

**I year (1st semester)
A.Y. 2017-2018**

Scientific Field	PHYSICS AND STATISTICS	TUTOR	ECTS
FIS/07	Applied Physics (Medicine)	Toschi Nicola	7
INF/01	Informatics	Toschi Nicola	2
MED/01	Medical Statistics	Iacobelli Simona	3
		TOT	12

**TOSCHI N.
COORDINATOR**

PROGRAM

**MEDICAL PHYSICS
MECHANICS**

Chapter 1: Introduction, Measurement, Estimating
 Chapter 2: Describing Motion: Kinematics in One Dimension
 Chapter 3: Kinematics in Two Dimensions; Vectors
 Chapter 4: Dynamics: Newton's Laws of Motion
 Chapter 5: Circular Motion; Gravitation
 Chapter 6: Work and Energy
 Chapter 7: Linear Momentum
 Chapter 8: Rotational Motion
 Chapter 9: Static Equilibrium; Elasticity and Fracture

TOPICS

**INTRODUCTION,
MEASUREMENT,
ESTIMATING**

1.1: The Nature of Science
 1.2: Physics and its Relation to Other Fields
 1.3: Models, Theories, and Laws
 1.4: Measurement and Uncertainty; Significant Figures
 1.5: Units, Standards, and SI Units
 1.6: Converting Units
 1.7: Order of Magnitude: Rapid Estimating
 1.8: Dimensions and Dimensional Analysis

TOPICS 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 2.6: Solving Problems 2.7: Falling Objects 2.8: Graphical Analysis of Linear Motion
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TOPICS 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
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TOPICS 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
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TOPICS CIRCULAR MOTION; GRAVITATION	5.1: Kinematics of Uniform Circular Motion 5.2: Dynamics of Uniform Circular Motion 5.3: Highway Curves, Banked and Unbanked 5.4: Nonuniform Circular Motion 5.5: Centrifugation 5.6: Newton's Law of Universal Gravitation 5.7: Gravity Near the Earth's Surface; Geophysical Applications 5.10: Types of Forces in Nature
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TOPICS	6.1: Work Done by a Constant Force
WORK AND ENERGY	6.2: Work Done by a Varying 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
	6.9: Energy Conservation with Dissipative Forces: Solving Problems
	6.10: Power

TOPICS	7.1: Momentum and Its Relation to Force
LINEAR MOMENTUM	7.2: Conservation of Momentum
	7.3: Collisions and Impulse
	7.4: Conservation of Energy and Momentum in Collisions
	7.5: Elastic Collisions in One Dimension
	7.6: Inelastic Collisions
	7.7: Collisions in Two or Three Dimensions
	7.8: Center of Mass (CM)
	7.9: CM of the Human Body
	7.10: Center of Mass and Translational Motion

TOPICS	8.1: Angular Quantities
ROTATIONAL MOTION	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
	8.9: Vector Nature of Angular Quantities

TOPICS	9.1: The Conditions for Equilibrium
STATIC EQUILIBRIUM; ELASTICITY AND FRACTURE	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

PROGRAM	Chapter 16: Electric Charge and Electric Field
MEDICAL PHYSICS ELECTRICITY AND MAGNETISM	Chapter 17: Electric Potential
	Chapter 18: Electric Currents
	Chapter 19: DC Circuits
	Chapter 20: Magnetism
	Chapter 21: Electromagnetic Induction and Faraday's Law

TOPICS	16.1: Static Electricity; Electric Charge and its Conservation
ELECTRIC CHARGE AND ELECTRIC FIELD	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
	16.10: Gauss's Law
	16.11: Electric Forces in Molecular Biology: DNA Structures and Replication

TOPICS	17.1: Electric Potential Energy and Potential Differences
ELECTRIC POTENTIAL	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
	17.11: The Electrocardiogram (ECG or EKG)

TOPICS	18.1: The Electric Battery
ELECTRIC CURRENTS	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
	18.10: Electrical Conduction in the Human Nervous System

TOPICS

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
- 19.7: Electric Hazards

TOPICS

MAGNETISM

- 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 a Electric Charge Moving in a Magnetic Field
- 20.5: Magnetic Field Due to a Long Straight Wire
- 20.8: Ampere's Law
- 20.9: Torque on a Current Loop; Magnetic Moment
- 20.11: Mass Spectrometer

TOPICS

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
- 21.8: Applications of Induction: Sound Systems, Computer Memory, Seismograph, GFCI

<p>PROGRAM</p> <p>MEDICAL PHYSICS VIBRATIONS AND WAVES</p>	<p>Chapter 11: Vibrations and Waves Chapter 12: Sound Chapter 22: Electromagnetic Waves Chapter 24: The Wave Nature of Light</p>
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<p>TOPICS</p> <p>VIBRATIONS AND WAVES</p>	<p>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</p>
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<p>TOPICS</p> <p>SOUND</p>	<p>12-1 Characteristics of Sound 12-2 Intensity of Sound: Decibels *12-3 The Ear and Its Response; Loudness 12-4 Sources of Sound: Vibrating Strings and Air Columns *12-5 Quality of Sound, and Noise; Superposition 12-6 Interference of Sound Waves; Beats 12-7 Doppler Effect *12-8 Shock Waves and the Sonic Boom * 12-9 Applications: Sonar, Ultrasound, and Medical Imaging</p>
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<p>TOPICS</p> <p>ELECTROMAGNETIC WAVES</p>	<p>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</p>
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<p>TOPICS</p> <p>THE WAVE NATURE OF LIGHT</p>	<p>24.4: The Visible Spectrum and Dispersion</p>
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<p>PROGRAM</p> <p>MEDICAL PHYSICS NUCLEAR PHYSICS AND RADIOACTIVITY</p>	<p>Chapter 27: Early Quantum Theory and Models of the Atom Chapter 30: Nuclear Physics and Radioactivity Chapter 31: Nuclear Energy; Effects and Uses of Radiation</p>
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<p>TOPICS</p> <p>EARLY QUANTUM THEORY AND MODELS OF THE ATOM</p>	<p>27.1 Discovery and Properties of the Electron 27.2: Planck's Quantum Hypothesis; Blackbody Radiation 27.10: Early Models of the Atom 27.11: Atomic Spectra: Key to the Structure of the Atom 27.12: The Bohr Model</p>
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<p>TOPICS</p> <p>NUCLEAR PHYSICS AND RADIOACTIVITY</p>	<p>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 30.10: Decay Series 30.11: Radioactive Dating 30.13: Detection of Radiation</p>
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<p>TOPICS</p> <p>NUCLEAR ENERGY; EFFECTS AND USES OF RADIATION</p>	<p>31.1: Nuclear Reaction and the Transmutation of Elements 31.4: Passage of Radiation Through Matter; Radiation Damage 31.5: Measurement of Radiation-Dosimetry 31.6: Radiation Therapy 31.7: Tracers and Imaging in Medicine 31.8: Emission Tomography 31.9: Nuclear Magnetic Resonance (NMR) and Magnetic Resonance Imaging (MRI)</p>
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PROGRAM	Chapter 13: Temperature and Kinetic Theory
MEDICAL PHYSICS THERMODYNAMICS	Chapter 14: Heat Chapter 15: The Laws of Thermodynamics

TOPICS	13.1: Atomic Theory of Matter
TEMPERATURE AND KINETIC THEORY	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

TOPICS	14.1 Heat as Energy Transfer
HEAT	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

TOPICS	15.1: The First Law of Thermodynamics
THE LAWS OF THERMODYNAMICS	15.2: Thermodynamic Processes and the First Law
	15.3: Human Metabolism and the First Law
	15.4: Second Law of Thermodynamics-Introduction
	15.7: Entropy and the Second Law of Thermodynamics

PROGRAM

Chapter 10: Fluids

**MEDICAL PHYSICS
FLUIDS**

TOPICS

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
- 10.13: Surface Tension and Capillarity
- 10.14: Pumps and the Heart

TEXTBOOKS

"PHYSICS: Principles with Applications" - Douglas C. Giancoli - Sixth edition, Pearson Education. Inc,
ISBN 0-13-060620-0

EXAM METHOD

- You will be required to attend independent examinations for both the Physics and the Statistics courses. You will be able to take both the Physics and Statistics exams either a) during the same exam session or b) during separate exam sessions, as long as both exams are taken within the same academic year.
- You will receive a single grade for the Integrated Course in Physics and Statistics, which will be calculated as a weighted average of the two grades obtained in Physics and Statistics. The weight will be the credit hours assigned to each course.
- Final Physics and Statistics grade = $(0.7 \text{ Physics grade}) + (0.3 \text{ Statistics grade})$

PHYSICS COURSE:

You will undergo a written assessment composed of multiple choice questions and problems.

If your score is:

- Below 15: exam failed
- Between 15 (included) and 17 (included): attend compulsory oral examination or withdraw (exam failed)
- 18 or more: keep this as your final grade or attend optional oral examination.

EXAM COMMISSION

The Coordinator, full Professors of the disciplines, Professors of similar disciplines, Specialists of the subject, compose the exam Commission of the Integrated Course.

Toschi Nicola, President

Iacobelli Simona

CONTACTS

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PREREQUISITES: Previous knowledge and competence in Basic Physics and Statistics.

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:

1. **Knowledge and Understanding**

- Demonstrate a comprehensive theoretical knowledge of the main physical principles and laws concerning kinetics, dynamics, electricity and magnetism, vibration and waves, radiation and nuclear physics and fluids dynamics.
- Understand the important conceptual models used in the core subject areas of physics, demonstrate the ability to correctly draw logical conclusions from these models and use them to make accurate quantitative predictions in realistic situations.
- Apply these concepts to the medical setting and understand their relationships with the physiological mechanisms which govern the human body as well as their application in the construction of diagnostic equipment.
- Identify and recognize the physical principles which govern the function of the specific human organs; demonstrate the importance of their regulation in order to maintain equilibrium.
- Study the main statistical terms and notions and understand their application.

2. **Applying Knowledge and Understanding**

- Apply the principles of physics to selected problems and to a variable range of situations.
- Bring into play the statistical concepts in the analysis of clinical data and their application in the conduction of clinical studies.
- Use the tools, methodologies, language and conventions of physics to test and communicate ideas and explanations.
- Learn how to conduct scientific experiments for the purpose of solving a scientific problem and to record and analyze the results

3. **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 subject in the clinical practice.

4. **Communication Skills**

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

5. **Learning Skills**

- Identify possible use of skills acquired during the course in the future career.
- Assess the importance of the acquired knowledge in the overall medical education process.