



---

## FISICA I

FIS/01 - 9 CFU - 2° Semester

### Teaching Staff

#### STEFANO ROMANO

**Email:** romano@lns.infn.it

**Office:** Laboratori Nazionali del Sud

**Phone:** +39 095 542 380

**Office Hours:** Lunedì 11:00-13:00; Mercoledì 8:30-10:30; Giovedì 8:00-10:00 - (si consiglia comunque di contattare il docente in anticipo per verificare che impegni istituzionali o personali non lo costringano a spostare il ricevimento di un giorno specifico.)

---

### LEARNING OBJECTIVES

The course has the following purposes: 1) provide knowledge on the fundamental physical laws of mechanics and thermodynamics; 2) provide the tools necessary for the applications of physical laws in problems of dynamics of material systems.

### COURSE STRUCTURE

The course consists of lectures and exercises/applications with the involvement of the students.

---

### DETAILED COURSE CONTENT

1. INTRODUCTION Phenomena - Physical magnitude - Unit of measurement - Dimensional equation - errors - Approximation - Scientific notation. 2. VECTORS General - Representation of physical quantities by means of vectors - vector calculation: sum, difference, product of a vector for a scalar, scalar product, vector product - Commutative property - Associative property - Components of a vector - Derivative of a vector - Integration. 3. KINEMATICS Speed - Acceleration - rectilinear motions - kinematics in the plane - Parabolic motion - Uniform circular motion. 4. DYNAMICS OF THE MATERIAL POINT Inertial principle - Inertial mass - Strength: 2nd Newton's law - Principle of action and reaction - Inertial reference systems - Galilean invariance principle - Galileo transformation - Speed composition law - Forces: gravitational force, weight force, friction force, elastic force, viscous force of resistance of the medium - Circular motions: Centripetal forces - Inertial reference systems: fictitious forces - Momentum . Impulse - Angular momentum. Mechanical moment. 5. CONSERVATION OF ENERGY Work - Kinetic energy - Kinetic energy theorem - Conservative forces - Potential energy - Calculation of potential energy - Potential energy and strength: energy diagrams and equilibrium stability - Central forces - Conservation of mechanical energy - Forces non-conservative. 6. OSCILLATIONS Simple harmonic oscillator: motion equation and solution -

kinetic energy and potential in simple harmonic motions - examples. 7. DYNAMICS OF MATERIAL POINT SYSTEMS Point systems. Internal forces and external forces - Center of mass - Angular momentum - Mechanical momentum - Theorem of the moment angular - Conservation of angular momentum. DYNAMICS OF THE RIGID BODY Rigid body - Motion of a rigid body - Equation of the motion of a rotating body - Rigid rotations around a fixed axis in an inertial reference system - Moment of inertia with respect to a fixed axis - Theorem of Huygens-Steiner - energy in the rotary motion - examples. 8. GRAVITATION Central forces - gravitational force - inertial mass and gravitational mass - gravitational field - gravitational potential energy. 9. MECHANICS OF FLUIDS States of aggregation of matter - Definition of fluid - Gases and liquids - Ideal fluids and real fluids - Density - Pressure - Statics of fluids - Pascal's principle - Stevino's law - Archimedes law - Torricelli's experience - Manometers and Barometers - Dynamics of fluids - Flow rate - Continuity equation - Bernoulli's theorem. 10. THERMOMETRY AND CALORIMETRY Thermal equilibrium - Temperature concept - Temperature measurement - Kelvin temperature - Heat calorimetric definition - Thermal capacity - Specific heat and latent heat - Calories - Heat sources - Mechanical heat equivalent. 11. THERMODYNAMIC SYSTEMS Thermodynamic systems and states - Macroscopic point of view - Thermodynamic coordinates - Thermodynamic equilibrium - Simple thermodynamic systems - PVT systems - State equation - Perfect gas status equation - Thermodynamic transformations - Quasistatic transformation - Reversible and irreversible transformations. 12. HEAT, WORK AND THE FIRST PRINCIPLE OF THERMODYNAMICS Work in a transformation of a PVT system - Adiabatic work - Internal energy - Definition of heat thermodynamics - First principle of thermodynamics - Differential form of the first principle of thermodynamics - Internal energy of an ideal gas: Joule experiment - Specific heat of ideal gases: Mayer report. 13. SECOND PRINCIPLE OF THERMODYNAMICS Conversion of work into heat and vice versa - Thermal machines - Otto cycle - Diesel cycle - Statement by Kelvin Planks of the second principle of thermodynamics - Refrigeration machines - Clausius statement of the second law of thermodynamics - Equivalence of the two statements Cycle of Carnot - Carnot Theorem - Carnot Machine - Absolute thermodynamic temperature. 14. ENTROPY Clausius's theorem - Entropy - Entropy and reversibility - Entropy and irreversibility - The principle of increasing entropy - Calculations of variation of entropy - Entropy of an ideal gas - Entropy and unusable energy.

---

## TEXTBOOK INFORMATION

1. MAZZOLDI, NIGRO, VOCI - Elementi di Fisica: Meccanica, Termodinamica (EdiSES)
  2. Mencuccini, Silvestrini - Fisica I (Liguori Editore)
-