Academic subject: General Physics 1

Degree Class: L- 35 – Scienze Matematiche		**Degree Course:** Mathematics	**Academic Year:** 2017/2018
		Kind of class: Mandatory	**Year:** 1 / **Period:** 2
			ECTS: 9 divided into **ECTS lessons:** 6 **ECTS exe/lab/tutor:** 3

Time management, hours, in–class study hours, out–of–class study hours
lesson: 48 exe/lab/tutor: 24 in–class study: 72 out–of–class study: 153

Language: Italian	**Compulsory Attendance:** no		
Subject Teacher: Piergiorgio Fusco	**Tel:** +39 080 544 3174 **e–mail:** piergiorgio.fusco@uniba.it	**Office:** Department of Physics Room R77, Ground floor	**Office days and hours:** Tuesday 17-19, Thursday 11-13, or by appointment

Prerequisites:
Good knowledge of high school Mathematics.

Educational objectives:
Knowledge of the main subjects of Mechanics and Thermodynamics. Ability to solve problems with a rational and scientific approach.

Expected learning outcomes (according to Dublin Descriptors)

Knowledge and understanding:
Knowledge and understanding of the main subjects of Mechanics and Thermodynamics. Consolidation of a logical-scientific mentality.

Applying knowledge and understanding:
Ability to apply knowledge of Physics to understanding, analysing and resolving problems and phenomena of Mechanics and Thermodynamics and, in general, of a scientific and technological nature.

Making judgements:
Ability to organize knowledge and data to cope with scientific and technological problems and situations in a rational and effective way.

Communication:
Ability to professionally discuss and present scientific and technological subjects, with particular reference to physical sciences.

Lifelong learning skills:
Ability to deal with subjects of Physics and, in general, of a scientific and technological nature.

Course program

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. Units of measure. 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 and kinetic energy. 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.

Teaching methods:
Lectures and exercises supported by on-screen dynamic presentations and examples on the blackboard.

Auxiliary teaching:
Didactic handouts provided by the teacher.

Assessment methods:
Written test with Mechanics and Thermodynamics problems, followed by oral exam on subjects of this program.

Bibliography:
Textbook: Mazzoldi, Nigro, Voci, "Elementi di Fisica Vol. I – Meccanica e Termodinamica", Edises
Supplementary textbook: Halliday, Resnick, Walker, "Fundamentals of Physics Extended", Wiley & Sons