Study Plan

School: School of Sciences and Technology
Degree: Bachelor
Course: Renewable Energies Engineering (cód. 698)

1st Year - 1st Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
MAT12877L	Mathematical Calculus I	*** TRANSLATE ME: ***	6	Semester	156
MAT0900L	Linear Algebra and Geometry I	Mathematics	6	Semester	156
QUI1090L	General Chemistry	Chemistry	6	Semester	156
INF0878L	Programming	Informatics	6	Semester	156
FIS13073L	Energy, Environment and Sustainability	*** TRANSLATE ME: ***	6	Semester	156

1st Year - 2nd Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
MAT12878L	Mathematical Calculus II	*** TRANSLATE ME: ***	6	Semester	156
MAT12619L	Introduction to Probability and Statistics	Mathematics	6	Semester	156
FIS0528L	Applied Thermodynamics	Mechanical Engineering	6	Semester	156
FIS13008L	General Physics I	*** TRANSLATE ME: ***	6	Semester	156
FIS13011L	Technical Drawing of Mechanical Systems	*** TRANSLATE ME: ***	6	Semester	156

2nd Year - 3rd Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
MAT13046L	Mathematical Analysis III	*** TRANSLATE ME: ***	6	Semester	156
FIS13009L	General Physics II	*** TRANSLATE ME: ***	6	Semester	156
FIS13010L	Electrical Theory	*** TRANSLATE ME: ***	6	Semester	156
FIS13006L	Engineering Mechanics I	*** TRANSLATE ME: ***	6	Semester	156
FIS13045L	Fluid Mechanics	*** TRANSLATE ME: ***	6	Semester	156

2nd Year - 4th Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS13012L	Introduction to Materials Science and Manufacturing Processes	*** TRANSLATE ME: ***	6	Semester	156
FIS13013L	Electrical Machines	*** TRANSLATE ME: ***	6	Semester	156
FIS0506L	Control and Automation	Electrotechnical Engineering	6	Semester	156
FIS13072L	Applied Electronics	*** TRANSLATE ME: ***	6	Semester	156

2nd Year - 4th Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS10987L	Energy and Mass Transfer	Mechanical Engineering	6	Semester	156

3rd Year - 5th Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS1805L	Solar Thermal Energy	Mechanical Engineering and Electrotechnical Engineering	6	Semester	156
FIS10989L	Photovoltaic Solar Energy	Mechanical Engineering and Electrotechnical Engineering	6	Semester	156
FIS1808L	Wind Energy	Mechanical Engineering and Electrotechnical Engineering	6	Semester	156
FIS10990L	Biomass and Fuels Energy	Mechanical Engineering and Electrotechnical Engineering	6	Semester	156
FIS1809L	Ocean Energy	Mechanical Engineering and Electrotechnical Engineering	6	Semester	156

3rd Year - 6th Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS10928L	Project of Energy Systems	Mechanical Engineering and Electrotechnical Engineering	12	Semester	312
FIS1812L	Energy Storage	Mechanical Engineering and Electrotechnical Engineering	6	Semester	156
FIS13074L	Electrical Energy Systems	*** TRANSLATE ME: ***	6	Semester	156

Options

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS13076L	Geothermal Energy	*** TRANSLATE ME: ***	6	Semester	156
FIS13075L	New Energy Vectors	*** TRANSLATE ME: ***	6	Semester	156
GES2310L	Entrepreneurship and Innovation	Management	6	Semester	156

Conditions for obtaining the Degree:

*** TRANSLATE ME: Engenharia de Energias Renováveis

Para obtenção do grau de licenciado em Engenharia de Energias Renováveis é necessário obter aprovação a 174 ECTS em unidades de curriculares obrigatórias e 6 ECTS em unidades curriculares optativas distribuídas da seguinte forma:

1º Ano

1º Semestre:

5 UC Obrigatórias num total de 30 ECTS

2º Semestre

5 UC Obrigatórias num total de 30 ECTS

2º Ano

3º Semestre

5 UC Obrigatórias num total de 30 ECTS

4º Semestre

5 UC Obrigatórias num total de 30 ECTS

3º Ano

5º Semestre

5 UC Obrigatórias num total de 30 ECTS

6º Semestre

3 UC Obrigatórias num total de 24 ECTS

1 UC Optativa num total de 6 ECTS ***

Program Contents

Back

Mathematical Calculus I (MAT12877L)

1. Sequences and series.
2. Real functions of one variable.
3. Differential calculus.
4. Sequences and series of functions.
5. Integral calculus and applications.

Back

Linear Algebra and Geometry I (MAT0900L)

Systems of linear equations.
Matrices.
Determinants.
Vector spaces.
Linear applications.
Eigenvalues and eigenvectors.
Geometry of plane and space.
Quadratic forms.

Back

General Chemistry (QUI1090L)

Course contents1. Introduction{\}newline
1.1 Models of atoms{\}newline
The principal quantum number{\}newline
Atomic orbitals{\}newline
Hydrogen atom{\}newline
Orbital Energies{\}newline
Electronic structure of polielectronic atoms{\}newline
The building-up Principle. The Aufbau rule. Exclusion Principle of Pauli. Hund's rule{\}newline
1.2 The Periodic Table{\}newline
Periodic classification of the elements.{\}newline
Electronic structure and the Periodic Table{\}newline
Periodic variation in physical properties{\}newline
Effective nuclear charge{\}newline
Atomic and ionic Radius {\}newline
Ionization Energy, Electronegativity and electron Affinity {\}newline
{\}newline
2. Chemical Bonding{\}newline
2.1 Lewis structures. Octet Rule.{\}newline
2.2 Bond types: ionic, covalent and metallic{\}newline
2.3 The Ionic Bond{\}newline
Ionic bond formation.{\}newline
Ions interaction{\}newline
Lattice energy of ionic compounds{\}newline
Ionic solids {\}newline
Polarizability and the ionic character of ionic bonds{\}newline
2.4 The Covalent Bond {\}newline
2.4.1 Lewis structure for polyatomic species{\}newline
The concept of Resonance {\}newline
Formal charge{\}newline
Electronegativity and Polar bonds {\}newline
2.4.2 Covalent bond strength. {\}newline
The variation of bond strength. Dissociation energy. Bond length.{\}newline
2.4.3 Exceptions to the Octet Rule: radicals and biradicals; expanded valence shell, incomplete octet {\}newline
2.4.4 Coordinative covalent bond. Complexes and coordination compounds.{\}newline
Ligands. Coordination number.{\}newline
Chelate; bi- and polidentate ligands.{\}newline
2.4.5 Molecular shape and structure {\}newline
The VSEPR model{\}newline
Molecules with lone pairs on the central atom{\}newline
Valence Bond Theory{\}newline
Hybridization of orbitals{\}newline
Hybridization in a more complex molecules{\}newline
Characteristics of double bonds{\}newline
Benzene ring and Kekule structures{\}newline
Polyatomics molecules{\}newline
Polar molecules{\}newline
2.5 Metallic bond{\}newline
Band theory. Conductor and semiconductors.{\}newline
Metals properties{\}newline
{\}newline
3. Properites of gases, Liquids and Solids {\}newline
3.1.1 Properties of gases{\}newline
Pressure{\}newline
Boyle's Law. Charles and Gay-Lussac's Law{\}newline
Avogadro Principle.{\}newline
3.1.2 The Ideal Gas model. Equation of Ideal Gases.{\}newline
Gas density{\}newline
3.1.3 Mixture of gases. Partial Pressure and Dalton's Law{\}newline
3.1.4 Real Gases. Deviation from linearity.{\}newline

Back

Programming (INF0878L)

Introduction to programming in Python.
Using the interpreter in script and interactive mode.
Variables, expressions and instructions.
Definition and Use of Functions.
Control structures.
Native data structures.
Sequential data structures: lists, tuples, and strings.
Associative data structures: dictionaries.
Basic concepts of input / output (I / O).
File manipulation.
Graphic interface.
Using to libraries / modules.
Libraries with advanced functionality for scientific calculation.
Program development.

Back

Energy, Environment and Sustainability (FIS13073L)

1. The Earth: land subsystems and their interaction. The main biogeochemical cycles. Resources: content, availability and strategic importance. Duration of resources and their distribution.
2. Sustainability and use of resources: Biocapacity and ecological footprint, the ecological balance, the water footprint and the carbon footprint. Energy and sustainability, life-cycle assessment in the context of sustainability. Diagnosis for sustainability in Portugal.
3. Energy sources: fossil fuels, nuclear energy and alternative sources (renewable energy). Energy and exergy analysis.
4. Energy: production, transmission, storage and consumption. The energy markets. Energy efficiency.
5. Energy and environment: pollution, greenhouse effect and climate change.

Back

Mathematical Calculus II (MAT12878L)

1. Differential Calculus in Rn

Algebraic and topological structure of Rn. Functions from Rn to Rm: Continuity and the notion of limit. Differentiability. Partial derivatives. Chain rule. Taylor's theorem in Rn and applications to the study of extreme values. Inverse and implicit function theorems. Extreme values of functions with constrained variables

2. Integral Calculus in Rn

Multiple integrals: Fubini's theorem, change of variables theorem, applications to the computation of physical quantities. Line integrals: Integrals of scalar fields and vector fields. Fundamental theorem of calculus for line integrals, conservative fields and scalar potentials. Green's theorem. Surface integrals: surface integrals of a scalar field, flux of a vector field, divergence theorem and Stokes' theorem.

Back

Introduction to Probability and Statistics (MAT12619L)

Theoretical Component

What is Statistics and its role in scientific work; population, sample. Probability: definitions, axiomatic and properties, conditional probability, Bayes' theorem; discrete models: uniform in n points, binomial, Poisson, geometric and hypergeometric; continuous models: uniform, exponential, normal, t-Student, chi-square; discrete random pair; central limit theorem. Descriptive statistics: graphical representation of data, sample characteristics. Statistical Inference: estimation by confidence intervals (for mean value, variance and difference of mean values of normal populations); hypothesis tests: on the mean value in normal populations and with large samples (t-tests); on variance in normal populations; adjustment; on the mean value based on small samples and on non-normal populations (Wilcoxon and signal test); for comparison of two populations, based on two independent samples and two paired samples (t-tests, Mann-Whitney, Wilcoxon's and signs). Simple Linear Regression.

Practical Component

Resolution of exercises involving the theory exposed in the theoretical classes and using the programs, whenever possible, SPSS or R. These exercises are chosen so as to illustrate the best possible the application of statistics in the area of Engineering and Industrial Management

Back

Applied Thermodynamics (FIS0528L)

Back

General Physics I (FIS13008L)

I. Mechanics

- Scientific method. Measurements, units and dimensions.
- Kinematics and dynamics of mass points. Newton's laws and applications.
- Work and energy. Collisions and momentum. Conservation laws.
- Systems of many particles. The rigid body. Angular momentum.
- Universal gravitation.

II. Oscillations and waves

- Periodic and simple harmonic motion. Forced oscillations and resonance.
- Coupled oscillators. Normal modes.
- Progressive waves. The Doppler effect.
- Superposition and interference. Standing waves.

III. Option

A.Thermodynamics

- Thermal equilibrium and temperature.
- The ideal gas. The equation of state. Internal energy, heat and work.
- Calorimetry. Work and heat in thermal processes.
- The kinetic theory of gases.
- The 2nd law of thermodynamics. Heat engines. Reversible and irreversible processes. Entropy.

B.Topics on mechanical properties of solids

- Stress, deformation, elasticity and Hooke's law.
- Microscopic model for mechanical constant of solids.

Back

Technical Drawing of Mechanical Systems (FIS13011L)

1. Technical Drawing as a language. The concept of projection, orthogonal projections and representations using multiple views. Freehand drawing. Main associated standardization and its justification.
2. Reading of drawings with multiple views representations and execution of perspectives.
3. Computer aided drafting.
4. Section views.
5. Auxiliary views and intersections.
6. Construction of parametric three dimensional computer models of parts and systems.
7. Phases of the design process. The importance of the material properties and brief introduction to the manufacturing processes.
8. Dimensioning.
9. Standardized mechanical parts. Assembly of parts and assembly drawings.
10. Dimensional tolerances and mating.
11. Introduction to the geometrical product specification.
12. Surface finish and edge requirements.

Back

Mathematical Analysis III (MAT13046L)

1. Introduction to Complex Analysis.
2. Ordinary Differential Equations.
3. Systems of ordinary differential equations.
4. Fourier series. Fourier integrals.

Back

General Physics II (FIS13009L)

I. Electromagnetism
Electrostatics. Electric charges and forces. Gauss's law
Electric potential. Capacitors
Electric current. Kirchhoff's rules. RC circuits
Magnetic fields and the Lorentz force
Sources of the magnetic field. Magnetism in matter
Electromagnetic induction. Faraday's law
AC-current
Maxwell's equations
Electromagnetic waves. Polarization
II. Optics
Nature of light. Geometric optics. Image formation by mirrors and lenses
Wave optics. Double-slit experiment. Diffraction and interference
III. Modern physics
Special relativity. Time dilation and Lorentz contraction. Relativistic momentum and energy
Introduction to quantum physics. Particle properties of light. Photoelectric effect and Compton scattering. Waveparticle duality. Uncertainty principle. Wave function
Atoms. Atomic spectra. Hydrogen atom in quantum mechanics. Periodic table of the elements
Nuclear physics. Stability and instability of nuclei. Elementar particles. Contemporary physics.

Back

Electrical Theory (FIS13010L)

1. Introduction
Applications of Maxwell's equations.

2. Stationary Electric Current
Ohm's law. Electrical energy sources. Joule's law.
Direct current circuit analysis. Kirchhoff's laws. Circuit analysis theorems.

3. Magnetostatics
Magnetic circuits analysis using Maxwell equations.

4. Varying Electromagnetic Field
Applications of Faraday's law: ideal transformer, electrical generator and motor.

5. Quasi Steady State Circuits
Sinusoidal voltages and currents; complex representation.
Analysis of alternating current circuits. Kirchhoff's law. Circuit analysis theorems.
Active, Reactive and Apparent Power.
Dynamic behavior of electric circuits.

6. Three-Phase Systems
Star and Triangle connections. Transformations. Circuit analysis with different loads. Unbalanced loads.

Back

Engineering Mechanics I (FIS13006L)

1. Revisions: the concept of force, parallelogram law for the addition of forces, vectors, static equilibrium of particles in 2D and 3D.
2. Rigid body. Moment of a force about a point. Couple of forces. Equivalent systems of forces. Distributed forces. Reduction to a resultant force or force-couple.
3. Free body diagram. Equations governing the static equilibrium of rigid bodies in 2D and 3D.
4. Center of gravity, mass and centroid.
5. Static analysis of rigid body trusses, structures and mechanisms in 2D and 3D. Static determinacy.
6. Determination of internal force resultants in bars, beams and cables.
7. Analysis of rigid body structures in the presence of dry friction. Study of wedges, screws, sliding bearings, belts and cables.
8. Second moments of area. The parallel axis theorem. Principal axis of an area.

Back

Fluid Mechanics (FIS13045L)

Introductory concepts: fluid properties, stresses, viscosity, surface tension, Newtonian and non-Newtonian fluids, flow classification. Fluid statics: hydrostatic equation, hydrostatic pressure distribution, hydrostatic force, hydrostatic moment, buoyancy and Archimedes principle, equilibrium and stability of immersed bodies. Volume control analysis, conservation of mass, momentum and energy, momentum equation, angular momentum equation. Differential forms: continuity, Navier-Stokes and energy equations. Simple analytic solutions of the Navier-Stokes equations. Pipe and ducts flow: head loss, turbulence, flow in multiple path pipe and duct systems, Moody diagram. Similitude and Modelling.

Back

Introduction to Materials Science and Manufacturing Processes (FIS13012L)

1) Industrial Materials and Materials Science: Properties. Polymers, Metal Alloys, Ceramic Materials, Magnetic Materials, Semi-conductive Materials.
2) Crystaline materials, imperfections
3) Binary phase diagrams
4) Electric properties of metals and semiconductors
5) Mechanical and Thermal properties, rheology
6) Magnetic and dielectric materials
7) Non-crystaline materials
8) Polymeric and composite materials
9) Introduction to surface Engineering
10) Mechanical testing: tension, compression, hardeness, fractura, fatigue

Back

Electrical Machines (FIS13013L)

1. Introduction to the study of Electrical Machines
Electromagnetic concepts and circuit analysis revisited.
Principles of electromechanical energy conversion.

2. Transformer
One-phase transformer.
Three-phase transformer.
Special transformers. The self-transformer. Measurement transformers.

3. DC Machines
Introduction and functioning principles. Generator functioning. Main characteristics. Application fields.
Motor functioning. Main characteristics. Application fields.

4. Asynchronous Machine.
Constructive aspects and functioning principles.
Three-phase induction machine.
One-phase induction machine.

5. Synchronous Machine.
Constructive aspects and functioning principles.
Generator study.
Synchronous motor.

6. Small motors
DC motors. Servomotor. Stepper motors.
Pulse Width Modulation (PWM). H bridges. Encoders.
Speed, direction and position control using microcontrollers.

Back

Control and Automation (FIS0506L)

PART I: Control Systems: 1) The Control of dynamic systems. Fundamental control types. Feedforward Control and Feedback Control. 2) Analysis of Transfer Function described systems: i) Time-domain analysis (1st order systems, 2nd order systems and multiple order systems). Project characteristics of 1st-order systems. Project characteristics of 2nd-order systems. System stationary response. Steady-state error. Stability criteria (Routh, Root Locus). P-Controller design using the Root Locus method. ii) Frequency-domain analysis. Bode diagram. Bode factors: 1st-order elementary factors, 2nd-order elementary factors. Bode stability criteria. Gain margin and phase margin. P-Controller design using the Bode method. iii) The PID controller. Usual design methods.3) Analysis of State-space described systems: Linear systems stability. Liapunov stability criteria. PART II: Industrial Automation: 1) Industrial logic components: pneumatic technology, electrical technology, electronic technology. 2) The Programmable Logic Controller (PLC). 3) Elementary components of an automatic system (sensors and actuators). 4) Combinatory systems and sequential systems. 5) Design of sequential automatic systems using the GRAFCET methodology. 6) Design and implementation of sequential automatic systems using Siemens LOGO PLCs. Programming with Simatic Ladder Logic Diagram (LADDER).

Back

Applied Electronics (FIS13072L)

- Introduction: Metrology and Electrical Engineering
- AC regime, electrical impedances, frequency and phase, power and energy, rms
- Semiconductors: Materials, energy bands, energy gap
- Semiconductors: Diodes, Thermistors NTC, characteristics R(T) and I(V), implementation in temperature measurements
- Circuits with diodes: Rectification
- Transistors: NPN and PNP
- Operational amplifiers
- Analog signal processing, circuits conditioners
- Digital signal processing: Microcontrollers, data acquisition boards
- Project implementation

Back

Energy and Mass Transfer (FIS10987L)

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Solar Thermal Energy (FIS1805L)

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Photovoltaic Solar Energy (FIS10989L)

1. Introduction.
The Physics of the Photovoltaic (PV) conversion.
PV Conversion technologies.
2. Photovoltaic systems.
Stationary systems and systems with tracking.
Photovoltaic systems with energy storage.
3. Applications and Projects.
Types of applications: autonomous (off grid), on grid, building integrated (BIPV), floating photovoltaic systems, photovoltaic irrigation and others (water purification, telecommunications systems, electric vehicles).
Design and energetic analysis of photovoltaic systems.
Testing and Monitoring Standards for Photovoltaic Systems.
Modeling of photovoltaic systems.
4. New Trends.
Photovoltaic Systems and Smart Grids
New technologies for photovoltaic systems and applications, new energy storage technologies.

Back

Wind Energy (FIS1808L)

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Biomass and Fuels Energy (FIS10990L)

1. Status of the Portuguese, European and World bioenergy: Statistics. Strategies.
2. Biomass as a fuel: Carbon cycle. Concept of bioenergy. Energy potential of biomass (virgin and residues). Conversion processes.
3. Handling and treatment of farming and agri-industry effluents: Legislation. Effluents types. Characterisation and production quantities. Handling systems. Storage facilities. Valorisation and treatment systems (compost, separation, etc.).
4. Physical processes for biomass conversion: dehydration and drying. Size reduction. Densification. Separation.
5. Biofuel production: bioethanol, biomethanol, biodiesel and biogas production.
6. Thermal energy production from biomass: combustion, gasification and pyrolysis.
7. Electricity production from biomass: Rankine, Brayton, Otto, Diesel and dual cycles. Combined cycle. Cogeneration.
8. Legislation for the biomass sector.

Back

Ocean Energy (FIS1809L)

The ocean as a physical system. Main mechanisms that force the ocean movements. Thermodynamic properties of the seawater. Ocean dynamics. Ocean hydrokinetic energy conversion. Ocean hydro-potential energy conversion. Ocean thermal gradient energy conversion. Ocean salinity gradient energy conversion. Other forms: deuterium and nuclear fusion; near and offshore wind energy conversion.

Back

Project of Energy Systems (FIS10928L)

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Energy Storage (FIS1812L)

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Electrical Energy Systems (FIS13074L)

Fundamental concepts: Per-unit system; Charge diagrams; power system topology.
Transformer: electrical parameters; Scheme equivalent; numerical applications.
Power transmission line: Electric Line Parameters: Resistance and inductance, transverse conductance and capacity.
Equations of the long line; exact model; Scheme equivalent; Line lossless; Power carry capacity; numerical applications.
Transmission and distribution of electricity; Function; Configuration; voltage levels; constituent elements; one-line diagrams.
Short circuits: neutral systems; Calculation of short-circuit currents symmetrical and asymmetrical; Applications using numerical informatics platform; Techniques limitation of short circuit currents.
Standards, regulations and technical orders applicable to these systems, indicators of quality of service.

Back

Geothermal Energy (FIS13076L)

Introduction. The energetic problem in the world. Geothermal energy.
Heat flow lost by the Earth by conduction.
The role of the water circulation in geothermal reservoirs.
Radiation heat transfer. Convection. Viscosity. Some notions of thermodynamics.
Geothermal survey (introduction). Geochemistry. Geophysical Prospecting.
Reserves and Resources. Evaluation of a geothermal reserve.
Production of electricity by geothermal (historical notes). Production of electrical energy. Geothermal pumps. Direct use of geothermal fluids. Some applications.
Environmental problems associated with the use of geothermal reserves. Costs. Used area and water required.
Geothermal energy in the future: main problems to solve.

Back

New Energy Vectors (FIS13075L)

1. Introduction
2. Hydrogen as energy carrier
3. Hydrogen production - electrolysis, thermolysis, photocatalytic production, thermochemical processes, gasification, steam reforming, biological processes. Integration of renewable energy sources. Centralized and decentralized production
4. Storage and transportation of hydrogen
5. Fuel cells - types and operation, energy analysis and efficiency. Applications
6. Safety and environmental impacts
7. Hydrogen economy
8. Synthetic fuels - Carbon neutral fuels and carbon negative fuels, production methods, carbon sources. Integration of renewable energy sources

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Entrepreneurship and Innovation (GES2310L)

Module 1 – Introduction to Entrepreneurship and Innovation
a. Definitions and concepts of Entrepreneurship
b. Profile and characteristics of entrepreneurs
c. Social entrepreneurship and intrapreneurship
d. What is innovation? Types of innovation
d. Dynamics of innovation

Module 2 – Conception and Structuring business ideas
a. Process and techniques of generating ideas
b. Design Thinking tool
c. Evaluation of business ideas
d. The process of creating a business idea and firm
e. Simulation games- from ideas to business formation