



Study Plan

School: School of Sciences and Technology
Degree: Bachelor
Course: Mechatronics Engineering (cód. 156)

1st Year - 1st Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
MAT0900L	Linear Algebra and Geometry I	Mathematics	6	Semester	156
MAT0905L	Mathematical Analysis I	Mathematics	6	Semester	162
FIS0703L	General Physics I	Physics	6	Semester	158
INF0878L	Programming	Informatics	6	Semester	156
QUI1090L	General Chemistry	Chemistry	6	Semester	156

1st Year - 2nd Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
MAT0906L	Mathematical Analysis II	Mathematics	6	Semester	162
PED0418L	Communication in Professional Context	Education Sciences	2	Semester	52
FIS0522L	Mechatronics System Design	Mechanical Engineering	6	Semester	156
FIS0704L	General Physics II	Physics	6	Semester	158
FIS0529L	Introduction to Mechatronic Engineering	Mechanical Engineering and Electrotechnical Engineering	2	Semester	52
MAT0925L	Introduction to Probability and Statistics	Mathematics	6	Semester	154
PED0122L	Methodology of Study and Research	Education Sciences	2	Semester	52

2nd Year - 3rd Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
MAT0907L	Mathematical Analysis III	Mathematics	6	Semester	162
FIS0510L	General Electrotechnics	Electrotechnical Engineering	6	Semester	156
GES0089L	Operation Management	Management	6	Semester	161
FIS0524L	Applied Mechanics	Mechanical Engineering	6	Semester	156
INF0884L	Computer Networks	Informatics	6	Semester	160

2nd Year - 4th Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS0506L	Control and Automation	Electrotechnical Engineering	6	Semester	156
FIS0507L	Electronics I	Electrotechnical Engineering	6	Semester	156
FIS0513L	Industrial Sensors and Actuators	Electrotechnical Engineering	6	Semester	156



2nd Year - 4th Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS0527L	Materials Technology	Mechanical Engineering	6	Semester	156
FIS0528L	Applied Thermodynamics	Mechanical Engineering	6	Semester	156

3rd Year - 5th Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS0505L	Industrial Automatism	Electrotechnical Engineering	6	Semester	156
FIS0508L	Electronics II	Electrotechnical Engineering	6	Semester	156
FIS0523L	Thermal Equipments	Mechanical Engineering	6	Semester	156
FIS0511L	Instrumentation	Electrotechnical Engineering	6	Semester	156
FIS0525L	Mechanics of Materials	Mechanical Engineering	6	Semester	156

3rd Year - 6th Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS0521L	Condition Control of Mechatronic Systems	Mechanical Engineering	6	Semester	156
FIS0509L	Industrial Electronics	Electrotechnical Engineering	6	Semester	156
FIS0512L	Electrical Machines	Electrotechnical Engineering	6	Semester	156
FIS0526L	Structural Mechanics	Mechanical Engineering	6	Semester	156
FIS0530L	Mechatronic System	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:

1º Ano

1º Semestre:

5 UC Obrigatórias num total de 30 ECTS

2º Semestre

7 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

5 UC Obrigatórias num total de 30 ECTS ***



Program Contents

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Linear Algebra and Geometry I (MAT0900L)

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

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Mathematical Analysis I (MAT0905L)

Sequences and series.
Real functions of one variable.
Differential calculus.
Sequences and series of functions.
Integral calculus and applications

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General Physics I (FIS0703L)

1. Introduction to Modern and Contemporary Physics
 - Physics as Science: fundamental forces, physical laws and constants, models and orders of magnitude; main subjects of present Physics.
 - Relativity: main concepts, speed of light.
 - Quantum Physics: wave-particle nature of matter, quantization and Planck's constant; the photoelectric and Compton effects; the spectral lines.
 - Present research on Physics: references to microscopic Physics, superconductivity and nanotechnology e applications; graphene.
2. Ondulatory Phenomena and Optics
 - Harmonic oscillator; electromagnetic waves and waves in matter; the Doppler effect. Lasers.
 - Geometrical optics: reflection and refraction; lenses and mirrors; optical devices. Interference and polarization.
3. Introduction to Thermodynamics
 - Temperature scales.
 - Kinetic Theory of Gases.
 - Calorimetry and Zero Principle of Thermodynamics;
 - 1st and 2nd Principles of Thermodynamics; entropy.



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Programming (INF0878L)

I – THE Python LANGUAGE

- Introduction to programming
- Using the interpreter
- Variables, expression and statements
- Defining and using functions
- Control structures
- Native data structures
- Vectors e matrices
- Basic input/output concepts (I/O)
- File handling
- Using libraries
- Handling errors and exceptions
- Program development

II – BRIEF NOTIONS ON NUMERICAL METHODS

- What are numerical methods?
- Nonlinear Equations
- Matrices and Vectors
- Linear Systems
- Optimization
- Nonlinear Systems
- Fitting / adjustment

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General Chemistry (QUI1090L)

1. Constitution of matter
2. Periodic table
3. Chemical bonding
4. States of aggregation of matter
5. Solutions
6. Chemical thermodynamics
7. Chemical equilibrium
8. Equilibrium in heterogeneous systems
9. Ionic equilibria in homogeneous systems: acid-base
10. Electrochemistry
11. (Optional Chapter)
Chemistry of life
Chemical corrosion
Chemical kinetics

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Mathematical Analysis II (MAT0906L)

- Topology and Sequences in \mathbb{R}^n .
- Limits and continuity of functions in \mathbb{R}^n .
- Differential Calculus of functions in \mathbb{R}^n .
- Taylor Formula.
- Inverse function and Implicit function.
- Free extrema and Conditioned extrema.
- Line integrals.
- Multiple integrals.
- Surface integrals.



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Communication in Professional Context (PED0418L)

1. Being and communicating
 - 1.1. Who I am and the way I am together with the other
2. Human communication
 - 2.1. Verbal aspect
 - 2.1.1. Communication models
 - 2.2. Non-verbal aspect
 - 2.2.1. Functions of non-verbal communication
 - 2.2.2. The body
 - 2.2.3. Non-verbal communication in professional context.
 - 2.2.4. The importance of active listening in the communicating process.
 - 2.2.4.1. Difficulties and obstacles to the listening process
3. Barriers to communication.
 - 3.1. Among people, among people and groups and among groups.
 - 3.2. In professional situations.
4. Production of materials for electronic presentation and its practical use.

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Mechatronics System Design (FIS0522L)

» Technical Drawing as a language{\}

The importance of Technical Drawing and standardization. Types of technical drawings and representations. Main associated standards: paper formats, scales, line types, line thicknesses, text and layouts. {\}

» Elaborating technical drawings{\}

The concept of projection, orthogonal projections, views and multiple views representations. Freehand drafting. Perspective drawing in general and based on orthogonal projections. Reading of multiple views drawings. Partial and auxiliary views. Computer aided drafting of orthogonal views and 3D models. {\}

» Section views{\}

Using sections as a mean to simplify the drawing reading. General rules for section drawings and conventional representations. Assembly drawings. {\}

» Introductory concepts of design{\}

The several stages present in the design process and the associated documentation. Material properties and manufacturing processes. Some insights and details in the design of structures and mechatronic equipments. The use of standard components in design and its drawing representations, bolts, washers, rivets, springs, bearings, couplings, valves, actuators, etc. {\}

» Dimensioning{\}

Writing dimensions and other information in drawings. Different dimensioning criteria according to the drawing purpose. {\}

» Tolerances{\}

Dimensional tolerancing, linear tolerances, angular tolerances and fits. Surface and edge finishes. Geometrical tolerancing, application and interpretation. Verification processes and methods. {\}

» Drawing of connections{\}

Brief description of welding processes. Welded, bolted and riveted connections. Types of welding, associated symbols and annotation rules. Associated standards and the elaboration of complete parts lists. {\}

» Introduction to the drawing of technical diagrams{\}

Symbolic representation of mechanical components, electrical wiring diagrams, piping, pneumatic and hydraulic network diagrams, thermal systems and manufacturing processes layouts.



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General Physics II (FIS0704L)

1. Mechanics:

- Review of Kinematics;
- Dynamics of the material point and of a system of points;
- Conservation principles (Kepler's laws);
- Movement in non inertial referentials;
- Elementary dynamics of a rigid body.

2. Electromagnetism:

- Electrostatics;
- Gauss' law; Capacitors;
- Electric current;
- Study of DC circuits; RC Circuits;
- Magnetic Field;
- Electromagnetic induction; Maxwell equations.

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Introduction to Mechatronic Engineering (FIS0529L)

- 1) The mechatronics engineer context in the industrial market.
- 2) Companies, productivity and competition. The organization of industrial companies. The organizational structure of a multinational industrial company? Business areas.
- 3) Departmental structure of business areas: Research and Development, Production, Quality, Logistics and Administrative services.
- 4) The tasks of a Mechatronics Engineer in the industrial context: Development, Technical Planning, Production, Quality assurance, Automation.
- 5) The dynamics of multifunctional teams in the problem solving approach, and in the launching of new products. The Project of new products/ processes.
- 6) Presentation of the main phases of the Project of a new industrial product: Economic viability study, Product development, Process development, Production, Quality assurance.
- 7) The main industrial Tools for each phase requirements of the Project of a new Product.

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Introduction to Probability and Statistics (MAT0925L)

1. Descriptive Statistics - Brief Review
2. Basic Probability Notions - Brief Review
3. Conditional Probability and Independence
4. Discrete and Continuous Random Variables
5. Discrete Random Vectors
6. The Most Important Families of Discrete and Continuous Probabilities Distributions
7. An Introduction to Sampling Theory
8. Statistical Inference (parametric and non-parametric)
9. Introduction to Simple Linear Regression
10. Some Non-Parametric Tests (Kolmogorov-Smirnov, Chi-Square, etc.)



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Methodology of Study and Research (PED0122L)

- Produce an academically sound work;
- Being able to use individual and group learning techniques and how the latter relate to the subject matter
- Scholarly research: processes and types
- Research Methodology: specific to the Social Sciences
- Different stages of research
- Diversity of approaches.
- Quantitative research / Qualitative research
- Sample, data collection; data process, analysis, and synthesis
- Scholarly paper
- Bibliography
- Citations and bibliographical references

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Mathematical Analysis III (MAT0907L)

- Introduction to Complex Analysis. Complex functions and analytic functions. Cauchy-Riemann equations. Laplace equation. Harmonic functions. Geometry of analytic functions. Elementary complex functions. Complex integration. Fundamental Theorem of Calculus. Cauchy's theorem and its evolution. Cauchy integral formula and applications. NCE/13/00836 - Apresentação do pedido - Novo ciclo de estudos http://www.a3es.pt/si/iportal.php/process_form/print?processId=f1edd77de120301020131510
- Ordinary Differential Equations. Exact equations and integrating factors. Elementary equations of 1st order. 2nd order linear equations.
- Systems of ordinary differential equations. Introduction and notations. Linear systems. Systems with constant coefficients. Stability of solutions. Planar autonomous systems.
- Fourier series. Convergence and the sum of the Fourier series. Expansion in series of sines and cosines. Periodic extensions. Complex Fourier series. Fourier integrals.



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General Electrotechnics (FIS0510L)

1. Introduction

2. Fundamental notions of electrostatics

Application of Maxwell's equations to electrostatics.

Capacitors and dielectrics.

3. Stationary Electric Current

Electric resistance; Ohm's law.

Electrical energy sources. Joule's law.

Direct current circuit analysis. Kirchhoff's laws. Circuit analysis theorems.

4. Magnetostatics

Application of Maxwell's equations to electrostatics.

Magnetic circuits analysis. Inductors.

5. Varying Electromagnetic Field

Faraday's law.

Ideal transformer. Electrical generator and motor.

6. 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.

7. Three-Phase Systems

Star and Triangle connections. Transformations. Circuit analysis with different loads. Unbalanced loads.

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Operation Management (GES0089L)

Part 1 - Introduction to Operations Management

1. What is operations management?

2. Operations Strategy

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

1. Quality management and statistical quality control

2. Product/service design

3. Process design and technology choice

Part 3- Operations system management

1. Supply chain management

2. Demand forecasting methods

3. Independent demand stocks management

4. Aggregated production planning

5. Resources planning: MRP, CRP and ERP

6. Production scheduling and the theory of constraints

7. Lean production systems and Just in time



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Applied Mechanics (FIS0524L)

The fundamental laws and concepts in Mechanics.

Static equilibrium of particles in 2D and 3D, free body diagram and corresponding equilibrium equations.

Definition of moment of a force about a point, the concept of couple. Reduction of a system of forces, point wise or distributed, to one equivalent resultant force and resultant couple.

Equations governing the static equilibrium of rigid bodies in 2D and 3D, free body diagrams equilibrium equations, constraints, statically determinacy or indeterminacy.

Centers of mass and centroids, Distributed loads.

Analysis of rigid body structures in 2D and 3D, trusses, structures having members acted by two or more actions, machines and mechanisms. Static determinacy.

Internal forces in bars, beams and cables.

Analysis of rigid body structures in the presence of friction.

Second moments and moments of inertia

Introduction to dynamics and to the vibration study of one degree of freedom systems.

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Computer Networks (INF0884L)

OSI Model

Modulation

Codification

Error detection and error correction

Flow control

Medium Access Control Algorithms (MAC-sublayer), in wired and wireless networks

Routing

IP addressing

TCP - connections, flow and congestion control

Programming within the TCP/IP framework, using sockets.

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Control and Automation (FIS0506L)

PART I: Control Systems:

1) Mathematical models for Control: Electrical, Mechanical, Fluidic, Thermal.

2) Analysis of systems - Transfer Function representation:

i) Time-domain analysis -1st order, 2nd order and multiple order systems -. Stationary response. Stability criteria. P-Controller design using the Root Locus method.

ii) Frequency-domain analysis. Bode diagram. Stability. Gain and phase margins. P-Controller design using the Bode method.

iii) PID controller. Usual design methods.

3) Analysis of systems represented by State-space formulation: Linear systems stability.

PART II: Industrial Automation:

1) Industrial logic components: pneumatic, electric and electronic technology.

2) Programmable automation. Basic components: Processing Unit, sensors and actuators.

3) Automatic Systems: Combinatory and sequential. Design of sequential systems using GRAFCET.

4) Implementation of automatic systems using Siemens LOGO PLC. (Programmable Logic Controller). LADprogramming.



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Electronics I (FIS0507L)

1. Introduction to Circuit Analysis. Basic concepts revisited.

Fundamental electric units. Ohm's Law. Resistors in Series and Parallel. Direct current circuits.

2. Semiconductors

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

3. Diode

The ideal and real diode. Characteristic curve. Approximate models. Small-signal model and its applications. Rectifier circuits.

The Zener diode and the light emitting diode. Applications.

4. Transistors

Bipolar Junction Transistor

Characteristic curves. Operation regions. Polarization schemes. Typical configurations: common emitter, common base, and common collector. Characteristics. Small signal analysis. Applications.

Field Effect Transistor

JFET and MOSFET. Characteristic curves.

5. Operational Amplifiers

Characteristics. Feedback.

Inverting and non-inverting configuration, voltage follower.

Summer, integrator and differentiator. Instrumentation amplifier. Comparator.

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Industrial Sensors and Actuators (FIS0513L)

1) Measurement of variables. Analogue, digital and binary signals. Measurement parameters: accuracy, reproducibility, sensibility, resolution. Calibration.

2) Industrial sensors: Constructive principles and application domains. Standard output-signals 0-10V, 0-20mA.

3) Analogue signal conditioning. Circuits with Operational Amplifiers (AMPOPs): linear and saturation zone. Implementation of ODE with AMPOPs.

4) Pneumatics and hydraulics. Hydrostatics, hydrodynamics, Bernoulli principle.

5) Industrial pneumatics and hydraulics: compressors, pressure-pumps, air-cleaning unit, oil-cleaning unit, accumulators, valves, cylinders and motors.

6) Electro-pneumatic automatic cycles - Combinatory and sequential. Functional diagrams. Circuit layout. Design of actuators and valves (loads and flows).

7) Electromechanical drivers. Energy flux. Evaluation of the partial energy losses in a motorized mechanical system. Total system efficiency.

8) Selection of driving elements - electric motors.



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Materials Technology (FIS0527L)

- 1) Industrial Materials and Materials Science: Mechanical properties, Electrical properties, Polymeric Materials, Metal Alloys, Ceramic Materials, Magnetic Materials, Semiconductors.
- 2) Metal-forming processes: compressing forming and tensile forming. Fundamentals, machine tools and parameters for industrial metal forming.
- 3) Cutting technologies: stamping, blanking, mechanical metal removing processes. Fundamentals and most significant machine parameters.
- 4) Welding technology and processes: resistance welding, arc welding (with/without gas). Laser welding. Fundamentals and most significant parameters.
- 5) Foundry.
- 6) Injection Molding.

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Applied Thermodynamics (FIS0528L)

Theory and practice

1. Basics

- 1.1 Extensive and intensive properties
- 1.2 States of equilibrium
- 1.3 Processes and cycles. Graphic representation.
- 1.3 Forms of Energy

2. Equations of state of pure substances

- 2.1 Phase diagram
- 2.2 Ideal Gas
- 2.3 Specific Heats
- 2.3 Phase changes. Enthalpy

3. Energy Transfer

- 3.1 Heat Transfer
- 3.2 Work
- 3.3 Chemical Energy
- 3.4 Energy of flows

4. First Law of Thermodynamics

- 4.1 Energy balance in closed systems
- 4.2 Balance of energy flows "stationary"
- 4.3 Energy balance in transient flow

5. Second Law of Thermodynamics

- 5.1 Introduction to the Second Law
- 5.2 Reversible and Irreversible Processes
- 5.3 Carnot cycle
- 5.4 Heat Engines, income.
- 5.5 Heat pumps efficiency ratios

6. Entropy

- 6.1 Changes of isentropic processes and entropy
- 6.2 Compressor isentropic efficiency
- 6.3 Isentropic efficiencies of turbulent "stationary"
- 6.4 Balance of entropy



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Industrial Automatism (FIS0505L)

- 1) Introduction to the industrial automation: control system, power system, Human-Machine Interface.
- 2) Boolean algebra review: Boolean Functions repres. 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 sequential units.
- 5) Review of sequential systems with Programmable Logic Controllers (PLC) Siemens-LOGO.
- 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). LAD and STL programming languages.
- 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).

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Electronics II (FIS0508L)

1. Introduction
Digital vs Analog systems. Integration levels. 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. State diagrams.
6. Registers and Counters
Simple registers, shift registers. Synchronous counters.
7. Memories
Memory types; RAM, ROM, EPROM. Memory capacity.
8. Programmable Logic
PLA. PAL. CPLD. FPGA
9. Circuit Families
RTL, DTL and TTL.

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Thermal Equipments (FIS0523L)

1. Fluid mechanics fundamentals: Fundamental theory. Solving fluid mechanics problems through integral and differential analyses.
2. Pipe flows: Incompressible laminar or turbulent flow inside circular ducts. The effect of rugosity. Moody chart. Non-circular ducts. Minor losses. Introduction to turbomachinery. Inclusion of a turbomachine in ducts. Fluid networks.
3. Thermal energy transfer: Conduction, convection and radiation.
4. Convection: Boundary-layer and thermal boundary layer. Incompressible laminar or turbulent flow over a flat surface. Heat transfer for the flat plate. Methodology for the treatment of convection.
5. Conduction: Steady state heat conduction. Thermal resistances. Critical thickness of insulation. Finned surfaces.
6. Heat Exchangers: Classification. Introduction to LMTD and -NTU Methods.
7. Thermal radiation: radiation among surfaces in a nonparticipating medium.



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Instrumentation (FIS0511L)

Introduction to Metrology: History, definitions, units and fundamental laws of physics. Notion of uncertainty and error, laws of errors and uncertainties propagation. Application to experimental data. Curve fitting by the least squares criterion.

Measurement transducers: Definition, physical principles, applications. Classifications of the measurement transducers.

Electrical analogue instruments: galvanometer, voltmeter, ammeter, ohmmeter, wattmeter, phase meter, oscilloscope, etc. ..)

Measurement of electrical quantities (voltage, current, resistance, impedance, etc .) Measurement of quantities other than electrical: displacement, velocity, force, temperature, ...)

Geophysical measurements and environmental parameters.

Introduction to digital instrumentation.

Signal processing algorithms: DFT, FFT, models adaptation.

Exercises and implementations with MatLab/ NI-Labview.

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Mechanics of Materials (FIS0525L)

THEORY OF ELASTICITY

Stress. Strain. Plane stress and plane strain. Pure cut. Stress concentration. Allowable stresses and safety factors. Generalized Hooke's Law. Safety of structures. Yielding criteria and rupture. Types of failure. Perfect elastic-plastic behavior. Shear stresses. Screws and rivets. Design.

Bending.

Shear and bending moment. Classical theories of bending. Stresses. Strains. Differential equation of the elastic line. Universal equations.

Torsion

Bars of circular cross section. Circular shafts . Stresses and strains; Power transmission. Terms of mechanical strength and rigidity.

Combined efforts.

Principal stresses. Equivalent stress. Gage. Mohr's circle. Membrane theory. Laplace equations. Pressure vessels. Spheres and cylinders. ASME Code VIII Div I and BS 5500.

Introduction to Buckling of columns

Critical loads and critical stress, Euler's formulas. Off-center loads. Eurocodes.

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Condition Control of Mechatronic Systems (FIS0521L)

1) Introduction to condition-based maintenance.

2) Measure and data acquisition.

3) Degradation and ruin in industrial equipment.

4) The role of mechanical vibrations in maintenance.

4a) Discussion about energy and energy methods.

4b) Second order ODEs: type of mechanical solutions.

4c) Harmonic and periodic right-hand-side: critical frequency, phase and magnitude diagrams.

4d) Response to an arbitrary right-hand-side by Duhamel integral.

4e) ODE integrators.

5) Machine components as rigid bodies

6) Mechanical vibrations in the context of condition-based-maintenance: n degrees-of-freedom.

7) Distributed systems. Partial differential equations of second order: classification and characterization of solutions.

8) Sensitivity analysis: application to maintenance.

9) Introduction to fracture mechanics.

10) Lubrication.



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Industrial Electronics (FIS0509L)

1. Introduction

Objectives and application examples.

2. Power Electronic Devices

Diode, Tiristor, GTO, BJT, MOSFET, IGBT

Devices characteristics comparison

3. AC/DC Converters ? Rectifiers

Analysis of different topologies

Power Flow. Power Factor

4. AC/AC Converters

Cicloconverters: Topology and functioning principles

Static Converters: Functioning as switch and with phase control

5. DC/DC Converters - "Chopper"

Analysis of different topologies

6. DC/AC Converters ? Inverters

Voltage Inverters: one and three phases topologies; Power Flow

Current Inverters

7. Regulation and Command of Power Converters

P;PI;PID Controllers. Regulation Circuits.

PWM Command. Tiristors, Transistors and IGBT's Command Circuits.

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Electrical Machines (FIS0512L)

Introduction to the study of Electrical Machines

Fundamental electromagnetic concepts and circuit analysis revisited. Principles of electromechanical energy conversion.

Transformer

Introduction ? constructive aspects. The one-phase transformer. The three-phase transformer. Special transformers. The self-transformer. Measurement transformers. Dynamic behavior analysis.

DC Machines

Introduction and functioning principles. Generator functioning. Main characteristics. Application fields. Motor functioning. Main characteristics. Application fields. Dynamic behavior analysis.

AC Machines

Asynchronous Machine. Constructive aspects and functioning principles. Three-phase induction machine. Application fields.

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

Special Electrical Machines

PM Synchronous machine. Switched Reluctance Machine. Step Motor.



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Structural Mechanics (FIS0526L)

General stress and strain relations and energy methods

Isotropic and anisotropic materials. Equilibrium and compatibility equations. Strain elastic energy. Principle of virtual work. Minimum potential energy. Castigliano's theorems.

Bending and torsion of non symmetric beams

Curved beams. Combined bending. Bending of unicellular and multicellular tubular beams. Torsion: warping function and stress function. Closed single profiles and multicell profiles. Shear flow. Stresses in curved beams. Shear center in bending. Thin-wall beams. The Prandtl elastic-membrane analogy. Shear flow in thin-wall beams. Shear center.

Elements of the theory of rectangular plates

Kirchoff theory's assumptions. Equilibrium equations. Boundary conditions. Classical theory of plates. Rectangular plates. Navier and Rayleigh-Ritz methods.

Introduction to the Finite Element Method

Computer aided design. Types of finite elements. Boundary conditions. Input and output. Commercial finite element programs.

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Mechatronic System (FIS0530L)

Part A: Mechanical Project

1) Kinematics of rigid bodies: General plane motion. Rotating frames. General 3D motion.

2) Dynamics of rigid bodies in 2D: General equations of motion for a rigid body. Work and Power. Impact analysis. Elastic and visco-elastic coupling. Vibration analysis.

3) Dynamic analysis of multi-body systems: Robot classes. Kinematics chains. Linear transformations. Direct and inverse kinematics. Robot Dynamics: Lagrange and Newton-Euler formulations. Computer-aided dynamics.

Part B: Controller/ PLC Design

1) The integrated mechatronics project. Robot Control. Industrial Automation.

2) The sensors project: Design, data acquisition and system integration (LabView).

3) Controller/PLC Project: Design and implementation with MATLAB/ Siemens SIMATIC. The implementation of Human-Machine Interfaces (Siemens HMI).

4) The Informatics Project. Industrial Networks and SCADA Systems (Supervisory Control and Data Acquisition).