UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Physics I

2021-1-E3001Q083

Aims

Provide students with the basis of Classical Mechanics, Thermodynamics and Special Relativity (only for Physics students) and the methodologies to solve problems on these subjects.

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

Lectures and exercise sessions.

During the Covid-19 emergency period, lessons will be held based on a mixed approach: partial attendance (about a quarter of the students, on a weekly rotation) and lessons videotaped in synchronous mode, available to the students for consultation.

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;

https://www.feynmanlectures.caltech.edu.

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 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 problems (written test);

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

WARNING: MODIFICATION OF THE ASSESSMENT METHOD DUE TO THE COVID-19 EMERGENCY.

During the Covid-19 emergency period, written and oral test will be held online only. They will be carried out using the WebEx or Google Meet platforms and for the oral test a public link will be published on the course e-learning page for virtual access to the examination of interested students.

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.