena is evaluated. • *Applying knowledge and understanding*: The ability to apply physical laws and procedures to interpret phenomena and solve problems is assessed. • *Making judgement*: The autonomy in analyzing the physical phenomena and laws presented in the course is evaluated. • *Communication skills*: The ability to professionally discuss and present scientific and technological topics and issues, with particular reference to physical sciences, is assessed. • *Learning skills*: The ability to interpret and learn scientific and technological themes and topics is assessed.
Grading policy	The written exam consists of problems and questions on the topics covered in the syllabus, graded out of thirty; the test is considered passed and the student can proceed to the oral exam if they achieve an overall score of at least 15/30, with at least 7/30 on Mechanics topics and 7/30 on Thermodynamics topics. The ability to understand the questions, to reason, to apply the learned knowledge and to correctly set up solutions is evaluated. Obtaining exact numerical results is appreciated but not decisive for the evaluation.

	The oral exam assesses the understanding, knowledge, and ability to discuss the topics covered in the course program. Proficiency in the subjects and the ability for independent reasoning are particularly significant. The final grade is based on a reasoned evaluation of performance in both exams. The exam is considered passed with an overall evaluation of at least 18/30. In case of an excellent written exam and a particularly brilliant oral examination in terms of clarity and completeness, honors (lode) can be awarded.

Further information	