Professional Master's Degree

Material Physics

technological university

Professional Master's Degree

Material Physics

- Modality: **online**
- Duration: **12 months**
- Certificate: **TECH Technological University**
- Dedication: **16h/week**
- Schedule: **at your own pace**
- Exams: **online**

Website: **www.techtitute.com/us/engineering/professional-master-degree/master-material-physics**

Index

01

Introduction

In recent years, more superconducting materials such as graphene, bismuth sulfides or more sustainable alternatives to replace organic and synthetic compounds, such as plastic, have been discovered. These changes are driven by the scarcity of resources and the imperative need to develop new and better materials. This is a reality in which engineering is of great use and professionals are in high demand. For this reason, TECH has created this 100% online program, allowing students to acquire the necessary knowledge about classical mechanics, electromagnetism and material physics itself. All through innovative teaching resources developed by specialists in this field.

A 100% online Professional Master's Degree that will allow you to delve into Material Physics and apply this science with current technology"

The scientific community that focuses its studies on Material Physics continues to make progress and provide society with greater knowledge about new properties of existing resources, the development of nanomaterials and the promotion of other technological, biological or health disciplines. A progress, where engineering professionals can make a great contribution thanks to direct technique application and physics concepts.

At the same time, the need to find new, more effective, efficient and sustainable materials has driven this area, both from the private and public sectors. An expanding field of study for engineering specialists who wish to thrive in the field of Material Physics. For this reason, TECH has created this Professional Master's Degree, where over course of 12 months, the graduate will obtain the necessary knowledge about fluid mechanics, advanced thermodynamics and optics.

All this, in addition, with a university program that has educational tools in which the latest academic teaching technology has been used. Therefore, through video conferences, detailed videos or case study simulations, students will be able to delve, in a much more dynamic way, into symmetries and conservation laws, the handling of Navier-Stokes equations or the connection between the microscopic structure (atomic, nanometric or micrometric) and the macroscopic material properties.

This way, TECH offers engineering professionals the most advanced and exhaustive knowledge on Material Physics. All this through an exclusively online program that you can access whenever and wherever you want. Students only need an electronic device (computer, tablet or cell phone) with Internet connection to be able to view the information on the virtual platform. Also, with the Relearning system, you will be able to reduce the long hours of study normally spent in other methodologies.

This **Professional Master's Degree in Material Physics** contains the most complete and up-to-date program on the market. The most important features include:

- Practical case studies are presented by experts in Physics
- The graphic, schematic, and practical contents with which they are created, provide scientific and practical information on the disciplines that are essential for professional practice
- Practical exercises where self-assessment can be used to improve learning
- Its special emphasis on innovative methodologies
- Theoretical lessons, questions to the expert, debate forums on controversial topics, and individual reflection assignments
- Content that is accessible from any fixed or portable device with an Internet connection

> *Excel in the field of new materials discovery, thanks to the solid concepts you will acquire in this program"*

> TECH adapts to you and has therefore created a university program, where you can distribute the teaching load according to your personal needs"

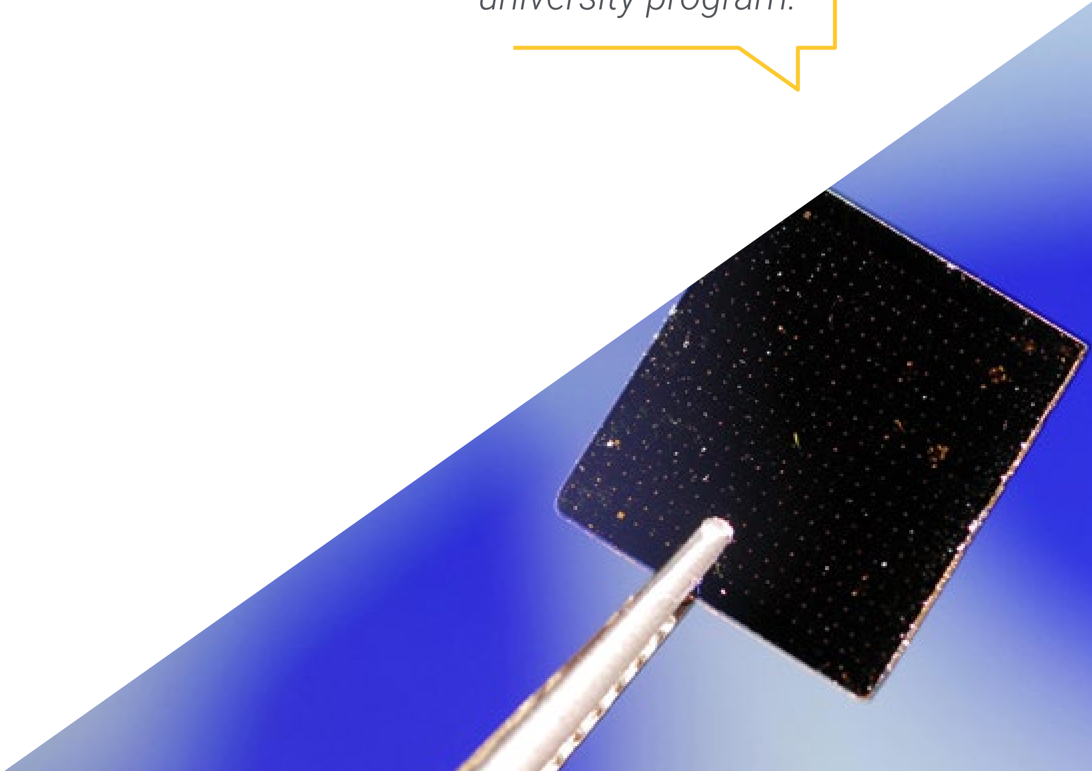
The program’s teaching staff includes professionals from the sector who contribute their work experience to this educational program, as well as renowned specialists from leading societies and prestigious universities.

The multimedia content, developed with the latest educational technology, will provide the professional with situated and contextual learning, i.e., a simulated environment that will provide immersive education programmed to learn in real situations.

This program is designed around Problem-Based Learning, whereby the professional must try to solve the different professional practice situations that arise during the academic year For this purpose, the student will be assisted by an innovative interactive video system created by renowned and experienced experts.

Enroll now in a program that will allow you to open doors in the field of Material Physics.

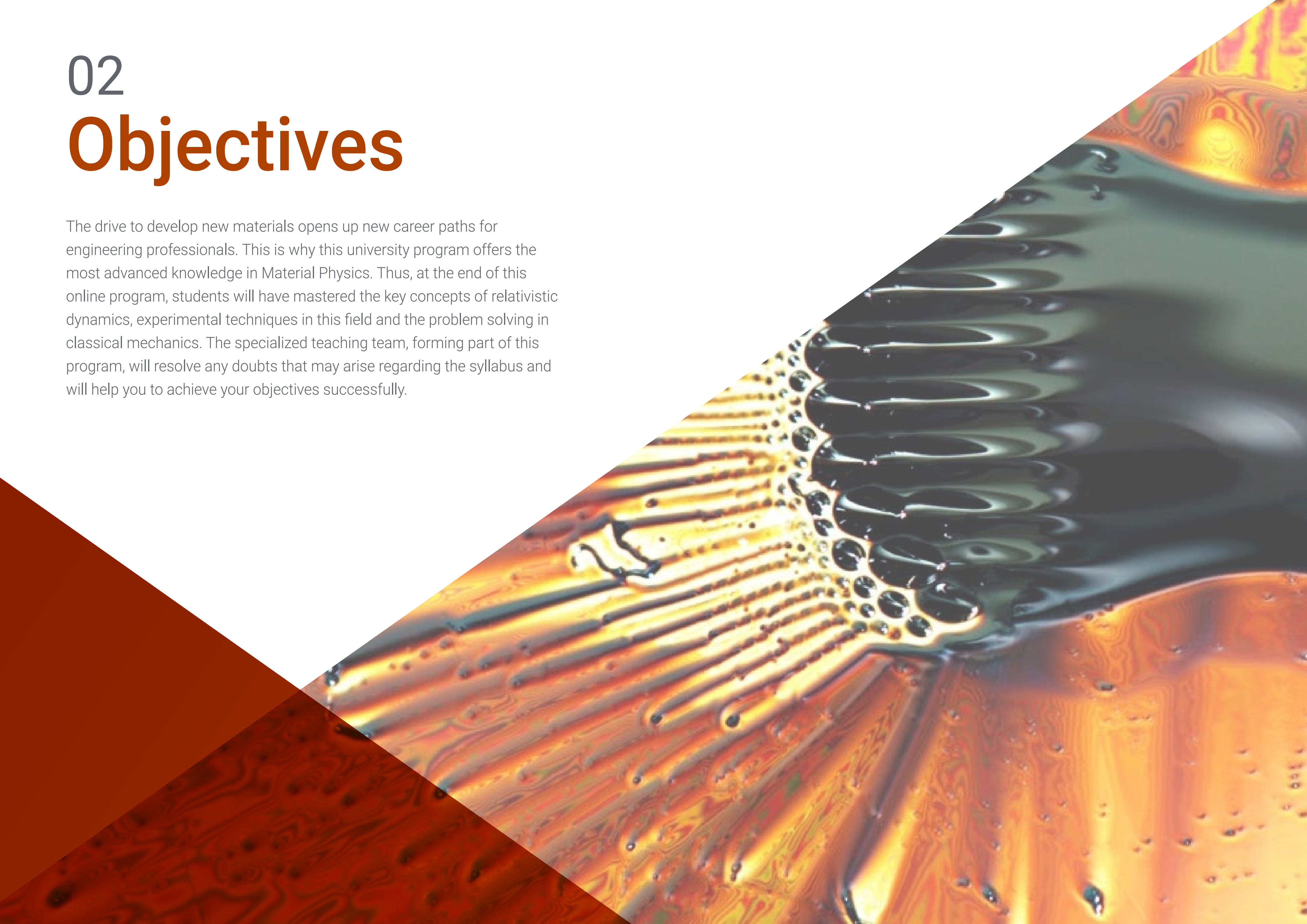
Gain essential knowledge about magnetostatics in both material media and vacuum with this university program.



02

Objectives

The drive to develop new materials opens up new career paths for engineering professionals. This is why this university program offers the most advanced knowledge in Material Physics. Thus, at the end of this online program, students will have mastered the key concepts of relativistic dynamics, experimental techniques in this field and the problem solving in classical mechanics. The specialized teaching team, forming part of this program, will resolve any doubts that may arise regarding the syllabus and will help you to achieve your objectives successfully.



> *Thanks to this university program, you will be able to understand the connection between the microscopic structure (atomic, nanometric or micrometric) and the macroscopic properties of materials"*

General Objectives

- Advance in Relativistic Dynamics
- Know the most relevant experimental techniques in Material Physics
- Be able to distinguish the use of experimental techniques to solve a problem in Materials Science
- Understand the relationship between optics and other physics disciplines

> *With this university program, you will be able to test the variation of the parameters of metals due to crystalline structures”*

Specific Objectives

Module 1. Optics

- Learn the basic knowledge of geometrical optics
- Know the physical principles on which the most common optical instruments are based
- Understand and analyze optical phenomena present in daily life
- Apply the concepts of optics to physical problem solving related to optics

Module 2. Classical Mechanics I

- Solidify knowledge of Newtonian mechanics
- Solve central Forces problems using rotational symmetry
- Know how to deal with particle and rigid solid systems
- Study rigid solid rotations, the inertia tensor and Euler's equations

Module 3. Electromagnetism

- Obtain a basic knowledge of the electric field and its properties
- Apply knowledge of vector analysis to electric field studies
- Achieve a basic understanding of the magnetic induction field
- Understand electrostatics both in vacuum and in material media
- Know dielectric characteristics

Module 4. Classical Mechanics II

- Know how to deal with particle systems and simple and coupled oscillators
- Understand and know how to use quadrivector mathematical tools
- Learn Lagrangian and Hamiltonian formalisms
- Know how to solve classical mechanics problems using Newton's formulation as well as Lagrange's and Hamilton's

Module 5. Electromagnetism II

- Obtain a basic knowledge of the magnetic field and its properties
- Gain an understanding of magnetostatics in both material media and in a vacuum
- Know conservation electromagnetism laws and use them in problem solving
- Know Maxwell's equations and be able to calculate various solutions such as electromagnetic waves and their propagation

Module 6. Advanced Thermodynamics

- Advance in the principles of thermodynamics
- Understand the concepts of collectivity and be able to differentiate between the different types
- Know how to distinguish which collectivity will be more useful to the study of a given system depending on the type of thermodynamic system
- Know the basics of the Ising model
- Gain knowledge of the difference between boson and baryon statistics

Module 7. Material Physics

- Know the relationship between Materials Science and Physics, and the applicability of this science in today's technology
- Understanding the connection between the microscopic structure (atomic, nanometric or micrometric) and the macroscopic properties of materials, as well as their interpretation in physical terms
- Master the multiple properties of materials

Module 8. Analog and Digital Electronics

- Understand the operation of linear, non-linear and digital electronic circuits
- Know the different forms of specification and implementation of digital systems
- Identify the different electronic devices and their operation
- Master the MOS digital circuits

Module 9. Statistical Physics

- Understand the theory of collectivities and be able to apply it to the study of ideal and interacting systems, including phase transitions and critical phenomena
- Know the theory of stochastic processes and be able to apply it to simple cases
- Be familiar with the elementary kinetic theory of transport processes and be able to apply it to dilute gases and quantum gases

Module 10. Fluid Mechanics

- Understand the general concepts of Fluid Physics and solve related problems
- Know the basic characteristics of fluids and their behavior under various conditions
- Know the constitutive equations
- Acquire confidence in the handling of the Navier-Stokes equations

03

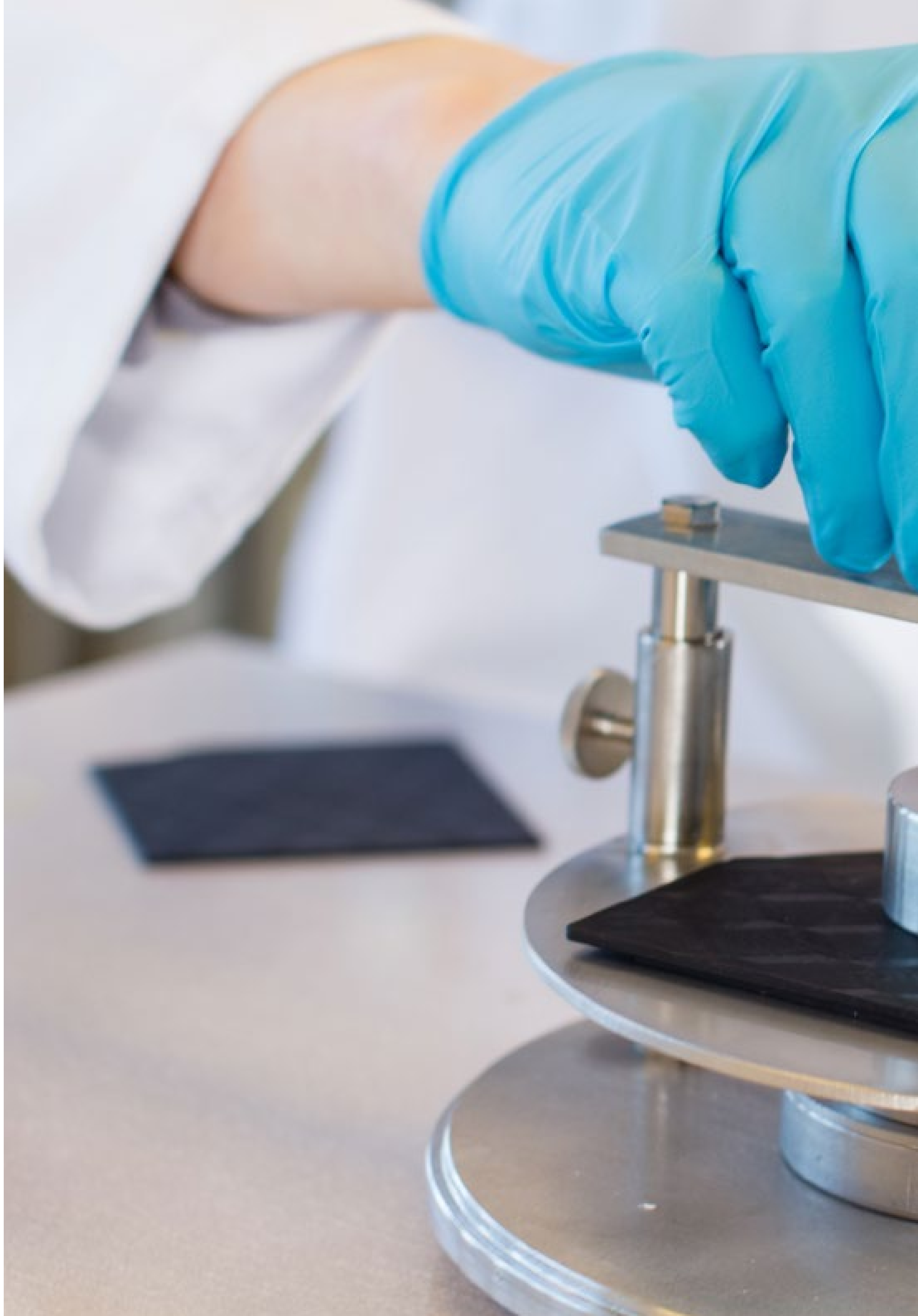
Skills

Thanks to this Professional Master's Degree, students will be able to obtain solid competences in the field of Material Physics. In addition, case studies provided in this program will enable you to enhance your problem-solving skills and master the indispensable techniques in this field. All this will lead to the necessary capabilities to develop new materials.

> *With this program you will be able to master the mechanical, electrical and physical behavior of materials. Enroll now"*

General Skills

- Know the mechanical, electronic and physical behavior of materials
- Be able to perform variation, charge distribution or magnetic field calculations
- Promote new material design and development



Specific Skills

- Know how to select and optimize materials
- Master the different material properties
- Apply and develop the necessary techniques within the framework of Material Physics

> *Acquire the knowledge you need to be able to develop the next material of the future. Enroll now"*

04

Structure and Content

This Professional Master's Degree has been structured in 10 modules which will allow students to delve into optics, classical mechanics, electromagnetism, statistical physics or Material Physics itself. The Relearning method, based on content reiteration, as well as the multimedia teaching material, will enhance learning. Likewise, students will be able to access this program's content 24 hours a day from any computer with Internet connection.

The multimedia resource library will be available 24 hours a day. Access it easily from your computer with internet connection"

Module 1. Optics

- 1.1. Waves: Introduction
  - 1.1.1. Wave Motion Equation
  - 1.1.2. Plane Waves
  - 1.1.3. Spherical Waves
  - 1.1.4. Harmonic Solution of the Wave Equation
  - 1.1.5. Fourier Analysis
- 1.2. Wavelet Superposition
  - 1.2.1. Superposition of Waves of the Same Frequency
  - 1.2.2. Superposition of Waves of Different Frequency
  - 1.2.3. Phase Velocity and Group Velocity
  - 1.2.4. Superposition of Waves with Perpendicular Electric Vectors
- 1.3. Electromagnetic Theory of Light
  - 1.3.1. Maxwell's Macroscopic Equations
  - 1.3.2. The Material Response
  - 1.3.3. Energy Relations
  - 1.3.4. Electromagnetic Waves
  - 1.3.5. Homogeneous and Isotropic Linear Medium
  - 1.3.6. Transversality of Plane Waves
  - 1.3.7. Energy Transport
- 1.4. Isotropic Media
  - 1.4.1. Reflection and Refraction in Dielectrics
  - 1.4.2. Fresnel Formulas
  - 1.4.3. Dielectric Media
  - 1.4.4. Induced Polarization
  - 1.4.5. Classical Lorentz Dipole Model
  - 1.4.6. Propagation and Diffusion of a Light Beam
- 1.5. Geometric Optics
  - 1.5.1. Paraxial Approximation
  - 1.5.2. Fermat's Principle
  - 1.5.3. Trajectory Equation
  - 1.5.4. Propagation in Non-Uniform Media
- 1.6. Image Formation
  - 1.6.1. Image Formation in Geometrical Optics
  - 1.6.2. Paraxial Optics
  - 1.6.3. Abbe's Invariant
  - 1.6.4. Increases
  - 1.6.5. Centered Systems
  - 1.6.6. Focuses and Focal Planes
  - 1.6.7. Planes and Main Points
  - 1.6.8. Thin Lenses
  - 1.6.9. System Coupling
- 1.7. Optical Instruments
  - 1.7.1. The Human Eye
  - 1.7.2. Photographic and Projection Instruments
  - 1.7.3. Telescopes
  - 1.7.4. Near Vision Instruments: Compound Magnifier and Microscope
- 1.8. Anisotropic Media
  - 1.8.1. Polarization
  - 1.8.2. Electrical Susceptibility Index Ellipsoid
  - 1.8.3. Wave Equation in Anisotropic Media
  - 1.8.4. Propagation Conditions
  - 1.8.5. Refraction in Anisotropic Media
  - 1.8.6. Fresnel Construction
  - 1.8.7. Construction with the Index Ellipsoid
  - 1.8.8. Retarders
  - 1.8.9. Absorbent Anisotropic Media
- 1.9. Interference
  - 1.9.1. General Principles and Interference Conditions
  - 1.9.2. Wavefront Split Interference
  - 1.9.3. Young's Stripes
  - 1.9.4. Amplitude Division Interferences
  - 1.9.5. Michelson's Interferometer
  - 1.9.6. Interference of Multiple Beams Obtained by Amplitude Division
  - 1.9.7. Fabry-Perot's Interferometer

1.10. Diffraction
    1.10.1. The Huygens-Fresnel Principle
    1.10.2. Fresnel and Fraunhofer Diffraction
    1.10.3. Fraunhofer's Diffraction through an Aperture
    1.10.4. Limitation of the Resolutive Power of the Instruments
    1.10.5. Fraunhofer Diffraction by Various Apertures
    1.10.6. Double Slit
    1.10.7. Diffraction Grating
    1.10.8. Introduction to Kirchhoff's Scalar Theory

Module 2. Classical Mechanics I

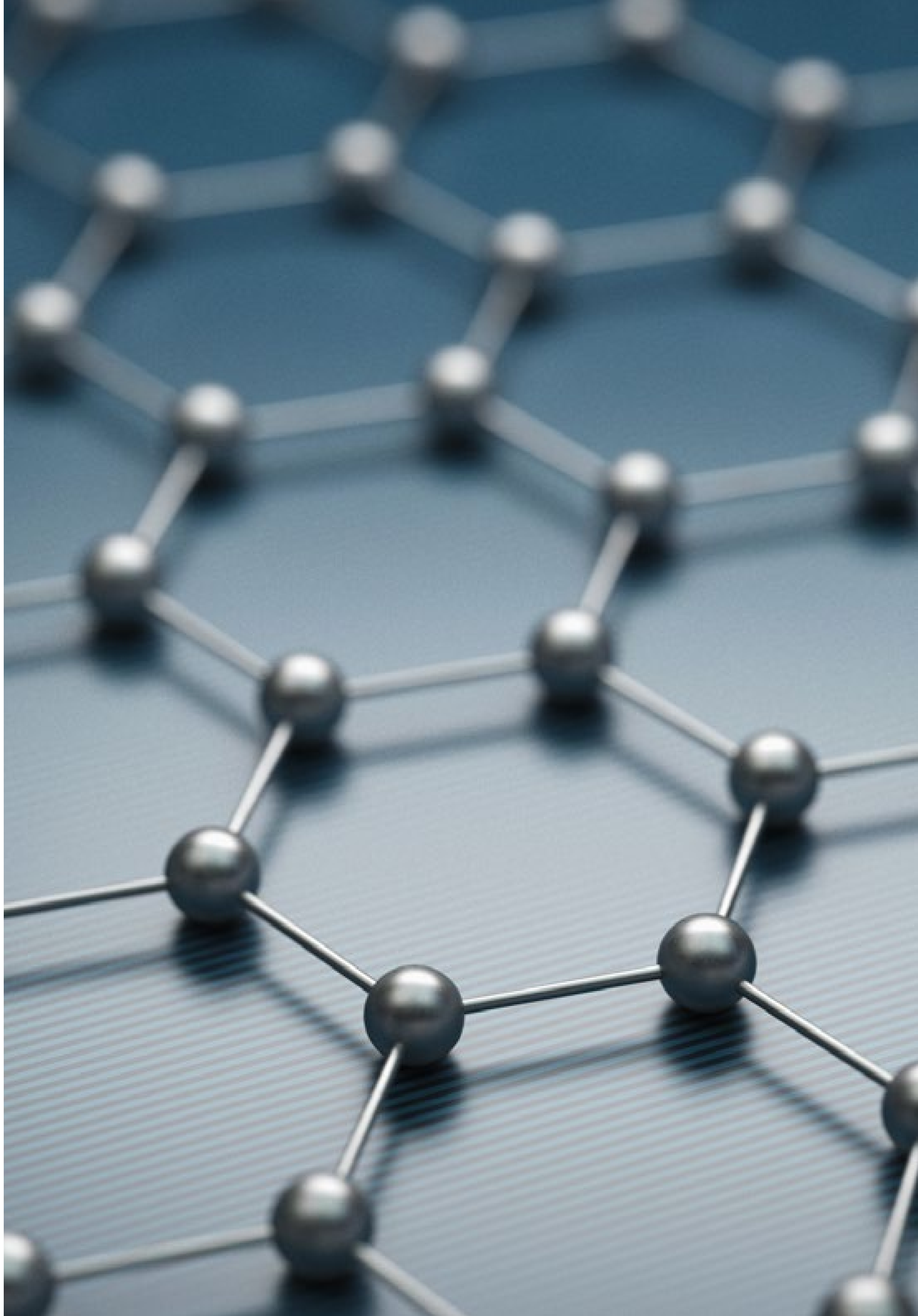
2.1. Kinematics and Dynamics: Review
    2.1.1. Newton's Law
    2.1.2. Reference Systems
    2.1.3. Motion Equation of Particles
    2.1.4. Conservation Theorems
    2.1.5. Particle System Dynamics
2.2. More Newtonian Mechanics
    2.2.1. Conservation Theorems for Particle Systems
    2.2.2. Universal Gravity Law
    2.2.3. Force Lines and Equipotential Surfaces
    2.2.4. Limitations of Newtonian Mechanics
2.3. Kinematics of Rotations
    2.3.1. Fundamentals of Mathematics
    2.3.2. Infinitesimal Rotations
    2.3.3. Angular Velocity and Acceleration
    2.3.4. Rotational Reference Systems
    2.3.5. Coriolis Force
2.4. Rigid Solid Study
    2.4.1. Rigid Solid Kinematics
    2.4.2. Inertia Tensor of Rigid Solids
    2.4.3. Main Inertia Axes
    2.4.4. Steiner and Perpendicular Axes Theorems
    2.4.5. Kinetic Energy of Rotation
    2.4.6. Angular Momentum
2.5. Symmetries and Conservation Laws
    2.5.1. Conservation Theorem of Linear Momentum
    2.5.2. Conservation Theorem of Angular Momentum
    2.5.3. Energy Conservation Theorem
    2.5.4. Classical Mechanic Symmetries: Galileo Group
2.6. Coordinate Systems: Euler Angles
    2.6.1. Coordinate Systems and Changes
    2.6.2. Euler Angles
    2.6.3. Euler Equations
    2.6.4. Stability Around a Major Axis
2.7. Rigid Solid Dynamics Applications
    2.7.1. Spherical Pendulum
    2.7.2. Free Symmetrical Top Movement
    2.7.3. Symmetrical Top Movement with a Fixed Point
    2.7.4. Gyroscopic Effect
2.8. Movement Under Central Forces
    2.8.1. Introduction to Central Force Fields
    2.8.2. Reduced Mass
    2.8.3. Trajectory Equation
    2.8.4. Central Field Orbits
    2.8.5. Centrifugal Energy and Effective Potential

2.9. Kepler's Problem
    2.9.1. Planetary Motion - Kepler's Problem
    2.9.2. Approximate Solution to Kepler's Equation
    2.9.3. Kepler's Laws
    2.9.4. Bertrand's Theorem
    2.9.5. Stability and Perturbation Theory
    2.9.6. 2-Body Problem

2.10. Collisions
    2.10.1. Elastic and Inelastic Shocks: Introduction
    2.10.2. Center of Mass Coordinate System
    2.10.3. Laboratory Coordinate System
    2.10.4. Elastic Shock Kinematics
    2.10.5. Particle Dispersion - Rutherford's Dispersion Formula
    2.10.6. Effective Section

Module 3. Electromagnetism

3.1. Vector Calculus: Review
    3.1.1. Vector Operations
        3.1.1.1. Scalar Products
        3.1.2.1. Vectorial Products
        3.1.3.1. Mixed Products
        3.1.4.1. Triple Product Properties
    3.1.2. Vector Transformation
        3.1.2.1. Differential Calculus
        3.1.2.1. Gradient
        3.1.2.2. Divergence
        3.1.2.3. Rotational
        3.1.2.4. Multiplication Rules



- 3.1.3. Integral Calculus
  - 3.1.3.1. Line, Surface and Volume Integrals
  - 3.1.3.2. Fundamental Calculus Theorem
  - 3.1.3.3. Fundamental Gradient Theorem
  - 3.1.3.4. Fundamental Divergence Theorem
  - 3.1.3.5. Fundamental Rotational Theorem
- 3.1.4. Dirac Delta Function
- 3.1.5. Helmholtz Theorem

3.2. Coordinate Systems and Transformations
- 3.2.1. Line, Surface and Volume Element
- 3.2.2. Cartesian Coordinates
- 3.2.3. Polar Coordinates
- 3.2.4. Spherical Coordinates
- 3.2.5. Cylindrical Coordinates
- 3.2.6. Coordinate Change

3.3. Electric Field
- 3.3.1. Point Charges
- 3.3.2. Coulomb's Law
- 3.3.3. Electric Field and Field Lines
- 3.3.4. Discrete Charge Distributions
- 3.3.5. Continuous Load Distributions
- 3.3.6. Divergence and Rotational Electric Field
- 3.3.7. Electric Field Flow: Gauss' Theorem

3.4. Electric Potential
- 3.4.1. Electric Potential Definition
- 3.4.2. Poisson's Equation
- 3.4.3. Laplace's Equation
- 3.4.4. Potential Charge Distribution Calculation

3.5. Electrostatic Energy
- 3.5.1. Electrostatic Work
- 3.5.2. Discrete Charge Distribution Energy
- 3.5.3. Continuous Charge Distribution Energy
- 3.5.4. Electrostatic Equilibrium Conductors
- 3.5.5. Induced Charges

3.6. Vacuum Electrostatics
- 3.6.1. Laplace's Equation in One, Two and Three Dimensions
- 3.6.2. Laplace's Equation - Boundary Conditions and Uniqueness Theorems
- 3.6.3. Image Method
- 3.6.4. Variable Separation

3.7. Multi-Polar Expansion
- 3.7.1. Approximate Potentials Away from the Source
- 3.7.2. Multi-Polar Development
- 3.7.3. Mono-Polar Term
- 3.7.4. Di-Polar Term
- 3.7.5. Coordinate Origins in Multipole Expansions
- 3.7.6. Electric Field of an Electric Dipole

3.8. Electrostatics in Material Media I
- 3.8.1. Dielectric Field
- 3.8.2. Dielectric Types
- 3.8.3. Vector Displacement
- 3.8.4. Gauss's Law in Dielectric Presence
- 3.8.5. Boundary Conditions
- 3.8.6. Electric Field within Dielectrics

3.9. Electrostatics in Material Media II: Linear Dielectrics
- 3.9.1. Electrical Susceptibility
- 3.9.2. Electrical Permittivity
- 3.9.3. Dielectric Constant
- 3.9.4. Dielectric Systems Energy
- 3.9.5. Dielectric Forces

3.10. Magnetostatics
- 3.10.1. Magnetic Induction Field
- 3.10.2. Electric Currents
- 3.10.3. Magnetic Field Calculation: Biot and Savart's Law
- 3.10.4. Lorentz Force
- 3.10.5. Divergence and Rotational Magnetic Field
- 3.10.6. Ampere's Law
- 3.10.7. Magnetic Vector Potential

Module 4. Classical Mechanics II

- 4.1. Oscillations
    - 4.1.1. Simple Harmonic Oscillator
    - 4.1.2. Damped Oscillator
    - 4.1.3. Forced Oscillator
    - 4.1.4. Fourier Series
    - 4.1.5. Green's Function
    - 4.1.6. Non-Linear Oscillators
- 4.2. Coupled Oscillations I
    - 4.2.1. Introduction
    - 4.2.2. Coupling of Two Harmonic Oscillators
    - 4.2.3. Normal Trends
    - 4.2.4. Weak Coupling
    - 4.2.5. Forced Vibrations of Coupled Oscillators
- 4.3. Coupled Oscillations II
    - 4.3.1. General Theory of Coupled Oscillations
    - 4.3.2. Normal Coordinates
    - 4.3.3. Multiple Oscillator Coupling: Continuous Boundary and Vibrating Wire
    - 4.3.4. Wave Equation
- 4.4. Special Relativity Theory
    - 4.4.1. Inertial Reference Systems
    - 4.4.2. Galileo's Invariance
    - 4.4.3. Lorentz Transformations
    - 4.4.4. Relative Velocities
    - 4.4.5. Linear Relativistic Momentum
    - 4.4.6. Relativistic Invariants
- 4.5. Tensor Formalism of Special Relativity
    - 4.5.1. Quadrivectors
    - 4.5.2. Quadrimomentum and Quadriposition
    - 4.5.3. Relativistic Energy
    - 4.5.4. Relativistic Forces
    - 4.5.5. Relativistic Particle Collisions
    - 4.5.6. Particle Disintegrations
- 4.6. Introduction to Analytical Mechanics
    - 4.6.1. Links and Generalized Coordinates
    - 4.6.2. Mathematical Tools: Variance Calculation
    - 4.6.3. Definition of Action
    - 4.6.4. Hamilton Principle: Extreme Action
- 4.7. Lagrangian Formulation
    - 4.7.1. Lagrangian Definition
    - 4.7.2. Variance Calculation
    - 4.7.3. Euler-Lagrange Equations
    - 4.7.4. Conserved Quantities
    - 4.7.5. Extension to Non-Holonomous Systems
- 4.8. Hamiltonian Formulation
    - 4.8.1. Phasic Space
    - 4.8.2. Legendre Transformations: Hamiltonian
    - 4.8.3. Canonical Equations
    - 4.8.4. Conserved Quantities
- 4.9. Analytical Mechanics-Extension
    - 4.9.1. Poisson Parentheses
    - 4.9.2. Lagrange Multipliers and Bond Forces
    - 4.9.3. Liouville Theorem
    - 4.9.4. Virial Theorem
- 4.10. Analytical Relativistic Mechanics and Classical Field Theory
    - 4.10.1. Charge Movement in Electromagnetic Fields
    - 4.10.2. Lagrangian of a Free relativistic particle
    - 4.10.3. Interaction Lagrangian
    - 4.10.4. Classical Field Theory: Introduction
    - 4.10.5. Classical Electrodynamics

Module 5. Electromagnetism II

5.1. Magnetism in Material Mediums
  - 5.1.1. Multi-Polar Development
  - 5.1.2. Magnetic Dipole
  - 5.1.3. Field Created by a Magnetic Material
  - 5.1.4. Magnetic Intensity
  - 5.1.5. Types of Magnetic Materials: Diamagnetic, Paramagnetic and Ferromagnetic
  - 5.1.6. Border Conditions

5.2. Magnetism in Material Media II
  - 5.2.1. Auxiliary Field H
  - 5.2.2. Ampere's Law in Magnetized Media
  - 5.2.3. Magnetic Susceptibility
  - 5.2.4. Magnetic Permeability
  - 5.2.5. Magnetic Circuits

5.3. Electrodynamics
  - 5.3.1. Ohm's Law
  - 5.3.2. Electromotive Force
  - 5.3.3. Faraday's Law and its Limitations
  - 5.3.4. Mutual Inductance and Self-Inductance
  - 5.3.5. Induced Electric Field
  - 5.3.6. Inductance
  - 5.3.7. Magnetic Field Energy

5.4. Maxwell's Equations
  - 5.4.1. Displacement Current
  - 5.4.2. Maxwell's Equations in Vacuum and in Material Media
  - 5.4.3. Boundary Conditions
  - 5.4.4. Solution Uniqueness
  - 5.4.5. Electromagnetic Energy
  - 5.4.6. Electromagnetic Field Drive
  - 5.4.7. Angular Momentum of Electromagnetic Fields

5.5. Conservation Laws
  - 5.5.1. Electromagnetic Energy
  - 5.5.2. Continuity Equation
  - 5.5.3. Poynting's Theorem
  - 5.5.4. Newton's Third Law in Electrodynamics

5.6. Waves electromagnetic: Introduction
  - 5.6.1. Wave Motion
  - 5.6.2. Wave Equation
  - 5.6.3. Electromagnetic Spectrum
  - 5.6.4. Plane Waves
  - 5.6.5. Sine Waves
  - 5.6.6. Boundary Conditions:
  - 5.6.7. Polarization

5.7. Electromagnetic Waves in Vacuums
  - 5.7.1. Wave Equation for Electric Fields and Magnetic Induction
  - 5.7.2. Monochromatic Waves
  - 5.7.3. Electromagnetic Wave Energy
  - 5.7.4. Electromagnetic Wave Momentum

5.8. Electromagnetic Waves in Material Media
  - 5.8.1. Flat Dielectric Waves
  - 5.8.2. Flat Conductor Waves
  - 5.8.3. Wave Propagation in Linear Media
  - 5.8.4. Medium Dispersive
  - 5.8.5. Reflection and Refraction

5.9. Waves in Confined Mediums I
  - 5.9.1. Maxwell's Guide Equations
  - 5.9.2. Dielectric Guides
  - 5.9.3. Modes in a Guide
  - 5.9.4. Propagation speed
  - 5.9.5. Rectangular Guide

5.10. Waves in Confined Mediums
  5.10.1. Resonant Cavities
  5.10.2. Transmission Lines
  5.10.3. Transitional Regime
  5.10.4. Permanent Regime

Module 6. Advanced Thermodynamics

6.1. Formalism of Thermodynamics
  6.1.1. Laws of Thermodynamics
  6.1.2. The Fundamental Equation
  6.1.3. Internal Energy: Euler's Form
  6.1.4. Gibbs-Duhem Equation
  6.1.5. Legendre Transformations
  6.1.6. Thermodynamic Potentials
  6.1.7. Maxwell's Relations for a Fluid
  6.1.8. Stability Conditions
6.2. Microscopic Description of Macroscopic Systems I
  6.2.1. Microstates and Macrostates: Introduction
  6.2.2. Phase Space
  6.2.3. Collectivities
  6.2.4. Microcanonical Collectivity
  6.2.5. Thermal Equilibrium
6.3. Microscopic Description of Macroscopic Systems II
  6.3.1. Discrete Systems
  6.3.2. Statistical Entropy
  6.3.3. Maxwell-Boltzmann Distribution
  6.3.4. Pressure
  6.3.5. Effusion
6.4. Canonical Collectivity
  6.4.1. Partition Function
  6.4.2. Ideal Systems
  6.4.3. Energy Degeneration
  6.4.4. Behavior of the Monoatomic Ideal Gas at a Potential
  6.4.5. Energy Equipartition Theorem
  6.4.6. Discrete Systems
6.5. Magnetic Systems
  6.5.1. Thermodynamics of Magnetic Systems
  6.5.2. Classical Paramagnetism
  6.5.3. ½" Spin Paramagnetism
  6.5.4. Adiabatic Demagnetization
6.6. Phase Transitions
  6.6.1. Classification of Phase Transitions
  6.6.2. Phase Diagrams
  6.6.3. Clapeyron Equation
  6.6.4. Vapor-Condensed Phase Equilibrium
  6.6.5. The Critical Point
  6.6.6. Ehrenfest's Classification of Phase Transitions
  6.6.7. Landau's Theory
6.7. Ising's Model
  6.7.1. Introduction
  6.7.2. One-Dimensional Chain
  6.7.3. Open One-Dimensional Chain
  6.7.4. Mean Field Approximation
6.8. Real Gases
  6.8.1. Comprehensibility Factor: Virial Development
  6.8.2. Interaction Potential and Configurational Partition Function
  6.8.3. Second Virial Coefficient
  6.8.4. Van der Waals Equation
  6.8.5. Lattice Gas
  6.8.6. Corresponding States Law
  6.8.7. Joule and Joule-Kelvin Expansions

- 6.9. Photon Gas
    - 6.9.1. Boson Statistics Vs. Fermion Statistics
    - 6.9.2. Energy Density and Degeneracy of States
    - 6.9.3. Planck Distribution
    - 6.9.4. Equations of State of a Photon Gas
- 6.10. Macrocanonical Collectivity
    - 6.10.1. Partition Function
    - 6.10.2. Discrete Systems
    - 6.10.3. Fluctuations
    - 6.10.4. Ideal Systems
    - 6.10.5. The Monoatomic Gas
    - 6.10.6. Vapor-Solid Equilibrium

Module 7. Material Physics

- 7.1. Materials Science and Solid State
    - 7.1.1. Field of Study of Materials Science
    - 7.1.2. Classification of Materials According to the Type of Bonding
    - 7.1.3. Classification of Materials According to Their Technological Applications
    - 7.1.4. Relationship between Structure, Properties and Processing
- 7.2. Crystalline Structures
    - 7.2.1. Order and Disorder: Basic Concepts
    - 7.2.2. Crystallography: Fundamental Concepts
    - 7.2.3. Review of Basic Crystal Structures: Simple Metallic and Ionic Structures
    - 7.2.4. More Complex Crystal Structures (Ionic and Covalent)
    - 7.2.5. Structure of Polymers
- 7.3. Defects in Crystalline Structures
    - 7.3.1. Classification of Imperfections
    - 7.3.2. Structural Defects
    - 7.3.3. Punctual Defects
    - 7.3.4. Other Imperfections
    - 7.3.5. Dislocations
    - 7.3.6. Interfacial Defects
    - 7.3.7. Extended Defects
    - 7.3.8. Chemical Imperfections
    - 7.3.9. Substitutional Solid Solutions
    - 7.3.10. Interstitial Solid Solutions
- 7.4. Phase Diagrams
    - 7.4.1. Fundamental Concepts
        - 7.4.1.1. Solubility Limit and Phase Equilibrium
        - 7.4.1.2. Interpretation and Use of Phase Diagrams: Gibbs Phase Rule
    - 7.4.2. 1 Component Phase Diagram
    - 7.4.3. 2 Component Phase Diagram
        - 7.4.3.1. Total Solubility in the Solid State
        - 7.4.3.2. Total Insolubility in the Solid State
        - 7.4.3.3. Partial Solubility in the Solid State
    - 7.4.4. 3 Component Phase Diagram
- 7.5. Mechanical Properties
    - 7.5.1. Elastic Deformation
    - 7.5.2. Plastic Deformation
    - 7.5.3. Mechanical Testing
    - 7.5.4. Fracture
    - 7.5.5. Fatigue
    - 7.5.6. Fluence
- 7.6. Electrical Properties
    - 7.6.1. Introduction
    - 7.6.2. Conductivity. Conductors
    - 7.6.3. Semiconductors
    - 7.6.4. Polymers
    - 7.6.5. Electrical Characterization
    - 7.6.6. Insulators
    - 7.6.7. Conductor-Insulator Transition
    - 7.6.8. Dielectrics
    - 7.6.9. Dielectric Phenomena
    - 7.6.10. Dielectric Characterization
    - 7.6.11. Materials of Technological Interest

- 7.7. Magnetic Properties
    - 7.7.1. Origin of Magnetism
    - 7.7.2. Materials with Magnetic Dipole Moment
    - 7.7.3. Types of Magnetism
    - 7.7.4. Local Field
    - 7.7.5. Diamagnetism
    - 7.7.6. Paramagnetism
    - 7.7.7. Ferromagnetism
    - 7.7.8. Antiferromagnetism
    - 7.7.9. Ferrimagnetism
- 7.8. Magnetic Properties II
    - 7.8.1. Domains
    - 7.8.2. Hysteresis
    - 7.8.3. Magnetostriction
    - 7.8.4. Materials of Technological Interest: Magnetically Soft and Hard
    - 7.8.5. Characterization of Magnetic Materials
- 7.9. Thermal Properties
    - 7.9.1. Introduction
    - 7.9.2. Heat Capacity
    - 7.9.3. Thermal Conduction
    - 7.9.4. Expansion and Contraction
    - 7.9.5. Thermoelectric Phenomena
    - 7.9.6. Magnetocaloric Effect
    - 7.9.7. Characterization of Thermal Properties
- 7.10. Optical Properties: Light and Matter
    - 7.10.1. Absorption and Re-Emission
    - 7.10.2. Light Sources
    - 7.10.3. Energy Conversion
    - 7.10.4. Optical Characterization
    - 7.10.5. Microscopy Techniques
    - 7.10.6. Nanostructures

Module 8. Analog and Digital Electronics

- 8.1. Circuit Analysis
    - 8.1.1. Element Constraints
    - 8.1.2. Connection Constraints
    - 8.1.3. Combined Constraints
    - 8.1.4. Equivalent Circuits
    - 8.1.5. Voltage and Current Division
    - 8.1.6. Circuit Reduction
- 8.2. Analog Systems
    - 8.2.1. Kirchoff's Laws
    - 8.2.2. Thévenin's Theorem
    - 8.2.3. Norton's Theorem
    - 8.2.4. Introduction to Semiconductor Physics
- 8.3. Devices and Characteristic Equations
    - 8.3.1. Diode
    - 8.3.2. Bipolar Transistors (BJTs) and MOSFETs
    - 8.3.3. Pspice Model
    - 8.3.4. Characteristic Curves
    - 8.3.5. Regions of Operation
- 8.4. Amplifiers
    - 8.4.1. Amplifier Operation
    - 8.4.2. Equivalent Circuits of Amplifiers
    - 8.4.3. Feedback
    - 8.4.4. Frequency Domain Analysis
- 8.5. Amplification Stages
    - 8.5.1. BJT and MOSFET Amplifier Function
    - 8.5.2. Polarization
    - 8.5.3. Equivalent Small-Signal Model
    - 8.5.4. Single-Stage Amplifiers
    - 8.5.5. Frequency Response
    - 8.5.6. Connection of Amplifier Stages in Cascade
    - 8.5.7. Differential Torque
    - 8.5.8. Current Mirrors and Application as Active Loads

- 8.6. Operational Amplifier and Applications
  - 8.6.1. Ideal Operational Amplifier
  - 8.6.2. Deviations from Ideality
  - 8.6.3. Sinusoidal Oscillators
  - 8.6.4. Comparators and Relaxation Oscillators
- 8.7. Logic Functions and Combinational Circuits
  - 8.7.1. Information Representation in Digital Electronics
  - 8.7.2. Boolean Algebra
  - 8.7.3. Simplification of Logic Functions
  - 8.7.4. Two-Level Combinational Structures
  - 8.7.5. Combinational Functional Modules
- 8.8. Sequential Systems
  - 8.8.1. Concept of Sequential System
  - 8.8.2. Latches, Flip-Flops and Registers
  - 8.8.3. State Tables and State Diagrams: Moore and Mealy Models
  - 8.8.4. Synchronous Sequential Systems Implementation
  - 8.8.5. General Structure of a Computer
- 8.9. MOS Digital Circuits
  - 8.9.1. Inverters
  - 8.9.2. Static and Dynamic Parameters
  - 8.9.3. Combinational MOS Circuits
    - 8.9.3.1. Step Transistor Logic
    - 8.9.3.2. Implementing Latches and Flip-Flops
- 8.10. Bipolar and Advanced Technology Digital Circuits
  - 8.10.1. BJT Switch. BTJ Digital Circuits
  - 8.10.2. TTL Transistor-Transistor Logic Circuits
  - 8.10.3. Characteristic Curves of a Standard TTL
  - 8.10.4. Emitter-Coupled Logic Circuits ECL
  - 8.10.5. Digital Circuits with BiCMOS

Module 9. Statistical Physics

- 9.1. Stochastic Processes
  - 9.1.1. Introduction
  - 9.1.2. Brownian Motion
  - 9.1.3. Random Walk
  - 9.1.4. Langevin Equation
  - 9.1.5. Fokker-Planck Equation
  - 9.1.6. Brownian Engines
- 9.2. Review of Statistical Mechanics
  - 9.2.1. Collectivities and Postulates
  - 9.2.2. Microcanonical Collectivity
  - 9.2.3. Canonical Collectivity
  - 9.2.4. Discrete and Continuous Energy Spectra
  - 9.2.5. Classical and Quantum Limits. Thermal Wavelength
  - 9.2.6. Maxwell-Boltzmann Statistics
  - 9.2.7. Energy Equipartition Theorem
- 9.3. Ideal Gas of Diatomic Molecules
  - 9.3.1. The Problem of Specific Heats in Gases
  - 9.3.2. Internal Degrees of Freedom
  - 9.3.3. Contribution of Each Degree of Freedom to the Heat Capacity
  - 9.3.4. Polyatomic Molecules
- 9.4. Magnetic Systems
  - 9.4.1. ½ Spin Systems
  - 9.4.2. Quantum Paramagnetism
  - 9.4.3. Classical Paramagnetism
  - 9.4.4. Superparamagnetism
- 9.5. Biological Systems
  - 9.5.1. Biophysics
  - 9.5.2. DNA Denaturation
  - 9.5.3. Biological Membranes
  - 9.5.4. Myoglobin Saturation Curve. Langmuir Isotherm

- 9.6. Systems with Interaction
    - 9.6.1. Solids, Liquids, Gases
    - 9.6.2. Magnetic Systems. Ferro-Paramagnetic Transition
    - 9.6.3. Weiss Model
    - 9.6.4. Landau Model
    - 9.6.5. Ising's Model
    - 9.6.6. Critical Points and Universality
    - 9.6.7. Monte Carlo Method. Metropolis Algorithm
- 9.7. Quantum Ideal Gas
    - 9.7.1. Distinguishable and Indistinguishable Particles
    - 9.7.2. Microstates in Quantum Statistical Mechanics
    - 9.7.3. Calculation of the Macrocanonical Partition Function in an Ideal Gas
    - 9.7.4. Quantum Statistics: Bose-Einstein and Fermi-Dirac Statistics
    - 9.7.5. Ideal Gases of Bosons and Fermions
- 9.8. Ideal Boson Gas
    - 9.8.1. Photons. Black Body Radiation
    - 9.8.2. Phonons. Heat Capacity of the Crystal Lattice
    - 9.8.3. Bose-Einstein Condensation
    - 9.8.4. Thermodynamic Properties of Bose-Einstein Gas
    - 9.8.5. Critical Temperature and Density
- 9.9. Ideal Gas for Fermions
    - 9.9.1. Fermi-Dirac Statistics
    - 9.9.2. Electron Heat Capacity
    - 9.9.3. Fermion Degeneracy Pressure
    - 9.9.4. Fermi Function and Temperature
- 9.10. Elementary Kinetic Theory of Gases
    - 9.10.1. Dilute Gas in Equilibrium
    - 9.10.2. Transport Coefficients
    - 9.10.3. Thermal Conductivity of the Crystalline Lattice and Electrons
    - 9.10.4. Gaseous Systems Composed of Moving Molecules

Module 10. Fluid Mechanics

- 10.1. Introduction to Fluid Physics
    - 10.1.1. No-Slip Condition
    - 10.1.2. Classification of Flows
    - 10.1.3. Control System and Volume
    - 10.1.4. Fluid Properties
        - 10.1.4.1. Density
        - 10.1.4.2. Specific Gravity
        - 10.1.4.3. Vapor Pressure
        - 10.1.4.4. Cavitation
        - 10.1.4.5. Specific Heat
        - 10.1.4.6. Compressibility
        - 10.1.4.7. Speed of Sound
        - 10.1.4.8. Viscosity
        - 10.1.4.9. Surface Tension
- 10.2. Fluid Statics and Kinematics
    - 10.2.1. Pressure
    - 10.2.2. Pressure Measuring Devices
    - 10.2.3. Hydrostatic Forces on Submerged Surfaces
    - 10.2.4. Buoyancy, Stability and Motion of Rigid Solids
    - 10.2.5. Lagrangian and Eulerian Description
    - 10.2.6. Flow Patterns
    - 10.2.7. Kinematic Tensors
    - 10.2.8. Vorticity
    - 10.2.9. Rotationality
    - 10.2.10. Reynolds Transport Theorem
- 10.3. Bernoulli and Energy Equations
    - 10.3.1. Conservation of Mass
    - 10.3.2. Mechanical Energy and Efficiency
    - 10.3.3. Bernoulli's Equation
    - 10.3.4. General Energy Equation
    - 10.3.5. Stationary Flow Energy Analysis

- 10.4. Fluid Analysis
    - 10.4.1. Conservation of Linear Momentum Equations
    - 10.4.2. Conservation of Angular Momentum Equations
    - 10.4.3. Dimensional Homogeneity
    - 10.4.4. Variable Repetition Method
    - 10.4.5. Buckingham's Pi Theorem
- 10.5. Flow in Pipes
    - 10.5.1. Laminar and Turbulent Flow
    - 10.5.2. Inlet Region
    - 10.5.3. Minor Losses
    - 10.5.4. Networks
- 10.6. Differential Analysis and Navier-Stokes Equations
    - 10.6.1. Conservation of Mass
    - 10.6.2. Current Function
    - 10.6.3. Cauchy Equation
    - 10.6.4. Navier-Stokes Equation
    - 10.6.5. Dimensionless Navier-Stokes Equations of Motion
    - 10.6.6. Stokes Flow
    - 10.6.7. Inviscid Flow
    - 10.6.8. Irrotational Flow
    - 10.6.9. Boundary Layer Theory. Clausius Equation
- 10.7. External Flow
    - 10.7.1. Drag and Lift
    - 10.7.2. Friction and Pressure
    - 10.7.3. Coefficients
    - 10.7.4. Cylinders and Spheres
    - 10.7.5. Aerodynamic Profiles
- 10.8. Compressible Flow
    - 10.8.1. Stagnation Properties
    - 10.8.2. One-Dimensional Isentropic Flow
    - 10.8.3. Nozzles
    - 10.8.4. Shock Waves
    - 10.8.5. Expansion Waves
    - 10.8.6. Rayleigh Flow
    - 10.8.7. Fanno Flow
- 10.9. Open Channel Flow
    - 10.9.1. Classification
    - 10.9.2. Froude Number
    - 10.9.3. Wave Speed
    - 10.9.4. Uniform Flow
    - 10.9.5. Gradually Varying Flow
    - 10.9.6. Rapidly Varying Flow
    - 10.9.7. Hydraulic Jump
- 10.10. Non-Newtonian Fluids
    - 10.10.1. Standard Flows
    - 10.10.2. Material Functions
    - 10.10.3. Experiments
    - 10.10.4. Generalized Newtonian Fluid Model
    - 10.10.5. Generalized Linear Viscoelastic Fluid Model
    - 10.10.6. Advanced Constitutive Equations and Rheometry

> *"Boost your career in Material Physics thanks to the comprehensive knowledge you will acquire over the course of this 12 months university program"*

05

Methodology

This academic program offers students a different way of learning. Our methodology uses a cyclical learning approach: **Relearning.**
This teaching system is used, for example, in the most prestigious medical schools in the world, and major publications such as the **New England Journal of Medicine** have considered it to be one of the most effective.

> Discover Relearning, a system that abandons conventional linear learning, to take you through cyclical teaching systems: a way of learning that has proven to be extremely effective, especially in subjects that require memorization"

Case Study to contextualize all content

Our program offers a revolutionary approach to developing skills and knowledge. Our goal is to strengthen skills in a changing, competitive, and highly demanding environment.

> *At TECH, you will experience a learning methodology that is shaking the foundations of traditional universities around the world"*

You will have access to a learning system based on repetition, with natural and progressive teaching throughout the entire syllabus.

The student will learn to solve complex situations in real business environments through collaborative activities and real cases.

A learning method that is different and innovative

This TECH program is an intensive educational program, created from scratch, which presents the most demanding challenges and decisions in this field, both nationally and internationally. This methodology promotes personal and professional growth, representing a significant step towards success. The case method, a technique that lays the foundation for this content, ensures that the most current economic, social and professional reality is taken into account.

> *Our program prepares you to face new challenges in uncertain environments and achieve success in your career"*

The case method is the most widely used learning system in the best faculties in the world. The case method was developed in 1912 so that law students would not only learn the law based on theoretical content. It consisted of presenting students with real-life, complex situations for them to make informed decisions and value judgments on how to resolve them. In 1924, Harvard adopted it as a standard teaching method.

What should a professional do in a given situation? This is the question that you are presented with in the case method, an action-oriented learning method. Throughout the program, the studies will be presented with multiple real cases. They will have to combine all their knowledge and research, and argue and defend their ideas and decisions.

Relearning Methodology

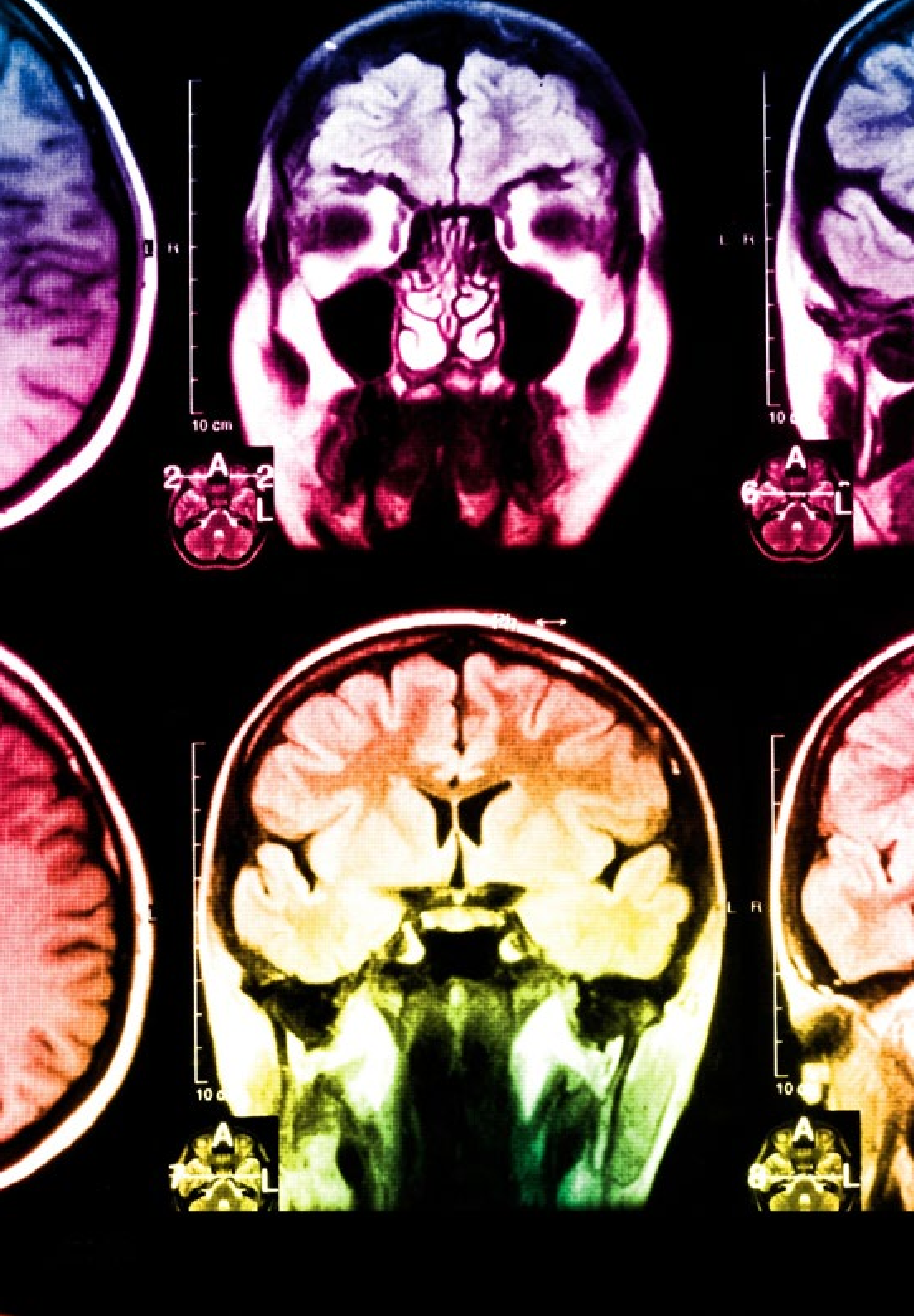
TECH effectively combines the Case Study methodology with a 100% online learning system based on repetition, which combines 8 different teaching elements in each lesson.

We enhance the Case Study with the best 100% online teaching method: Relearning.

In 2019, we obtained the best learning results of all online universities in the world.

At TECH, you will learn using a cutting-edge methodology designed to train the executives of the future. This method, at the forefront of international teaching, is called Relearning.

Our university is the only one in the world authorized to employ this successful method. In 2019, we managed to improve our students' overall satisfaction levels (teaching quality, quality of materials, course structure, objectives...) based on the best online university indicators.



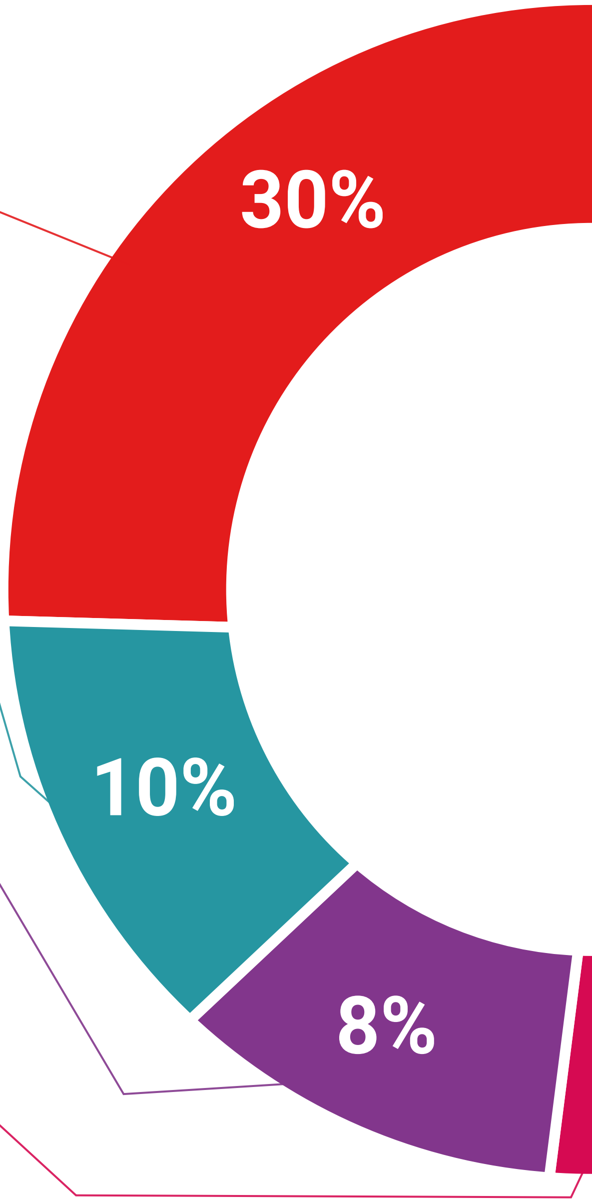
In our program, learning is not a linear process, but rather a spiral (learn, unlearn, forget, and re-learn). Therefore, we combine each of these elements concentrically. This methodology has trained more than 650,000 university graduates with unprecedented success in fields as diverse as biochemistry, genetics, surgery, international law, management skills, sports science, philosophy, law, engineering, journalism, history, and financial markets and instruments. All this in a highly demanding environment, where the students have a strong socio-economic profile and an average age of 43.5 years.

Relearning will allow you to learn with less effort and better performance, involving you more in your training, developing a critical mindset, defending arguments, and contrasting opinions: a direct equation for success.

From the latest scientific evidence in the field of neuroscience, not only do we know how to organize information, ideas, images and memories, but we know that the place and context where we have learned something is fundamental for us to be able to remember it and store it in the hippocampus, to retain it in our long-term memory.

In this way, and in what is called neurocognitive context-dependent e-learning, the different elements in our program are connected to the context where the individual carries out their professional activity.

This program offers the best educational material, prepared with professionals in mind:



Study Material

All teaching material is produced by the specialists who teach the course, specifically for the course, so that the teaching content is highly specific and precise.

These contents are then applied to the audiovisual format, to create the TECH online working method. All this, with the latest techniques that offer high quality pieces in each and every one of the materials that are made available to the student.

Classes

There is scientific evidence suggesting that observing third-party experts can be useful.

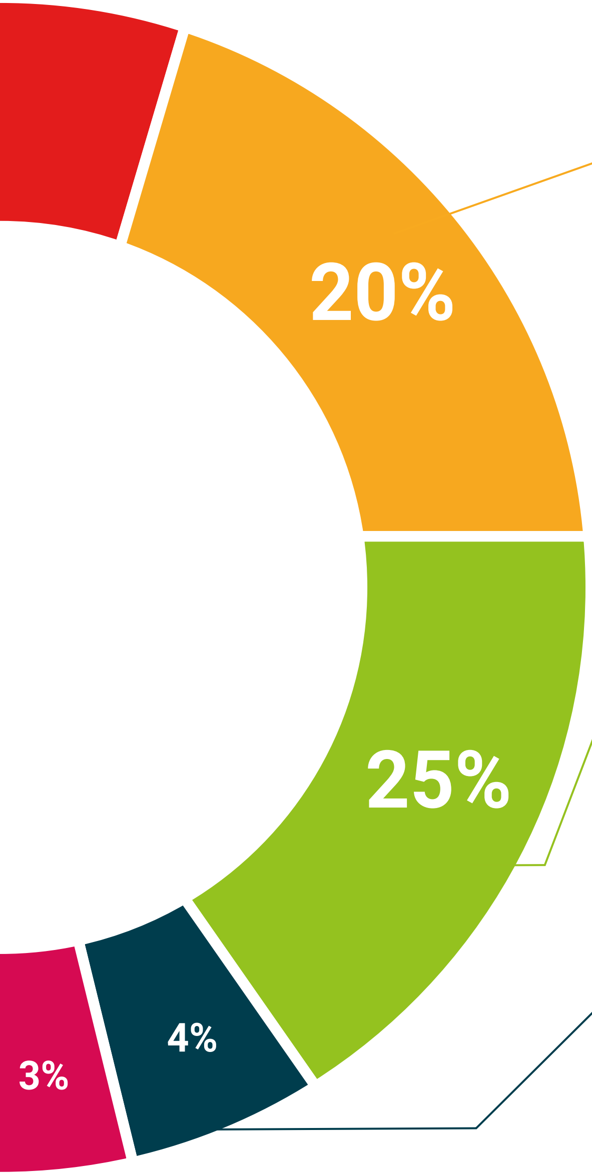
Learning from an Expert strengthens knowledge and memory, and generates confidence in future difficult decisions.

Practising Skills and Abilities

They will carry out activities to develop specific skills and abilities in each subject area. Exercises and activities to acquire and develop the skills and abilities that a specialist needs to develop in the context of the globalization that we are experiencing.

Additional Reading

Recent articles, consensus documents and international guidelines, among others. In TECH's virtual library, students will have access to everything they need to complete their course.



Case Studies

Students will complete a selection of the best case studies chosen specifically for this program. Cases that are presented, analyzed, and supervised by the best specialists in the world.

Interactive Summaries

The TECH team presents the contents attractively and dynamically in multimedia lessons that include audio, videos, images, diagrams, and concept maps in order to reinforce knowledge.

This exclusive educational system for presenting multimedia content was awarded by Microsoft as a "European Success Story".

Testing & Retesting

We periodically evaluate and re-evaluate students' knowledge throughout the program, through assessment and self-assessment activities and exercises, so that they can see how they are achieving their goals.

06

Certificate

The Professional Master's Degree in Material Physics guarantees students, in addition to the most rigorous and up-to-date education, access to a Professional Master's Degree issued by TECH Technological University.

> *Successfully complete this program and receive your university qualification without having to travel or fill out laborious paperwork"*

This **Professional Master's Degree in Material Physics** contains the most complete and up-to-date program on the market.

After the student has passed the assessments, they will receive their corresponding **Professional Master’s Degree** issued by **TECH Technological University** via tracked delivery*.

The diploma issued by **TECH Technological University** will reflect the qualification obtained in the Professional Master's Degree, and meets the requirements commonly demanded by labor exchanges, competitive examinations, and professional career evaluation committees.

Title: **Professional Master’s Degree in Material Physics**

Official N° of hours: **1,500 h.**

tech technological university

Awards the following

DIPLOMA

to

Mr./Ms. _________________, with identification number ____________.

For having successfully passed and accredited the following program

PROFESSIONAL MASTER’S DEGREE

in

Material Physics

This is a qualification awarded by this University, equivalent to 1,500 hours, with a start date of dd/mm/yyyy and an end date of dd/mm/yyyy.

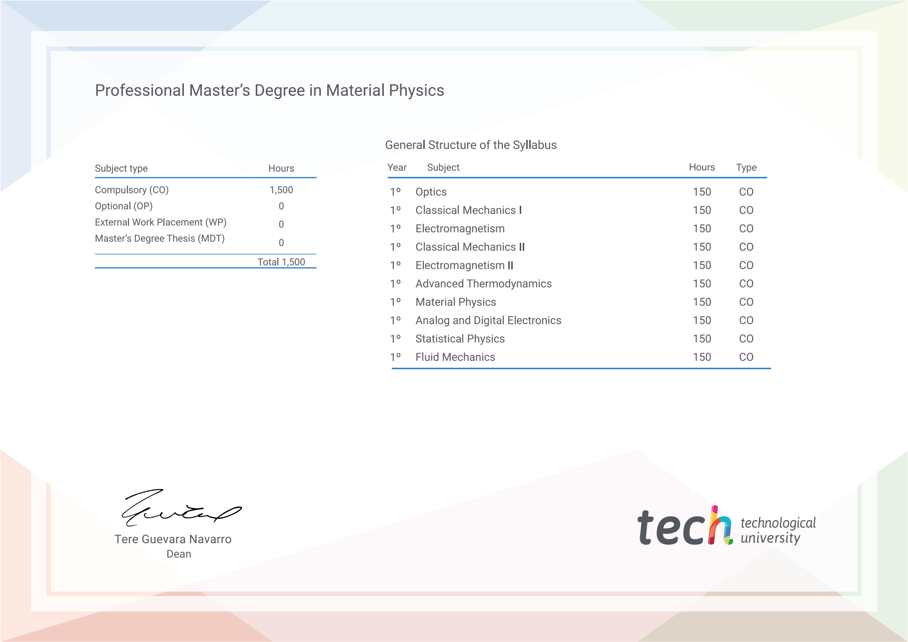
TECH is a Private Institution of Higher Education recognized by the Ministry of Public Education as of June 28, 2018.

June 17, 2020

Tere Guevara Navarro
Dean

This qualification must always be accompanied by the university degree issued by the competent authority to practice professionally in each country.

Unique TECH Code: AFWORD23S techtitute.com/certificates



Professional Master’s Degree in Material Physics

Subject type	Hours
Compulsory (CO)	1,500
Optional (OP)	0
External Work Placement (WP)	0
Master’s Degree Thesis (MDT)	0
	Total 1,500

General Structure of the Syllabus

Year	Subject	Hours	Type
1º	Optics	150	CO
1º	Classical Mechanics I	150	CO
1º	Electromagnetism	150	CO
1º	Classical Mechanics II	150	CO
1º	Electromagnetism II	150	CO
1º	Advanced Thermodynamics	150	CO
1º	Material Physics	150	CO
1º	Analog and Digital Electronics	150	CO
1º	Statistical Physics	150	CO
1º	Fluid Mechanics	150	CO

Tere Guevara Navarro
Dean

tech technological university

*Apostille Convention. In the event that the student wishes to have their paper diploma issued with an apostille, TECH EDUCATION will make the necessary arrangements to obtain it, at an additional cost.

tech technological university

Professional Master's Degree
Material Physics

- Modality: **online**
- Duration: **12 months**
- Certificate: **TECH Technological University**
- Dedication: **16h/week**
- Schedule: **at your own pace**
- Exams: **online**

Professional Master's Degree

Material Physics

tech technological university