UNIVERSITÀ degli STUDI di CATANIA

DEPARTMENT OF CHEMICAL SCIENCES
Bachelor's Degree in Chemistry
Academic Year 2017/2018 - 1° Year

PHYSICS I M - Z

FIS/01 - 6 CFU - 2° Semester

Teaching Staff

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LEARNING OBJECTIVES

The course is intended as an introduction to the study of the phenomena of mechanics and fluids addressing the study of classical mechanics of the material point, systems of material points and rigid bodies, the principles of static and dynamics of fluids and training the student to the "problem" solving ": the ability to solve physics problems related to the afore mentioned topics.

DETAILED COURSE CONTENT

0) Introduction
The scientific method in Physics. Laws and principles. Operational definition of a physical quantity; fundamental and derived physical quantities, direct and indirect; the three fundamental physical quantities in Mechanics: mass, space and time and their units of measurement. The measurement: direct and indirect measurement; units of measurement, multiples and submultiples, systems of measurement units (International System, CGS System, Practical System of Engineers and the British System).

1) Kinematics of the material point
The schematization of material point. Reference systems: the Cartesian coordinate system, curvilinear abscissa. Time law and trajectory, time chart. Vectors position and displacement of a material point in 3 dimensions. Speed: average and instantaneous speed; acceleration: average and instantaneous acceleration. Classification of motions. The inverse problem of kinematics and the initial conditions of a problem. Uniform rectilinear motion. Evenly accelerated rectilinear motion. Serious motion: in free fall and with a non-zero initial speed, with a non-zero starting speed and a straight upward spin, with a non-zero start speed and a downward throw. Projectile motion: law of movement composition, trajectory, maximum height, range, flight time, ground speed; projectile motion with initial velocity facing downwards and with initial horizontal velocity. Uniform circular motion: angular velocity and centripetal acceleration. Uniformly accelerated circular motion: angular acceleration; centripetal and tangential acceleration. Periodic motion: period, pulsation and frequency. Simple harmonic motion: characteristics,

hourly law and hourly diagram. Accelerated motion on any trajectory. Relative motions in the simple case of uniform rectilinear translational motion between reference systems. Relative reasons in the general case. Composition laws of displacements, speeds and accelerations. Drag speed and acceleration. Acceleration of Coriolis.
Kinematics exercises of the material point

2) Dynamics of the material point
Inertial reference systems. The fundamental principles of the dynamics of the material point: the Zero or Relativity Principle of G. Galilei; the I Principle of dynamics or Principle of inertia. Invariance and covariance of physical laws in the presence of inertial reference systems. Operational definition of inertial mass. Definition of force. II Principle of dynamics or Newton's law. III Principle of dynamics or principle of action and reaction. Constant forces: weight force, friction force: binding reaction, static and dynamic friction; inclined plane smooth and rough; tensions and constraints: ideal wires and pulleys. The simple pendulum: isochronism in a regime of small oscillations, resolution of the differential equation of motion, hourly law and its characteristics. Position-dependent forces: elastic force. Forces that depend on the speed: strength of the medium or viscous friction force in laminar motion regime, Stokes' law and viscosity coefficient; free fall of a serious in the air: resolution of the differential equation of motion, hourly law and velocity trend, limit speed. Moment of a force compared to a pole. Angular momentum or momentum compared to a pole. Relationship between moment of force and derivative of angular momentum. Conservation of angular momentum.
Dynamics exercises of the material point: the Forces

3) Work and energy
Work of a constant force and a variable force: definition, properties and units of measurement. Work in the presence of more forces: the principle of independence of simultaneous actions. Average and instantaneous power: definition, properties and units of measurement. Calculation of the work of the weight force, of the dynamic friction force, of the elastic force, of the strength of the vehicle. Theorem of the living Forces or Theorem of the kinetic energy. Notion of force field. Conservative and non-conservative forces (dissipative). Properties of conservative forces. Potential function; equipotential surfaces and lines of force. Potential energy: definition, properties and units of measurement. Calculation of the potential function (and potential energy) of the weight force and of the elastic force. Kinetic energy: definition, properties and units of measurement. Mechanical energy: mechanical energy for a serious vacuum, mechanical energy for a vacuum spring, mechanical energy of the simple pendulum. Principle of conservation of mechanical energy.
Dynamics exercises of the material point: Work and Energy

4) Oscillations
The harmonic oscillator in the vacuum: resolution of the differential equation of motion and its properties. Oscillations of a material point hanging from a spring and forces weight and oscillations of a material point on a horizontal constraint (ie in the presence of dynamic friction). The harmonic oscillator damped by a viscous friction force (harmonic oscillator in a fluid): over-damped or super-critical motion, damped or critical motion, under-damped or sub-critical motion in the presence of smooth constraint and rough constraint : differential equations and their solution (equations of motion). The forced harmonic oscillator (in the presence of medium or in a fluid): resolution of the differential equation of motion, the hourly law: transient phase and stationary phase, study of the amplitude of the particular solution: the phenomenon of resonance. Mechanical energy of simple harmonic oscillator.

5) Universal Gravitation

The gravitational attraction force: the law of Universal Gravitation and its properties for material points, for objects with spherical symmetry, for objects of irregular shape and its expression in an arbitrary Cartesian reference system and in a reference system with origin coinciding with a of the masses. Gravity field source (ie in the presence of two masses in the case M >> m). The gravitational field in spherical coordinates: central field with spherical symmetry. Calculation of the work of the gravitational pull force. Calculation of the gravitational potential function. Potential energy, equipotential surfaces and lines of force for the gravitational field. Mechanical energy for a material point in a gravitational force field. Calculation of the escape velocity.The three laws of Kepler: statement and property; Kepler's Law (with proof: flat orbits); Kepler's Law; III Kepler's law and eccentricity of the orbits. Dynamics exercises of the material point: Gravitation

6) Dynamics of systems of material points and rigid body
The material point systems: discrete and continuous modeling. Mass center of a system of material points and calculation in significant cases. Density of linear, superficial and volumetric mass. Internal forces, external forces. Total amount of motion of a system of material points. Total moment of external forces for a system of material points. Total angular momentum for a system of material points. Kinetic energy for a system of material points. The center of mass theorems; II The center of mass theorem. Cardinal equations of the motion of a system: The cardinal equation, II cardinal equation. Principle of conservation of the total momentum for a system of material points and remarkable cases. The schematization of a rigid body. You like freedom. Moment of inertia, calculation of the moment of inertia for significant cases. Huygens-Steiner's theorem. Kinetic energy for a rigid body. Motion of rigid bodies: translational motion; rotary motion: precession of the total angular momentum vector, expression of the axial angular momentum; roto-translatory motion: pure rolling. Symmetry axes, inertia axes, central axes. Rotation of a rigid body around a fixed axis: axial equation of motion, conservation of axial angular momentum.
Dynamics exercises of systems of material points and rigid body

7) Fluidostatic and fluid dynamics
Fluids: liquids and aeriforms. The perfect fluid modeling. Average and absolute density for a fluid, relative density. Pressure and unit of measurement, cutting effort. Fundamental equation of fluidostatic; Stevino's law; Torricelli experience; the Pascal Principle; trend of atmospheric pressure with altitude; the principle of Archimedes. Lagrangian and Eulerian description for moving fluids. Stationary regime. Flow line, flow tube. Continuity equation for moving fluids: flow rate. Bernoulli's theorem.
Fluidostatic and fluid dynamics exercises

TEXTBOOK INFORMATION

1. R. Davidson “Metodi matematici per un corso introduttivo di Fisica” casa editrice EdiSES;

2. S. Rosati "Fisica Generale", casa editrice Ambrosiana;

3. D. Halliday, R. Resnick, J. Walker "Fondamenti di Fisica" casa editrice Ambrosiana;

4. S. Focardi, I. Massa, A. Uguzzoni: “Fisica Generale” Volume 1: Meccanica, II edizione, casa editrice Ambrosiana;

5. S. Focardi, I. Massa, A. Uguzzoni: “Fisica Generale” Volume 2: Termidinamica e Fluidi, II edizione, casa editrice Ambrosiana;

6. P. Mazzoldi, M. Nigro, C. Voci: “Elementi di Fisica” Meccanica e Termodinamica, II edizione, casa editrice EdiSES;

7. R. Bellotti, G.E. Bruno, G. Florio, N. Manna “Esercizi di Fisica” Meccanica e Termodinamica casa editrice Ambrosiana

Lo studente è comunque libero di scegliere qualsiasi altro testo di Fisica Generale 1 di livello universitario.