# . – General Physics I

## Prof.ssa. Stefania Pagliara

***COURSE AIMS AND INTENDED LEARNING OUTCOMES***

The course covers the basic principles and a number of relevant applications of classical Newtonian mechanics, with respect to particles and particle systems, and thermology and thermodynamics.

At the end of the course, students will be able to:

- confront and solve physics problems on mechanics and thermodynamics;

- apply the topics covered in the course in an accurate and critical way;

- discuss, using appropriate terminology, concrete and every-day cases involving the basic course principles.

***COURSE CONTENT***

Mechanics of the particle method

Scalar and vector quantities. Sum and difference of vectors. Resolving vectors. Dot product and cross product. Derivative of a vector. Vector integration.

Kinematics of a point: Definition of trajectory. Definition of velocity. Definition of acceleration. Uniform motion. Uniformly accelerated motion. Circular motion. Parabolic motion. Simple harmonic motion. Motion in space.

Point dynamics: Principle of inertia and inertial frames of reference. Newton's laws. Momentum and impulse. Resultant force and balance.

Reaction forces. Classification of forces. Dynamic action of forces. Weight force. Dynamic friction. Elastic force. Force of friction. Simple pendulum.

Job. Power. Kinetic energy. Work of weight force. Work of a spring force. Work of a force of dynamic friction. Conservative forces. Potential energy. Conservation of mechanical energy. Angular momentum. Moment of force.

Relative motions: Reference systems. Speed ​​and relative accelerations. Galilean relativity. Dragging straight translational motion. Dragging uniform circular motion.

Oscillations: Properties of the differential equations of the harmonic oscillator. Energy of the harmonic oscillator. Sum of harmonic motion.

Gravitation: Central forces. Gravitational force. Inertial mass and gravitational mass. Gravitational field. Gravitational potential energy.

Dynamics of particle systems

Dynamics of particle systems. Definition of centre of mass. Theorem of the motion of the centre of mass. Conservation of momentum. Theorem of angular momentum. Conservation of angular moments.

Centre of mass reference system. König theorems.

Kinetic energy theorem.

Impulsive phenomena. Elastic and inelastic collisions. Integral observer with the laboratory and supportive observer with the centre of mass. Collisions classification. Explosions.

The two-body problem and reduced mass.

Rigid body and its properties. Translational-rotational motion of a rigid body.

Huygens-Steiner parallel axis theorem. Static equilibrium of a rigid body.

True rolling motion. Compound pendulum. Gyroscope and processing.

Collision between a particle and a rigid body.

Thermology and thermodynamics

Thermodynamic states and systems. Thermodynamic equilibrium. Principle of thermal equilibrium. Temperature and thermal expansion. Laws of the expansion of bodies. Thermometric characteristics, fixed points and temperature scales.

Adiabatic systems. Joule's experiments. Heat. First law of thermodynamics. Internal energy.

Thermodynamic processes. Heat and work. Calorimetry. Heat capacity and specific heat. Isothermal processes. Phase changes. Heat transfer. Thermal expansion of solids and liquids.

Ideal gas and real gas at equilibrium. Boyle and Gay-Lussac laws. Ideal gas law.

Real gases and their behaviour. Van der Waals equation.

Kinetic theory of gases. Molecular bases of pressure. Joule-Clausius equation. Boltzmann constant. Internal energy. Molecular velocity and mean free path. Maxwell-Boltzmann distribution.

Second law of thermodynamics. Reversibility and irreversibility. Kelvin and Clausius statement and equivalence. Carnot engine. Carnot's theorem. Absolute thermodynamic temperature.

Cyclic transformations of a thermodynamic system. Thermal machines and refrigeration equipment. Thermodynamic cycles.

The entropy function of state. Clausius theorem. Entropy of systems, the environment, and the universe. Principle of increase of entropy. Entropy of an ideal gas. Unusable energy. Microscopic interpretation of entropy.

***READING LIST***

P. Mazzoldi - M. Nigro - C. Voci, *Elementi di Fisica,* EdiSES, Naples.

J.M. Knudsen - P.G. Hjorth, *Elements of Newtonian mechanics,* Springer, Berlin.

D. Sette - A. Alippi, *Lezioni di Fisica – Meccanica e Termodinamica,* Masson, Milan.

C. Mencuccini - V. Silvestrini, *Meccanica e Termodinamica,* Liguori.

R.P. Feynman - R.B. Leyghton - M. Sands, *La Fisica di Feynman,* vol.1 Zanichelli, Bologna.

E. Fermi, *Termodinamica,* Ed. Boringhieri.

M.W. Zemansky, *Calore e Termodinamica,* vol.1, Zanichelli, Bologna.

***TEACHING METHOD***

The course will be taught through 40 hours of lectures and 40 hours of assignments, inclusive of the solving of problems and discussion of examples and practical cases. The lectures will be conducted by the course professor.

***ASSESSMENT METHOD AND CRITERIA***

Students will be assessed through an interview in which the professor will evaluate:

* the extent to which the course concepts have been acquired;
* the reasoning/analytical capacity developed;
* command of terminology and communications skills.

The interview will be preceded by a written test consisting of three exercises: one about a particle, one about particle systems, and one about thermodynamics.

Students must pass the written text before going through an interview.

***NOTES AND PREREQUISITES***

There are no prerequisites for attending the course.

*Further information can be found on the lecturer's webpage at http://docenti.unicatt.it/web/searchByName.do?language=ENG or on the Faculty notice board.*