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
MAT0900	Linear Algebra and Geometry I	Mathematics	6	Semester	156
MAT0905	Mathematical Analysis I	Mathematics	6	Semester	162
FIS0703	General Physics I	Physics	6	Semester	158
INF0878	Programming	Informatics	6	Semester	156
QUI1090	General Chemistry	Chemistry	6	Semester	156

1st Year - 2nd Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
MAT0906	Mathematical Analysis II	Mathematics	6	Semester	162
PED0418	Communication in Professional Context	Education Sciences	2	Semester	52
FIS0522	Mechatronics System Design	Mechanical Engineering	6	Semester	156
FIS0704	General Physics II	Physics	6	Semester	158
FIS0529	Introduction to Mechatronic Engineering	Mechanical Engineering and Electrotechnical Engineering	2	Semester	52
MAT0925	Introduction to Probability and Statistics	Mathematics	6	Semester	154
PED0122	Methodology of Study and Research	Education Sciences	2	Semester	52

2nd Year - 3rd Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
MAT0907	Mathematical Analysis III	Mathematics	6	Semester	162
FIS0510	General Electrotechnics	Electrotechnical Engineering	6	Semester	156
GES0089	Operation Management	Management	6	Semester	161
FIS0524	Applied Mechanics	Mechanical Engineering	6	Semester	156
INF0884	Computer Networks	Informatics	6	Semester	160

2nd Year - 4th Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS0506	Control and Automation	Electrotechnical Engineering	6	Semester	156
FIS0507	Electronics I	Electrotechnical Engineering	6	Semester	156
FIS0513	Industrial Sensors and Actuators	Electrotechnical Engineering	6	Semester	156
FIS0527	Materials Technology	Mechanical Engineering	6	Semester	156
FIS0528	Applied Thermodynamics	Mechanical Engineering	6	Semester	156

3rd Year - 5th Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS0505	Industrial Automatisms	Electrotechnical Engineering	6	Semester	156
FIS0508	Electronics II	Electrotechnical Engineering	6	Semester	156
FIS0523	Thermal Equipments	Mechanical Engineering	6	Semester	156
FIS0511	Instrumentation	Electrotechnical Engineering	6	Semester	156
FIS0525	Mechanics of Materials	Mechanical Engineering	6	Semester	156

3rd Year - 6th Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS0521	Condition Control of Mechatronic Systems	Mechanical Engineering	6	Semester	156
FIS0509	Industrial Electronics	Electrotechnical Engineering	6	Semester	156
FIS0512	Electrical Machines	Electrotechnical Engineering	6	Semester	156
FIS0526	Structural Mechanics	Mechanical Engineering	6	Semester	156
FIS0530	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

Back

Linear Algebra and Geometry I (MAT0900)

Back

Mathematical Analysis I (MAT0905)

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

Back

General Physics I (FIS0703)

Back

Programming (INF0878)

Back

General Chemistry (QUI1090)

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

Back

Mathematical Analysis II (MAT0906)

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

Back

Communication in Professional Context (PED0418)

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.

Back

Mechatronics System Design (FIS0522)

» Technical Drawing as a language{\}newline 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.{\}newline {\}newline » Elaborating technical drawings{\}newline 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.{\}newline {\}newline » Section views{\}newline Using sections as a mean to simplify the drawing reading. General rules for section drawings and conventional representations. Assembly drawings.{\}newline {\}newline » Introductory concepts of design{\}newline 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.{\}newline {\}newline » Dimensioning{\}newline Writing dimensions and other information in drawings. Different dimensioning criteria according to the drawing purpose.{\}newline {\}newline » Tolerances{\}newline Dimensional tolerancing, linear tolerances, angular tolerances and fits. Surface and edge finishes. Geometrical tolerancing, application and interpretation. Verification processes and methods.{\}newline {\}newline » Drawing of connections{\}newline 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.{\}newline {\}newline » Introduction to the drawing of technical diagrams{\}newline Symbolic representation of mechanical components, electrical wiring diagrams, piping, pneumatic and hydraulic network diagrams, thermal systems and manufacturing processes layouts.

Back

General Physics II (FIS0704)

1. Mechanics:
- Review of da Kinematics;
- Dynamics or the material point and of a system od 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.

Back

Introduction to Mechatronic Engineering (FIS0529)

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.

Back

Introduction to Probability and Statistics (MAT0925)

Back

Methodology of Study and Research (PED0122)

- 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

Back

Mathematical Analysis III (MAT0907)

-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=f1edd
77 de 120 30/10/2013 15:10
-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.

Back

General Electrotechnics (FIS0510)

1. Introduction

2. Fundamental notions of electrostatics
Electric charge; Electrostatic force; Coulomb’s law.
Electric field; Electric potential; Electric voltage.
Capacitors and dielectrics; capacitors in series and parallel.
Application of Maxwell’s equations to electrostatics.

3. Stationary Electric Current
Current density and Electric current intensity.
Electric resistance; Ohm’s law; Resistors in series and parallel; Voltage and Current dividers.
Electrical energy sources; Voltage and current sources; Independent sources and controlled sources; Electric circuits; Power and Energy; Joule’s law.
Analysis of direct current circuits. Kirchhoff’s laws. Superposition theorem. Norton and Thèvenin theorems. Maximum power transfer theorem. Bridge circuits; Star-Triangle and Triangle-Star transformations.

4. Magnetostatics
Magnetic materials classification.
Maxwell equations applied to magnetostatics
Ampère’s law; Magnetic flux. Magnetomotive force; Magnetic reluctance. Magnetic saturation. Inductors; Inductors in series and parallel.
Magnetic circuits analysis. Analogy between electric and magnetic circuits.

5. Varying Electromagnetic Field
Faraday’s law.
Self and Mutual induction coefficients. Ideal transformer.
Mechanical generators of electric energy. Basic principles of electric machines (Força de Laplace).

6. Quasi Steady State Circuits
Fundamental notions: sinusoidal voltages and currents; average and rms values; complex or symbolic representation of a sinusoidal function.
Analysis of single-phase steady state alternating current circuits. Kirchhoff’s law. Superposition theorem. Norton and Thèvenin theorems. Maximum power transfer theorem.
R; RL; RC; RLC circuits. Defenition of impedance and admitance. Impedances in series and parallel.
Active, Reactive and Apparent Power. Power factor.
Introduction to the dynamic behavior of electric circuits.

7. Three-Phase Systems
Star and Triangle connections; Star-Triangle and Triangle-Star transformations.
Line and Phase voltage and currents; Circuit analysis with different loads.
Active, Reactive and Apparent Power. Unbalanced loads.

Back

Operation Management (GES0089)

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

Back

Applied Mechanics (FIS0524)

Introduction to Mechanics

What is Mechanics, its fundamental laws and concepts. Vectors, properties and operations. The concept of particle. Parallelogram law for the addition of forces. Resultant force of concurrent forces, force vector components and rectangular Cartesian components, in 2D and 3D. Free body diagram of a particle and the corresponding static equilibrium equations in 2D and 3D.

Equivalent systems of forces

The concept of rigid body. Definition of moment of a force about a point and about an axis. The concept of couple and its representation by a vector. Reduction of a system of forces, point wise or distributed, to one equivalent resultant force and resultant couple. Definition of equivalent systems of forces, reduction to only one force or to a force and wrench. Distributed forces and their equivalent force-couple system.

Static equilibrium of rigid bodies

Equations governing the static equilibrium of rigid bodies in 2D and 3D. Free body diagrams and the reaction or connection forces developed by the supports and connections. Constraints imposed by the supports and other connections, and the reactions statically determinacy or indeterminacy. Resultant forces exerted by a fluid on submerged surfaces.

Centers of mass and centroids

The concept of center of mass of a body and determination of its location. Determination of centroids of volumes, areas and lines. Centers of mass and centroids by composition of features. Application to the study of distributed loads.

Analysis of rigid body structures

Static analysis of trusses 2D and 3D using nodal equilibrium or the equilibrium of sections. Analysis of structures, machines and mechanisms, in 2D and 3D. Statically determinate and indeterminate structures. Introduction to the study of gear transmissions.

Internal forces in bars, beams and cables

The concept of bars, beams and cables and internal forces. Determination and drawing of axial force, shear forces, bending moments and torque diagrams in 2D and 3D. Static equilibrium of cables with simple concentrated and distributed loads.

Analysis of rigid body structures in the presence of friction

Definition of friction and friction forces. The laws of dry friction. Static equilibrium of structures in the presence of friction. Study of wedges, screws, sliding bearings, belts and cables.

Second moments and moments of inertia

Determination of the second moments, polar moment and radius of gyration of an area. The parallel axis theorem. The product of area (inertia) and the principal axis of area (inertia). Definition and computation of moments of inertia, products of inertia and radius of gyration for rigid bodies. The inertia tensor.

Introduction to dynamics

Fundamentals of rigid bodies kinematics. Equations of motion for rigid bodies in 2D. Applications introducing to the analysis of oscillatory systems.

Back

Computer Networks (INF0884)

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.

Back

Control and Automation (FIS0506)

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.

Back

Electronics I (FIS0507)

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 e 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.

Back

Industrial Sensors and Actuators (FIS0513)

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.

Back

Materials Technology (FIS0527)

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.

Back

Applied Thermodynamics (FIS0528)

Theory and practice

1. Basics

1.1 Extensive and intensive properties

1.2 States of equilibrium

1.3 Processes and cycles. Graphic reprtesentation.

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

Back

Industrial Automatisms (FIS0505)

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).

Back

Electronics II (FIS0508)

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

Thermal Equipments (FIS0523)

Back

Instrumentation (FIS0511)

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

Mechanics of Materials (FIS0525)

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 transmition. 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.

Back

Condition Control of Mechatronic Systems (FIS0521)

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.

Back

Industrial Electronics (FIS0509)

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.

Back

Electrical Machines (FIS0512)

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.

Back

Structural Mechanics (FIS0526)

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.

Back

Mechatronic System (FIS0530)

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 dynamis.

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).