Study Plan

School: School of Sciences and Technology
Degree: Bachelor
Course: Mechatronics Engineering (cód. 703)

Specialization Automation and Robotics

1st Year - 1st Semester
Specialization Automation and Robotics

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
INF13175L	Programming I	*** TRANSLATE ME: ***	6	Semester	156
QUI1090L	General Chemistry	Chemistry	6	Semester	156
FIS13237L	Introduction to Mechatronics Systems	*** TRANSLATE ME: ***	6	Semester	156

***** TRANSLATE ME:UC de Recuperação no 1º Ano do 2º Semestre *****

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
MAT12878L	* Mathematical Calculus II	*** TRANSLATE ME: ***	6	Semester	156

1st Year - 2nd Semester
Specialization Automation and Robotics

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
FIS13008L	General Physics I	*** TRANSLATE ME: ***	6	Semester	156
FIS13011L	Technical Drawing of Mechanical Systems	*** TRANSLATE ME: ***	6	Semester	156
INF13194L	Programming II	*** TRANSLATE ME: ***	6	Semester	156

***** TRANSLATE ME:UC de Recuperação no 1º Ano do 1º Semestre *****

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

2nd Year - 3rd Semester
Specialization Automation and Robotics

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
MAT13046L	Mathematical Analysis III	*** TRANSLATE ME: ***	6	Semester	156
GES2332L	Operation Management	Management	6	Semester	156

2nd Year - 3rd Semester
Specialization Automation and Robotics

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

2nd Year - 4th Semester
Specialization Automation and Robotics

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS13013L	Electrical Machines	*** TRANSLATE ME: ***	6	Semester	156
FIS13012L	Introduction to Materials Science and Manufacturing Processes	*** TRANSLATE ME: ***	6	Semester	156
FIS0507L	Electronics I	Electrotechnical Engineering	6	Semester	156
FIS0506L	Control and Automation	Electrotechnical Engineering	6	Semester	156
FIS0528L	Applied Thermodynamics	Mechanical Engineering	6	Semester	156

3rd Year - 5th Semester
Specialization Automation and Robotics

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS0505L	Industrial Automatisms	Electrotechnical Engineering	6	Semester	156
FIS0511L	Instrumentation	Electrotechnical Engineering	6	Semester	156
FIS0508L	Electronics II	Electrotechnical Engineering	6	Semester	156
FIS13094L	Mechanics of Materials	*** TRANSLATE ME: ***	6	Semester	156
FIS13045L	Fluid Mechanics	*** TRANSLATE ME: ***	6	Semester	156

3rd Year - 6th Semester
Specialization Automation and Robotics

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS13221L	Design of Mechatronics Systems	*** TRANSLATE ME: ***	6	Semester	156

3rd Year - 6th Semester
Specialization Automation and Robotics

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
Group of Options					

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS13007L	Engineering Mechanics II	*** TRANSLATE ME: ***	6	Semester	156
FIS13015L	Manufacturing Processes	*** TRANSLATE ME: ***	6	Semester	156
FIS13238L	Microprocessors and Embedded Systems	*** TRANSLATE ME: ***	6	Semester	156
FIS0509L	Industrial Electronics	Electrotechnical Engineering	6	Semester	156
FIS0526L	Structural Mechanics	Mechanical Engineering	6	Semester	156
FIS13220L	Robotics	*** TRANSLATE ME: ***	6	Semester	156

Specialization Aeronautics

1st Year - 1st Semester
Specialization Aeronautics

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
INF13175L	Programming I	*** TRANSLATE ME: ***	6	Semester	156
QUI1090L	General Chemistry	Chemistry	6	Semester	156
FIS13237L	Introduction to Mechatronics Systems	*** TRANSLATE ME: ***	6	Semester	156
***** TRANSLATE ME:UC de Recuperação no 1º Ano do 2º Semestre *****					

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
MAT12878L	* Mathematical Calculus II	*** TRANSLATE ME: ***	6	Semester	156

1st Year - 2nd Semester
Specialization Aeronautics

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
FIS13008L	General Physics I	*** TRANSLATE ME: ***	6	Semester	156
FIS13011L	Technical Drawing of Mechanical Systems	*** TRANSLATE ME: ***	6	Semester	156
INF13194L	Programming II	*** TRANSLATE ME: ***	6	Semester	156

1st Year - 2nd Semester
Specialization Aeronautics

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
***** TRANSLATE ME:UC de Recuperação no 1º Ano do 1º Semestre *****					
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

2nd Year - 3rd Semester
Specialization Aeronautics

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
MAT13046L	Mathematical Analysis III	*** TRANSLATE ME: ***	6	Semester	156
GES2332L	Operation Management	Management	6	Semester	156
FIS13010L	Electrical Theory	*** TRANSLATE ME: ***	6	Semester	156
FIS13009L	General Physics II	*** TRANSLATE ME: ***	6	Semester	156
FIS13006L	Engineering Mechanics I	*** TRANSLATE ME: ***	6	Semester	156

2nd Year - 4th Semester
Specialization Aeronautics

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS13013L	Electrical Machines	*** TRANSLATE ME: ***	6	Semester	156
FIS13012L	Introduction to Materials Science and Manufacturing Processes	*** TRANSLATE ME: ***	6	Semester	156
FIS0507L	Electronics I	Electrotechnical Engineering	6	Semester	156
FIS0506L	Control and Automation	Electrotechnical Engineering	6	Semester	156
FIS0528L	Applied Thermodynamics	Mechanical Engineering	6	Semester	156

3rd Year - 5th Semester
Specialization Aeronautics

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS0505L	Industrial Automatisms	Electrotechnical Engineering	6	Semester	156
FIS0511L	Instrumentation	Electrotechnical Engineering	6	Semester	156
FIS0508L	Electronics II	Electrotechnical Engineering	6	Semester	156
FIS13094L	Mechanics of Materials	*** TRANSLATE ME: ***	6	Semester	156
FIS13045L	Fluid Mechanics	*** TRANSLATE ME: ***	6	Semester	156

3rd Year - 6th Semester
Specialization Aeronautics

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS13235L	Design of Aeronautic Systems	*** TRANSLATE ME: ***	6	Semester	156
FIS13229L	Flight Safety and Certification	*** TRANSLATE ME: ***	6	Semester	156
FIS13230L	Aircraft Systems	*** TRANSLATE ME: ***	6	Semester	156
FIS13231L	Aircraft Performance	*** TRANSLATE ME: ***	6	Semester	156

Group of Options

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS13007L	Engineering Mechanics II	*** TRANSLATE ME: ***	6	Semester	156
FIS13015L	Manufacturing Processes	*** TRANSLATE ME: ***	6	Semester	156
FIS10987L	Energy and Mass Transfer	Mechanical Engineering	6	Semester	156
FIS13220L	Robotics	*** TRANSLATE ME: ***	6	Semester	156

Specialization Energy

1st Year - 1st Semester
Specialization Energy

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
INF13175L	Programming I	*** TRANSLATE ME: ***	6	Semester	156
QUI1090L	General Chemistry	Chemistry	6	Semester	156
FIS13237L	Introduction to Mechatronics Systems	*** TRANSLATE ME: ***	6	Semester	156

***** TRANSLATE ME:UC de Recuperação no 1º Ano do 2º Semestre *****

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
MAT12878L	* Mathematical Calculus II	*** TRANSLATE ME: ***	6	Semester	156

1st Year - 2nd Semester
Specialization Energy

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
FIS13008L	General Physics I	*** TRANSLATE ME: ***	6	Semester	156
FIS13011L	Technical Drawing of Mechanical Systems	*** TRANSLATE ME: ***	6	Semester	156
INF13194L	Programming II	*** TRANSLATE ME: ***	6	Semester	156

1st Year - 2nd Semester
Specialization Energy

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
***** TRANSLATE ME:UC de Recuperação no 1º Ano do 1º Semestre *****					
MAT12877L	* Mathematical Calculus I	*** TRANSLATE ME: ***	6	Semester	156
MAT0900L	* Linear Algebra and Geometry I	Mathematics	6	Semester	156

2nd Year - 3rd Semester
Specialization Energy

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
MAT13046L	Mathematical Analysis III	*** TRANSLATE ME: ***	6	Semester	156
GES2332L	Operation Management	Management	6	Semester	156
FIS13010L	Electrical Theory	*** TRANSLATE ME: ***	6	Semester	156
FIS13009L	General Physics II	*** TRANSLATE ME: ***	6	Semester	156
FIS13006L	Engineering Mechanics I	*** TRANSLATE ME: ***	6	Semester	156

2nd Year - 4th Semester
Specialization Energy

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS13013L	Electrical Machines	*** TRANSLATE ME: ***	6	Semester	156
FIS13012L	Introduction to Materials Science and Manufacturing Processes	*** TRANSLATE ME: ***	6	Semester	156
FIS0507L	Electronics I	Electrotechnical Engineering	6	Semester	156
FIS0506L	Control and Automation	Electrotechnical Engineering	6	Semester	156
FIS0528L	Applied Thermodynamics	Mechanical Engineering	6	Semester	156

3rd Year - 5th Semester
Specialization Energy

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS0505L	Industrial Automatisms	Electrotechnical Engineering	6	Semester	156
FIS0511L	Instrumentation	Electrotechnical Engineering	6	Semester	156
FIS0508L	Electronics II	Electrotechnical Engineering	6	Semester	156
FIS13094L	Mechanics of Materials	*** TRANSLATE ME: ***	6	Semester	156
FIS13045L	Fluid Mechanics	*** TRANSLATE ME: ***	6	Semester	156

3rd Year - 6th Semester
Specialization Energy

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS13236L	Energy Systems Design	*** TRANSLATE ME: ***	6	Semester	156
FIS13007L	Engineering Mechanics II	*** TRANSLATE ME: ***	6	Semester	156
FIS10987L	Energy and Mass Transfer	Mechanical Engineering	6	Semester	156

Group of Options

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS0509L	Industrial Electronics	Electrotechnical Engineering	6	Semester	156
FIS13015L	Manufacturing Processes	*** TRANSLATE ME: ***	6	Semester	156
FIS13233L	Thermal Equipment	*** TRANSLATE ME: ***	6	Semester	156
FIS13074L	Electrical Energy Systems	*** TRANSLATE ME: ***	6	Semester	156
FIS1812L	Energy Storage	Mechanical Engineering and Electrotechnical Engineering	6	Semester	156

Conditions for obtaining the Degree:

*** TRANSLATE ME: Engenharia Mecatrónica

Para obtenção do grau de licenciado em Engenharia Mecatrónica é necessário obter aprovação a 180 ECTS em unidades de curriculares obrigatórias distribuídas da seguinte forma:

Área de especialização de Automação e Robótica

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

1 UC Obrigatórias num total de 6 ECTS

UC Optativas num total de 24 ECTS do Grupo de Optativas do semestre

Área de especialização de Aeronáutica

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

4 UC Obrigatórias num total de 24 ECTS

UC Optativas num total de 6 ECTS do Grupo de Optativas do semestre

Área de especialização de Energia

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

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

Programming I (INF13175L)

Notion of algorithm and instruction
Edit, compile, and debug process
IDEs and pseudo-code
Notion of constant and variable
Arithmetic and Expressions
Basic types: integer, real, boolean, string
Instruction and assignment
Decision structures: comparison, multiple alternatives, nested branches
Repetition structures: while, for, sentinel values, nested loops
Functions: parameters and return value
Scope of variables and function reuse
One and two-dimensional arrays
Structures
Sequential Access Files
Recursion

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

Introduction to Mechatronics Systems (FIS13237L)

1. Introduction.
2. Introduction to microcontroller programming using Arduino. Button, LEDs and small motors interface and control. Pulse Width Modulation (PWM).
3. Introduction to graphical programming using LabView. Dataflow concept. Control panel and block diagram. Structures for flow control.
4. Introduction to the use of numerical tools using Matlab {\} Octave. Matrix operations. Function plotting. Flow control. Polynomial root computation. Minimization of multidimensional functions. Solving simple differential equations.
5. Introduction to the use of symbolic calculation tools using Mathematica. Expression simplification. Antiderivatives and integrals calculation.
6. Presentation of the branches: Mechatronics, Aerospace and Energy.

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

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

Programming II (INF13194L)

Object-oriented analysis and program design.
A general-purpose object-oriented language (Java).
Incremental program development.
Class libraries (packages).
Simple graphical user interfaces.

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

Operation Management (GES2332L)

Part 1 - Introduction to Operations Management

What is operations management?
Operations Strategy
Demand forecasting methods

Part 2 - Design, analysis and improvement of the operating system

Quality management and statistical quality control
Product/service design
Processs design and tecnhology choice

Part 3- Operations system management

Supply chain management
Independent demand stocks management
Aggregated production planning
Resources planning: MRP, CRP and ERP
Lean production systems
Production Scheduling
Theory of constraints

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

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

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

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

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

Electronics I (FIS0507L)

1. Introduction to Circuit Analysis. Basic concepts revisited.
Fundamental electric units. Electric potential. Electric voltage. Current intensity. Electromotive force. Ohm's Law. Resistors in Series and Parallel. Direct current circuits.

2. Semiconductors
Semiconductor materials. Intrinsic and Doped semiconductors. Type N and type P semiconductors. PN junction. Potential energy barrier. Direct and Inverse Polarization.

3. Diode
The ideal diode. Characteristic curve. The real diode. Characteristic curve. Approximate models. Small-signal model e its applications. Rectifier circuits.
The Zener diode, the tunnel diode and the light emitting diode (LED). Applications.

4. Transistors
Bipolar Junction Transistor (BJT)
Characteristic curves. Operation regions. Polarization schemes. Typical configurations: common emitter, common base, and common collector. Characteristics. Small signal analysis. Applications.
Field Effect Transistor
The Junction FET (JFET). Characteristic curves. The Metal-Oxide Semiconductor FET (MOSFET). Characteristic curves.
5. Operational Amplifiers
Real and ideal characteristics. Analysis of OpAmps with feedback.
Linear circuits with OpAmps: inverting configuration, non- inverting configuration, voltage follower, current-voltage and voltage-current converters, differential amplifier.
Operational circuits with OpAmps: inverting and non-inverting summer, integrator and differentiator.
Nonlinear Circuits with OpAmps: comparators, rectifiers and limiting circuits.

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 Thermodynamics (FIS0528L)

Back

Industrial Automatisms (FIS0505L)

1) Introduction to the industrial automatic machines: the control system, the power system, the Human-Machine Interface. 2) Boolean algebra review: Boolean Functions representation (algebraic form, truth tables, Karnaugh diagrams). Simplifying Boolean expressions. Implementation of Boolean expressions using electronic gates.3) Review of the Design of sequential automatic systems using the GRAFCET methodology.4) Implementation of automatic systems using sequencial units. 5) Design and implementation of sequential systems using Programmable Logic Controllers (PLC) Siemens-LOGO: digital I/O and analogue I/O.6) Design and implementation of sequential systems using Programmable Logic Controllers (PLC) Siemens-S7-***: digital I/O and analogue I/O. Structured programming (FC, FDB, DB).7) Programming Human-Machine Interfaces (Siemens HMI).8) Communication - Human-Machine Interfaces and PLC Siemens S7-***. 9) Local Control and Distributed Control. Communication between distributed systems. Industrial communication networks (Profibus network and Ethernet network).

Back

Instrumentation (FIS0511L)

Introduction to Metrology: history, definition, fundamental and derived units. Notion of uncertainty and error. Law of the propagation of uncertainties.

Electrical signals: periodic signals; sinewave signals; average and RMS value; Fourier series; frequency spectrum; harmonic distortion; Fourier transform.

Operational amplifiers: characteristics (gain, slew-rate, saturation, power supply, input and output impedance, offset voltage, bias currents, noise); basic configurations (inverting, non-inverting, summing, difference); common mode rejection ratio; instrumentation amplifier. Configurations: integrating, differentiating, logarithmic, anti-logarithmic, division, multiplication, functional. Isolation amplifiers. Voltage comparators with/without hysteresis.

Digital to Analog converters: ideal converter; conversion technique; resistance ladder network; accuracy and precision; conversion speed and current output.
Analog to Digital converters: voltage-frequency; voltage-time; simultaneous; successive approximations; sigma-delta; pipeline. ADC transfer function: offset, gain, INL and DNL.

Data acquisition systems: controllers with ADCs. Acquisition mode. Multiplexer. Programmable gain amplifier. Sample/Hold. Differential and Referenced inputs. Bandwidth. Sampling frequency. Sampling theorem. Aliasing. Synchronous and asynchronous coherent sampling. Non-coherent sampling. Frequency spectrum and frequency resolution. Spectral leakage. Windowing. Amplitude spectrum and power spectrum. FFT. Average and RMS value estimation. ENOB.

Analog instruments. Moving coil: voltmeter, ammeter, ohmmeter. Moving coil with rectification. Electronic voltmeter. Electromagnetic. Electrodynamic. Wattmeter. Electrostatic. Thermoelectric converter. Precision class. Reading errors.

Digital instruments. Input conditioning. AC/DC mode. RMS converters. Bandwidth. Communication interfaces. Accuracy. Time and frequency measurements. Universal digital counter.

Transducers: Definition, Physical Principles, Applications. Measurement transducer classification. Signal conditioning. Extensometers: metallic; semiconductor. LVDT.

Back

Electronics II (FIS0508L)

1. Introduction

Digital systems versus Analog systems. Levels pf integration. Applications. Number systems. Binary numbers.

2. BOOLEAN Algebra

Logic functions. Axioms, properties and theorems. Canonical forms. Karnaugh maps. Gate-Level minimization. Don't-care conditions. NAND and NOR implementation.

3. Digital Integrated Circuits

Logic families. Electric levels. Main characteristics: Fan-Out; Propagation delays; Noise margin. TTL circuits. Positive, negative and mixed logic.

4. Combinational circuits

Coders and decoders. Multiplexers. Comparators. Summers.

5. Synchronous Sequential Circuits

SR and D latches. SR, D, T and JK Flip-Flops. Mealy and Moore state machines. State diagrams.

6. Registers and Counters

Simple registers, shift registers. Synchronous counters.

7. Memories

Memory characteristics and capacity. Memory types; RAM, ROM, EPROM. Dynamic RAM.

8. Programmable Logic

PLA. PAL. CPLD. FPGA

9. Circuit Families

RTL, DTL and TTL.

Back

Mechanics of Materials (FIS13094L)

1) Strain tensor, compatibility equations.
2) Stress tensor, equilibrium equations, Cauchy's lemma.
3) Generalized Hooke's Law.
4) Longitudinally loaded members.
5) Bending: normal stresses and shear stresses. Displacement equation. Integration methods.
6) Torsion of circular sections, torsion of open and closed thin-walled profiles.
7) Introduction to the Kirchhoff-Love theory applied to circular plates.
8) Structural stability. Introduction to Euler's Theory.
9) Energy theorems.

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

Design of Mechatronics Systems (FIS13221L)

1) Presentation of the main phases of the Project of a new industrial product: Economic viability study, Product development, Process development, Production, Quality assurance. Main industrial Tools for each phase requirements of the Project of a new Product.
2) Ethics and professional deontology. The Engineering in the service of safety, health and public welfare.
3) The scope of Projects in Mechanical Engineering, Electrotechnical Engineering (Electronics and Instrumentation) and Mechatronics Engineering (Automation and Automatic Control).
4) Mechanical Design. Example of International Codes for Mechanical Design (lifting devices, pressurized tanks, ...).
5) The Electronic and Instrumentation Design. Example of Design Softwares (Mentor Graphics, LabView, ...).
6) Automation and Control Design. The mechanical system and the control system. Design Software in Automatic Control (MatLab). Programmed Automation Technologies. Design and implementation with the Siemens Simatic architecture

Back

Engineering Mechanics II (FIS13007L)

1. Revisions of kinematics and kinetics of particles. Equations of motion in different coordinate systems. Numerical solutions of ordinary differential equations.
2. Kinematics of rigid bodies in 2D and 3D. Frames of reference in motion. Planar mechanisms, kinematic joints and constraint equations. Numerical solution of systems of nonlinear equations.
3. Motion of a continuum body, deformation gradient, polar decomposition, deformation and rotation. The axioms of conservation of mass, linear momentum, angular momentum and conservation of energy. Application to a rigid body. Centre of mass, inertia tensor.
4. Kinetics of rigid bodies and mechanical systems in planar motion.
5. Applications of the conservation of energy and impulse and momentum principles.
6. Kinetics of rigid bodies in 3D. Motion of a gyroscope.
7. Introduction to the dynamical analysis of mechanical system using a computer program. Applications to robotics and attitude mechanics in aerospace systems.

Back

Manufacturing Processes (FIS13015L)

1) Technological processes of plastic forming: complements of Bulk and sheet forming.
2) Technological cutting processes by CNC cutting and punching.
3) Numerical simulation of plastic deformation processes.
4) Machining; main features. Machine tools.
5) Welding, brazing and bonding processes.
6) Casting.
7) Molding and injection of plastics.
8) Simulation software for manufacturing processes: stamping, forging, plastics injection, casting.
9) Composites manufacturing: advanced fiber deposition, textile fiber deposition, spray deposition, filament winding, Lanxide, stitching and tufting and Z-pinning processes.
10) Rapid prototyping / 3D modeling.

Back

Microprocessors and Embedded Systems (FIS13238L)

1. Introduction.
2. Hardware description language (VHDL).
3. Microcontroller architectures. Data processing unit. Control unit. Memory units. Addressing modes. Instruction set architecture. Assembler programming.
4. Arduino architecture. Main components and interfaces. Communication: series; Serial Peripheral Interface (SPI); and Inter-Integrated Circuit (I2C). Pulse Width Modulation (PWM) applications.
5. Real-time systems. Timers. Interruptions and Interrupt Service Routines (ISR). Data acquisition.

Back

Industrial Electronics (FIS0509L)

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Structural Mechanics (FIS0526L)

Back

Robotics (FIS13220L)

1)Manipulator robots. Robot classes. Components of a robotic system.
2)Mathematical models of typical joints. Kinematic chains. Kinematics and linear transformations: direct kinematics and inverse kinematics. Denavit-Hartenberg formulation.
3)Robot Dynamics: Lagrange and Newton-Euler formulations. Trajectory planning.
4)Robot Control: independent joint-control, work space-control. Practical implementation with Laboratory Robots – Online and Offline Programming.
5)Robotic sensors: position/speed, proximity, force/torque, artificial vision sensors.
6)Introduction to automatic vision. Equipment for industrial vision. Digital signal processing. Filtering. Textures and form classification. Introduction to pattern recognition.
7)The integration of artificial vision in industrial automation controlled by PLC (Programmable Logic Controller). Practical implementations with vision sensors Siemens VS-710 (Siemens-ProVision).

Back

Design of Aeronautic Systems (FIS13235L)

The Project Assignment must have at least the following general
basic structure,
adaptable to specific cases of the topics under study:
1 - Introduction
2 - Framework
3 - Methodology (materials and methods)
4 - processing and analysis of data
5 - Discussion and interpretation of results
6 - Conclusions
7 – References.

Back

Flight Safety and Certification (FIS13229L)

1. Introduction: Safety vs. Security.

2. Safety and Prevention of Occurrences: Regulation and Legislation; Information systems; Human Factors; Airport infrastructures; Case Study Analysis.

3. Safety and Investigation of Occurrences: Regulation and Legislation; Technical and Operational Components; Role of Air Traffic Control; Case Study Analysis.

4. Security: Regulation and Legislation; Technical and Operational Components; Airport infrastructures; Case Study Analysis.

5. ICAO Regulations; EASA Certification; EASA Regulation: Part 21, 145, M, 66, 147.

Back

Aircraft Systems (FIS13230L)

Instrumental Electronics – Rectifiers. Semiconductors and transistors. Amplifiers. Spectral decomposition; Nyquist-Shannon theorem. Data Acquisition: sampling, A/D and D/A conversions. Signal Processing.

Aircraft Systems – General description of aircraft systems. Aircraft electrical, hydraulic and pneumatic systems. Control surfaces. Pressurization systems. Landing gear. Anti-icing/de-icing. Emergency systems. Fuel systems. ...

Analysis and Control of Aircraft Systems – Laplace transforms and transfer functions. First and second order systems. Analysis in the time and frequency domains. State space modeling. Stability analysis. PID and LQR Controller design.

Back

Aircraft Performance (FIS13231L)

1. Introduction;
2. International Standard Atmosphere;
3. Forces Acting on an Airplane;
4. Level Flight;
5. Climb and Descent;
6. Take-off and Landing;
7. Turning Flight;
8. Energy Methods;
9. Flight Envelopes and Conclusions.

Back

Energy and Mass Transfer (FIS10987L)

Back

Energy Systems Design (FIS13236L)

The work plan for each student will be defined by the supervisor in coordination with the course coordinator, respecting and fulfilling the general objectives and competences to develop in the curricular unit. The activities may, in general, be divided into the following topics:

1. participation in research or activities done in a business environment;
2. attendance to seminars, workshops or courses;
3. study or project development;
4. report writing.

The study or project will be framed in at least one of the following topics:

I. energy resource assessment and utilization;
II. selection and sizing of equipment and technologies;
III. design of energy equipment or process optimization;
IV. calculating the energy production from a renewable or conventional energy source;
V. economic, financial or environmental analysis of energy systems.

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Thermal Equipment (FIS13233L)

1-Thermal energy needs: Industrial processes with heat or cold needs. Temperature levels. Fuels and energy carriers. Air conditioning systems.
2. Systems for heat generation: Steam generators, boilers, furnaces, heat pumps. Thermal fluid. Heat recovery. Cogeneration.
3. Systems for cold generation: Refrigeration and refrigeration systems. Refrigerants. Carnot refrigeration cycle. COP. Vapour compression cycle. Absorption cycle. Heat Pumps.
4. Gas mixtures: Ideal gas mixtures and humid air. Thermodynamic properties of mixtures. Thermal Comfort. Psychometry applications. Psychrometric charts. Air-Conditioning processes analysis. Cooling towers.

Back

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

Energy Storage (FIS1812L)