UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

CONSIGLIO INTERCLASSE IN MATEMATICA

General information	**Academic year 2022-2023**
Academic subject	**Physics 1**
Degree programme	Mathematics (L-35)
Programme year	First
Term	Second semester (February 27, 2023 – May 26, 2023)
European Credit Transfer and Accumulation System credits (ECTS)	9
Language	Italian
Attendance	Not compulsory, but strongly recommended

Lecturers		
Name and surname	Piergiorgio Fusco (instructor of record)	Leonardo Di Venere (exercises)
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Department and office	Department of Physics, ground floor, room R77	Department of Physics, ground floor, room R78a
Virtual meeting room	Microsoft Teams, code cnrvmay	Microsoft Teams
Web page	https://www.ba.infn.it/~fusco/f1mat.html	
Office hours	Face-to-face: Tuesday 17-19, Thursday 11-13, other days by appointment Online: Microsoft Teams, code 00zkcpr	Friday 15-17, face-to-face or online on demand

Syllabus	
Learning objectives	Knowledge of the main subjects of Mechanics, Fluid Dynamics, Thermodynamics and Gravitation. Consolidation of a logical and scientific mentality. Ability to solve problems with a rational and scientific approach.
Course prerequisites	Very good knowledge of high school algebra and geometry. Knowledge of the basics of Trigonometry. Knowledge of the basics of Mathematical Analysis is recommended.
Course contents	Vector operations Scalars and vectors. Product of a scalar times a vector. Sum and difference of vectors. 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. The units of measurement. Measurement errors. Representation of physical quantities, scientific notation, dimensional analysis. Particle kinematics Reference system. Position, displacement, velocity, acceleration. Motion along a straight line. Free fall motion. Simple harmonic motion. Motion in a plane. Polar components. Acceleration in the motion in a plane. Circular motion. Angular velocity and angular acceleration. Centripetal and tangential acceleration. Vector notation in circular motion. Rotation of a unit vector. Projectile motion. Kinematics of relative motion

	Theorem of relative velocities. Theorem of relative accelerations. Special cases. Particle Dynamics Newton's First Law. Forces. Acceleration and mass. Newton's Second Law. Newton's Third Law. Weight, tension, contact forces, friction, elastic force. Drag force and terminal speed. Linear momentum. Theorem of linear momentum. Centripetal force. Pendulum. Angular momentum of a particle. Torque. Theorem of angular momentum. Conservation of angular momentum. Dynamics of relative motion Inertial and non-inertial reference systems. Straight relative motion. Rotational relative motion. Motion with respect to Earth. Work and energy Work. Power. Kinetic energy. Work-energy theorem. Conservative forces. Potential energy. Work and potential energy of weight and of an elastic force. Mechanical energy and its conservation. Dynamic friction. Work of non-conservative forces. Conservation of energy. Study of the 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 moment for systems of particles. Conservation of the angular momentum. Center-of-mass reference system. Momentum in the center-of-mass system. König's theorem for the angular momentum. König's theorem for the 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 of rotation. Precession of angular momentum. Rotation of the rotation axis. Axes of inertia. Rotational inertia. Huygens-Steiner's theorem. Complex 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 the angular momentum. Statics and equilibrium. Collisions Collision between two particles. Laboratory system and center-of-mass system. 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. Measuring 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 experiment. Work and energy of a thermodynamic system. Heat and work. The First Law of Thermodynamics. Thermodynamic transformations. Reversible and irreversible transformations. Calorimetry. Mole. Specific molar heat. Phase changes. Latent heat. Heat sources. Heat conduction. Convection of heat. Irradiation. Thermal expansion. Ideal gases Boyle's isothermal law. Volta–Gay-Lussac's isobaric and isochoric laws. Avogadro's Law. Ideal gas law. 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 transformations. Efficiency of a thermal machine. 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 machine. Efficiency of thermal machines. Absolute thermodynamic temperature. Clausius' Theorem. Entropy. Entropy increase. Entropy of the universe. Entropy variation computation in various processes. Third Principle of Thermodynamics. Entropy and statistics. Macrostates, microstates, thermodynamic probabilities. Boltzmann's equation. Entropy and disorder. Gravitation Central force. Angular momentum. 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	Lecture slides provided by prof. Fusco.

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

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

Expected learning outcomes	
Knowledge and understanding	Knowledge and understanding of the main topics of Mechanics, Fluid Dynamics, Thermodynamics and Gravitation.

	Consolidation of a logical-scientific mentality.
Applying knowledge and understanding	Ability to apply knowledge of Physics to the understanding, analysis and resolution of physical and, in general, scientific and technological problems and phenomena.
Making judgements	Ability to organize knowledge and interpret data situations, in a rational and effective way, in order to deal with scientific and technological problems and situations.
Communication skills	Ability to discuss and present scientific and technological subjects in a professional manner, with particular reference to the physical sciences.
Learning skills	Ability to further learn physical, scientific and technological subjects in subsequent studies.

Assessment and feedback	
Assessment methods	Written test, lasting two and a half hours, consisting of problems of Mechanics and Thermodynamics, to check the ability to understand the questions, to correctly set the resolutions using the physical laws and procedures taught, and to obtain the exact results. The grades are published on the teacher's web pages. If the written test is passed, an oral exam verifies the knowledge of the subjects and the ability to deal with laws and physical 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 judgements*: The autonomy in analyzing the physical phenomena and laws presented in the course is evaluated. • *Communication skills*: The ability to both understand and expose the physical phenomena and laws presented in the course is assessed. • *Learning skills*: The ability to interpret and learn scientific and technological themes and topics is assessed.
Grading policy	The written test consists of problems of Mechanics and Thermodynamics whose scores are added up so that the maximum total mark is 30/30; the test is passed when a mark of at least 15/30 is obtained, with at least 7/30 in Mechanics and 7/30 in Thermodynamics. The ability to understand the questions, to reason, to use the knowledge learned and to correctly set the resolutions is evaluated. Obtaining the exact numerical results is appreciated but not decisive for the evaluation. The oral test consists of an exam in which the understanding, the knowledge and the ability to discuss the subjects of the course are assessed. Particularly significant are the mastery of the topics and the ability to reason independently. The final grade is based on an evaluation of the performance in the two tests. In case of an excellent written test and an oral test brilliant for clarity and completeness, honors can be attributed.

Additional information	