UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Fisica I

1920-1-E2702Q003

Aims

The course provides the basic notions of classical mechanics for the material point, rigid bodies, fluids and mechanical waves. Furthermore, the course trains the students to apply the acquired theoretical knowledge to the solution of real world problems. In particular, it teaches the abstraction process necessary for the modeling of the investigated system and its conversion into mathematical relations.

Contents

1.

Detailed program

1. Physics and measurement

- Standards of length, mass, and time
- Matter and model building
- Dimensional analysis
- Conversion of units
- Estimates and order of magnitude calculations
- Significant figures

- Position, velocity, and speed
- Instantaneous velocity and speed
- Particle under constant velocity
- Acceleration
- Motion diagrams
- Particle under constant acceleration
- Freely falling objects
- Kinematic equations derived from calculus

- Coordinate systems
- Vector and scalar quantities
- Some properties of vectors
- Components of a vector and unit vectors

- The Position, velocity, and acceleration vectors
- Two- and three- dimensional motion with constant acceleration
- Projectile motion

- Particle in uniform circular motion
- Tangential and radial acceleration
- Relative velocity and relative acceleration

5. The laws of motion

- The laws of motion
- The concept of force
- Newton’s first law and inertial frames
- Mass
- Newton’s second law
- The gravitational force and weight
- Newton’s third law
- Analysis models using Newton’s second law
- Forces of friction

- Extending the particle in uniform circular motion model
- Nonuniform circular motion
- Motion in accelerated frames
- Motion in the presence of resistive forces

- Systems and environments
- Work done by a constant force
- The scalar product of two vectors
- Work done by a varying force
- Kinetic energy and the work–kinetic energy theorem
- Potential energy of a system
- Conservative and nonconservative forces
- Relationship between conservative forces and potential energy
- Energy diagrams and equilibrium of a system

- Non isolated system (energy)
- Isolated system (energy)
- Situations involving kinetic friction
- Changes in mechanical energy for nonconservative forces
- Power

9. Linear momentum and collisions

- Linear momentum
- Isolated system (momentum)
- Nonisolated system (momentum)
- Collisions in one dimension
- Collisions in two and three dimensions
- The center of mass
- Systems of many particles
- Deformable systems
- Rocket propulsion

- Angular position, velocity, and acceleration
- Rigid object under constant angular acceleration
- Angular and translational quantities
- Torque
- Rigid object under a net torque
- Calculation of moments of inertia
- Rotational kinetic energy
- Energy considerations in rotational motion
- Rolling motion of a rigid object

- The vector product and torque
- Nonisolated system (angular momentum)
- Angular momentum of a rotating rigid object
- Isolated system (angular momentum)
- The motion of gyroscopes and tops

- Rigid object in equilibrium
- More on the center of gravity
- Examples of rigid objects in static equilibrium
- Elastic properties of solids

13. Universal gravitation

- Newton’s law of universal gravitation
- Free-fall acceleration and the gravitational force

- Particle in a field (gravitational)
- Kepler’s laws and the motion of planets
- Gravitational potential energy
- Energy considerations in planetary and satellite motion

- Pressure
- Variation of pressure with depth
- Pressure measurements
- Buoyant forces and Archimedes’s principle
- Fluid dynamics
- Bernoulli’s equation
- Other applications of fluid dynamics

- Motion of an object attached to a spring
- Particle in simple harmonic motion
- Energy of the simple harmonic oscillator
- Comparing simple harmonic motion with uniform circular motion
- The pendulum
- Damped oscillations
- Forced oscillations

- Propagation of a disturbance
- Traveling wave
- The speed of waves on strings
- Reflection and transmission
- Rate of energy transfer by sinusoidal waves on strings
- The linear wave equation

- Pressure variations in sound waves
- Speed of sound waves
- Intensity of periodic sound waves
- The doppler effect

- Waves in interference

- Standing waves
- Waves under boundary conditions
- Resonance
- Standing waves in air columns
- Standing waves in rods and membranes
- Beats: interference in time
- Nonsinusoidal wave patterns

Prerequisites

A good algebra and trigonometry background is required, as well as the knowledge acquired in the Mathematics I lectures during the same semester, in particular, calculus (derivatives and integrals). The start of Physics I course will be intentionally postponed, with respect to Mathematics I, to allow acquiring the required knowledge.

Teaching form

Lectures and exercises

Textbook and teaching resource

Serway, Jewett
Physics for Scientists and Engineers (9^{th} edition)
Brooks/Cole Cengage Learning

Other options:

Halliday, Resnick, Walker
Fundamentals of Physics – Volume One (10^{th} edition)
Wiley

Semester

25 November 2019 – 31 January 2020

March 2020 - June 2020

Assessment method

The grading is based on both a written test and an oral exam. Passing the written test is required to access to the oral exam.

The written test is split into four sections, each one dealing with the concepts of four different parts of the course. Each section is graded separately (A: Excellent, B: Good, C: Satisfactory, D: Unsatisfactory, E: Extremely unsatisfactory). The test is considered passed if at least three out of four sections are satisfactory, not necessarily in the same test. That is, positive outcomes in each specific section stack. Furthermore, in case in a future test the student wants to improve the grade of a specific section, only the best grade will be considered.

Four intermediate tests are also scheduled, one for each one of the four parts of the course. Passing an intermediate test, implies the passing of the respective part of the final written exam.

During the final written exam, as well as the intermediate ones, it is possible to use only a scientific calculator and a cheat sheet, as long as it is strictly handwritten by the student on a personal sheet of paper, in A4 format, provided by the teacher.

The oral exam has not to be necessarily taken at the same time as the written test. A passed written test, in fact, is considered valid until the last exam of the current academic year (i.e. until May 2021) also in case of a failed oral exam.

Rating

Office hours

Any day by appointment via e-mail.