UNICAMILLUS

Degree Course in Dentistry and Dental Prosthetics 2022/2023

Course: Applied Physics
CFU Number: 7
Course Coordinator: Prof. Alessandra Filabozzi; email: alessandra.filabozzi@unicamillus.org
Professors:

- Prof. Alessandra Filabozzi (4 CFU)**;** email: alessandra.filabozzi@unicamillus.org
- Prof. Antonio Napolitano (3 CFU); email: antonio.napolitano@unicamillus.org

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 part 1 (Prof. Filabozzi)

Mechanics

Chapter **1:** Introduction, Measurement, Estimating
1.4: Measurement and Uncertainty; Significant Figures
1.5: Units, Standards, and SI Units
1.6: Converting Units
1.8: Dimensions and Dimensional Analysis

Chapter **2:** Describing Motion: Kinematics in One Dimension
2.1: References Frames and Displacement
2.2: Average Velocity
2.3: Instantaneous Velocity
2.4: Acceleration
2.5: Motion at Constant Acceleration

Chapter **3:** Kinematics in Two Dimensions; Vectors
3.1: Vectors and Scalars
3.2: Addition of Vectors-Graphical Methods
3.3: Subtraction of Vectors and Multiplication of a Vector By a Scalar
3.4: Adding Vectors by Components

Chapter **4:** Dynamics: Newton's Laws of Motion
4.1: Force
4.2: Newton's First Law of Motion
4.3: Mass
4.4: Newton's Second Law of Motion
4.5: Newton's Third Law of Motion
4.6: Weight-The Force of Gravity; and the Normal Force
4.7: Solving Problems with Newton's Laws: Free-Body Diagrams
4.8: Problems Involving Friction, Inclines

4.9: Problem Solving-A General Approach

Chapter **5:** Circular Motion; Gravitation
5.1: Kinematics of Uniform Circular Motion
5.2: Dynamics of Uniform Circular Motion
5.6: Newton's Law of Universal Gravitation

Chapter **6:** Work and Energy
6.1: Work Done by a Constant Force
6.3: Kinetic Energy and the Work-Energy Principle
6.4: Potential Energy
6.5: Conservative and Nonconservative Forces
6.6: Mechanical Energy and its Conservation
6.7: Problem Solving Using Conservation of Mechanical Energy
6.8: Other Forms of Energy: Energy Transformations and the Law of Conservation of Energy
6.10: Power

Chapter **7:** Linear Momentum
7.1: Momentum and Its Relation to Force
7.2: Conservation of Momentum
7.8: Center of Mass (CM)
7.10: Center of Mass and Translational Motion

Chapter **8:** Rotational Motion
8.1: Angular Quantities
8.2: Constant Angular Acceleration
8.4: Torque
8.5: Rotational Dynamics; Torque and Rotational Inertia
8.6: Solving Problems in Rotational Dynamics
8.7: Rotational Kinetic Energy

Chapter **9:** Static Equilibrium; Elasticity and Fracture
9.1: The Conditions for Equilibrium
9.2: Solving Statics Problems
9.3: Applications to Muscles and Joints
9.4: Stability and Balance
9.5: Elasticity; Stress and Strain
9.6: Fracture

Fluids
Chapter **10:** Fluids
10.1: Phases of Matter
10.2: Density and Specific Gravity
10.3: Pressure in Fluids
10.4: Atmospheric Pressure Gauge Pressure

10.5: Pascal's Principle
10.6: Measurement of Pressure; Gauges and the Barometer
10.7: Buoyancy and Archimedes' Principle
10.8: Fluids in Motion; Flow Rate and the Equation of Continuity
10.9: Bernoulli's Principle
10.10: Applications of Bernoulli's Principle: from Torricelli to Airplanes, Baseballs, and TIA
10.11: Viscosity
10.12: Flow in Tubes: Poiseuille's Equation, Blood Flow

Electricity and Magnetism
Chapter **16:** Electric Charge and Electric Field
16.1: Static Electricity; Electric Charge and its Conservation
16.2: Electric Charge in the Atom
16.3: Insulators and Conductors
16.4: Induced Charge; the Electroscope
16.5: Coulomb's Law
16.6: Solving Problems Involving Coulomb's Law and Vectors
16.7: The Electric Field
16.8: Field Lines
16.9: Electric Fields and Conductors

Chapter **17:** Electric Potential
17.1: Electric Potential Energy and Potential Differences
17.2: Relation Between Electric Potential and Electric Field
17.3: Equipotential Lines
17.4: The Electron Volt, a Unit of Energy
17.5: Electric Potential Due to Point Charges
17.7: Capacitance
17.8: Dielectrics
17.9: Storage of Electric Energy

Chapter **18:** Electric Currents
18.1: The Electric Battery
18.2: The Electric Current
18.3: Ohm's Law: Resistance and Resistors
18.4: Resistivity
18.5: Electric Power
18.8: Microscopic View of Electric Current

Chapter **19:** DC Circuits
19.1: EMF and Terminal Voltage
19.2: Resistors in Series and in Parallel
19.3: Kirchhoff's Rules
19.4: EMFs in Series and in Parallel; Charging a Battery
19.5: Circuits Containing Capacitors in Series and in Parallel

19.6: RC Circuits-Resistor and Capacitor in Series

Chapter **20:** Magnetism
20.1: Magnets and Magnetic Fields
20.2: Electric Current Produce Magnetic Fields
20.3: Force on an Electric Current in a Magnetic Field: Definition of B
20.4: Force on an Electric Charge Moving in a Magnetic Field
20.5: Magnetic Field Due to a Long Straight Wire
20.8: Ampere's Law

Chapter **21:** Electromagnetic Induction and Faraday's Law
21.1: Induced EMF
21.2: Faraday's Law of Induction; Lenz's Law
21.3: EMF Induced in a Moving Conductor
21.4: Changing Magnetic Flux Produces an Electric Field

COURSE SYLLABUS Physics part 2 (Prof. Napolitano)

Vibrations and Waves
Chapter **11:** Vibrations and Waves
11.7: Wave Motion
11.8: Types of Waves: Transverse and Longitudinal
11.9: Energy Transported by Waves
11.10: Intensity Related to Amplitude and Frequency
11.11: Reflection and Transmission of Waves
11.12: Interference; Principle of Superposition
11.13: Standing Waves; Resonance

Chapter **12:** Sound
12-1 Characteristics of Sound
12-2 Intensity of Sound: Decibels
12-4 Sources of Sound: Vibrating Strings and
Air Columns
12-6 Interference of Sound Waves; Beats
12-7 Doppler Effect

Chapter **22:** Electromagnetic Waves
22.1: Changing Electric Fields Produce Magnetic Fields; *Maxwell's Equations*
22.2: Production of Electromagnetic Waves
22.3: Light as an Electromagnetic Wave and the Electromagnetic Spectrum
22.5: Energy in EM Waves

Chapter **24:** The Wave Nature of Light
24.4: The Visible Spectrum and Dispersion

Chapter **25:** Optical Instruments
25-11: X-Rays and X-Ray Diffraction
25-12: X-Ray Imaging and Computed Tomography (CT Scan)

Nuclear Physics and Radioactivity

Chapter **27:** Early Quantum Theory and Models of the Atom
27.10: Early Models of the Atom
27.12: The Bohr Model

Chapter **30:** Nuclear Physics and Radioactivity
30.1: Structure and Properties of the Nucleus
30.2: Binding Energy and Nuclear Forces
30.3: Radioactivity
30.4: Alpha Decay
30.5: Beta Decay
30.6: Gamma Decay
30.7: Conservation of Nucleon Number and Other Conservation Laws
30.8: Half-Life and Rate of Decay
30.9: Calculations Involving Decay Rates and Half-life

Chapter **31:** Nuclear Energy; Effects and Uses of Radiation
31.1: Nuclear Reaction and the Transmutation of Elements
31.5: Measurement of Radiation-Dosimetry
31.9: Nuclear Magnetic Resonance (NMR) and Magnetic Resonance Imaging (MRI)

Thermodynamics

Chapter **13:** Temperature and Kinetic Theory
13.1: Atomic Theory of Matter
13.2: Temperature and Thermometers
13.3: Thermal Equilibrium and the Zeroth Law of Thermodynamics
13.4: Thermal Expansion
13.6: The Gas Laws and Absolute Temperature
13.7: The Ideal Gas Law
13.8: Problem Solving with the Ideal Gas Law
13.9: Ideal Gas Law in Terms of Molecules: Avogadro's Number
13.10: Kinetic Theory and the Molecular Interpretation of Temperature

Chapter **14:** Heat
14.1 Heat as Energy Transfer
14.2 Internal Energy
14.3: Specific Heat
14.4: Calorimetry
14.5: Latent Heat
14.6: Heat Transfer: Conduction
14.7: Heat Transfer: Convection

14.8: Heat Transfer: Radiation

Chapter **15:** The Laws of Thermodynamics
15.1: The First Law of Thermodynamics
15.2: Thermodynamic Processes and the First Law
15.4: Second Law of Thermodynamics-Introduction

COURSE STRUCTURE

The teaching is structured in 70 hours of frontal teaching on both theoretical and applicative topics, divided into lessons of 2, 3 or 4 hours, based on the academic calendar. Before the course, there will be preliminary lessons necessary to the recovery of the mathematical concepts and skills that are necessary prerequisites for a successful development of the Integrated Course.

COURSE GRADE DETERMINATION

The Physics test consists of a written test and an oral exam. The written test is aimed at evaluating both the theoretical knowledge and the student's ability to solve problems; the oral exam is aimed at the evaluation of the theoretical knowledge. The written test consists of a series of multiple choice questions. The maximum score, equal to 30, is foreseen for those who answer all the questions correctly; the minimum score, equal to 18 out of 30, is foreseen for those who correctly answer 18/30 of the questions, taking into account the different weight attributed to them. The questions may have a different weight based on the complexity of the question and on the particular knowledge that is verified. There is no penalty for wrong answers. Only students with a minimum score of 18/30 are admitted to the oral exam.
During the oral exam the examining commission will evaluate the student's ability to apply the knowledge and will ensure that the skills are adequate to achieve the objectives. They will also be assessed: judgment autonomy, communication skills and learning skills as indicated in the Dublin descriptors.

READING MATERIALS

PHYSICS: Douglas C. Giancoli “PHYSICS: Principles with Applications” Seventh edition or subsequent, Pearson Education. Inc