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
MAT00900L	Linear Algebra and Geometry I	Mathematics	6	Semester	156
MAT00905L	Mathematical Analysis I	Mathematics	6	Semester	162
FIS00703L	General Physics I	Physics	6	Semester	158
INF00878L	Programming	Informatics	6	Semester	156
QUI01090L	General Chemistry	Chemistry	6	Semester	156

1st Year - 2nd Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
MAT00906L	Mathematical Analysis II	Mathematics	6	Semester	162
PED00418L	Communication in Professional Context	Education Sciences	2	Semester	52
FIS00522L	Mechatronics System Design	Mechanical Engineering	6	Semester	156
FIS00704L	General Physics II	Physics	6	Semester	158
FIS00529L	Introduction to Mechatronic Engineering	Electrotechnical Engineering Mechanical Engineering	2	Semester	52
MAT00925L	Introduction to Probability and Statistics	Mathematics	6	Semester	154
PED00122L	Methodology of Study and Research	Education Sciences	2	Semester	52

2nd Year - 3rd Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
MAT00907L	Mathematical Analysis III	Mathematics	6	Semester	162
FIS00510L	General Electrotechnics	Electrotechnical Engineering	6	Semester	156
GES00089L	Operation Management	Management	6	Semester	161
FIS00524L	Applied Mechanics	Mechanical Engineering	6	Semester	156
INF00884L	Computer Networks	Informatics	6	Semester	160

2nd Year - 4th Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
EME00506L	Control and Automation	Electrotechnical Engineering	6	Semester	156
EME00507L	Electronics I	Electrotechnical Engineering	6	Semester	156
FIS00513L	Industrial Sensors and Actuators	Electrotechnical Engineering	6	Semester	156
FIS00527L	Materials Technology	Mechanical Engineering	6	Semester	156
EME00528L	Applied Thermodynamics	Mechanical Engineering	6	Semester	156

3rd Year - 5th Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
EME00505L	Industrial Automatisms	Electrotechnical Engineering	6	Semester	156
EME00508L	Electronics II	Electrotechnical Engineering	6	Semester	156
FIS00523L	Thermal Equipments	Mechanical Engineering	6	Semester	156
EME00511L	Instrumentation	Electrotechnical Engineering	6	Semester	156
FIS00525L	Mechanics of Materials	Mechanical Engineering	6	Semester	156

3rd Year - 6th Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
EME00521L	Condition Control of Mechatronic Systems	Mechanical Engineering	6	Semester	156
EME00509L	Industrial Electronics	Electrotechnical Engineering	6	Semester	156
FIS00512L	Electrical Machines	Electrotechnical Engineering	6	Semester	156
EME00526L	Structural Mechanics	Mechanical Engineering	6	Semester	156
FIS00530L	Mechatronic System	Electrotechnical Engineering Mechanical 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 (MAT00900L)

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

Back

Mathematical Analysis I (MAT00905L)

Back

General Physics I (FIS00703L)

Back

Programming (INF00878L)

- Introduction to programming: algorithms, variables, data types, arithmetic operators, logical values and operators, relational operators.
- Control structures: selection, repetition, decision making.
- Data structures: lists, tuples, dictionaries, sets.
- Working with text: string manipulation, text parsing.
- Functions and modularity.
- Using and creating modules.
- Methods (and classes).
- Looping structures.
- Working with files (I/O).
- Plots.
- Scientific computing libraries.

Note: The order may vary.

Back

General Chemistry (QUI01090L)

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 (MAT00906L)

Back

Communication in Professional Context (PED00418L)

Back

Mechatronics System Design (FIS00522L)

» 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 (FIS00704L)

Back

Introduction to Mechatronic Engineering (FIS00529L)

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 (MAT00925L)

Descriptive StatisticsBasic Probability NotionsConditional probabilities and independence Random Variables and VectorsMore important Discrete and Continuous distributionsStatistical Inference (parametric and non parametric)Linear Regression Analysis

Back

Methodology of Study and Research (PED00122L)

Conteúdo da unidade curricular - A Universidade;- A aprendizagem na Universidade;- A organização do trabalho na Universidade;- As competências de investigação;- Dinâmicas de aprendizagem individuais;- Dinâmicas de aprendizagem grupais.

Mathematical Analysis III (MAT00907L)

1. Elements of Differential Geometry in R3
1.1. General information on the space Rn
1.2. Contours and parameterized curves
1.3. Length of arc. Parameterization by arc length
1.4. Curvature and torsion. Frenet-Serret formulas
1.5. Surfaces.
1.6. Tangent plane and normal line to a surface. Orientability.
2. Introduction to Complex Analysis
2.1. General.
2.2. Complex functions and analytic functions.
2.3. Cauchy-Riemann equations.
2.4. Laplace equation. Harmonic functions.
2.5. Geometry of analytic functions. ConformalÂ transformation.
2.6. Elementary complex functions.
(I) Exponential function
(Ii) trigonometric and hyperbolic functions
(Iii) logarithm function
(Iv) Generalized complex powers functions
2.7. Complex integration
(I) Path Integral
(Ii) Elementary properties
2.8. Fundamental Theorem of Calculus.
2.9. Cauchys theorem and its evolution.
2.10. Cauchy integral formula and applications
3. Ordinary Differential Equations
3.1. Definitions and generalities.
3.2. Exact equations and integrating factors.
3.3. Basic equations of 1st order
(I) equation with separable variables
(Ii) homogeneous equation
(Iii) homographic Equation
(Iv) linear equation of 1st order
(V) Bernoulli Equation
(Vi) Ricati Equation
3.4. Linear equations of 2nd order
(I) reduction of order.
(Ii) Particular solution of the nonhomogeneous equation
(Iii) homogeneous equation with constant coefficients
4. Systems of ordinary differential equations
4.1. Introduction and notations
4.2. Linear systems
4.3. Systems with constant coefficients
4.4. Linear periodic systems
4.5. Asymptotic behavior of solutions for linear systems.
4.6. Stability of solutions
4.7. Planar autonomous systems
5. Fourier series
5.1. Periodic functions.
5.2. Trigonometric series.
5.3. Euler formulas for Fourier coefficients.
5.4. Orthogonality.
5.5. Uniform convergence
5.6. Convergence and the sum of the Fourier series.
5.7. Functions with a generic period 2L
5.8. Expansion in series of sines and cosines
5.9. Periodic extensions
5.10. Complex Fourier series.
5.11. Fourier integrals.

Back

General Electrotechnics (FIS00510L)

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.

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Operation Management (GES00089L)

Ver relatório da UC GES2332.

Back

Applied Mechanics (FIS00524L)

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 (INF00884L)

Back

Control and Automation (EME00506L)

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). LAD-programming.

Back

Electronics I (EME00507L)

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

Industrial Sensors and Actuators (FIS00513L)

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 (FIS00527L)

Constitution of matter{\}newline
The primary classes of materials. Atomic structure and chemical bonding. Crystalline structure, directions and crystallographic planes, comparison between the different structures, polymorphism and allotropy.{\}newline
{\}newline
* Solidification and defects{\}newline
The pure substances and alloys solidification process. Single crystals and polycrystals. Substitutional and interstitial solutions. Point, line and planar defects in the crystalline structure. Diffusion processes in solids and its industrial usefulness.{\}newline
{\}newline
* Materials macroscopic properties{\}newline
Mechanical properties, the concepts of stress and strain. Main mechanical tests: uniaxial tension, compression, hardness, crack propagation, fatigue and creep. Elastic, plastic and viscous behaviour. {\}newline
Influence of the microstructure in the plasticity and fracture. Thermal properties.{\}newline
Electrical conduction. Dielectric behaviour. Magnetic behaviour. Active materials and the piezoelectric, electrostrictive and magnetostrictive phenomena.{\}newline
{\}newline
* Phase diagrams{\}newline
Pure substances, Gibbs phase rule. Binary alloys, rule of mixtures, chemical transformations in the solidification process. Non equilibrium cooling effects. Intermediate phases and compounds. Ternary systems.{\}newline
{\}newline
* Introduction to metal alloys{\}newline
Ferrous alloys, Fe-C and Fe-Fe3C phase diagrams, steels and cast irons. Influence of the alloying elements in the mechanical properties of steels. Aluminium, copper, magnesium, titanium and nickel alloys. Thermal treatments of steels and aluminium.{\}newline
{\}newline
* Introduction to metal forming processes{\}newline
Fundamentals, machine tools and parameters for industrial metal forming: die forming, forging, rolling, extrusion, bending and deep drawing.{\}newline
{\}newline
* Introduction to cutting processes{\}newline
Some theoretical principles and fundamental parameters for stamping, blanking, mechanical metal removing processes and electrical discharge machining.{\}newline
{\}newline
* Introduction to welding processes{\}newline
Fundamentals and most significant parameters, resistance welding, arc welding (with/without gas). Laser welding.{\}newline
{\}newline
* Introduction to foundry processes{\}newline
Types of molding, pouring, cooling effects and solidification. Types of defects and non-destructive testing.{\}newline
{\}newline
* Introduction to polymer and ceramics processing{\}newline
Different classes of polymers, its main properties and usual manufacturing processes. Ceramic materials and its processing.{\}newline
{\}newline
* Introduction to composite materials{\}newline
Design considerations. Anisotropic behaviour. Some insights on the manufacturing process, structural defects and non-destructive testing.

Back

Applied Thermodynamics (EME00528L)

1 – Basic Concepts
Systems. Closed systems and open systems. Properties of a system. Specific volume. Pressure. Temperature. State of equilibrium. Processes and cycles.
2 – Energy and 1st Law of Thermodynamics
Reviews on mechanical energy. Work, energy, heat. Energy balance in closed systems. Energy analysis of Cycles.
3 – Calculation of properties. Tables
Introduction. P-v-T relation. Diagrams. Phase change. Obtaining Thermodynamic properties using tables. Energy balance. Specific heats. Compressibility. Ideal Gas. Energy balance with ideal gases.
4 – Open Systems
Conservation and mass balance. Energy Conservation. Examples in stationary regime. Transient Regime.
5 – Second Law of Thermodynamics
Carnot Cycle. Entropy. Entropy Variation. Entropy balance in closed systems.
6 – Steam Power Systems
Introduction. Ideal Rankine Cycle. Comparison with the Carnot Cycle.

Back

Industrial Automatisms (EME00505L)

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

Electronics II (EME00508L)

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 (FIS00523L)

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 e-NTU Methods.
7. Thermal radiation: radiation among surfaces in a nonparticipating medium.

Back

Instrumentation (EME00511L)

Introduction to Metrology: history; definition; fundamental and derivative units. Notion of uncertainty and errors; Law of propagation of uncertainties.

Electrical Signals: periodic signals; sinusoidal signs; average and effective value; Fourier series; Fourier transform.

Operational Amplifiers: characteristics (gain, inflection rate, saturation, power, input and output impedance, offset voltage, polarization currents, noise); assemblies.

Digital-Analog Converters: ideal converter; conversion techniques; resistance network; accuracy and precision; conversion speed and current output.
Analog-Digital Converters: voltage-frequency; tension-time; simultaneous; successive approaches;

Acquisition Systems:

Analog instruments. Movable board:
Digital instruments...

Measurement Transducers:

Back

Mechanics of Materials (FIS00525L)

Back

Condition Control of Mechatronic Systems (EME00521L)

Syllabus: 1) Introduction to preventive and predictive maintenance. Condition-based maintenance. Classification of maintenance techniques, planning and the weight of the economic factor. Primary and Secondary functions, reliability.2) Measurements and information gathering methods. Instrumentation.3) Damage and degradation of Industrial equipments. Illustrations. Fatigue, plastic flow, creep and rupture. Typical mechanical failure: shafts, gearing, pipes, etc.4) Mechanical vibrations in the context of maintenance: 1 DOF4a) D'Alembert principle and the use of inertial forces in the free-body diagrams. Energy and energy-based methods to obtain the equilibrium in the sense of d'Alembert..4b) Second-order ODEs: characteristic equation, types of response, stable and unstable systems. Damped and non-damped frequencies, damping ratio. Superposition principle and response shift.4c) Response to non-zero initial conditions.4d) Constant right-hand side. Static displacement. Harmonic right-hand side, critical frequency, phase diagram and frequency ration. Periodic right-hand side: Truncated Fourier series.4e) Response to an arbitrary excitation: Dirac-Delta, equivalence to an initial velocity inversely proportional to the mass. Duhamel integral. General response.4f) ODE integrators: reduction to a first-order system. Superposition response to a first-order ODE, central difference numerical integration, critical time step, Courant number. 4g) Stationarity of the Lagrangian, Euler-Lagrange equations. 5) Machine components as rigid bodies:5a) Basis change and vector transformation: alibi-alias and orthogonal matrices.5b) Rigid-body DOF. Euler angles and general rotation matrix. Euler theorem. Rotation matrix eigensystem. Chasles theorem. Angular velocity and acceleration, general case.5c) General motion of a rigid body. 5d) Inertia matrix, general motion equations. 5e) Typical inertia matrices and solutions 5e) Bidimensional case. 6) N degrees-of-freedom:6a) General motion equations by the Euler-Lagrange method.6b) Free undamped case: orthogonality, eigenshapes and frequencies, modal basis. 6c) Modal decoupling in the proportional case. General response.6d) Frequency response and basis motion. Accelerometer modus-operandi.7) Fourier Series and Gibbs phenomenon. How to filter it. 8) Fourier transforms in detail. 9) Continuous media. Second order PDEs: classification and characterization of the solutions. Functional spaces and internal products, the introduction of a metric.10) Beams and plates: modal basis and general solution. Boundary conditions by using distributions and integration of the motion equations.11) Sensitivity analysis.12) Lubricants: viscosity, indices, maintenance role.13) Practical works and papers done by the students.{\}newline

Back

Industrial Electronics (EME00509L)

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Electrical Machines (FIS00512L)

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 behaviour analysis. DC Machines Introduction and functioning principles. Generator functioning. Main characteristics. Application fields. Motor functioning. Main characteristics. Application fields. Dynamic behaviour analysis. AC Machines Asynchronous Machine. Constructive aspects and functioning principles. Three-phase induction machine. One-phase induction machine. Application fields. Dynamic behaviour analysis. Synchronous Machine. Constructive aspects and functioning principles. Generator study. Synchronous motor. Dynamic behaviour analysis. Special Electrical Machines PM Synchronous machine. Switched Reluctance Machine. Step Motor. Etc.

Back

Structural Mechanics (EME00526L)

1. The concepts of stress and strain, strain measurements, constitutive laws, anisotropic case with thermal effects, equations of motion and equations of compatibility. Yield and failure criteria.
2. Torsion of straight members with arbitrary cross section, and thin walled open, closed and multicelular cross sections.
3. Curved beam theory for members with arbitrary cross section in nonsymmetrical bending. Shear stress arising from the shear forces, bending and torsion coupling and shear centre.
4. Introduction to the analysis of plates. Kinematical hypothesis and corresponding governing equations. Solution methods for rectangular plates and circular plates with axisymmetrical loading. Brief introduction to laminates and the analysis of axisymmetrical shells.
5. Energy theorems useful for structural analysis and corresponding applications. Approximations using the Rayleigh-Ritz method.
6. Introduction to matrix structural analysis and the Finite element method.

Back

Mechatronic System (FIS00530L)

≫ Rigid body kinematics{\}newline
Planar motion by translation and rotation. Velocity and acceleration. General motion of a rigid body in space. Determination of velocities and accelerations using rotating frames. Motion of spatial rotation and possible parametrizations.{\}newline
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≫ Kinematics of mechanical systems and application to robotics{\}newline
Types of standard kinematic joints. Modelling kinematic joints and actuators as constraint equations. Systems of equations determining the motion of a mechanical system and its analytical or numerical solution. Application to the study of robotic systems. Direct and inverse kinematics of robotic end effectors. Non invertibility of the constraint equations for some configurations.{\}newline
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≫ Kinetics of mechanical systems{\}newline
Principles of the linear and angular momentum. Equations of motion for a rigid body. Equations of motion for a mechanical system. The numerical solution of the equations of motion and analysis software. Application to robotics. Determination of the actions the actuators should provide to approach a prescribed motion.{\}newline
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≫ Development of mechatronic systems{\}newline
Robotic systems. Selection of sensors, its location and data acquisition. Selection of actuators and the implication on the system response. Associated electronics. Simple control systems synthesis. Practival implementations.{\}newline
Introduction to micro-electromechanical systems (MEMS).