Master's Degree in Dentistry and Dental Prosthetics 2023/2024

Teaching: Applied Physics
Scientific Disciplinary Sector: FIS/07
Responsible Professor: Prof. Alessandra Filabozzi; email: alessandra.filabozzi@unicamillus.org
Number of University Educational Credits (CFU): 7

PREREQUISITES
Knowledge and competence in Basic Mathematics and Physics at High School level.

LEARNING OBJECTIVES
Aim of the integrated course of Applied Physics is to provide students with knowledge on the fundamentals of applied physics necessary for their future activity. In particular, the comprehension of physical principles at the base of medical physics and of functioning of medical instrumentation will be addressed.
At the end of the course, the students will know the fundamental concepts of application of the Scientific Method to the study of biomedical phenomena (choice and measure of parameters, evaluation of errors), they will be able to describe physical phenomena of complex systems using suitable mathematical tools, they will know the scientific basis of medical procedures and principles of functioning of the equipment commonly used for diagnostics and therapeutics.

LEARNING OUTCOMES
The specific learning outcomes of the program are coherent with the general provisions of the Bologna Process and the specific provisions of EC Directive 2005/36/EC. They lie within the European Qualifications Framework (Dublin Descriptors) as follows:

Knowledge and understanding
- Understand the experimental method and learn the use and transformation of measure units.
- Know and understand the proper terminology of physics.
- Know and understand the main physical principles and laws concerning kinetics, dynamics, electricity and magnetism, vibration and waves, radiation, balance regulating principles and fluids.
- Apply these concepts to biological and physiological phenomena in living organisms.
- Identify and recognize the physical principles which govern the function of the specific human organs.

Applying knowledge and understanding
- Apply the principles of physics to selected problems and to a variable range of situations.
- Use the tools, methodologies, language and conventions of physics to test and communicate ideas and explanations.

Communication Skills
- Present the topics orally in an organized and consistent manner.
- Utilize a proper scientific language coherent with the topic of discussion.

Making judgements

- Recognize the importance of an in-depth knowledge of the topics consistent with a proper medical education.
- Identify the fundamental role of a proper theoretical knowledge of the topic in the clinical practice.

Learning skills

At the end of the course, the student should have acquired independent method for studying and updating through different kind of literature or through scientific literature.

COURSE SYLLABUS - Physics

Mechanics

1: Introduction, measurement, estimation; measurement and uncertainty; Significant digits, units, standards and SI units; Unit conversion; Dimensions and dimensional analysis

2: Description of movement: kinematics in one dimension: Reference systems and displacement; average speed; instantaneous speed; acceleration; movement at constant speed

3 Kinematics in two dimensions; Carriers; Vectors and scalars; Vector sum - Graphical methods; Subtraction of vectors and multiplication of a vector with a scalar; Sum of vectors by components

4: Dynamics: Newton's Laws of Motion; Force; Newton's first law of motion; Mass; Newton's second law of motion; Newton's third law of motion; Weight: the force of gravity; and normal Strength; Solving problems with Newton's laws: free body diagrams; Problems involving friction, inclinations; Troubleshooting: A General Approach

5: Circular movement; Gravitation; Kinematics of uniform circular motion; Dynamics of uniform circular motion; Newton's law of universal gravitation

6: work and energy; Work done by a Constant Force; Kinetic energy and the principle of the energy of work; Potential energy; Conservative and Non-Conservative Forces; Mechanical energy and its conservation; Solving problems using the law of conservation of mechanical energy; Other forms of energy: energy transformations and the law of conservation of energy; Power

7: Linear Moment: Moment and its relation to force; Preservation of the moment
Center of Mass (CM); Center of mass and translational motion

8: Rotational movement; angular quantities; Constant angular acceleration; Couple; Rotational dynamics; Torque and rotational inertia; Problem solving in rotation dynamics; Rotational kinetic energy

9: Static balance; Elasticity and fracture; The conditions for equilibrium; Troubleshooting Static; Applications on muscles and joints; stability and balance; Elasticity; Stress and tension; Fracture

10: Fluids; Phases of Matter; Density and specific gravity; Pressure in fluids; Pressure relative to atmospheric pressure; Pascal's principle; Pressure measurement; Gauges and barometer; Buoyancy and Archimedes' principle; moving fluids; Flow rate and continuity equation; Bernoulli's Principle, Applications of Bernoulli's Principle: from Torricelli to Airplanes, Baseballs and TIAs, Viscosity, Flow in test tubes: Poiseuille's equation, blood flow

11: Vibrations and waves, Wave motion, Types of waves: transversal and longitudinal, Energy carried by waves, Intensity relative to amplitude and frequency, reflection and transmission of waves, Interferences; Superposition principle, Standing waves; Resonance

12: Sound, Sound characteristics, Sound intensity: decibels, Sound sources: vibrating strings and Air columns, Sound wave interference; Doppler effect.

13: Electric charge and electric field, static electricity; Electric charge and its conservation, Electric charge in the atom, insulators and conductors, Induced charge; the electroscope, Coulomb's law, Solving problems concerning Coulomb's law and vectors, The electric field, Field lines, electric fields and conductors
14: Electric potential, Electric potential energy and potential differences, Relationship between electric potential and electric field, Equipotential lines, The electron volt, a unit of energy: Electric potential due to point charges: Capacities: Dielectrics: storage of electric energy
15: Electric currents: The electric battery, The electric current, Ohm's law: resistance and resistors, resistivity, electric energy, Microscopic view of the electric current
16: DC circuits; EMF and terminal voltage, Resistors in series and in parallel, Kirchhoff's rules, EMF in series and in parallel; Charging a Battery, Circuits Containing Capacitors in Series and in Parallel, RC Circuits-Resistor and Capacitor in Series, Electrical Phenomena in Biological Systems
17: Magnetism; Magnets and magnetic fields, electric current produces magnetic fields, Force on an electric current in a magnetic field: definition of B, Force on an electric charge moving in a magnetic field, magnetic field due to a long straight wire, Law of Amperes
18: Electromagnetic induction and Faraday's law, induced EMF, Faraday's law of induction; Lenz's law, EMF induced in a moving conductor, The change in magnetic flux produces an electric field
19: Electromagnetic waves, Variable electric fields produce magnetic fields; Maxwell's equations, Production of electromagnetic waves, Light as an electromagnetic wave and the electromagnetic spectrum, Energy in EM waves
20: The Wave Nature of Light, Visible Spectrum and Scattering, Optical Instruments
21 X-rays and X-ray diffraction, X-ray imaging and computed tomography (CT), Nuclear physics and radioactivity, Early quantum theories and model of the atom, early models of the atom, Bohr's model
22: Nuclear Physics and Radioactivity, Structure and Properties of the Nucleus, Binding Energy and Nuclear Forces, Radioactivity, Alpha Decay, Beta Decay, Gamma Decay, Nucleotide Number Conservation and Other Conservation Laws, Half-Life and Decay, Calculations Involving Rates of decay and half-life
23: Nuclear power; Effects and Uses of Radiation, Nuclear Reaction and Transmutation of Elements, Measurement of Radioactivity-Dosimetry, Nuclear Magnetic Resonance (NMR) and Magnetic Resonance Imaging (MRI)
24: Thermodynamics, Theory of Temperature and Kinetics, Atomic Theory of Matter, Temperature and Thermometers, Thermal Equilibrium and Zeroth's Law of Thermodynamics, Thermal Expansion, The Gas Laws and Absolute Temperature, The Ideal Gas Law, Troubleshooting with the ideal gas law, ideal gas law in terms of molecules: Avogadro's number, kinetic theory and molecular interpretation of temperature
25: Heat, Heat as energy transfer, Internal energy, specific heat, Calorimetry, Latent heat, Heat transfer: conduction, Heat transfer: convection, Heat transfer: radiation, The laws of thermodynamics, The first law of thermodynamics, thermodynamic processes and the first law, Second law of thermodynamics: introduction

COURSE STRUCTURE

The Teaching is structured in 70 hours of frontal teaching on both theoretical and applied topics, divided into lessons of 2, 3 or 4 hours, based on the academic calendar. In the first part of the course, a recovery of mathematical concepts and skills is carried out, which are indispensable prerequisites for a successful implementation of the Integrated Course.

COURSE GRADE DETERMINATION

The Physics test consists of a written test aimed at evaluating both the theoretical knowledge and the student's ability to solve problems. The test lasts for one hour. The written test consists of a series of multiple choice questions (between 10 and 12 questions), with only one right answer. Questions may have different weights, in any case between 1 and 3, based on the complexity of the question and the particular knowledge being tested; if the wheight is different, it will be given. The score is given out of thirty, and it is equal to the sum of the scores obtained for each question. The maximum score, equal to 30, is expected for those who answer all the questions correctly; the minimum score, equal to 18 out of 30, is expected for those who correctly answer 18/30 of the questions, taking into account the different weights attributed to them.There is no penalty for wrong answers or not given. The exam will be overall evaluated according to the following criteria:

➢ Not suitable: significant deficiencies and/or inaccuracies in knowledge and understanding of the topics; limited analysis and synthesis skills, frequent generalizations.

➢ 18-20: just sufficient knowledge and understanding of the topics with possible imperfections; Sufficient analytical, synthesis and independent judgment skills.

➢ 21-23: knowledge and understanding of routine topics; correct analysis and synthesis skills.

➢ 24-26: fair knowledge and understanding of the topics; good analysis and synthesis skills.

➢ 27-29: complete knowledge and understanding of the topics; remarkable analytical and synthesis skills.

➢ 30-30L: excellent level of knowledge and understanding of the topics. Remarkable analytical and synthesis skills and independent judgement.

READING MATERIALS

“FISICA Biomedica” D.Scannicchio, casa Editrice Edises