COURSE DETAILS

"PHYSICS IN MEDICINE"

SSD FIS/07*

DEGREE PROGRAMME: ENGLISH COURSE IN MEDICINE AND SURGERY

ACADEMIC YEAR2024-25

GENERAL INFORMATION–TEACHER REFERENCES

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GENERAL INFORMATION ABOUT THECOURSE

INTEGRATED COURSE (IF APPLICABLE): PHYSICS IN MEDICINE
TEACHINGLANGUAGE: ENGLISH
YEAR OF THE DEGREE PROGRAMME(I, II, III): I
SEMESTER (I, II, ANNUAL): I
CFU: 5

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

none

PREREQUISITES (IF APPLICABLE)

Mathematical functions and their graphic representation. Just the concepts of the derivative and the integral of a function and their geometrical interpretation. The main physical quantities and their unit of measurements. Mechanics: Basic Statics, Kinematics and Dynamics.

LEARNING GOALS

The first objective is methodological: the goal is to train students in understanding and interpreting physical phenomena involved in Life Sciences and developing in the student analysis/synthesis skills needed for their educational program and during their professional life. Attention is dedicated to the decomposition of a complex phenomenon into simpler steps, by identifying the fundamental parameters determining its dynamics, and by evaluating the applicability of the Physics laws on the base of the assumed hypotheses.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

Students are expected to know and interpret fundamental Physics laws, to illustrate and explain these laws within their natural frame, and to provide examples of these laws taken from Life Sciences, thus demonstrating the capability to correctly determine the physical mechanisms at the basis of the proposed phenomena.

Applying knowledge and understanding

Students are expected to:

• Determine and interpret the physical quantities at the basis of biochemical transformations through Thermodynamics Principles.

• Apply the perfect gas laws to breathing mechanisms.

• Analyze and justify phenomena related to surface tension through the exerted inter-molecular forces in solids and liquids.

• Interpret the dynamics of blood circulation and breathing system in terms of models based on hydrodynamics laws.

• Explain wave properties and features. Utilize them to understand and interpret the functions of listening system and vision.

• Describe how optical devices work.

• Describe electric and magnetic phenomena and understand their relation with electrophysiology and biomedical instrumentation.

• Describe ionizing radiations and illustrate methods for their generation and attenuation.

COURSE CONTENT/SYLLABUS

THERMODYNAMICS

Thermodynamical system and state. Zero principle of Thermodynamics. Thermal dilatation. Temperature scales. Calorimetry. Thermodynamical work. Thermodynamical transformations. First principle of Thermodynamics. Internal energy. Perfect gases and their transformations. State equation of perfect gases. Second principle of Thermodynamics. Thermal engines. Carnot's cycle: efficiency. Entropy. Thermodynamical potentials.

GASES AND GAS MIXTURES

Microscopic model of perfect gas: pressure, temperature, internal energy. Freedom degrees of a molecule. Equipartition of

energy. Partial pressure and Dalton's law. Henry's law. Pressure and solubility of breathing gases. High pressure breathing.

DYNAMICS OF LIQUIDS
Continuity equation. Bernoulli theorem: consequences and applications. Flux by parallel planes: Newton's law: shear stress, velocity gradient, viscosity. Newtonian liquids. Flux in a cylindrical pipe: Poiseuille's law. Comparison with Ohm's law: hydrodynamical resistance. Laminar and turbulent flux: Reynolds number. Variation of Reynolds number in human circulatory system. Aorta flux. Blood velocity and pressure in human circulatory system. Aortic pressure measurements. Non-Newtonian liquids Differential viscosity. Cardiac work.

WAVE PHENOMENA
Wave motions. Description and parameters of a wave. Superposition principle and Fourier's theorem. Sound wave nature and velocity in different media. Sound intensity and decibel scale. Sound pressure.

GEOMETRICAL OPTICS
Geometrical optics. Reflection and refraction. Refraction index. Total reflection. Critical angle. Light dispersion. Plane mirror. Spherical diopter. Thick lens. Thin lenses. Dioptric power. Diverging and converging lenses. Magnification. Thin lenses systems. Human eye: structure and optical media. Simplified eye. Light ray path in human eye. Accommodation power. Human eye refractive disorders and their correction. Diffraction by a circular hole. Eye spatial resolution.

ELECTRICITY
Electric charge. Conductor and insulators. Electrostatic induction. Coulomb's law, electrical field and potential. Gauss theorem. Electrical capacitance. Series and parallel capacitors. Electric direct current: Ohm's law. Series and parallel of resistors. Magnetic effects of electric current: Biot and Savart's law. Ampere's law. Lorentz's law. Tesla.

BASIC IONIZING RADIATION
Electromagnetic radiation and photons. Atomic models. X-ray and their production. Characteristic radiation. X-radiation absorption, half value layer. Atomic nucleus. Nuclear forces. Mass defect. Nuclear stability. Radioactivity. Radioactive decay law. Activity. Alfa, Beta and Gamma decay. Physical and biological half-life.

READINGS/BIBLIOGRAPHY

College Physics, OpenstaxCollege Rice University, Houston Texas USA (ebook available for free at https://cnx.org/contents)
Other supports for teaching materials: Slides of FDA and IDA (https://www.docenti.unina.it - Search for ALTUCCI CARLO)

TEACHING METHODS

Lectures and exercises. A) Lectures for approx. 75% of total hours; B) practical exercises for approx. the remaining 25% of total hours. Some online material is used besides the recommended textbook available online and the teacher's presentations.

EXAMINATION/EVALUATION CRITERIA

*For **integrated courses**, this field should encompass all modules, with indication of the relative weight of each module on the final mark. For integrated courses, this field should be coordinated by the reference teacher for the course.*

a) Examtype:

Examtype	
writtenandoral	X
onlywritten	
onlyoral	
projectdiscussion	
other	

In case of a written exam, questions refer to: (*)	Multiple choiceanswers	X
	Open answers	
	Numericalexercises	

(*) multiple options are possible

b) Evaluation pattern:

- Test of multiple choice questions concerning topics included in formal lectures and other learning activities

- Oral exam concerning topics included in formal lectures and other learning activities
Passing the written test is obligatory before accessing the oral exam. Typically, but non-necessarily, the final mark increases after the oral exam, compared to the initial mark of the passed written test.

CALENDAR of THE COURSE LESSONS

Week	Day		Timetable	Module	Topics	Teacher
1	Wednesday	23/10/2024	15.30 - 17.05	Thermodynamics	System and thermodynamic state. Zeroth law of thermodynamics. Thermal expansion. Thermometric scales. Calorimetry. Equilibrium of a thermodynamicsystem.	Altucci
	Thursday	24/10/2024	13.00 - 14.35	Thermodynamics	Heat transfer mechanisms. Conduction. Fourier's law. Convection. Irradiance: Black body. Law of Wien and Stefan-Boltzmann	Altucci
	Friday	25/10/2024	13.00 - 13.45	Thermodynamics	Thermodynamic transformations. Work in thermodynamics.	Altucci
2	Wednesday	30/10/2024	15.30 – 17.05	Thermodynamics	the first principle of thermodynamics. Internal energy. Ideal gases and their transformations. State Equation of idealgases.	Altucci
	Thursday	31/10/2024	13,00 – 14,35	ADI	First approach with Problem Solving	Altucci
3	Wednesday	06/11/2024	15.30 - 17.05	Thermodynamics	2nd law of thermodynamics. Entropy. Thermal machines. The Carnot cycle: yield.	Altucci
	Thursday	07/11/2024	13.00 - 14.35	Thermodynamics	Microscopic model of an ideal gas: pressure, temperature, internal energy. Degrees of freedom. Equipartition of energy	Altucci
	Friday	08/11/2024	13,00 – 13,45	ADI	First approach with Problem Solving	Altucci
4	Wednesday	13/11/2024	15.30 - 17.05	Thermodynamics	Partial pressure and Dalton's law. Henry's law. Pressure and solubility of respiratory gases.	Altucci
	Thursday	14/11/2024	13.00 - 14.35	Liquids	Ideal liquids: hydrostatics.-Stationary motion of a liquid, flow rate. Bernoulli'stheorem: consequences and applications in Medicine.	Altucci
	Friday	15/11/2024	13,00 – 13,45	ADI	Laboration/exercises	Altucci
5	Wednesday	20/11/2024	15.30 - 17.05	Liquids	Newtonian liquids. Simple sliding: Newton's law, tangential force, speed	Altucci

					gradient, viscosity. Laws of hydrostatics.	
	Thursday	21/11/2024	13.00 - 14.35	Liquids	Flow in a cylindrical duct. Poiseuille's law Comparison with Ohm's law: hydrodynamic resistance. Laminar motion and turbulentmotion.	Altucci
	Friday	22/11/2024	13.00 - 13.45	ADI	Laboration/exercises	Altucci
6	Wednesday	27/11/2024	15.30 - 17.05	Liquids	Reynolds number and circulatory system. Flow rate of the aorta. Blood speed and pressure in the human circulatory system.	Altucci
	Thursday	28/11/2024	13.00 - 14.35	Liquids	Measurement of aortic pressure. Non Newtonian liquids: Cardiac work.	Altucci
	Friday	29/11/2023	13.00 – 14.35	ADI	Laboration/exercises	Altucci
7	Wednesday	04/12/2024	15.30 - 17.05	Liquids	Surface phenomena: experimental evidence. Intermolecular forces. Surface tension: definitions	Altucci
	Thursday	05/12/2024	13.00 - 14.35	Liquids	Capillarity: contact angle, Jurin's law. Laplace's law for separating surfaces of different shapes. Gaseous emboli.	Altucci
	Friday	06/12/2024	13.00 - 13.45	ADI	Laboration/exercises	Altucci
8	Wednesday	11/12/2024	15.30 - 17.05	Waves and Acoustics	Wave motions, description and parameters of a wave. The superpositionprinciple.	Altucci
	Thursday	12/12/2024	13.00 - 14.35	Waves and Acoustics	Nature of sound waves and their propagation speed in the various media. Sound intensity and decibel scale. Sound pressure.	Altucci
	Friday	13/12/2024	13.00 - 13.45	ADI	Laboration/exercises	Altucci
9	Wednesday	18/12/2024	15.30 - 17.05	Waves and Acoustics	Stationary sound waves on strings. Doppler effect. Intensity, pitch and timbre.	Altucci
	Thursday	19/12/2024	13.00 - 14.35	Optics	Ray optics. Reflection and refraction. Refractive index. Total internal reflection. Light dispersion. Flatmirror. Sphericaldiopter. Thicklens.	Altucci
	Friday	20/12/2024	13.00 - 13.45	ADI	Laboration/exercises	Altucci
10	Wednesday	08/01/2025	15.30 - 17.05	Optics	Thin lens. Dioptric power. Diverging and converging lenses. Magnification. Thin multi-lens system.	Altucci
	Thursday	09/01/2025	13.00 - 14.35	Optics	The human eye: structure and optical media. Simplified eye model. Path of light rays in the human eye. Accommodative power. Refractive defects of the eye and their correction. eye resolution.	Altucci
	Friday	10/01/2025	13.00 - 13.45	ADI	Laboration/exercises	Altucci
11	Wednesday	15/01/2025	15.30 - 17.05	Elettricity and Magnetism	Electric charges. Conductors and insulators. electromagnetic induction. Resistors in series and parallel. Magnetic field and electric current: Biot/Savart's law. Ampere's law. Lorentz law.	Altucci
	Thursday	16/01/2025	13.00 - 14.35	Elettricità e magnetismo	Motion of a charge in a uniform electric field. Alternating current loops: Resistive, capacitive and inductive loop. The RLCloop: the	Altucci

					impedance.	
	Friday	17/01/2025	13.00 - 13.45	ADI	Laboration/exercises	Altucci
12	Wednesday	22/01/2025	15.30 - 17.05	Radiations	Electromagnetic radiation and photons. Main features and spectrum of electromagnetic waves. Atomic models. X-rays and their production. Characteristic radiation. X-ray absorption, hemivalent thickness.	Altucci
	Thursday	23/01/2025	13.00 - 14.35	Radiations	The atomic nucleus. Nuclear forces. mass defect. Stability of nuclei. Radioactivity. Law of radiative decay	Altucci
	Friday	24/01/2025	13.00 - 13.45	ADI	Laboration/exercises	Altucci
13	Wednesday	29/01/2025	15.30 - 17.05	Radiations	Activity. Alpha, beta and gamma decay. Physical and biological half-life.	Altucci
	Thursday	30/01/2025	13.00 - 14.35	Lasers and Medicine	Concepts of a laser	Altucci
	Venerdì	31/01/2025	13.00-13.45	ADI	SEMINAR: applications of lasers in Medicinec	Altucci