Main course information	
Academic subject	Physics for Biologists (section of "Physics integrated course")
Degree course	Biological Sciences
Classe di laurea	L-13
ECTS credits (CFU)	6
Compulsory attendance	According to degree course rules
Teaching language	Italian
Academic Year	2019/2020

Docente responsabile	
Name & SURNAME	Pietro Mario Lugarà
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Tutorial time/day	Mon 16-18 ; Tue 11-12 ; Thu 11-12 ; Fri 12-13

Course details	Study area	SSD code	Type of class
	Physics	FIS/07	Basic

Teaching schedule	Year	Semester
	I	II

Modalità erogazione	CFU/ECTS	Lessons (hours)	CFU/ECTS lab	Lab hours	CFU/ECTS tutorial/workshop	Tutorial/workshop hours	CFU/ECTS field trip	Field trip Hours
	5	40	0	0	I	15	0	0

Time management	Total hours	Teaching hours	Self-study hours
	150	55	95

Academic Calendar	First lesson	Final lesson
	According to degree course rules	According to degree course rules

Syllabus	
Course entry requirements	Elementary algebraic calculus – Trigonometry – Graphical representations – Basic notions of differential and integral calculus.
Expected learning outcomes (according to Dublin Descriptors) (it is recommended that they are congruent with the learning outcomes contained in A4a, A4b, A4c tables of the SUA-CdS)	
Knowledge and understanding	Knowledge of the basic aspects related to the study of motions and interactions between bodies, electromagnetism and optics and their description through general laws.
Applying knowledge and understanding	Ability to independently recognize the main characteristics of a physical phenomenon of biological interest and describe it through relationships between physical quantities.
Autonomy of assessment	Ability to assess the dimensional and conceptual suitability of models and relationships between physical quantities.
Communication skills	Skills in the Italian language exposition of concepts, models and relationships between physical quantities for the description of phenomena of biological interest. Ability in skilled presentation and dissemination of acquired knowledge with appropriate scientific language.
Learning skills	Based on the principles of mechanics and electromagnetism, formulate the fundamental laws governing the dynamics of bodies, fluids, electricity and magnetism, the propagation of waves, geometrical and physical optics.

Syllabus	
Course contents	**In Short** Kinematics and dynamics of translational and rotational motion of particles and rigid bodies – Oscillations – Mechanical waves – Statics and dynamics of fluids – Electricity and magnetism – Electromagnetic waves – Geometrical and physical optics. **In Details** Introduction - Physical quantities - Vector algebra : addition and difference; components of a vector ; scalar and vector product. Kinematics of a single particle – Uniform and uniformly accelerated rectilinear motion- Vertical motion of a body under constant gravity acceleration – Two-dimensional motion ; bullet motion – Curvilinear motion : normal and tangential components of acceleration - Uniform and uniformly accelerated curvilinear motion – Periodic motions – Simple harmonic motion – Phasors - *Fourier's analysis of non-harmonic periodic motions (outline).* Relative motion – Frames of reference : uniform and accelerated relative translational motion and uniform relative rotational motion - Consequences of Earth's rotation on the motion of bodies. [*The Lorentz Transformation and its consequences (outline)*] Dynamics of a particle - Law of Inertia - Concept of Force - Mass – Second and third laws of dynamics – Linear Momentum – Principle of conservation of momentum – Reformulation of second and third laws of dynamics - Force of gravity - Static and Kinetic Frictional Forces - Centripetal Forces - Banked curves – Resistive forces: limiting velocity - Aerodynamic resistance – Variable mass systems : jet propulsion. Work of a force - Kinetic Energy Theorem - Power - Concept of Conservative Force; potential energy; mechanical energy conservation - Examples of conservative forces: gravity; elastic force - *Generalization of energy conservation; mass-energy (outline)* . Impulse Theorem - Collisions - Elastic one-dimensional Collision - Inelastic collisions : Ballistic Pendulum – Cross Section concept . Rotation dynamics: torque of a force; angular momentum; definitions in terms of vector products – Conservation of the angular moment : central forces - Particle systems - Center of mass - Dynamics of the center of mass - System dynamics - Kinetic energy of a system of particles- Dynamics of a rigid body: moment of inertia - Principal axes of inertia - Parallel Axes (Steiner's) Theorem - Motion of translation and rotation of a rigid body . Equilibrium of rigid bodies - Limits of elasticity – Concurrent forces : resultant and resultant torque - Parallel forces : center of parallel forces- Center of Gravity – Couple - Levers : types; mechanical gain. Oscillatory motion dynamics – Elastic force : harmonic oscillator - Oscillator energy - Simple pendulum : small oscillations : motion law ; period ; energy - Compound pendulum – Superposition of two simple harmonic motions in the same direction - Beats – Damped oscillations - Forced oscillations in the presence of damping : amplitude resonance and energy resonance - Power transfer . Wave motion; propagation - Transverse and longitudinal waves - Wavefront – Plane Waves and Spherical Waves - Mechanical Waves – Superposition and Interference - Beats - Standing Waves - Waves in a String: Velocity, Power and Intensity - Sound Waves : Velocity, Absolute and Relative Intensity - Oscillating Systems and Sound Sources - Doppler Effect - Mach Waves. Fluids - Intermolecular forces (outline) - Pressure in a fluid – Pascal's Principle and Stevin's theorem - Communicating vessels ; hydraulic press; pressure gauge – Archimede's L aw - Measurement of the atmospheric pressure - Surface tension : thin layer; spherical layer; drop - Forces on contact surfaces between fluids - Forces on solid-liquid contact surface : wettability - Capillarity : Jurin's law - Fluid dynamics: flow lines; flow - Laminar flow - Principle of continuity - Bernoulli's theorem - Torricelli's Law – Venturi's Principle; venturimeter - Pitot tube - Frictional forces in real fluids : Newtonian and non-Newtonian fluids - Hagen-Poiseuille's Law - Resistance to flow;

	Series and Parallel arrangements of pipes - Turbulent motion (outline) - Sedimentation and centrifugation. Electric interaction : empiric aspects; electric charge - Conductors and insulators: elementary notions - Coulomb's Law - Field Concept - Electrostatic Field and Electrostatic Potential – Field Strength Lines; Equipotential surfaces - Quantization of electric charge : Millikan's experiment (outline) - Flux of a vector field through a surface – Gauss theorem for the electrostatic field - Charged conductors : electrostatic field; capacity - Coupled conductors: induction - Capacitors - Work to load a capacitor : energy stored per volume unit - Electric dipole : potential and field - Dipole in the electrostatic field - Dipolar layer - Polarization of matter : Electric susceptibility - Relative dielectric constant - Charge motion produced by an electric field in a conductor: mobility; current intensity; current density; conductivity - Ohm's Laws - Series and Parallel arrangements of Conductors – Electromotive Force Generators – Closed paths and Junctions in circuits. Magnetic interaction - Natural magnets – Magnetic force on an electric current; the magnetic induction vector – Lorentz Force - Magnetic field produced by a rectilinear current - Forces between two rectilinear currents : standard of current - Displacement current- Ampere-Maxwell Law - Magnetic field of a coil and a solenoid - Forces and torque on a coil in a magnetic field - Magnetization of matter - Classification of magnetic materials - Hysteresis . Electromagnetic Induction - Lenz Law - Faraday-Henry Law - Mutual Induction and Self-Induction - Inductance of solenoid - Energy stored in an inductance; Energy density associated with magnetic field - Alternate RLC circuits: impedance - Resonance and maximum power transfer . Maxwell's Equations (outline) - Electromagnetic waves - Electromagnetic spectrum - Velocity of light in vacuum - Energy density for electromagnetic waves - Intensity - Radiation pressure (outline) – Velocity of electromagnetic waves through matter : refraction index. Huygens' Principle – Geometrical Optics - Rays - Reflection and refraction on flat and spherical surfaces; Snell's Laws – Total Reflection – The Eye as an optical instrument - Polarization of waves - Polarization by reflection : Brewster's angle – Birefringence (outline). Interference of two coherent sources - Young's Experiment - Intensity in Interference patterns - Interference from Thin Films – Michelson's Interferometer (outline) - Diffraction : generalities - Diffraction from a slit : qualitative and quantitative aspects - Diffraction from two or more slits - Diffraction gratings : angular dispersion and resolving power – Concept of photon - Photoelectric effect (outline) - Light absorption : Lambert-Beer's law.
Course books/ Bibliography	D. HALLIDAY, R. RESNICK, **J. WALKER** "Fondamenti di Fisica" VII edizione (2015); Casa Ed. Ambrosiana ISBN 978-88-08-18229-6
Notes	Additional slides for selected topics
Teaching methods	Frontal lessons with video-projector, overhead projector, traditional blackboard, numerical tutorials.
Assessment methods (indicate at least the type written, oral, other)	Final Oral Test for the whole of " Physics Integrated Course "
Evaluation criteria (Explain for each expected learning outcome what a student has to know, or is able to do, and how many levels of achievement there are	Knowledge of the fundamentals of the dynamics of bodies, fluids, electricity and magnetism, wave propagation, geometrical and physical optics. Correct formulation and derivation of fundamental relationships describing the dynamic behavior of bodies and fluids, oscillations, wave propagation, electric and magnetic phenomena and optics, with particular regard to living matter.
Further information	