UNIVERSIDAD DE BURGOS

COURSE DESCRIPTIONS

Bachelor's Degree in Industrial Electronics and Automation Engineering

➢ 1st year

6392 ALGEBRA AND DIFFERENTIAL EQUATIONS

Linear algebra
Introduction Linear systems. Matrices and determinants.
Solving linear systems.
Matrices: Definitions and properties.
Determinants.
Inverse matrix.
Rank of a matrix.

Vector spaces
Real vector space.
Subspaces.
Linear dependence and independence.
Generating set, bases and dimension.
Linear applications.
Linear map.
Image and nucleus of a linear map.
Matrices associated to a linear map.
Theorem of similarity.

Diagonalization
Eigenvalues and Eigenvectors.
Characteristic polynomial, multiplicity of eigenvalues; eigen subspace.
Diagonalization of matrices and endomorphisms.
Differential Equations.

Introduction to the study of differential equations. Differential Equation Systems.
Differential Equation Systems. First definitions.
Solution of a D.E. system.: general solution and particular solution.
Homogeneous Linear Differential Equation Systems.
Complete Linear Differential Equation Systems.

First Order Differential Equations and Linear Differential Equations
Solution of a D.E.: general solution and particular solution.

First Order Differential Equations
Linear Differential Equations of the nth order.
Properties of the homogenous linear equations.
Linear equations of constant coefficients.
Complete linear equations.

Laplace Transform
Definition of the Laplace Transform.
Properties of the Laplace Transform.
Solution of Differential Equations and Systems of Differential Equations by means of the Laplace Transform.

6393 CALCULUS

Numerical sets
The real number
Successive extensions of the number concept. Topological definitions of the real line. The absolute value.
The complex number.
Definitions. Operations with complex numbers.

Real functions of real variable
Continuity
First definitions. Limits. Continuity. Theorems on continuous functions.
Derivability
First definitions. Theorems on derivable functions. Graphical representation of functions.
Integration of functions
The definite integral.
Definition of primitive. Properties. Calculation of primitives.
The definite integral.
Definition and properties. Theorems of the average value. Fundamental Theorem of Barrow's Rule. Improper Integrals. Applications.

Numerical and functional series
Numerical series
Definitions. Criteria of convergence.
Functional series
Definitions. Power Series. Development of Power Series.

6394 PHYSICS I

INTRODUCTION

TOPIC 1. SCALAR AND VECTORIAL MAGNITUDES - UNITS
PHYSICS
1.1. Introduction.

1.2. Scalar and Vectoral Magnitudes.
1.3. Basic operations with vectors.
1.4. Magnitudes and dimensions.
1.5. Dimensional analysis.
1.6. Units and systems of units.

MECHANICS OF THE PARTICLE AND THE SOLID

TOPIC 2. KINEMATICS OF THE PARTICLE
2.1. Introduction.
2.2. Position Vector.
2.3. Velocity Vector.
2.4. Acceleration Vector. Intrinsic components.
2.5. Circular movement. Angular velocity.
2.6. Relative movement.

TOPIC 3. DYNAMICS OF THE PARTICLE
3.1. Introduction.
3.2. Newton's Laws.
3.3. Linear momentum.
3.4. Habitual forces in Mechanics.
3.5. Free body diagram.
3.6. Inertial and non-inertial frames of reference.
3.7. Inertial Forces.

TOPIC 4. WORK AND ENERGY
4.1. Introduction.
4.2. Field Concept.
4.2. Work of a force. Power.
4.3 Kinetic energy. Theorem of the kinetic energy.
4.4. Conservative forces. Potential energy.
4.5. Principle of energy conservation.

TOPIC 5. DYNAMICS OF A RIGID BODY
5.1. Introduction.
5.2. Particle Systems. Rigid Body Concept.
5.3. Centre of Masses.
5.4. Centre of Mass Theorem.
5.5. Momentum of a Force.
5.6. Fundamental Equation of Rotation Dynamics.
5.7. Momentum of Inertia.
5.8. Angular Momentum of a Rigid Body.
5.9. Work and Energy in Rotation Motion.
5.10. Rolling Movement.

TOPIC 6. HARMONIC OSCILLATOR
6.1. Introduction.
6.2. Simple Harmonic Movement.

6.3. Dynamic Solution of Simple Harmonic Movement.
6.4. Harmonic Oscillator Energy.
6.5. Examples of Harmonic Oscillator.

TOPIC 7. MECHANICAL WAVES
7.1. Introduction.
7.2 Undulatory movement. Longitudinal and cross-sectional waves.
7.3. Mathematical description of a wave.
7.4. Examples of mechanical waves.
7.5. Energy in the undulatory movement.
7.6. Static waves.

FLUID MECHANICS
TOPIC 8. FLUID MECHANICS
8.1. Introduction.
8.2. Properties of the fluids.
8.3. Pressure.
8.4. Fundamental hydrostatic equation.
8.5. Archimedes' Principle.
8.6. Measurement of pressure. Barometers and manometers.
8.7. Continuity Equation.
8.8. Bernoulli Equation. Applications.

6395 GRAPHIC EXPRESSION

INDUSTRIAL TECHNICAL DRAWING

1. NORMALIZATION
1.1. Object of Technical Drawing.
1.2. Classification of Technical Drawings.
1.3. Standardization.

2. PLANE GEOMETRY
2.1. Basic operations.
2.2. Technical curves. Tangencies.

3. PROJECTION SYSTEMS
3.1. Dihedral system: Fundamentals.
3.2. Flat figures and surfaces.

4: PERSPECTIVES

5: STANDARDIZED REPRESENTATION
5.1. Views, cuts, sections, cracks and annotations.
5.2. Basic elements and diagrams.
5.3. Basic concepts of unions.
5.4 Assemblies and cuttings.
5.5 Adjustments, Geometrical and Dimensional tolerances.

CAD

6: 2D CAD. Internship applications
6.1 Basic applications.

7: 3D CAD Initiation
7.1. Representation of simple objects.
7.2. Basic operations.

6396 BASIC COMPUTING

Introduction to Computer science
History and Basic Concepts.

Office Automation
Word processing.
Spreadsheet.
Presentation.

Introduction to Operating Systems
Memory and Processes.
Management of Files and Users.

Introduction to Programming
Basic concepts.
Programming.

Computer Networks and Internet
Networks.
Internet.

6397 MATERIAL SCIENCE: STRUCTURE AND PROPERTIES.

Material Science.

Atomic Structure and Interatomic Bonding
Introduction. Atomic structure. Atomic bonding in solids.

Structure in Crystalline solids
Introduction. Fundamental concepts. Unit Cells. Crystalline structures of metals. Density Calculations. Polymorphism and allotropy. Crystalline systems. Crystallographic directions and planes. Crystalline and non-crystalline materials.

Atomic diffusion in solids
Introduction. Mechanisms of diffusion. Stationary and non-stationary Diffusion Factors. Diffusion and material treatment.

Phase Diagram
Phase diagram of pure substance Gibbs phases rule. Engineering Alloys. Isomorphic binary alloy system. Binary eutectic systems. Iron-carbon System

Material Properties

Material Electrical Properties
Material Magnetic Properties
Material Optic Properties
Thermal properties
Mechanical properties

6398 EXTENDED CALCULUS AND GEOMETRY

Differential and Integral Calculus

Differential calculus
The n-dimensional Euclidean space.
Scalar and Vector Functions: limits, continuity and differentiability.
Relative, conditioned and absolute extremes.
Curves and surfaces: tangent straight line and tangent plane.

Integral calculus
Double Integrals. Applications.
Triple integrals. Applications.
Integrals of line and surface. Applications.

6399 PHYSICS II

THERMODYNAMICS
TOPIC 1. TEMPERATURE AND HEAT
1.1. Introduction.
1.2. Concept of temperature.
1.3. Thermometers and temperature scales.
1.4. Dilation of solids and liquids.
1.5. Heat. Calorimetry.
1.6. Heat Transfer.
TOPIC 2. PRINCIPLES OF THE THERMODYNAMICS
2.1 Introduction.
2.2. Thermodynamic systems. Ideal gas.
2.3. Internal energy. First principle of Thermodynamics.
2.4. Thermodynamic processes of an ideal gas.
2.5. Second principle of Thermodynamics. Thermal machines.

ELECTROMAGNETISM

TOPIC 3. ELECTRIC FIELD IN VACUUM

3.1. Introduction.
3.2. Coulomb's Law.
3.3. Electrical field strength.
3.4. Potential Energy and Electrical Potential.
3.5. Gauss's Law. Applications.

TOPIC 4. ELECTRIC FIELD IN MATERIAL MEDIA

4.1. Introduction.
4.2. Conductors and dielectrics.
4.3 Electric field in conductors.
4.4. Electric field in dielectrics.
4.5. Capacitors.

TOPIC 5. DIRECT CURRENT

5.1. Introduction.
5.2. Electric current. Current Intensity.
5.3. Ohm's Law Electrical resistance.
5.4. Association of resistance.
5.5. Energy of the electric current. Joule's Law.
5.6. Generators. Electromotive force.
5.7. Kirchhoff's Laws.
5.8. Ammeters and voltmeters.

TOPIC 6. MAGNETIC FIELD

6.1. Introduction.
6.2. Magnetic field. Lorentz Force.
6.3. Force of a magnetic field on a current.
6.4. Sources of magnetic field.
6.5. Ampère's Law.
6.6. Magnetic force between conductors.
6.7. Magnetic field in material media. Magnets.

TOPIC 7. ELECTROMAGNETIC INDUCTION AND ALTERNATING CURRENT

7.1. Introduction.
7.2. Flow of a magnetic field.
7.3. Faraday and Lenz Laws.
7.4. Generation of alternating currents.
7.5. Self-induction.
7.6. Mutual induction.
7.7. Energy associated with a coil.
7.8. Transformers.

FUNDAMENTALS OF OPTICS

TOPIC 8. FUNDAMENTALS OF OPTICS

8.1. Introduction.
8.2. Nature of light. Electromagnetic spectrum.
8.3. Propagation of light.
8.4. Reflection and refraction.
8.5. Interference and diffraction.

6400 CHEMISTRY

Topic 1
Introduction to chemical concepts
Atomic structure. Periodic table and properties of the elements. Chemical bonding. Bonding Polarity. The concept of a mole. Stoichiometry. Chemical reactions. Acid-base and oxidation-reduction.
Topic 2
Chemical energy: heat and work
Nature of energy. Heat and work. Status Functions. Enthalpy. First law. Heat capacity. Reaction Enthalpy. Enthalpies of Hess's Law.

Topic 3
Spontaneous processes and chemical equilibrium
Spontaneous processes and entropy. Second law of Thermodynamics. Entropies of standard reaction. Equilibrium and Gibbs Energy. Reversibility of chemical reactions. Law of mass action. Thermodynamic constants of equilibrium. Alternatives Forms of the equilibrium constant. Le Chatelier Principle.
Topic 4
Condensed media
Intermolecular forces. Variation of steam pressure with temperature. Raoult's Law. Boiling, melting and solidification. Liquid mixtures. Solubility. Phase Diagrams. Solubility of gases: Henry's Law. Colligative properties. Osmosis. Desalination. Colloidal mixtures.
Topic 5
Gaseous State
Nature of gases. Pressure. Units of pressure. Natural laws of gases. Ideal Gas Law. Applications of the ideal gas law. Gas mixtures. Deviation from the ideal gas law. Real gases. Composition of the atmosphere. Quality of air and atmospheric pollutants.
Topic 6
Acids and bases
Brønsted and Lowry Theory. The pH and its experimental measurement. Acid ionization and water bases. Effect of the common ion. pH Regulating solutions. Acid-based titration curves. Polyacids. Acid-based Indicators.
Topic 7
Electrochemistry
Electrode Potentials. Electromotive forces from electrochemical batteries. Nernst Equation. Quantitative treatment of redox balances. Voltaic cells of Electrolytic batteries. Corrosion.
Topic 8
Foundations of Chemical Kinetics
Reaction Speed: Law of speed and order of reaction. Kinetic constants. Integrated Speed Equation. Average lifespan. Models of reactions. Effect of temperature. Arrhenius Equation.

6401 BUSINESS ECONOMICS
Introduction to the company.
The company and the entrepreneur.
Company management.
The management of the company and the management process.

Development and growth of the company.
Human Resources.
Introduction to the company's human resources.
Financial subsystem in the company and accounting.
Introduction to the financial function of the company and to accounting.
Introduction to investment-financing decisions in the company.
Commercial subsystem.
Introduction to the business management.
The Marketing-mix.
Current trends in business management.
Current trends in business management and Business models.
Creation of companies.
Entrepreneurs.

- **2nd year**

6402 THERMAL ENGINEERING

TOPIC 1: ENERGY, TECHNOLOGY AND SOCIETY
Useful Power Production. Energy models in history. Power sources. Power Production Systems. Thermal and nuclear power plants. Energy Management. Energy and environment.

TOPIC 2: FUNDAMENTAL CONCEPTS
Object of Thermodynamics. System and wall. State Properties. Thermodynamic Process and change of state. State of equilibrium.

TOPIC 3: PRINCIPLE 0. EQUATION OF THERMAL STATE AND TEMPERATURE
Principle 0 of Thermodynamics. Thermal balance. Equation of Thermal state. Thermometers and temperature scales. Thermometric scale of the ideal gas. Equation of thermal state of the ideal gas.

TOPIC 4: FIRST PRINCIPAL OF THERMODYNAMICS
Work in Thermodynamics. First Principle: formulation in closed systems. Formulation in open systems. Formulation in cyclical processes.

TOPIC 5: THERMODYNAMIC PROPERTIES OF PURE SUBSTANCES
Ratio p - v - T. Pressure - Temperature Diagram. Pressure - Volume Diagram. Specific Heat under pressure and constant volume. Compressibility Factor. Polytrophic processes

TOPIC 6: SECOND PRINCIPLE OF THERMODYNAMICS
The transformation of energy. Carnot´s Theorems. Thermodynamic temperature and entropy. Generation of entropy. Irreversibility. Temperature - Entropy, Enthalpy - Entropy and Pressure - Enthalpy Diagrams.

TOPIC 7: PROCESSES IN OPEN SYSTEMS

Discharge Processes. Valves, nozzles and diffusers. Heat Exchange Processes. Adiabatic work processes. Turbines, compressors and pumps. Non-Adiabatic Work Processes. Staggered compressions and expansions. Heat technology.

TOPIC 8: INTRODUCTION TO HEAT TRANSFER
Basic heat transfer mechanisms: conduction, convection, radiation. Importance of heat transfer. Thermal conductivity. Density. Viscosity. Specific Heat. Tables of Thermophysical properties of materials.

TOPIC 9: UNI-DIMENSIONAL STATIONARY CONDUCTION
Equation Fourier. Flat, cylindrical and spherical geometry. Analysis of uni-dimensional stationary conduction. Flat symmetry; Cylindrical symmetry; Spherical Symmetry. Global transfer coefficient.

TOPIC 10: FLUIDOMECHANICS OF CONVECTION
The problem of the heat convection. Dimensionless numbers. Forced convection. Experimental correlations for heat transfer in forced convection. Natural convection. Experimental correlations for heat transfer in natural convection. Heat transfer in phase changes.

TOPIC 11: HEAT EXCHANGERS
Classification of heat exchangers. Temperature Profiles in heat exchangers. Mean Logarithmic Temperature Difference.

TOPIC 12: THERMAL RADIATION
Thermal radiation. Fundamental laws. Radiation in Non-absorbent media.

TOPIC 13: COMBUSTION
Fuels and their Properties. Stoichiometry of combustion. Combustion control.
Environmental aspects of combustion.

6403 STATISTICS AND NUMERICAL CALCULUS

Statistics

Descriptive statistics
Statistical description of a variable.
Measures associated with a distribution.
Joint description of two variables.
Introduction to simple linear regression.

Probability and Random Variables
Probability.
Discrete random variables. Usual models.
Continuous random variables. Usual models.

Confidence Intervals
Random and Statistical Samples.
Specific estimation.

Estimation by confidence intervals (normal populations and proportions).

Statistical hypothesis testing
Statistical hypothesis testing (normal populations and proportions).

Numerical analysis

Introduction to Numerical Analysis
Origins and objectives of the numerical calculation. Necessity of numerical analysis in engineering. Errors.
Operating cost and efficiency. Introduction to MATLAB.

Interpolation
Global Interpolation: Newton and Lagrange. Segmental Interpolation: Linear, Quadratic and Splines.

Quadrature and Numerical Differentiation
Introduction. Rules of quadrature and degree of accuracy. Simple and Compound Rules of Quadrature Obtaining and errors of Numerical Differentiation.

Solving Non-linear Equations.
Introduction. Methods using intervals: Bisection. Iterative methods: Newton.

Numerical Resolution of Ordinary Differentials Equations.
Euler Method, Runge-Kutta Method.

6404 FUNDAMENTALS OF ELECTRICAL ENGINEERING

ELECTRICAL CIRCUITS

TOPIC 1. Introduction to the electrical circuits.
TOPIC 2. Direct Current Circuits.
TOPIC 3. Circuits in sinusoidal alternating current.
TOPIC 4. Three-phase circuits.
Low Voltage Electrical Installations.
TOPIC 5. Low Voltage Electrical Installations.

ELECTRICAL MACHINES
TOPIC 6. Introduction to Electrical Machines.

ELECTRICAL SAFETY
TOPIC 7. Electrical Safety.

6405 PRODUCTION MANAGEMENT

BLOCK 1: PRODUCTION BASICS.
Production in a competitive global market.
Project Management.

BLOCK 2: STRATEGIC PILLARS.
Product and process.
Media Capacity and Distribution.
Localization and delocalization of production.

BLOCK 3: TACTICAL DECISIONS.
Organization of flows.
Planning of productive means.
Organization of people.
Excellence of productive systems.

6406 MATERIALS ELASTICITY AND RESISTANCE

Chapter 1: Introduction
1.1. Elasticity and Strength of Materials.
1.1.1. Objective of these disciplines.
1.1.2. Study Model: the deformable solid.
1.1.3. Fundamental hypotheses.
1.2. Review: concepts of Static.
1.2.1. Conditions of Equilibrium.
1.2.2. Degrees of freedom of a system.
1.2.3. Coercions.
1.2.4. Degree of external and internal indeterminate static.
1.2.5 Degree of total indeterminate static.
1.3. Review: Surface Properties.
1.3.1. Geometric centre and static momentum.
1.3.2. Moments and products of surface inertia.
1.3.3. Steiner's Theorem.
1.3.4. Main axes of inertia.

Chapter 2: Stress Analysis
2.1. State of stress at a point.
2.1.1. Concept of stress: normal and tangential components.
2.1.2. Elementary Parallelepiped Equilibrium.
2.1.3. Stress Tensor.
2.2. Stresses and main directions.
2.2.1. Main stresses.
2.2.2. Main Directions.
2.3. Mohr's Circumferences.
2.3.1. Representation of stresses in planes parallel to a major axis.

2.3.2. Representation of stresses on any plane.

Chapter 3: Analysis of deformations
3.1. State of deformations at a point.
3.1.1. Concept of stress: longitudinal and transversal components
3.1.2. Deformation of the elementary parallelepiped.
3.1.3. Deformation Tensors.
3.2. Deformations and main directions.
3.2.1. Main deformations.
3.2.2. Main Directions.
3.3. Mohr's Circumferences.
3.3.1. Representation of deformations in perpendicular directions to a main axis.
3.3.2. Representation of deformations in any direction.
3.4. Variations of length, area and volume.
3.4.1. Variations of length.
3.4.2. Area Variations.
3.4.3. Variations in volume.
3.4.4. Thermal expansion.

Chapter 4: The Elastic Problem
4.1. Behaviour of materials.
4.1.1. The traction test.
4.1.2. Ductile and fragile materials.
4.1.3. Linear elastic behaviour: Hooke's Law.
4.1.4. Relationship between E, v and G.
4.1.5. Lamé Coefficients.
4.2. Design Conditions.
4.2.1. Design of components.
4.2.2. Safety and weighting coefficients.
4.2.3. Equivalent voltage.
4.2.4. Von Mises Criterion for Ductile Materials.
4.2.5. Mohr Criterion for Fragile Materials.
4.3 The Elastic Problem in Bars.
4.3.1. The Elastic Problem.
4.3.2. The Bar Element.
4.3.3. System of Coordinated Axes in a section.
4.3.4. Transversal section requirements.
4.3.5. Equilibrium of a slice.
4.3.6. Requirement diagrams.
4.4. Bar Structures.
4.4.1. Bar Structure Analysis.
4.4.2. Symmetry and anti-symmetry.

Chapter 5: Traction/Compression
5.1. Solution of the Elastic Problem in Traction and under Compression.
5.1.1. Bernouilli's Hypothesis.
5.1.2. Stresses.
5.1.3. Deformations.

5.2. Calculation of articulated structures.
5.2.1. Articulated Structures.
5.2.2. Resolution of Isostatic Structures.
5.2.3. Resolution of Hyperstatic Structures.
5.3. Calculation of tanks and rings under pressure.
5.3.1. Tanks.
5.3.2. Rings.

Chapter 6: Cutting
6.1. Solution of the Elastic Problem in Cutting.
6.1.1. Simplifying Hypotheses
6.1.2. Stresses.
6.1.3. Deformations.
6.2. Screwed joints.
6.2.1. Behaviour of the cutting joint.
6.2.2. Distribution of a centred shear load.
6.2.3. Distribution of an eccentric shear load.
6.3. Welded joints.
6.3.1. Welding behaviour.
6.3.2. Stresses due to a centred shear load.
6.3.3. Stresses due to an eccentric shear load.

Chapter 7: Pure, simple, and Complex Bending
7.1. Solution of the Elastic Problem in Pure Bending.
7.1.1. Navier-Bernouilli Hypothesis.
7.1.2. Stresses: Navier's law.
7.1.3. Deformations: Elastic Equation.
7.2. Simple Bending.
7.2.1. Stresses and deformations in Simple Bending.
7.3. Complex Bending.
7.3.1. Complex Bending Stresses and deformations.

Chapter 8: Calculation of deformation in bending
8.1. Methods of Calculation.
8.1.1. Double Integration Method.
8.1.2. Mohr's Theorems.
8.2. Indeterminate static in Bending.
8.2.1. Resolution of hyperstatic bending.
8.2.2. Continuous Beams.
8.2.3. Gerber Beams.

Chapter 9: Bending instability: Buckling
9.1. Introduction.
9.1.1. System Stability and Instability.
9.1.2. Instability of a Bar from Bending.
9.1.3. Linear and non-linear elastic buckling.
9.2. Linear elastic buckling.
9.2.1. Euler's Formula.

9.2.2. Influence of Links.
9.2.3. Slenderness Limit.
9.3. Non-Linear Elastic Buckling.
9.3.1. Tetmajer's Formula.

Chapter 10: Torsion
10.1. Solution of the Elastic Problem in Circular Section Bar Torsion.
10.1.1. Coulomb Hypothesis.
10.1.2. Stresses.
10.1.3. Deformations.
10.2. Uniform Torsion in Non-circular Sections.
10.2.1. Membrane Analogy.
10.2.2. Elliptical, Equilateral, Triangular and Rectangular Sections.
10.2.3. Thin Open Sections.
10.2.4. Thin Closed Sections.

6407 FLUID MECHANICS ENGINEERING

TOPIC 1.-INTRODUCTION. BASIC CONSIDERATIONS
Historical review of fluid mechanics. Units. dimensions and magnitudes. System of Units. Fundamental laws of mechanics and Thermodynamics. Continuity Equation. Mass conservation. Equation of fluid energy. Equation of fluid energy in motion. Equation of the
Equation of state.

TOPIC 2.-PROPERTIES OF FLUIDS
Definition of Fluid. Fluid as a continuous medium. Properties of fluids.
Introduction. Density. Relative density. Specific volume. Specific weight.
Surface stress. Steam pressure.
Dynamic Viscosity. Kinematic viscosity. Compressibility.
Isothermal Compressibility. Volumetric Expansion Coefficient. Newton's Law of Viscosity.
Newtonian Fluids. Properties of an ideal gas. Law of Perfect Gases.
Normal physical air conditions. Normal technical air conditions.
General equation of gases. Equation of state for perfect gases.
Compressibility of fluids. Effect of pressure in Isothermal Processes.
Effect of pressure on Isentropic Processes. Sonic Velocity. Mach Number.

TOPIC 3.-FLUID STATICS. STUDY OF THE PRESSURE INSIDE A FLUID.
Introduction. Pressure concept. Units. Ways of expressing pressure. Manometric pressure.
Pressure at a point. Fundamental Law of Hydrostatics. Equilibrium of a particle.
Pascal's Principle. Energy concept of piezometric heights.
Pressure difference between two points. Incompressible fluids. Compressible fluids.
Mechanical gain in the transmission of pressures in a fluid. Hydraulic press.
Fluid column pressure gauges. The manometer. The multi-fluid manometer. Measurement of pressure drop. The Barometer. Hydrostatics. Summary.

TOPIC 4.-STUDY OF PRESSURE FORCES EXERTED ON SUBMERGED SURFACES. BUOYANCY-PUSH FORCES. STABILITY OF BODY IN FLOTATION.

Introduction. Geometric characteristics of surfaces. Study of pressure forces.
Horizontal wall. Sloping wall. Vertical
Study of pressure forces exerted on curved surfaces.
Vertical component. Horizontal component. Gravity dams, forces of water on the dam.
Gravity dams, landslide. Gravity dams, probability of overturning.
Pushing forces on submerged bodies. Archimedes' Principle.
Examples. Vertical thrust. Buoyancy and stability. Stability of submerged bodies.
Stability of bodies in flotation.

TOPIC 5.-RELATIVE EQUILIBRIUM. FLUID DYNAMICS. FUNDAMENTALS OF FLUID MOTION
Distribution of moving pressures as a rigid solid. In Cartesian coordinates.
Constant linear acceleration. Constant angular acceleration. Description
Motion according to Lagrange. Motion according to Euler.
Definitions. Pathlines, streamlines, streaklines. Mass flow.
Discharge rate or volumetric flow. Flow types. One-dimensional flows. Incompressible-compressible flow.

Permanent and uniform flow. Non-viscous/viscous flow. Laminar/turbulent flow.
Description of fluid motion. Material derivative. Reynolds Transport theorem.
RTT, special situations.

TOPIC 6.- LAW OF MOMENTUM, NEWTON'S 2nd PRINCIPLE APPLIED TO THE PASSAGE OF A FLUID CURRENT
Calculation of force exchanged with fluid in the event of a variation in the amount of flow motion.
Introduction. Newton's Laws Control Volume. CV forces.
Volumetric forces. Surface forces. Law of momentum.
Applications. Force exerted by flow when passing through the surface of a turbine blade.
Calculation of force exerted by fluid passing through a nozzle. Calculation of force exerted by fluid passing through a gate. Principle of turbomachine operation. Momentum moment.

TOPIC 7.- BERNOULLI'S EQUATION
Application of Newton's 2nd principle to transport over a current line.
Bernoulli Equation. Energy concept of the terms of the Bernoulli equation.
Kinetic energy correction factor. Restrictions on the use of Bernoulli's equation.
Total pressure. Pilot tube. Static pressure. Piezometric tube.
Dynamic pressure. Static Pitot tube. Prandtl's tube. Level lines.
Energy level lines. Drive height lines. Application of Bernoulli's equation.
Torricelli's theorem applied to unloading speed in tanks.
Venturi effect. Speed calculation, combining a differentia manometer.
Analysis of load terms in siphon. Negative manometric pressure points.
Emptying time of a tank: example of non-permanent flow.
Approach of Bernoulli's equation in cases of compressible flow. Isothermal flow.
Adiabatic flow.

TOPIC 8.- GENERAL ENERGY EQUATION
First principle of Thermodynamics. Energy conservation. General energy equation.
Energy equation. Energy treatment for centrifuge pumps.
Principle of operation. Net height. Net positive suction height NPSH.

Net available inlet height, NPSHa. Net required inlet height, NPSHr.
Suction height Ha. Performance. Operating point.
Energy treatment for turbines. Principle of operation. Net height.
Hydraulic turbines Performance.

TOPIC 9.- FLOW IN PIPELINE SYSTEMS. EFFECT OF VISCOSITY ON FLUID TRANSPORT IN CLOSED DUCTS.
Reynold's Experiment. Reynold's Number. Stabilization of the boundary layer in internal flows.
Laminar and turbulent flow. Calculation of load losses.
Stabilization of the boundary layer in internal flows. Pressure drop in flow in a circular conduit.
Darcy-Weisbach equation. Hagen-Poiseuille equation.
Colebrook equation. Moddy's Abacus. Calculation of pipeline transport.
Basic pipeline problems. Pipeline systems. Serial pipeline.
Parallel pipelines. Calculation of minor losses in pipeline flow.
Loss coefficients. Equivalent length. Calculation of losses in pipeline flow.
Total losses. Treatment for non-circular sections. Hydraulic radius measurement for flow and speed.
Obstruction flowmeters. Venturi tube.
Orifice plate. Flow meter.

TOPIC 10.- COMPRESSIBLE FLOW.
Stagnation properties. Speed of sound and Mach number. One-dimensional isentropic flow.
Isentropic flow in nozzles. Duct flow with energy transfer.
Adiabatic flow in a friction duct.

TOPIC 11.- TRANSPORT IN OPEN CHANNELS
Classification of flow in an open channel. Introduction. Uniform and non-uniform flow.
Laminar and turbulent flow. Wet perimeter. Subcritical, critical and supercritical flow.
Energy analysis of flow in an open channel Specific energy for a uniform flow without friction.
Energy and continuity equation for flow with friction.
Energy equation for uniform flow with friction. Energy equation for gradual flow variations.
Energy equation for rapid flow variations and hydraulic jump.
Flow control and measurement. Flow through a gate.
Flow through a weir. Cross-section of an open channel.
Optimum section. Optimum cross-section for a rectangular channel. Optimum section for a trapezoidal channel.

TOPIC 12.- HYDRAULIC MACHINES
General information about hydraulic pumps. General information about hydraulic turbines.

LABORATORY PRACTICES
Internship no. 1: Compressible-nozzle flow.
Pressure distribution nozzle unit.
Internship no. 2: Compressible-turbine flow.
Experimental impulsion turbine.

LABORATORY PROBLEMS
Problem no. 1: ees program. Generic exercises.
Ees program. Generic exercises.
Problem no. 2: static fluid exercises – ees.

Static fluid exercises – ees.
Problem no. 3: Pressure force exercises.
Pressure force/buoyancy exercises – ees.
Problem no. 4: Buoyancy exercises.
Buoyancy exercises – ees.
Problem no. 5: Fluid dynamics exercises.
Fluid dynamics exercises – ees.
Problem no. 6: Law of Momentum exercises.
Fluid dynamics exercises – ees.
Problem no. 7: Bernoulli's equation exercises.
Fluid dynamics exercises – ees.
Problem no. 8: Friction flow exercises.
Discharge meter exercises – ees.
Problem no. 9: Open Channel transport exercises.
Open channel exercises – ees.
Problem no. 10: Machine hydraulics exercises.
Open channel exercises – ees.

EXTRA ASSESSMENT
Laboratory Internship reports.
Troubleshooting.

6408 FUNDAMENTALS OF ELECTRONICS

Size
1-Introduction to the different types of electronics: Analogical, digital instrumentation, communications, energy conversion.
2-Introduction to the types of signals and strategies of the different "electronics".
3-Basics of solid-state semiconductor devices.
4-PN union.
5-Diode union. Electrical characterization.
6-Second-order effects.
7-Diodes, models, resolution techniques.
8-Circuits with diodes: applications.
9-Single-phase rectifiers.
10-Passive filters.
11-Stabilized power supplies.
12-Reference Voltage Sources.

Practices
1-Introduction to the laboratory system. Instrumentation-I.
2-Instrumentation-II. Function Generator and Oscilloscope.
3-Introduction to the OrCAD Electronic Simulator.
4-Rectifier Diode Study.
5-Simulation of circuits with diodes.
6-Creation of one's own library of components in OrCAD and

Creation of one's own components.
7-Simulation and assembly of the double wave rectifier with condenser filter, and with LC filter.
8-Stabilized power source with Zener diode.
9-Miscellaneous assemblies with voltage regulators.

6409 MECHANISMS

1. Topological analysis of mechanisms.
2. Articulated mechanisms.
3. Graphic synthesis of mechanisms.
4. Graphic and algebraic kinematics of flat mechanisms.
5. Machine static.
6. Machine Dynamics.
7. Power transmission systems in machines.

6410 AUTOMATISMS AND INDUSTRIAL CONTROL

1. Introduction to Automatisms and Industrial Control.
2. Electrical Automatisms.
3. Pneumatic Automatisms.
4. Electro-Pneumatic Automatisms.
5. Hydraulic Automatisms.
6. Control with industrial programmable controllers (PLCs).

6411 ELECTRICAL CIRCUITS THEORY

UNIT 1
GENERAL INFORMATION ON CIRCUIT THEORY
Electrical systems and circuits. Properties. Dual circuits.
Behaviour of real and ideal elements: basic differences. Power and energy.

UNIT 2
ADVANCED STUDY OF METHODS FOR THE RESOLUTION OF LINEAR CIRCUITS.
Equivalence between electrical circuits. Circular equations. Nodal equations.
Theorems for the study of circuits.

UNIT 3
STUDY OF STATIONARY SINUSOIDAL CIRCUITS.
General concepts. Study of frequency and time. Resonance condition.
Quality coefficients. Resonance study.
Introduction to passive filters.

UNIT 4
THREE-PHASE SYSTEMS
Complement to the study of balanced and unbalanced systems. Importance of the neutral. Neutral displacement method.

UNIT 5
COMPLETE RESPONSE IN FIRST-ORDER CIRCUITS
Basic concepts. First-order linear circuits. Calculation of the complete answer.

➢ 3rd year

6412 ANALOG ELECTRONICS

THEORETICAL TOPICS
Transistors.
Amplification.
Feedback.
Operational amplifier and applications.
Wave generation.
Active filters.
Analog Integrated Circuits.

6413 DIGITAL ELECTRONICS

INTRODUCTION TO DIGITAL ELECTRONICS

NUMBERING SYSTEMS AND CODES
Numbering systems: hexadecimal, decimal, octal and binary. Binary codes.

BOOLEAN ALGEBRA. LOGICAL FUNCTIONS AND SIMPLIFICATION.
Boolean algebra. Logic functions. Function simplification.

VHDL PROGRAMMING LANGUAGE

INTRODUCTION TO VHDL LANGUAGE
Introduction to VHDL language.
Advantages of using VHDL for hardware description.
Styles of VHDL description.
VHDL LANGUAGE SYNTAX.
Syntactic elements of VHDL.
1. Operators and expressions.
2. Data types.
3. Attributes.
4. Declaration of constants, variables and signals.

Instructions in data flow architecture.
Instructions in algorithmic behavioural architecture.
Instructions in structural architecture.

VHDL LANGUAGE STRUCTURE

ENTITY DECLARATION.
ARCHITECTURE DECLARATION.
Data flow description.
1. Data flow execution structures.
2. Examples of data flow description.

Algorithmic behavioural description.
1. Difference between variable and signal.
2. Structures of series execution.

Structural description.
1. Components, reference and link.
2. The configuration unit.

Subprograms, packages and libraries.

DESIGN METHODS

COMBINATION SYSTEMS
Basic components:
Logic gates.
Functional blocks:
Multiplexer and demultiplexer.
Encoder and decoder.
Comparators.
Generators and parity detectors.
Arithmetic circuits: addition, ALU and multiplication.
Design of combinational circuits.

SEQUENTIAL SYSTEMS
Basic components:
Flip-flop.
Functional blocks:
Records.
Counters.
Design of sequential circuits.
Status machines.

MEMORIES
Classification.
Parameters of a memory.
Memory structure.
Memory operations.

Circuit design with memories.

VHDL FOR SYNTHESIS

SYNTHESIS
Introduction to synthesis.
Methodology of synthesis in a logical device.
Integration of the design in a logical device.
Restrictions and optimization.

6414 AUTOMATIC REGULATION

Regulation.
Introduction to control systems.
Mathematical representation y modelling systems.
Temporary response.
Basic control actions.
Control System Stability.
Root place.
Frequency response.
Status space control.
Control system design.

6415 TECHNOLOGY OF ELECTRONIC SYSTEMS

Regulations.
Logical families. Characteristics.
Power semiconductor devices.
Semiconductor Thermal Protection.
Optoelectronic elements.
Communication elements.

Electronic Technology Practices
Passive and active electronic components.
PCB design and manufacture.

6416 ELECTRIC MACHINES

TRANSFORMERS
Single-phase transformers.
Study of single-phase transformers, definition, fundamental parameters, regulation, characteristic tests, parallel coupling.
Instrument transformers.
Definition of voltage and current transformers, definition, basics and basic characteristics, use, advantages and disadvantages.

Autotransformers.
Definition, comparison with a transformer, characteristics, use, advantages and disadvantages.
Three-phase transformers.
Definition, constitution, forms of connection, currents, connections, hourly indices,
parallel coupling.

ASYNCHRONOUS MACHINES
General concepts.
General constitution of rotating electric machines, coils, types of coils, induced emf in alternating current coils, parameters on which emf depends, rotating magnetomotive force, electromagnetic torque.
Asynchronous motors.
Constitution, operating principle, slip, induced emf and electromagnetic torque, characteristic curves, vacuum and load operation, balance of power, performance, asynchronous motor start-ups, start-up current and start-up stop.

DIRECT CURRENT MACHINES
General concepts.
Definition, alternating sine emf, basic alternator, coils, classes of coils, electrical bonding, induced reaction, switching.
Direct current generators
Definition, basic characteristics, balance of power, dynamo or independent excitation generator, shunt generator, series generator, compound generator, comparison of direct current generators, applications of dc generators.
Direct current motors
definition, balance of power, starting dc motors, characteristics of DC motors,
series motors, shunt motor, composite motor, operational stability,
braking, reversal of rotation direction, application of DC motors
SYNCHRONOUS MACHINES
General concepts.

6417 POWER ELECTRONICS

Introduction to Power Electronics
•Revision of power poles.
•Transitional Revision.

Applications of Power Converters
•General information on Power electronics applications.

Energy converters

AC/DC converters
• Uncontrolled rectifiers.
• Fully controlled rectifiers.
• Semi-controlled rectifiers.
• AC/DC analysis.
•Internal voltage drops.
• Negative effects created on the AC network.

Static Switches
- DC Static Switches.
- AC Static Switches.
- Resonant switches.

DC/DC converters
- General information.
- DC/DC converters, working in a single quadrant.
- DCI converters, working in a several quadrants.
- DC/DC converters, capacitor switching.
- Transformer coupled DC/DC converters.

DC/AC converters
- General information.
- Topologies of DC/AC converters.
- Multilevel DC/AC converters.
- DC/AC converter control.
- Resonant inverters.

AC/AC converters
- AC regulators.
- Cycloconverters.
- Matrix converters.

6418 MICROPROCESSOR-BASED SYSTEMS

UNIT I. PROGRAMMABLE SYSTEMS
Introduction to programmable systems.
Architecture of microprocessor systems.
Operation of a microprocessor-based system.
Microcontroller architecture.
Microcontroller operation.

UNIT II: MICROPROCESSOR SOFTWARE
Software Tools.
Assembler programming.
High level language programming.

UNIT III: PERIPHERALS: INPUT AND OUTPUT DEVICES
Input and output devices
Types of peripherals.

6419 ELECTRONIC INSTRUMENTATION

Introduction to electronic measurement systems
Sensors.

Resistive sensors.
Generator sensors.
Variable Reactance Sensors.

Signal Conditioning
Amplification.
Interference and Noise.
Insulation.

Data Acquisition
A/D Conversion.
D/A Conversion.
Data Acquisition Systems.

6420 INDUSTRIAL PROCESSES CONTROL

Industrial Process Control.
Introduction to Discreet Time control.
Signal sampling and reconstruction.
Mathematical representation of discreet systems.
Stability of discreet systems.
Discreet Controller Design.
Advanced Discreet Controller Design.

6421 INDUSTRIAL PRODUCTION AND FABRICATION SYSTEMS

STANDARDIZATION
1.Definition and purpose of standardization. 2. Advantages of the standardization. 3. General principles of the standardization. 4. National standardization bodies. 5. Standardization in Spain. UNE standards, 6. The international standardization.

ISO standards.

NORMAL NUMBERS
1. Introduction. 2. Fundamental series. 3. Properties of normal numbers.

DIMENSIONAL TOLERANCES
1. Introduction. 2. The system of fundamental ISO tolerances. Fundamental Concepts. 3. Group of nominal ISO sizes up to 500 mm. 3.1. Fundamental tolerances. 3.2. Tolerance positions. 3.2.1. Fundamental reference differences 3.2.2. Fundamental reference differences in holes. 3.2.3. Standard tables of tolerance positions. 4. Group of nominal ISO sizes greater than 500 mm. 4.1. Fundamental tolerances. 4.2. Tolerance positions. 5. Designation of dimensions with tolerance. 6. Free measurement tolerance.

SETTINGS

1. Definition. 1.1. Movable or playful setting. 1.2. Fixed setting or setting with interference. 1.3. Indeterminate setting. 2. Base Hole setting. 3. Base Axis setting. 4. Mixed system. 5. Standardization of settings. 6. Calculation of the standard setting.

OPERATIONS WITH DIMENSIONS

1. Introduction. 2. Addition of levels. 3. Size Transfer.

MANUFACTURING PROCESS SELECTION

1. Introduction. 2. Stages in product design. 3. Factors that influence the selection process. 3.1. Materials. 3.2. Manufacturing Processes. 4. Process selection strategy. 5. Process information maps. 6. Manufacturing process selection. 7. Information contained in premiums. 8. Cost Designs. 8.1. Basic manufacturing costs. 8.2. Relative cost coefficients. 8.3. Material costs.

FUNDAMENTALS OF MOLDING PROCESSES

1. Introduction. 2. Fundamentals of sand casting. 2.1. Model Design. 2.2. Mould Construction. 2.3. Distribution system design. 2.3.1. Water trough design. 2.3.2. Riser design. 2.4. Casting temperature. 2.5. Solidification.

PATTERNS, INSTRUMENTS AND DIMENSIONAL MEASUREMENT MACHINES

1. Introduction. 2. Standard lamps and lasers. 3. Interferometry. 3.1. Image interpretation. 3.2. Fizeau Interferometer. Measurement of Gauge blocks. 4. Edge patterns. 4.1. Gauge Blocks or Johansson blocks. 4.1.1. Qualities and 4.1.2. Materials and care of gauge. 4.2. Gauge end bars or rods. 5. Trace measuring equipment. 5.1. Rulers. 5.2. Calliper 5.3. Exterior micrometres. 5.3.1. Interior micrometres. 5.4. Measurement Machines. 6. Indirect comparison measurement instruments. 6.1. Dial indicator.

AMPLIFICATION SYSTEMS

1. Introduction. 2. Mechanical amplification. 3. Pneumatic amplification. 4. Electronic amplification. 5. Optical amplification.

LENGTH VERIFICATION

1. Introduction. 2. Gap gauge tolerances. 3. Plug gauge tolerances. 4. Tables.

PATTERNS AND ANGULAR MEASUREMENT INSTRUMENTS

1. Introduction. 2. Angular patterns. 2.1. Graduated circle. 2.2. Squares and rulers. 2.3. Angular gauge blocks. 2.4. Gauge polygons or optical polygons. 2.5. Formation of angular gauges. 3. Instruments for measuring angles. 3.1. Goniometer or angle protractor. 3.2. Bubble level. 3.3. Sine bar. 3.4. Indexing plate. 3.5. Autocollimator.

UNITS OF MEASUREMENT

1. Definitions. 2. International system of units of measure. 3. Gauges.

TRACEABILITY

1. The traceability concept. 2. Calibration plan. 2.1. Level diagram. 2.2. Instruction file or calibration procedures. 2.3. Data archiving. 2.4. Calibration labels. 2.5. Exterior traceability chart. 3. Participation in intercomparisons.

INFLUENCE OF UNCERTAINTY ON MEASUREMENT
1. Qualities of measuring instruments. 2. Relationship between height tolerance and 3. Relationship between uncertainty of measurement and scale division. 4. Selection of measuring instruments.

PRACTICES
PRACTICE 1. Measurement of a piece with a calliper.
PRACTICE 2. Measurement of a piece with an exterior micrometre.
PRACTICE 3. Measurement of a piece with a profile projector.
PRACTICE 4. Measurement of dimensions by comparison.

INTRODUCTION TO PRODUCTION SYSTEMS
1. Concept of production systems. 2. Types.

PLANT LAYOUT
1. Factors. 2. Plant layout by product. 3. Plant layout by process.

CLASSIC PRODUCTION SYSTEMS
1. Systems Q. 2. Systems P. 3. Procurement policies. 4. Safety stock. 5. Service companies.

ERP SYSTEMS
1. MRP I. 2. MRP II. 3. ERP.

JIT SYSTEMS
1. JIT Fundamentals. 2. JIT Tools.

➢ 4th year

6422 INDUSTRIAL COMPUTING

1. Introduction to industrial computer science.
2. Programmable controllers and Industrial PCs.
3. Basic PLC programming.
4. Industrial communications.
5. Human Machine Interfaces (HMI).
6. SCADA Systems.

6423 TECHNICAL OFFICE WORK

BACKGROUND

Professional Curriculum.

THEORETICAL AND PRACTICAL KNOWLEDGE

Basic concepts about the project and its classification. Project documents.

Project environment.
Industrial project regulations.

1ST CASE STUDY. Implementation and study of industrial project (to be specified during the course).

2ST CASE STUDY. Implementation and study of industrial project (to be specified during the course).

KNOWLEDGE ONLY THROUGH PRACTICAL APPLICATIONS

Specific techniques for assuring the correct.
Análisispreliminares de riesgos.
Failure mode and effects analysis.

THE USER'S DEMANDS. PRODUCT QUALITY.

Quality function deployment.
Direction, planning and management of projects.
Multidisciplinary projects. "Concurrent engineering".

DOCUMENTATION-GATHERING WORK.

6431 INDUSTRIAL AUTOMATION

1. Introduction to industrial automation.
2. Industrial automatisms.
3. Advanced PLC programming.
4. Modelling and programming of Discrete Event Systems (DEVs).
5. Field buses for industrial process control.
6. Industrial automation and control projects.

6432 INDUSTRIAL ROBOTICS

1. Introduction to robotics.
2. Robot Kinematics.
3. Robot Dynamics.
4. Trajectory Planning.
5. Robot Control.
6. Programming of industrial robots.

6424 APPLICATION OF INDUSTRIAL ELECTRONICS

1 Introduction

2 Control of Electrical Machines
•Fundamentals: AC motor control.
•Topologies of power sources.
•Control of used Energy Converters.

3 High frequency Heating
•Induction furnaces.
•Dielectric ovens.
•Microwave Heating.
•Control of used Energy Converters.

4 Energy Converters applied to the transport and distribution of electrical energy
•Reactive Energy Compensation.
•HVDC Transport.
•Active filters.

5 Power supply for equipment and systems
•High performance Rectifiers.
•Uninterruptible power supplies.
•Control of used Energy Converters.

6 Other Applications of Energy Converters
•Energy Converters for Welding.
•Electrical vehicle.
•Electronic ballast.

6425 AUTOMATION OF SOLAR AND WIND FACILITIES

Unit 1
Advanced solar energy concepts.

Unit 2
Advanced wind energy concepts.

Unit 3
Design of electrical systems for solar and wind power facilities.

Unit 4
Monitoring and control of solar and wind power facilities.

UNIVERSIDAD DE BURGOS

6426 RENEWABLE ENERGIES

Renewable Energies and Preservation of the Environment
Energy resources - Non-renewable Resources: environmental problems - Renewable resources - Energy outlook for Spain and the world.

Solar radiation
Characteristics of the solar radiation - Magnitudes - Sun's movement in the celestial sphere - Irradiance data.
Solar maps.

Solar Thermal energy
Thermal conversion at low temperatures: the flat solar collector - Efficiency Curve - Low temperature Facilities - Conversion to medium temperatures - Conversion to high temperatures.

Photovoltaic Solar energy
Photovoltaic effect - Photovoltaic Cells and modules - Photovoltaic Facilities - Applications.
Wind energy
Winds: wind speed and energy - Wind Machines -The three-blade wind turbine - Wind power Facilities

Hydraulic energy
Hydroelectric power plants - Harvestable Energy and power - Turbines and alternators - Pumping stations - Mini power stations.

Biomass Energy
Biomass Concept - Combustion-based techniques – Other thermo-chemical processes: gasification and pyrolysis - Energy crops – Biofuels – Biogas.

Geothermal energy
Terrestrial heat - Geothermal Manifestations - High temperature Technologies - Medium and low temperature Technologies - Very low temperature Technologies: heat pump.

Economics of the Renewable Energy Installations
Income and expenses generated by the installation - Economic Incentives - Economic Analysis of an installation.

Nuclear fusion
Fusion reactions - Controlled Fusion: requirements - Confinement - Objective: commercial power stations.

6427 SAFETY AND WORK PLACE ACCIDENT PREVENTION

- Basic concepts of Safety and Health at Work.
- General techniques for the analysis, evaluation and control of risks at work.
- Environment of the Prevention of Labour Risks.
- Regulations and basic documentation in the field of prevention.

6428 ELECTRONIC SYSTEM INTEGRATION

Theory
Integration and synthesis of electronic control systems
Integration of devices in projects and facilities.
Installation and operation of electronic equipment.
Maintenance and calibration of equipment.

EMI
• Generation of electromagnetic disturbances.
• Transmission of the disturbances.
• Negative effects they generate.
• Protection.
Protection in electronic systems.
• Against overcurrent and short circuits.
• Against power surges.

6429 ELECTRICAL INSTALLATIONS

TOPIC 1: GENERAL INFORMATION ON ELECTRICAL INSTALLATIONS
Generation. Transport. Consumption. High and Low voltage. Regulations. National Electrical system. Management. Situation and trends.

TOPIC 2: ELEMENTS OF INSTALLATIONS
Electrical conduits. Switchgear. Parts of the installations.

TOPIC 3: LOW VOLTAGE INSTALLATIONS
Definition. General considerations. Types of low voltage installations.

TOPIC 4: GROUNDING INSTALLATIONS
Description Design fundamentals.

TOPIC 5: LIAISON FACILITIES
Description. Design fundamentals.

TOPIC 6: INTERIOR INSTALLATIONS
Description. Design fundamentals.

TOPIC 7: ELECTROMAGNETIC COMPATIBILITY
Regulations. Problems and their possible solutions. The network analyser and its usefulness in electrical installations.

TOPIC 8: THE ELECTRICAL PROJECT
Basic considerations. Content and design.

TOPIC 9: CRITERIA FOR QUALITY CONTROL OF FACILITIES
Basic concepts. Procedures. Service tests for clearance of electrical installations.

TOPIC 10: SAFETY IN ELECTRICAL INSTALLATIONS
General information. Prevention Technical Standards. Safety study.

TOPIC 11: HIGH VOLTAGE INSTALLATIONS
Classification. Transformer substations. Design program Management of MT-BT Transformer substations. Substations and their elements.

6430 COMPUTER-ASSISTED DESIGN

TOPIC 0. INTRODUCTION
0.1. Importance of incorporating computer-aided design into the production process.
0.2. Types of computer-aided design in companies.
0.3. Beginning to sketch.
0.4. Beginning to design.

TOPIC 1. BASIC 3D MODELING
1.1. Reference plans.
1.2. Sketches.
1.3. Sketch Tools.
1.4. Basic annotation.
1.5. Basic geometric relations.
1.6. Extrusion.
1.7. Gaps.
1.8. 3D Visualization.
1.9. Rounding.

TOPIC 2. ADVANCED 3D MODELING
2.1. Working with plans.
2.2. Symmetries.
2.3. Angles of departure.
2.4. Partitions.
2.5. Equidistance.
2.6. Trimming and lengthening.
2.7. Holes.
2.8. Choice of views.

TOPIC 3. REVOLUTION OPERATIONS, SWEEPS

3.1. Construction lines and axes of revolution.
3.2. Creation of Solids per revolution.
3.3. Creation of Solids by sweeping.
3.4. Circular matrices.
3.5. Modification, editing and reframing.
3.6. Chamfers.
3.7. Physical properties.
3.8. Equations.

TOPIC 4. SHELLS, REINFORCEMENTS, RIBS
4.1. Resizing and displacements.
4.2. Division of elements.
4.3 Measurement Tools.
4.4. Library Operations.
4.5. Customization of toolbars.
4.6. Linear matrices.
4.7. Reference baselines.
4.8. Copying elements in different positions.
4.9. Drilling Assistant.
4.10. Virtual cuts or sections.
4.11. Solids defined by a line or lines.
4.12. Text engraving.

TOPIC 5. COMPLEX SOLIDS
5.1. Parts Configurations.
5.2. Curves.
5.3. 3D Sketches.
5.4. Sweeps with guide curves.
5.5. Coatings.

Topic 6. MODELING WITH SURFACES
6.1. General principles.
6.2. Creation of simple surfaces.
6.3. Creation of complex surfaces.
6.4. Free surfaces.
6.5. Modification of Surfaces (trimming, sewing, normal, etc.).
6.6. Formation of the solid.

TOPIC 7. ASSEMBLIES
7.1. Defining system options.
7.2. Defining the basic element of the assembly.
7.3. Adding new components.
7.4. Relationships between components (References).
7.5. Selection Filters.
7.6. Intelligent position relationships.
7.7. Subassemblies.
7.8. Hiding components.
7.9. Assembly Criteria, from top to bottom or from bottom to top.

TOPIC 8. INTERFERENCES OR COLLISIONS

8.1. Interferences.
8.2. Movements and collisions.
8.3. Correction of interferences.

TOPIC 9. EXPLODING OR QUARTERING IN 3D

9.1. Inserting exploded views.
9.2. Explosion direction.
9.3. Distances of the exploded elements.
9.4. Editing the steps in the explosion.
9.5. Assembly of the explosion.
9.6. Configuration Manager.

TOPIC 10. OBTAINING PLANS, VIEWS

10.1. Properties of a document (first dihedral). Selection of form.
10.2. Main views.
10.3. Scrolling views.
10.4. Simple views (tagged views).
10.5. Total cut views.
10.6. Offset or misaligned views.
10.7. Auxiliary views.
10.8. Projected views.
10.9. Detail views.
10.10. Parallel plane cutting.
10.11. Cuts with folds.
10.12. Cutting room.
10.13. Break lines.
10.14. Views of cuts in perspective.
10.15. Partial breakages.

TOPIC 11. ANNOTATIONS AND LIST OF COMPONENTS

11.1. Obtaining and modifying dimensions.
11.2. Creation of list of components.
11.3. Customize materials list.
11.4. Added texts, title blocks.
11.5. Notes, element identification.
11.6. Coordinate dimensions: baseline sizes, dimensions by coordinates, etc.
11.7. Layers.

TOPIC 12. PRINTING OF PLANS AND IMAGES

12.1. Printing configuration.
12.2. Output formats.

TOPIC 13. COMPUTER PHOTOREALISM

13.1. Elements of the virtual scene.
13.2. Scene illumination.
13.3. Creation and assignment of materials to 3D geometric models.
13.4. Texture properties, transparency and reflectance in materials.

13.5. Types of renderings.

TOPIC 14. COMPUTER ANIMATION

14.1. Collapsed turns and device explosions.
14.2. Creating and editing timeline frame keys.
14.3. Playback and recording of animation.
14.4. Simulation of operation.