

Degree Course in Dentistry and Dental Prosthetics 2021/2022

Integrated Course: Applied Physics

CFU Number: 7

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Module: Physics part 1

CFU number: 4

SSD: FIS/07

Professor: Prof. Alessandra Filabozzi; email: alessandra.filabozzi@unicamillus.org

Module: Physics part 2

CFU number: 3

SSD: FIS/07

Professor: Prof. Antonio Napolitano; 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

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: Reference 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

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