UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Basic Physics

2021-1-E3201Q066

Aims

The course, in addition to taking up and analyzing the topics dealt with in the physics of secondary schools, will provide the notions of physics necessary to address many of the topics present in other courses of the degree in STA, in particular in advanced courses in chemistry, biology, sciences of land and applied physics.

The main topics will concern the study of motion and its causes, universal gravitation, Newton's laws and thermodynamics, the latter preparatory for chemistry and biology courses. Furthermore, thermodynamics, together with the basic notions of energy and its conservation, will allow the student to tackle a complex physical system from an energetic point of view. During the course the student will finally acquire the fundamental notions of vector calculus, taken up in the initial lessons and widely used in the following.

Contents

Introduction to Physics, one-dimensional kinematics, vectors in Physics, two-dimensional kinematics, Newton’s laws of motion, applications of Newton’s laws, work and kinetic energy, potential energy and conservation of energy, linear momentum and collisions, rotational kinematics and energy, rotational dynamics and static equilibrium, gravity, fluids, temperature and heat, phases and phase changes, the laws of thermodynamics.

Detailed program

Introduction to Physics:
- Units of length, mass and time;
- Dimensional analysis;

- Converting units;
- Order-of-magnitude calculations;
- Scalars and vectors.

One-dimensional kinematics:
- Position, distance and displacement;
- Average speed and velocity;
- Instantaneous velocity;
- Acceleration;
- Motion with constant acceleration;
- Application of the equation of motion;
- Freely falling objects.

Vectors in Physics:
- Scalars versus vectors;
- The components of a vector;
- Adding and subtracting vectors;
- Position, displacement, velocity and acceleration vectors.

Two-dimensional kinematics:
- Motion in two dimensions;
- Projectile motion: basic equations;
- Zero launch angle;
- General launch angle;
- Projectile motion: key characteristics.

Newton's laws of motion:
- Force and mass;
- Newton's first law of motion;
- Newton's second law of motion;
- Newton's third law of motion;
- The vector nature of forces: forces in two dimensions;
- Weight;
- Normal forces.

Applications of Newton's laws:
- Frictional forces;
- Strings and springs;
- Translational equilibrium;
- Connected objects;
- Circular motion.

Work and kinetic energy:
-Work done by a constant force;
- Kinetic energy;
- Work done by a variable force;
- Power.

Potential energy and conservation of energy:
- Conservative and nonconservative forces;
- Potential energy and the work done by conservative forces;
- Conservation of mechanical energy;
- Work done by nonconservative forces;

Linear momentum and collisions:

- Linear momentum;
- Conservation of linear momentum;
- Inelastic collisions;
- Elastic collisions;
- Center of mass.

Rotational kinematics and energy:
- Angular position and velocity;
- Rolling motion;
- Rotational kinetic energy and the moment of inertia;
- Conservation of energy.

Rotational dynamics and static equilibrium:
- Torque;
- Zero torque and static equilibrium.

Gravity:
- Newton's law of universal gravitation;
- Gravitational attraction of spherical bodies;
- Kepler's laws of orbital motion;
- Gravitational potential energy;
- Energy conservation.

Fluids:
- Density;
- Pressure;
- Static equilibrium in fluids: pressure and depth;
- Archimedes' Principle and buoyancy;
- Applications of Archimedes' Principle;
- Fluid flow and continuity;
- Bernoulli's equation;
- Application of Bernoulli's equation.

Temperature and heat:
- Temperature and the zeroth law of thermodynamics;
- Temperature scales;
- Thermal expansion;
- Heat and mechanical work;
- Specific heats;
- Conduction, convection and radiation.

Phases and phase changes:
- Ideal gases;
- The kinetic theory of gases;
- Phase equilibrium and evaporation;
- Latent heats;
- Phase changes and energy conservation.

The laws of thermodynamics:
- The zeroth law of thermodynamics;
- The first law of thermodynamics;
- Thermal processes;
- Specific heats for an ideal gas: constant pressure and constant volume;
- The second law of thermodynamics;
- Heat engines and the Carnot cycle;

- Refrigerators, air conditioners and heat pumps;
- Entropy;
- Order, disorder and entropy;
- The third law of thermodynamics.

Prerequisites

Basic knowledge of Mathematics.

Teaching form

Frontal lessons on theory (7 cfu), problem solving (1 cfu) and tutoring sessions.

Textbook and teaching resource

Textbook:

- James S. Walker, "Fondamenti di Fisica con MasteringPhysics", 6th edition, Pearson. (also available in English)

Further study material:

- Set of exercises on the online platform MasteringPhysics;
- Exercises solved during tutoring sessions.

Semester

Second semester.

Assessment method

Two written tests at the end of the course (one per part of the course). These can be followed by an oral exam if deemed necessary by the teacher or if requested by the student. The maximum score that can be obtained in a written test is 33. If the average of the scores obtained in the two written tests is less than 21, the oral test is compulsory. It is compulsory to repeat one or both tests if the average of the scores is less than 15. If the oral test is not taken, the final score of the exam is the rounded sum of the scores obtained in the two written tests. One or both of the written tests can also be taken during classes, tentatively in April and June. Each test is considered valid for a total duration of one solar year. For the score computation only the last tests submitted are considered.

Each written test is made of approximately 4 exercises to be answered in 120 minutes. Students can use textbooks and a calculator during written exams. However, they cannot use personal notes or workbooks.

Office hours

By appointment via e-mail.