

FINAL PROGRAM FOR THE EXAM

Module: PHYSICS APPLIED TO BIOTECHNOLOGY

Didactic Unit 1: Methods of Physics

- Measurements. Units of measurement. Fundamental and derived quantities, dimensional analysis. Scalar and vector quantities. Reference systems.

Didactic Unit 2: Mechanics

- Kinematics of a material point: definitions of position and displacement over time; trajectory and motion law; average and instantaneous velocity; average and instantaneous acceleration; study of rectilinear and curvilinear motions; introduction to harmonic motion.
- Dynamics of a material point: the three laws of dynamics; definition of force and main examples (weight, gravitational force, contact forces and friction, tension, elastic forces); Hooke's law for ideal springs.
- Work and energy: concept of mechanical work; definition of power; the kinetic energy theorem; conservative and non-conservative forces; potential energy; gravitational and elastic potential energy; the mechanical energy conservation theorem.

Didactic Unit 3: Fluid Mechanics

- States of matter. Definition of pressure and density, and their role in the static and dynamic behavior of fluids.
- Laws of hydrostatics: Stevin's law; Pascal's principle; Archimedes' principle and analysis of floating conditions.
- Fluids in motion (hydrodynamics): flow and flow rate, steady and turbulent flow; continuity equation; Bernoulli's theorem; Torricelli's theorem.
- Real fluids and viscosity.
- Surface phenomena: surface tension; capillarity and behavior of fluid interfaces.

Didactic Unit 5: Thermodynamics

- Fundamental concepts: thermodynamic variables (pressure, volume, temperature) and thermodynamic state; state functions; characteristics of ideal gases, ideal gas law, universal gas constant; real gases.
- Heat and thermal capacity: energy exchange in the form of heat; definition of heat capacity and specific heat; calorimetry.
- Heat transfer mechanisms: thermal conduction, convection, and radiation; heat flow; thermal emission, Wien's law, and radiated power.
- First law of thermodynamics: internal energy, heat, and work; reversible and irreversible transformations; canonical transformations in ideal gases (isothermal, isochoric, isobaric, adiabatic).
- Thermodynamic cycles; heat engines, efficiency, Carnot cycle; entropy.

Didactic Unit 6: Electricity and Magnetism

- Electric charge and interactions: fundamental properties of electric charge, unit of measurement, charge conservation; interaction between point charges and Coulomb's law; electric field; motion of a charge in a uniform electric field; Gauss's law.
- Electric energy and electric potential: definition of electric potential and potential difference; electric dipole and dipole moment.
- Conductors and dielectrics (insulators).
- Electric current: direct current, current intensity, electric generator, and applied potential difference; Ohm's laws, resistance, and resistivity; series and parallel combinations of resistors.
- Capacitance and capacitors: concept of electrical capacitance.
- Magnetic field: Lorentz force; circular motion of a charge in a uniform magnetic field; torque on a current loop in a magnetic field; magnetic dipole moment.
- Biot-Savart law. Examples: straight wire, circular loop, ideal solenoid.
- Electromagnetic induction.

Module: PRINCIPLES OF MATHEMATICS AND BIOSTATISTICS

Mathematics:

- Recall: equations and inequalities
- Elementary algebraic functions: linear, quadratic, polynomial, absolute value, power, exponential, logarithm, trigonometric
- Limits and continuity: properties, right and left continuity, asymptotes
- Concept of derivative, main rules of derivation, calculation of derivatives of algebraic and transcendental functions, maximums and minimums of a function, sign of the derivative, inflection points.
- Integral calculus: Definition of integral, definite integral, properties of the integral. Indefinite integral, main integration formulas.

Statistics:

- Populations and variables
- Absolute and percentage frequencies
- Mode, mean, median
- Variance and standard deviation
- Quartiles and interquartile range
- Normal distribution
- Some statistical tests: t-Student