FISICA I M - Z

FIS/01 - 6 CFU - 2° Semester

Teaching Staff

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LEARNING OBJECTIVES

The learning objective of the course is to provide a complete knowledge of classical mechanics via the following learning achievements:

- Knowledge of the fundamental laws of classical mechanics in kinematics, Newton’s laws and the conservation principles.
- Knowledge of the dynamics of rigid bodies, oscillators, and fluid mechanics.
- Solution to problems in Physics related to the topics treated during the course.

In particular, the course aims at developing the following skills:

- **Knowledge and understanding:** to build the fundamental knowledge of mechanics and thermodynamics, and the understanding of their mathematical description.
- **Applying knowledge and understanding:** To develop and/or improve the ability to identify the key laws in Physics describing phenomena in mechanics or thermodynamics; to correctly apply such laws to solve problems in Physics by appropriate analytical and numerical skills.
- **Making judgments:** to provide skills for the estimation of the correct order of magnitude of variables in mechanics and thermodynamics.
- **Communication skills:** to develop and improve presentation skills and learn the language of science.
- **Learning skills:** to apply mathematical tools and theoretical models to problems in Physics.

COURSE STRUCTURE

The course is worth 6 CFU and will be structured in front lectures (5 CFU) and example classes (1 CFU).

Attendance is mandatory and strongly recommended in order to familiarize with the content of the course.

DETAILED COURSE CONTENT

Physical quantities and units of measurement. The scientific method. Physical quantities and units of measure. The International System (SI). Scientific notation. Dimensional issues. Fundamental quantities and derived quantities. Measurement errors and approximations. Significant figures. Function approximations.

Scalars and vectors. Scalar and vector quantities. Invariance and symmetry. Vector algebra. Vector analysis: derivatives and integrals of vectors.

Kinematics. Speed, acceleration and hourly law of motion. Smooth and uniformly accelerated rectilinear motion. Vertical motion. Simple harmonic motion. Rectilinear motion damped exponentially. Plane motion: speed and acceleration. Circular motion. Parabolic motion. Motions in space.

Physical quantities and measure units. The scientific method. Physical quantities and measure units. The International System of Units (SIU). Scientific notation. Dimensionality. Fundamental quantities and derived quantities. Measurement of errors and approximations. Significant figures. Approximation of mathematical functions.

Vector calculus. Scalar quantities and vectors. Invariance and symmetry of systems. Vector calculus: algebra, derivatives and integrals with vectors.

Kinematics. Equations of motion. Linear motion and uniformly accelerated linear motion. Vertical motion. Harmonic oscillator. Damped linear motion. Motion in a plane: velocity and acceleration. Circular and parabolic motion. Motion in the space.

Dynamics of point particles. Newton’s laws. Impulse (step) and momentum. Sum and equilibrium of forces. Examples: weight, friction, viscosity, centripetal force, elastic force and Hook’s law. Inclined plane. Pendulum. Tension. Frames of reference. Relative velocity and acceleration. Inertial frames of reference. Galilean invariance.

Work and energy. Work, power and kinetic energy. Theorem of kinetic energy and examples. Conservative forces and potential energy. Non-conservative forces. Conservation of energy. Force vs potential energy. Angular momentum. Central forces.

Systems of point particles. Systems of n point particles. Internal and external forces. Centre of mass. Conservation of momentum. Conservation of angular momentum. König’s theorem. Kinetic energy theorem.

Rigid body dynamics. Properties of a rigid body. Motion of a rigid body. Continuous distribution of mass, density and position of the body mass. Rigid rotations in three dimensions in an inertial frame of reference. Energy and virtual work of forces. Inertia. Huygens-Steiner’s theorem. Pendulum. Pure rolling. Conservation of energy in the motion of a rigid body. Rolling resistance.

Oscillators and waves. Differential equation of a harmonic oscillator. Equation of motion and solution for simple harmonic oscillator. Mass-spring system: a simple harmonic oscillator. Energy of a simple harmonic oscillator. Sum of harmonic oscillators in one and two dimensions. Damped and driven

harmonic oscillators. Resonance.

Fluid mechanics. Fluids. Pressure. Static equilibrium. Archimede's principle. Internal friction and ideal fluid's viscosity. Fluid flow: steady and unsteady flow. Flow rate. Bernoulli's theorem. Torricelli's theorem. Pascal's principle. Laminar vs turbulent flow.

Gravity. Central forces. Kepler's laws. Newton's law of universal gravitation. Inertia vs gravitational mass. Gravitational fields and gravitational potential energy.

TEXTBOOK INFORMATION

1. R. Davidson *"Metodi matematici per un corso introduttivo di Fisica"* casa editrice EdiSES;
2. **R. Serwey, J. Jewett: *Fisica per Scienze ed Ingegneria*, Vol.I, V Edizione,casa editrice EdiSES;**
3. **P.Mazzoldi, M. Nigro, C. Voci: "*Elementi di Fisica" Meccanica e Termodinamica*, II edizione, casa editrice EdiSES;**
4. Focardi S., Massa I., Uguzzoni A., Villa M. - *Fisica generale - MECCANICA E TERMODINAMICA*, Casa editrice Ambrosiana;
5. Halliday, Resnick, Krane, *Fisica 1*, Casa editrice Ambrosiana

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