UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Physics I

2526-1-E3502Q006

Aims

1. Knowledge and Understanding
By the end of the course, students will acquire:
• In-depth knowledge of the fundamental concepts of classical mechanics (particles, systems of particles, rigid bodies), classical thermodynamics, gravitation, fluid dynamics, mechanical waves, and special relativity.
• An understanding of physical laws and conservation principles underlying observable phenomena.
• Familiarity with mathematical and geometric tools for describing motion, with the use of vector formalism and reference frame transformations.
2. Applied Knowledge and Understanding
Students will develop the ability to:
• Set up and solve physics problems in mechanics and thermodynamics using appropriate mathematical tools, identifying the relevant physics laws.
• Develop simplified models to describe complex physical phenomena, assessing the validity of the approximations used.
• Tackle elementary relativity problems (application of Lorentz transformations, particle collisions, space-time diagrams).
3. Independent Judgment
Students will be able to:
• Correctly interpret theoretical predictions and evaluate numerical results obtained when solving problems.
4. Communication Skills
Students will be able to:
• Clearly and accurately explain the concepts covered in the course, using proper scientific and mathematical language.
• Present and discuss the solutions to exercises in a clear, organized, and rigorous manner, both in written and oral form.
5. Learning Skills
The course will provide:
• Methodological skills to approach the study of subjects in subsequent years.
• The ability to consult specialized texts in order to independently deepen their understanding of the concepts

presented during lectures.

Contents

Kinematics and dynamics of a massive point, N points, a rigid body.

Conservation of mechanical energy, conservation of momentum and angular momentum.

Gravitation.

Harmonic oscillator, resonance, waves in elastic media.

Principles of thermodynamics, kinetic theory of ideal gas, temperature, internal energy, entropy.

Lorentz transformations for time and space, energy and momentum.

Detailed program

Operational definition of physical quantities. Units of measurement.

Properties of vectors and operations.

Equation of motion, position, velocity and acceleration for a point. Straight line motion, circular motion, parabolic motion and harmonic motion. Polar coordinates and intrinsic coordinates, Galilean Relativity, inertial reference systems, rotating reference systems.

Newton's Principia, real and inertial forces, elastic force, weight, friction forces, examples of simple dynamical systems, torque of a force and momentum, angular momentum.

Work, kinetic energy-work theorem, conservative forces, potential energy and conservation of mechanical energy.

Center of mass and its properties, Koenig's theorems, impulse theorem, elastic and inelastic collisions in the laboratory and in the system of the center of mass, variable mass systems.

Rigid body, rotation around a fixed axis, moment of inertia, rolling motion, impacts between rigid bodies, static of rigid body.

Simple pendulum, physical pendulum, torsion pendulum, spinning and precession.

Free, damped and forced harmonic oscillator. Resonance.

Kepler's laws and universal gravitation, stable orbits, two-body problem, escape velocity, connection between energy and orbit.

Propagating phenomena, wave equation, vibrating strings, pressure waves, propagation velocity.

Thermodynamic equilibrium, thermometry, quasi-static transformations, reversibility, heat exchanges, specific heat, phase transitions, first principle of thermodynamics and internal energy, heat exchange mechanisms.

Equation of ideal gases, isochoric, isobar, adiabatic transformations, free expansion of Joule, thermic cycles and refrigerators.

Second principle of thermodynamics, Clausius integral, entropy and increase of the universe entropy.

Statistical theory of ideal gases, Maxwell velocity distribution, microsopic interpretation of thermodynamic variables.

Static of fluids, pressure and principle of Pascal, hydrostatic force, law of Stevino.

Dynamics of ideal fluids, Bernoulli equation, real fluids.

The principles of special relativity, the Michelson-Morley experiment.

Lorentz transformations, simultaneity and causality, time dilation and space contraction.

Minkowski metrics, space-time vector and energy-moment vector, relativistic invariants.

Prerequisites

Basic knowledge of mathematics (capability to solve equations and systems of equations).

A basic knowledge of calculus (differential and integral) is recommended.

Teaching form

Instructional teaching with lectures and exercise sessions.

Textbook and teaching resource

The reference textbooks are:

Mazzoldi, Nigro, Voci, "Fisica - volume 1", EdiSES

Halliday, Resnick, Krane, "Fisica 1", Casa Editrice Ambrosiana

Resnik, "Introduzione alla Relatività Ristretta", Casa Editrice Ambrosiana

Semester

First and second semester.

October - November: mechanics and dynamics of a massive particle (4 CFU).

December - January: mechanics and dynamics of systems of massive particle and rigid bodies (4 CFU).

March - April: Mechanical waves and thermodynamics (4 CFU).

May - June: Fluid Mechanics and Special Relativity (4 CFU).

Assessment method

There will be a written test (resolution of exercises and problems) and an oral test (discussion on the course topics), after passing the written test.

The written test can be replaced by four partial tests, two per semester. The students of the Course in Mathematics must take only the first three partial tests.

The written test is considered passed if a non-negative result is obtained in 3/4 of the tests [or 2/3 of the tests for the students of the Course in Mathematics]. Absence counts as negative result.

After passing the written test it is possible to take the oral exam at any session, within the academic year. Passing the written test remains valid even after the oral exam has not been passed.

Oral tests are held starting from the day of the written test and in the following days, according to a calendar communicated in the e-learning website.

The final result is not a weighted average of the results of the written and oral tests, but is determined by a global assessment, based on:

- precision and correctness in solving the exercises (written test);
- knowledge of the physics subjects, ability to discuss practical cases, precision of language, clarity, completeness and readiness in the exposition (oral test).

Office hours

Usually the teacher is always available for discussions, however the presence is guaranteed only if previously arranged, either in classroom or by e-mail.

Sustainable Development Goals

QUALITY EDUCATION | DECENT WORK AND ECONOMIC GROWTH | INDUSTRY, INNOVATION AND INFRASTRUCTURE