UNIVERSIDAD DE BURGOS

COURSE DESCRIPTIONS

Bachelor's Degree In Mechanical Engineering

➢ 1st year

6302 CALCULUS

Numerical sets

The real number

Successive extensions of the number concept. Topological definitions of the real straight line.
The absolute value.

The complex number

Definitions. Operations with complex numbers.

Real functions of real variable

Continuity.

First definitions. Limits, properties. Continuity and properties. Theorems
on continuous functions.

Derivability

First definitions. Theorems on derivable functions. Graphical representation of functions

Integration of functions

The definite integral

Definition of primitive. The indefinite integral: Properties. Calculation of primitives.

The definite integral

Integrable function on an interval [a, b]: The definite integral. The mean value theorems, the fundamental theorem of integral calculus and Barrow's rule. 1st, 2nd improper integrals.
Improper integrals: convergence, divergence and oscillation. Applications of the defined integral to the calculation of areas, lengths and volumes.

Numerical and functional series

Numerical series

Definitions. Criteria of convergence. Sum of number series.

Functional series

Functional series: Definitions. Power Series. Development in power series of certain functions.

6303 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 with 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. Systems of differential equations
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 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.

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6304 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. PARTICLE DYNAMICS

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 THE 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.

6305 CHEMISTRY

UNIT I: FUNDAMENTAL CHEMISTRY

Topic 1: Chemical bond, chemical reactions and stoichiometry

Composition of Matter. Atomic and molecular concepts. Chemical bonding: ionic, covalent, metallic and intermolecular bonds. Ways of expressing the

Types of chemical reactions. Balances and calculations. Theoretical and experimental performance. Limiting reagent.

Topic 2: Dissolutions and colloidal systems

Nature and type of solutions. Colligative properties: molecular solutions and electrolytes.

Topic 3: Thermodynamics, chemical equilibrium and chemical kinetics.

Chemical applications of the 1st and 2nd principles of Thermodynamics:
Chemical balance. Equilibrium Displacement.
Le Chatelier Principle. Reaction rate: concept and factors on which it depends.

UNIT II: EQUILIBRIUM IN AQUEOUS SOLUTION

Topic 4: Acid/Base, Precipitation and Complexation Balances

Acid/base equilibrium: strength of acids and bases; pH concept; pH calculation in solutions.
Dissolution/precipitation and complexing equilibria: product of solubility, solubility modifications, complex stability.

Topic 5: Oxidation-reduction equilibria and electrochemical

Oxidation/reduction equilibria: galvanic and electrolytic cells; potential standard of reduction; electromotive force of batteries.

UNIT III: ENVIRONMENTAL CHEMISTRY

Topic 6: Water.

Water: Importance and properties. Composition of natural waters. Water pollution. Pollution indicator parameters. Water quality criteria.

Topic 7: The atmosphere

Composition of the atmosphere. Air quality criteria. Main atmospheric pollutants.
Global problems: greenhouse effect, ozone layer depletion, acid rain.

6306 GRAPHIC EXPRESSION

Plane geometry.

Projection systems, foundations, flat figures and surfaces. Perspectives. Standardized Representation. Views, cuts, sections, breaks, dimension, basic elements and schemes. Basic concepts of Joints, Sets and Disassemblies. 2D CAD. 3D initiation.

6307 EXTENSION OF CALCULUS AND GEOMETRY

Differential and Integral Calculus

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

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

6308 BASIC COMPUTING

Introduction to Computer science
History, Basic Concepts and Software Licenses.
Hardware.
Central Processing Unit, Storage.
Number and information representation systems.
Office Automation
Word processing.
Spreadsheet.
Presentations.
Introduction to Operating Systems
General concepts.
Process management and memory management.
File management.
Introduction to Programming
Basic concepts.
Programming.
Computer Networks and Internet
General concepts.
Internet.

6309 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 Transmission.

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 A 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 A 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.

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.

6310 SCIENCE OF MATERIALS. STRUCTURES AND MATERIALS

Materials Science.

Atomic Structure and Interatomic Bonding

Introduction. Atomic structure. Atomic bonding in solids

Structure in Crystalline solids

Introduction. Fundamental concepts. Unit Cells Crystalline structure of Density Calculations. Polymorphism and allotropy. Crystalline systems. Crystallographic directions and planes. Crystalline and non-crystalline materials Non-crystalline solids

Atomic diffusion in solids

Introduction. Mechanisms of diffusion. Dissemination in stationary and non-stationary
Diffusion Factors. Diffusion and material treatment

Phase Diagram

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

Material Properties

Mechanical properties of materials.
Electrical properties of materials.
Magnetic properties of materials.
Optical properties of materials.
Thermal properties of materials.

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6311 INTRODUCTION TO BUSINESS

I. Part:

1. - ECONOMICS AND ECONOMIC ANALYSIS

Concept of economics. Scarcity and choice.
Economic activity.
The circular flow of income.
The frontier of production possibilities.

2. - BUSINESS AND THE MARKET

The market.
Demand.
Supply.
Market equilibrium.
Supply and demand curves.
Calculation of the demand curve.
Displacements of the demand curve.
Changes in prices and the elasticity of demand.
AREAS OF THE COMPANY.

3.- BUSINESS ADMINISTRATION

Planning.
Organizing.
Directing.
Supervising.

4. - COST ANALYSIS

Cost Accounting.
Cost and types of costs.
Cost Model - volume – profit.
Fundamental phases in cost analysis.
Personnel costs.
Material Costs.
Indirect costs.

5. - VALUATION OF INVESTMENTS

Investment and financing.
Types of investments.
Investment Valuation.
- Timeless criteria.
-Net cash Flow per committed monetary unit.
-Average annual net cash flow.

-Pay-back period.
Time criteria.
-Net present Value (NPV).
-Internal rate of return (IRR).
-relationship between the NPV and the IRR criteria.

6. - STEPS TO CREATE A COMPANY

Administrative steps.
Plan of company.

PART II: ACCOUNTING

7. - ACCOUNTING

Accounting.
The balance.
The books.
Economic and Financial structure.
Expenses and Income.
Profit and loss account.
Accounting Cycle.
General accounting plan. Accounting principles and standards.
VAT.
Stocks and adjustments.
Weighted average price.
FIFO.
LIFO.
Depreciation of assets.
Linear.
Tables.
Diminishing depreciation with constant depreciation.
Diminishing depreciation of sum of digits.
Activity-based.
Wages and salaries.
Differences from the General Construction Accounting Plan.
Construction work accounting.
Construction work executed by us for us.
Construction work executed by others for us.
Construction work executed by us to sell.
Executed work units at the established prices.
Construction work executed based on costs.
Fulfilled contract Method.
Loan repayment.
American.
French.
Constant quotas.

Balance sheet Analysis.
Distribution of profits.
Losses.
Ratios. Profitability, liquidity and activity.

➢ 2nd year

6312 THERMAL ENGINEERING I

INTRODUCTION

TOPIC 1: **ENERGY, TECHNOLOGY AND SOCIETY**

Useful Power Production. Energy models in history. Sources of energy. Power Production Systems. Thermal and nuclear power plants. Energy and environment

THERMODYNAMICS

TOPIC 2: FUNDAMENTAL CONCEPTS.
TOPIC 3: PRINCIPLE 0. EQUATION OF THERMAL STATE AND TEMPERATURE.
TOPIC 4: FIRST PRINCIPLE OF THERMODYNAMICS.
TOPIC 5: THERMODYNAMIC PROPERTIES OF PURE SUBSTANCES.
TOPIC 6: 2ND PRINCIPLE OF THERMODYNAMICS.
TOPIC 7: PROCESSES IN OPEN SYSTEMS. CYCLES OF HEAT TRANSMISSION.
TOPIC 8: INTRODUCTION TO HEAT TRANSFER.

THERMOPHYSICAL PROPERTIES OF MATERIALS.

TOPIC 9: STATIONARY ONE-DIMENSIONAL CONDUCTION.
TOPIC 10: HEAT CONVECTION.
TOPIC 11: HEAT EXCHANGER SYSTEMS.
TOPIC 12: COMBUSTION.

6313 ELECTRICAL ENGINEERING FUNDAMENTALS

ELECTRICAL CIRCUITS

TOPIC 1. INTRODUCTION TO ELECTRICAL CIRCUITS.
TOPIC 2. CIRCUITS IN CONTINUOUS CURRENT.
TOPIC 3. CIRCUITS IN SINUSOIDAL ALTERNATING CURRENT.
TOPIC 4. THREE-PHASE CIRCUITS.
LOW VOLTAGE ELECTRICAL INSTALLATIONS.
TOPIC 5. LOW VOLTAGE ELECTRICAL INSTALLATIONS.

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ELECTRICAL MACHINES

TOPIC 6. INTRODUCTION TO ELECTRICAL MACHINES.

ELECTRICAL SAFETY

TOPIC 7. ELECTRICAL SAFETY.

6314 ELASTICITY AND STRENGTH OF MATERIALS

TOPIC 1. INTRODUCTION TO ELASTICITY AND STRENGTH OF MATERIALS

1.1 Introduction.

1.2. Object of Elasticity and Strength of Materials.

1.3 - Tensions and Deformations.

TOPIC 2. REVIEW OF STATIC

2.1 Introduction.

2.2 Types of supports and charges.

2.3 Equilibrium equations of the rigid solid.

2.4 Calculation of internal reactions and efforts.

2.4 Mechanical properties of a section. Area, centre of gravity and moments of inertia.

TOPIC 3. DIAGRAMS OF EFFORTS

3.1 Introduction

3.2 Internal stresses in a section: axial, shear, bending and torsion moment.

3.3. Calculation of stress diagrams.

3.4. Relationship between shear force (V) and bending moment (M).

TOPIC 4. TRACTION AND COMPRESSION

4.1 Introduction.

4.2 Tensions and Deformations. Bernouilli's Hypothesis.

4.3 Relationship between load and elongation.

4.4 Diagrams, N, sye.

4.5 Hyperstaticity (grade 1).

4.6 Temperature variations.

TOPIC 5. UNIFORM TORSION

5.1. Introduction.

5.2. Diagrams of torsional moments.

5.3. Tensions in circular and tubular section axes.

5.4. Power transmission in circular axes.

5.5. Hyperstaticity in torsion.

5.6. Tension distribution in other types of sections.

TOPIC 6. GENERAL THEORY OF BENDING

6.1 Introduction. Types of bending.
6.2 Previous hypotheses.
6.3 Tensions in pure flexion. Navier's Law.
6.4 Resistant module of a section. Sizing sections.

TOPIC 7. SHEARING

7.1. Introduction.
7.2. Elementary theory of shearing.
7.3. Deformations produced by pure shear.
7.4. Calculation of feather keys and grooved axes.
7.5. Calculation of screwed and riveted joints.
7.6. Calculation of welded joints.
7.7. Tangential tensions due to shear stress.

TOPIC 8. COMBINED REQUESTS

8.1 Introduction.
8.2 Simple Bending.
8.3 Deflected bending.
8.4 Complex Bending.
8.5 Thin wall tanks.

TOPIC 9. TRANSFORMATION OF TENSIONS AND FAULT CRITERIA

9.1. Introduction.
9.2 Graphical representation of the tensional state. Mohr's Circle.
9.3 Stresses and main directions.
9.4 Fault criteria.

TOPIC 10. BUCKLING

10.1. Introduction.
10.2. Stability analysis.
10.3. Critical buckling load.
10.4. Influence of Links.
10.5. Critical efforts. Euler's Formula.

6315 FLUID MECHANICAL ENGINEERING

CHAPTER 1.-INTRODUCTION. BASIC CONSIDERATIONS

Historical review of fluid mechanics. Units. dimensions and magnitudes. System of Units. Fundamental laws of mechanics and Thermodynamics. Equation of state.

CHAPTER 2.-PROPERTIES OF FLUIDS

Definition of Fluid. Properties of fluids: density, specific gravity, surface tension, steam pressure, kinematic and dynamic viscosity, compressibility. Law of conservation of mass. Density. Specific weight, Relative density. Newton's Law of Viscosity. Newtonian fluids. Viscosity. Dynamic and kinematics. Properties of an

ideal gas. Law of Perfect Gases. Compressibility of fluids. Law of perfect gases. Fluid compressibility. Effect of pressure on the compressibility of gases on isothermal and Isentropic processes.

CHAPTER 3.-FLUID STATICS. STUDY OF THE PRESSURE IN A FLUID

Introduction. Pressure concept. Units. Ways of expressing pressure. Atmospheric
Relative pressure. Gauge pressure. Pressure at a point. Fundamental Law of Hydrostatics. Pascal's Principle. Energy concept of piezometric heights. Pressure difference between two points. Pressure variation for compressible fluids. Mechanical gain in the transmission of pressures in a fluid. Hydraulic press. Fluid column pressure gauges. Piezometers, differential
pressure gauge.

CHAPTER 4.-STUDY OF PRESSURE FORCES EXERTED ON SURFACES

Introduction. Geometric characteristics of surfaces. Calculation of the centre of gravity. First order moment. Second order moments. Moments of inertia. Product of inertia.
Study of the pressure forces exerted on flat surfaces submerged in a liquid. Resultant forces and centre of pressure. Study of pressure forces exerted on curved surfaces.
Resultant forces and centre of pressure.

CHAPTER 5.-BUOYANCY AND THRUST FORCES. STABILITY OF A BODY IN FLOTATION

Thrust forces on submerged bodies. Archimedes' Principle. Hydrometer. Instruments for measuring density. Stability of submerged bodies. Stability of bodies in flotation.
Centre of Gravity and Calculation of the Metacentric Height on prismatic bodies.

CHAPTER 6.- RELATIVE EQUILIBRIUM

Constant linear acceleration. Calculation of the pressure on characteristic points of the deposit. New pressure forces on the walls of the container. Rotating containers. Constant angular velocity. Maximum angular speed.

CHAPTER 7.- FLUID DYNAMICS - FUNDAMENTALS OF FLUID MOTION

Description of fluid motion. Movement according to Lagrange and Euler.
Definitions: Pathlines, streamlines, and streaklines. Volumetric flow, mass
Flow types: One-dimensional flow, incompressible-compressible flow. Mach number. Permanent uniform flow. Non-viscous viscous flow. Laminar-turbulent flow. Reynold's Number. Isothermal-adiabatic flow.
Principle of energy conservation. Continuity Equation. Permanent flow. Non-permanent flow.

CHAPTER 8.- BERNOULLI'S EQUATION - IDEAL CONDITIONS OF TRANSPORTATION.

Application of Newton's 2nd Law to transport over a streamline. Bernoulli's Equation.
Energy concept of the terms of the Bernoulli equation. Total, pressure, dynamic pressure, static pressure. Piezometer, Pitot Tube and Static Pitot Tube. Energy level lines.
Piezometric line. Drive height lines. Applications of Bernouilli's equation; restrictions on its use: Torricelli's theorem applied to discharge speed in tanks. Venturi effect. Speed calculation, combining a differential pressure gauge. Analysis of charge terms in a 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.

CHAPTER 9.- LAW OF MOMENTUM, NEWTON'S 2nd LAW APPLIED TO THE PASSAGE OF A STREAMLINE

Calculation of force exchanged with fluid in the event of a variation in the quantity of motion of a flow. 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.

Variation of the section and direction of flow. Principle of turbomachine operation. Momentum moment. Table: Integral forms of the Fundamental Laws. Continuity. Energy. Momentum.

CHAPTER 10.- GENERAL ENERGY EQUATION

System transformation to control volume. Reynolds Transport theorem. Extension of Bernouilli's equation with mechanical energy exchange terms. Energy treatment for centrifugal pumps and Turbines. Analysis of the yields and useful energy, in the exchange of energy. Energy level lines. First law of Thermodynamics applied to a fixed control volume to the passage of a fluid current. General Energy Equation, for permanent flow. Mechanical and thermodynamic energy terms. Load loss term in fluid transport. Control volume with several flow inputs and outputs.

6316 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).

6317 GRAPHIC EXPRESSION II

Mechanical sets

- Introduction to industrial drawing.
- Drawing of assembly, cutting and standardized designation of materials.
- Thread dimension representation.
- Removable joints. Types of joints. Designation of normalized elements.
- Springs. Classes and representation of springs.
- Bearings. Representation, designation, election and elements of fixing and protection of bearings.
- Representation of welded joints.

Functional dimensioning

- Surface qualities. Roughness. Surface classes. Symbols. Indications in the drawing of the quality and the class of surface.
- Dimensional tolerance. Definitions. Way to indicate tolerances in the dimensions. Calculation of the magnitude of the tolerance zone. Systems and choice of adjustments. General dimensional tolerances.
- Geometric tolerances. Introduction. Application of geometric tolerances.

Tolerances of form, orientation, situation and oscillation. Indication in the drawings of geometric tolerances.
Application of the principle of maximum material. General geometric tolerances.
- Functional dimensioning. General approach to the problem. Chain of dimensions.
Calculation of the condition dimension. Distribution of tolerance in the chain of dimensions. Influence of geometric tolerances on the dimensional chain. Transfer of dimensions.

Drawing and design of installations
- Drawing and design of pneumatic installation. Bases for the design and interpretation of
Actuators. Distribution valves. Blocking valves.
Types of schemes. Symbology. Design of simple schemes.
- Electrical drawing in the building. Symbols of electrification in the building.
Electrical diagrams in the building. Installation of link between the public network and the interior installation.
- Electrical drawing in industrial installations. Electric circuits of controlling motors.
Symbols of electrical circuits. Types of electrical circuit diagrams.
The main and control circuit.
Drawing and computer aided design.
- Drawing of plans and diagrams of 2D installations.

6318 BASICS OF ELECTRONICS

Thematic Unit 1. INTRODUCTION TO ELECTRONICS APPLICATIONS
INTRODUCTION.
APPLICATIONS.

Thematic Unit 2. Components. Diodes and transistors
Applications.
PASSIVE COMPONENTS.
SEMICONDUCTOR DIODE.
TRANSISTORS.
APPLICATIONS.

Thematic Unit 3. Fundamentals of analogue circuits
AMPLIFIERS.
OPERATIONAL AMPLIFIERS.

Thematic Unit 4. Fundamentals of digital circuits
DIGITAL REPRESENTATION OF INFORMATION.

SWITCHING ALGEBRA. LOGICAL FUNCTIONS.
COMBINATIONAL CIRCUITS.
SEQUENTIAL CIRCUITS.

Thematic Unit 5. Fundamentals of communications
SIGNS. TRANSMISSION CHANNELS.
GUIDED AND UNGUIDED MEANS OF TRANSMISSION.
SIGNAL TRANSMISSION
TRANSMISSION ERRORS.

6319 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.

6320 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.
Statistical inference
Random and Statistical Samples.
Specific estimation.
Estimation by confidence intervals (normal populations and proportions).
Statistical hypothesis testing (normal populations and proportions).

Numerical calculus
Interpolation.
Polynomial interpolation.
Polynomial interpolation.

Cubic splines.
Quadrature and Numerical Differentiation
Complex quadrature rules.
Simple and Complex Rules of Quadrature.
Numerical derivation.
Numerical resolution of nonlinear equations.
Bisection method.
Secant method.
Fixed-point iteration.
Newton's method.
Numerical Resolution of Ordinary Differentials Equations.
Euler’s method.
Runge-Kutta Methods.

6321 PRODUCTION MANAGEMENT

Topic 1
The Productive Function of the Company.
Topic 2
Product Selection and Design.
Topic 3
Selection and Design of the Productive Process.
Topic 4
Capacity and Location of Facilities.
Topic 5
Planning, Programming and Project Control.
Topic 6
Design, Measurement and Compensation of Work.
Topic 7
Inventory management.
Topic 8
Quality: Management and Control.
Topic 9
Ethical Management: Corporate Social Responsibility.
Topic 10
Health and safety at work.

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➢ 3rd year

6322 INDUSTRIAL PRODUCTION AND MANUFACTURING SYSTEMS

INDUSTRIAL PRODUCTION AND MANUFACTURING 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 ISOs. 4.1. Fundamental tolerances. 4.2. Tolerance positions. 5. Designation of dimensions with tolerance. 6. Measurement of Free tolerances.

6323 MATERIAL ENGINEERING

Materials Engineering

Theory of alloys.

General concepts of alloys. Phase Diagram. Hardening treatments.

Ferrous alloys

General concepts of steels. Types of steels. Foundries. Types of foundries.

Non-ferrous alloys

Light alloys. Common alloys. Super-alloys.

Corrosion

General principles. Types of corrosion.

Welding

General principles. Types of welding. Inspection of welded joints.

Ceramic materials.

Shaping of ceramic materials. Properties of ceramic materials.

Polymeric materials

Types of polymeric materials. Properties of polymeric materials.

Composite materials

Theory of composite materials.

6324 STRUCTURAL ANALYSIS

1. BASIC CONCEPTS OF ELASTICITY AND STRENGTH OF MATERIALS

1.1. Introduction and objectives.
1.2. Equations of static equilibrium.
1.3. Stress diagrams. Axial, cutting, bending, and torsion.
1.4. Stress and deformation in sections subjected to simple stresses.
1.5. Stress and deformation in sections subjected to combined stresses.
1.6. Stress combination. Mohr's Circle.

2. CALCULATION OF MOVEMENTS IN BEAMS AND AXLES

2.1. Introduction and objectives.
2.2. The differential equation of the elastic.
2.3. Calculation of displacements and turns with the elastic equation.
2.4. Calculation of displacements and turns using Mohr's theorems.
2.5. Overlay method.
2.6. Resolution of hyperstatic structures.

3. ENERGY METHODS

3.1. Introduction and objectives.
3.2. Work of external forces and deformation energy.
3.3. Deformation energy for different types of stresses.
3.4. Principle of conservation of energy.
3.5. Impact loads
3.6. Principle of the virtual jobs. Unit load method.
3.7. Castigliano's theorem.

4. CALCULATION OF ARTICULATED STRUCTURES

4.1. Introduction and objectives.
4.2. Methods of analysis of isostatic articulated structures.
4.4.1. Method of nodes.
4.4.2. Method of the sections.
4.5. Calculation of displacements by energy theorems.
4.5.1. Castigliano's theorem.
4.5.2. Unit load method.
4.6. Calculation of hyperstatic articulated structures.
4.7. Variations of temperature.
4.8. Particular cases: Execution errors and tensors.

5. CALCULATION OF RETICULATED STRUCTURES

5.1. Introduction and objectives.
5.2. Degree of hyperstaticity.
5.3. Degree of translationality.

5.4. Intranslational Reticulated Structures.
5.4.1. Continuous beams.
5.4.2. Semiportals.
5.4.3. Portals.
5.4.4. Intranslational structures with bearings.
5.5 Translational reticulated structures.
5.6. Cable-stayed structures.

6. MATRIX CALCULATION OF STRUCTURES
6.1. Introduction and objectives.
6.2. Nomenclature and methodology.
6.3. Stiffness matrix of a bar.
6.4. Stiffness matrix of the structure.
6.5. Boundary conditions and loads.
6.6. Resolution of matrix equations.
6.7. Calculation of efforts at bar end.

6325 GRAPHIC ENGINEERING

- Introduction to design with high level cad tools.
- Basic part design.
- Catalogue of parts and design tables.
- Basic surfaces.
- Advanced surfaces.
- Creation and management of assemblies.
- Functional and 3d assembly simulation. Layout and creation of plans.
- Reverse engineering.
- Vertical 3d cad applications.
- Management of data in concurrent engineering.

6326 MECHANISMS II

TOPIC 1.-ALGEBRAIC SYNTHESIS OF MECHANISMS
• Two-position synthesis.
• Three-position synthesis.
• Fixed and mobile pivot circumferences.
• Synthesis of more than 3 positions.
• Synthesis of generation of trajectories.
• Synthesis of generation of functions.

TOPIC 2.-SPACE MECHANISMS

• Homogeneous transformations.
• Representation of Denavit-Hartemberg.
• Direct and inverse kinematic problem of an MRI.
• Application to Stanford industrial robot.

TOPIC 3.-CAM AND FOLLOWER MECHANISMS
• Classification of cams and followers
• Design of kinematic diagrams of the follower.
• Cam design.
• Desmodromic cams.

TOPIC 4.-GEAR THEORY
• Involute profiles.
• Cylindrical-straight gears
• Helical gears.
• Concurrent gears.
• Cross gears.

TOPIC 5.-GEAR TRAINS
• Fixed gear trains.
• Planetary gear trains.
• Gearboxes.

6327 HYDRAULIC MACHINES

Hydraulic turbines.

TOPIC 1.-INTRODUCTION. BASIC CONSIDERATIONS.

Introduction.

General concepts of fluid mechanics.
Classification of fluid machines.
General equation of the turbomachines.
Equations of Resemblance.

TOPIC 2. PUMPS AND FANS.
Centrifugal and axial pumps.
Positive displacement pumps.
Axial and Centrifugal fans.
Calculation and sizing of pumping systems.
Calculation and sizing of ventilation systems.

TOPIC 3. POWER PLANTS. HYDRAULIC TURBINES.
Hydroelectric power plants.
Pumping stations.
Hydraulic turbines.
Action turbines.

Reaction turbines.

TOPIC 4. ENERGY AND ENVIRONMENT.
Hydraulic Power in Mix of electricity generation.

6328 THERMAL ENGINEERING II

FUNDAMENTALS OF THERMODYNAMICS AND HEAT TRANSMISSION. EXERGY ANALYSIS
Concept of exergy and anergy. Exergy associated with work. Exergy associated with heat. Exergy of a stream of matter. Exergy of closed systems. Balance of exergy. Destroyed exergy. Introduction to Thermoeconomics.

POWER PRODUCTION SYSTEMS
Ideal Rankine cycle. Irreversibilities in the Rankine cycle. Improvements in the Rankine cycle. Ideal Brayton cycle. Irreversibilities in the Brayton cycle. Improvements in the Brayton cycle. Aviation Gas turbines. Otto cycle. Diesel cycle. Ericsson, Stirling and dual cycles.

COLD PRODUCTION SYSTEMS
Cold production systems. Refrigerants. Environmental issues. Compression refrigeration systems. Absorption cooling.

COGENERATION AND ENERGY SAVING
Introduction. Advantages of cogeneration. Cogeneration and trigeneration systems. Examples.

THERMODYNAMICS OF HUMID AIR
Thermodynamic properties of ideal gas mixtures. Thermodynamic properties of real gases. Thermodynamic properties of humid air: psychrometry. Processes with psychrometric systems.

HEAT TRANSMISSION MECHANISMS
Stationary one-dimensional driving. Driving in transitory regime. Additional surfaces. Fins. Convection. Thermal radiation heat transmission. Form factor. Reradiating surfaces.

COMBUSTION TECHNOLOGY
COMBUSTION TECHNOLOGY. Classifications and basic concepts of combustion. Thermochemistry and chemical kinetics. Fuels. Pyrolysis and gasification. Self-ignition, detonation, deflagration, premixed or diffusive combustion, laminar or turbulent combustion. Combustion of gases, liquids and solids. Environmental aspects of combustion.

ENERGY TECHNOLOGY
BOILERS AND STEAM GENERATORS
Classification of boilers. Types of boilers. Fundamental elements of a boiler. Home. Burners. Superheaters and reheaters. Elements of regulation and control in boilers. Boiler performance. Heat recovery systems in boilers. Condensing boilers. Boiler safety measures. Maintenance of boilers and steam generators.

PROCESS HEAT EXCHANGERS

Types of heat exchangers. Hypothesis for the thermal calculation of heat exchangers. Calculation of exchangers by the average logarithmic temperature difference method. Calculation of exchangers by the method of number of transmission units. NUT relations — effectiveness in shell and tube heat exchangers. Plate heat exchangers. Cross flow interchangers and finned tubes. Cooling towers. Analysis of heat exchange. Cooling jackets in tanks.

HEATING AND AIR CONDITIONING SYSTEMS
Heat generators. Water distribution systems. Two-tube installations. One-tube installations. Compensated facilities. Air conditioning systems: single duct and double duct system. Thermal loads. Ventilation. Design of air conditioning systems.

ENERGY, SOCIETY AND ENVIRONMENT:
Energy sectors. Energy efficiencies. Energy losses. Energy savings. Energy sources. Energy saving in industry. Demand, efficiency and consumption. The Energy Project. Energy and the environment. Environmental impact studies.

6329 MACHINE DESIGN I

Fault criteria under static charges.
Fault theories under fluctuating loads. (Fatigue).
Transmission shafts and couplings.
Lubrication systems and friction bearings.
Roller bearings.

6330 STEEL STRUCTURES

Metallic materials and structures
Structural steel and structural steel products. Behaviour of structural steel

Bases of calculation, project regulations and frequent typologies of building metal structures
Safety and service structures
Actions (normative) and stresses (analysis models) on construction structures
Particular calculation bases for metal structures of construction.
Structural configuration of industrial buildings. Preliminary structural analysis.

Analysis and sizing of metallic structural elements
Uniform, warping and mixed twist of pieces with thin wall section
Buckling of compressed ideal and real pieces. Elastic and plastic analysis of tensioned and flexed parts. Instability phenomena in the flexed parts (lateral buckling and panel dent).

Joints in metal building structures
Frequent typologies and global behaviour of the joints.
Local analysis, sizing and execution of bolted joints.
Local analysis, sizing and execution of welded joints.

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6331 MECHANICAL TECHNOLOGY

INTRODUCTION TO PLASTIC DEFORMATION PROCESSES

1. Introduction. 2. The tensile trial. 2.1. Conventional or Technological deformation stress curve. 2.2. Creep curve. 3. Elastic behaviour of the metals. 3.1. Tensions in a point. 3.2. Flat state stresses. 3.3. Mohr' Circle in a flat stress state. 3.4. Three-dimensional stress state. 3.5. Mohr's Circle in three dimensions. 3.6. Types of deformation. 3.7. Stress/deformation relations. 3.8. Spherical components or strain and deformation reliefs. 4. Creep criteria in ductile metals. 4.1. Tresca Criterion. 4.2. Von Misses Criterion. 5. Plastic behaviour of metals. 5.1. Justification and objectives of plastic deformation processes. 5.2. Tests to determine the creep stress. 5.3. Load required to produce creep in homogeneous deformation. 5.4. Work formula for the calculation of loads in homogeneous deformation. 5.5 Slip line field theory. 5.6. Effect of temperature on deformation processes. 5.7. Effect of speed of deformation on plastic deformation processes. 5.8. Friction and lubrication.

FORGING

1. Description of the process. 2. Calculation of stresses in forging. 2.1. Free forging. 2.2. Stamping. 3. Upsetting and heading

LAMINATION

1. Description of the process. 2. Variations of the process. 3. Forces and geometric relationships in lamination. 4. Approximate calculation of the load, torsion and power of lamination in homogeneous deformation.

STRETCHING

1. Description of the process. Elemental analysis of stretching efforts.

CONTINUOUS EXTRUSION OF METALS

1. Description of the process. 2. Variations of the basic process. 3. Elementary analysis of the efforts in the extrusion.

PLATE BENDING AND CURVING

1. Definition. 2. Fundamental problems of bending. 3. Minimum bending radius. 4. Determination of neutral fibre. 5. Calculation of developments. 6. Marking of pieces. 7. Calculation of efforts in bending. 8. Elastic recovery. 9. Bending procedures. 10. Bending machines. 11. Other bending operations.

SHEARING, CUTTING AND PUNCHING

1.Definition of the process. 2. Sheet metal cutting operations. 3. Shearing. 4. Relationship between the thickness of the sheet and the dimensions of the cross section of the punch. 5. Parts of a die. 6. Play between the punch and the matrix. 7. Use of the sheet. 8. Calculation of the efforts in die-cutting. 9. Calculation of punch buckling. 10. Structural classification of punches.

DEEP DRAWING

1. Definition. 2. Rounding of the die and punch. 3. Play between the die and the punch. 4. Calculation of the primitive disk. 5. Calculation of the number of deep drawings. 6. Forces of deep drawing and the press plate. 7. Deep drawing speeds. 8. Lubrication. 9 Defects of deep drawn pieces.

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THE LATHE

1. The machine tool. 2. Axle systems for machines — tools. 3. Parallel lathe: standardized description and terminology. 4. Tailstock. 5. Lathe carriages. 6. Kinematic chain to move the carriages. 7. Advances of the main carriage. 8. Advances of the transversal carriage.

GEOMETRY OF CUTTING TOOLS

1. Introduction. 2. Single-cutting tool. 3. ISO Regulations for the nomenclature of cutting tools. 4. Influence of the effective angles in machining. 5. Constant profiling tools. 6. Nomenclature of lathe tools. 7. Chip breaker.

CUTTING TOOL MATERIALS

1. How to choose the material of the tool. 2. General properties of cutting tool materials. 3. Materials used in the construction of cutting tools. 4. Study of the cut. 5. Choosing the blades at work in series. 6. Wear of cutting tools.

CUTTING SPEED

1. Introduction. 2. Cutting speed. 3. Taylor's theory. 4. Generalized Taylor equation. 5. Kronenberg theory. 6. Denis theory. 7. Economics of machining.

CUTTING EFFORTS

1. Introduction. 2. Geometry of the cut. 3. Chip types and study models of cutting efforts. 4. Shear plane Model. 5. Three-dimensional cut. 6 Specific cutting pressure method. 7. Cutting power. 8. Times of machining.

TURNING OPERATIONS

1. Introduction. 2. Turning. 3. Facing. 4. Grooving and bucking. 5. Eccentric turning. 6. Knurling. 7. Shape turning. 8. Degree of roughness in turning. 9 Calculation and construction of cones.

EVALUATION OF MEASURE UNCERTAINTY

1.Terminology. 2. Calibration. 3. Measurement methods. 4. Law of propagation of uncertainty or law of propagation of variances. 5. Assessment of measure uncertainty of input estimates. Estimation of typical uncertainty. 5.1. Typical Type A evaluation of uncertainty. 5.2. Typical Type B evaluation of uncertainty. 5.3. Input quantities related to more than one source of uncertainty. 5.4. Correlated input magnitudes. 5.4.1. Estimation of covariance through functional relationships between correlated variables and those that influence them. 5.4.2. Estimation of the covariance from n pairs of independent, repeated and simultaneous observations. 6. Calculation of expanded uncertainty. 6.1. Calculation of the coverage coefficient through normal distribution. 6.2. Calculation of the coverage coefficient from Student's t-distribution. 7 Expression of the measurement result.

CALIBRATION

1. Calibration. 2. Local calibration or calibration of a point on the scale of the instrument. 2.1. Calibration operation. 2.2. Calculation of measure uncertainty in the environment of the calibrated point. 3. Global calibration of the measuring instrument. 3.1. Linear interpolation method. 3.2. Common correction method. 3.3. Maximum uncertainty method. 4. Measuring instruments of double direction. 5. Proper uncertainty of a measuring instrument. 6. Rejection Criteria.

INDIRECT MEASUREMENTS

1. Indirect measures: dimensions and angles. 1.1. Dimension measuring knowing angles. 1.2. Calculation of angles of known dimensions. 1.3. Measurement of dimensions and angles by means of shoes. 2. Radius measurement. 2.1. Two-roll method. 2.2. Fixed roll probe method. 2.3. Three-point method. 2.4. Chord deflection method. 2.5. Measurement of lenses with a spherometer. 3. Conicity and inclination. 3.1. Measurement and verification of cones.

THREAD MEASUREMENT

1. Definition. 2. Normalized terminology. 3. Classification of threads. 4. Thread systems. 4.1. Whitworth system. 4.2. Sellers system. 4.3. ISO metric thread. 4.4.1. Diameter series and ISO steps. 4.4.2. Tolerances of ISO thread system. 4.4.3. Tolerances for the screw tolerance qualities. 4.4.4. Tolerances for the nut tolerance qualities. 4.4.5. Tolerance positions of the ISO thread. 4.4.6. Complete designation of the ISO metric thread. Measurement and verification of threads. 5.1. Measurement of external threads. 5.1.1. Measurement of the outside diameter. 5.1.2. Measurement of the internal diameter. 5.1.3. Measurement of the average diameter. 5.1.4. Measurement of the angle of the thread. 5.1.5. Measurement of the pitch of the thread. 5.2. Internal thread measurement.

MEASUREMENT OF DENTED GEARS

1. Introduction. 2. Classification of dented gears. 3. Cylindrical gears with straight teeth. Standardized terminology. 3.1. Calculation of fundamental magnitudes. 4. Cylindrical gears of helical teeth. 5. Straight-tooth conical wheels. 6. Verification of cogwheels. 7. Measurement of tooth thickness. 7.1. Measurement of tooth thickness by means of a Vernier calliper. 7.2. Measurement of the base thickness by means of a micrometre of saucers. 8. Step measurement. 9 Verification of profile shape. 10. Measurement of eccentricity. 11. Measure of distortion.

PRACTICES

PRACTICE 1. Calibration of the calliper.
PRACTICE 2. Calibration of the outdoor micrometre.
PRACTICE 3. Measurement of an outer cone.
PRACTICE 4. Measurement of an inner cone.
PRACTICE 5. Measurement of a thread.
PRACTICE 6. Measurement of a cylindrical straight-tooth gear.

➢ 4th year

6332 INDUSTRIAL INSTALLATIONS

Building envelope.
Transportation of fluids.
Thermal insulation of equipment and ducts.
Noise and vibrations in installations.
Indoor water installations.
Ventilation facilities.
Heating facilities.
Electrical installations.
Fire installations.

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6333 MACHINE DESIGN II

Calculation and design of gears.
Brakes and clutches.
Flexible elements of power transmission.
Springs.
Power screws and bolted connections.
Mechanical transmission sets.

6334 STRUCTURE II

1.- Structures of Reinforced Concrete: combination of actions and safety factors.
2.- Reinforced Concrete Structures: materials.
3.- Reinforced Concrete Structures: Ultimate Limit States.
4.- Reinforced Concrete Structures: Service Limit State.
5.-Reinforced Concrete Structures: structural regions. Crank and tie rod method. Short cantilevers. Foundations. Walls.
6.- Foundations and walls: constructive general information. Floor slabs.

6335 HEAT ENGINES

Topic 1 Generalities on thermal machines
Initial definitions. Classification of thermal machines.

Topic 2 Cycles of work in alternative internal combustion engines
Introduction. Actual or indicated cycle. Theoretical cycles. Performance. Indicated parameters of the AICE.

Topic 3 Determination of the fundamental magnitudes
Engine testing. Characteristic curves of an engine. Energy balance in the engine. Cooling systems. Lubrication.

Topic 4 Processes of renewal of load
Renewal of load in four-stroke Engines. Renewal of load in two-stroke Motors. Overfeeding of engines.

Topic 5 Combustion in AICEs
Fuels. Combustion in SIM. Combustion in CIM. Feeding systems. Ignition system. Diesel injection systems.

Topic 6 Steam turbines
Introduction. Thermodynamic cycles in steam turbines. Real energy balance of a steam turbine power plant.

Topic 7 Gas turbines
Introduction. Brayton cycle. Real energy balance of a gas turbine. Combined cycle power plants.

Topic 8 Jet Engines
Rocket engine. Expression of thrust. Jet injectors. Turbojets.

Topic 9 Introduction to Cogeneration
Cogeneration systems. Fundamental parameters Fuel cells.

Topic 10 Environmental impact of thermal machines
Environmental impact of energy development. Environmental impact of fuels. Environmental impact of thermoelectric and nuclear energies.

6336 TECHNICAL OFFICE

BACKGROUND
Professional C.V. or resumé.
THEORETICAL AND PRACTICAL KNOWLEDGE
Basic concepts on the project and its classification.
Project documents.
Project environment.
Industrial project regulations.
1st case study. Implementation and project study (to be specified during the course).
2nd case study. Implementation and project study (to be specified during the course).

KNOWLEDGE ONLY THROUGH PRACTICAL APPLICATIONS
Practices
Specific techniques for assuring the correct operation of the industrial product. Analysis of preliminary risks. Failure mode and effects analysis of
User demands. Product quality. Quality function deployment. Direction, planning and management of projects. Multidisciplinary projects. “concurrent engineering”. Documentation-gathering work.

6367 INDUSTRIAL INSTALLATIONS

Topic 1 General information about air conditioning
Psychrometric diagram. Air temperature. Moisture content. Sensitive heat. Latent heat. Ventilation. Air cleaning. Comfort conditions

Topic 2 Thermal loads in refrigeration
Transmission through walls. Determination of charges. Equivalent temperature difference. Solar contributions through glass. Gain by occupants. Gain by ventilation.

Topic 3 Air conditioning system
“Autonomous” System \ "all air \". Collective System \ "all air \". Mixed air-water system. All water system.
Topic 4 Production of cold and heat
Refrigeration by mechanical compression. Types of compressors. Condensers cooled by air, water, and evaporative condensers. Refrigeration absorption facilities.

Topic 5 Heat pump
Definition. Classification of heat pumps according to the heat source (ground, air, water); according to the exchange fluid: air-air; air-water. Heating performance COP, instantaneous and seasonal.

Topic 6 Air conditioners
Elements of an air conditioner. Air conditioners for conventional, multi-zone and double duct with terminal unit systems.

Topic 7 Air ducts
Types of conduits. Singular elements, elbows, derivations. Air circulation speed. Static and dynamic pressure. Pressure drop. Methods of calculation.

Topic 8 Grids and terminal units
Distribution of air in the premises: grids and diffusers. Geometry of the air jet. Fan-coils. Inductors

Topic 9 Regulation of air conditioning installations
Introduction. Regulation of single-zone, multi-zone and double-duct systems.

Topic 10 Indoor air quality (ventilation)
Ventilation flows. Natural, hybrid and mechanical ventilation. Sizing of ventilation openings. Extraction and impulsion ducts. Hybrid and mechanical vacuum cleaners.

Topic 11 Savings and recovery of thermal energy
Expelled air energy recuperator. Static and rotary recuperators. Free-cooling economizer cycle. Heat transfer between building zones (loop of Water).

Topic 12 Solar contribution for domestic hot water
Establishment of the minimum solar contribution. Calculation of demand. Components and general conditions of the facility.

6368 MECHANICAL TECHNOLOGY

TOPIC 1. MILLING MACHINES
1. Classification of milling machines.
2. Universal rotary table milling machine.
3. Kinematic chain of the horizontal milling machine.
4. Description of the elements that characterize the milling machine.
5. Special milling machines.

TOPIC 2. MILLING MACHINES

1. The milling tool and the milling operation.
2. Tooth geometry.
3. Classification of milling machines.
4. Types of milling.
5. Blade plate.
6. Sharpening of cutting blades.

TOPIC 3. CUTTING CONDITIONS

1. Cutting speed in milling.
2. Theory of Taylor and Kronenberg.
3. Denis's theory.
4. Minimum cost or maximum economy speed.
5. Guidance values for the selection of progress.
6. Study of the chip section.
7. Number of teeth in contact with the piece.
8. Study of the cutting efforts.
9. Cutting power in the milling.

TOPIC 4. MILLING MACHINE ACCESSORIES

1. Introduction.
2. Tool clamping.
3. Securing parts.
4. Vertical head.
5. Mortising device.
6. Dividers.
7. Vertical divider or circular table.
8. Linear division.

TOPIC 5. DRILLS

1. Introduction.
2. Column drilling machine.
3. Classification of drills.

TOPIC 6. CUTTING CONDITIONS IN DRILLING

1. Cutting speed and advance movement.
2. Effort in drilling. Cutting power.
3. Drilling: types.
4. Morse cones.

TOPIC 7. DRILL BITS

1.Drill bits: definition.
2. Types of drill bits.
3. Helical drills.
4. Sharpening of the helical drill.

TOPIC 8. BROACHING

1.Description and types of broaching machines.
2. Broach: geometry and cutting conditions.

TOPIC 9. MECHANICAL SAW

1. Introduction.
2. Sawing machines.
3. Sawing tools.

TOPIC 10. GRINDERS

1. Classification of grinders.
2. Front flat grinder.
3. Tangential flat grinder.
4. Cylindrical grinder for exteriors.
5. Cylindrical grinder for interiors.
6. Cylindrical grinder without centres.
7. Special grinders.
8. Honing.
9. Lapping and polishing.

TOPIC 11. GRINDING WHEELS

1. Characteristics of grinding wheels.
2. Designation of grinding wheels.
3. Rules for the selection of a grinding wheel.
4. Reviving the grinding wheel.
5. Formation of the chip in the grinding.
6. Cutting efforts and cutting power in grinding.
7. Choice and influence of cutting conditions on the behaviour of the grinding wheel.

TOPIC 12. HYDROSTATICS

1. Introduction.
2. Density and specific weight.
3. Pressure: Units.
4. Fundamental principle of Hydrostatics.
6. Pascal's Principle.
7. Elements of an oleo hydraulic installation.
8. How a pump is loaded: cavitation.
9. Types of pumps.
10. How pressure is generated.
11. Practices.

TOPIC 14. DISTRIBUTING VALVES

1. Valves.
2. Distribution valves.
3. Classification by the number of routes and positions.
4. Classification by the drive system.
5. Classification by its internal construction.
6. Two position valves.
7. Three position valves.
8. Types of centres, drainages and pilings.
9. Practices.

TOPIC 15. PRESSURE VALVES

1. Introduction.

2. Safety valve.
3. Discharge valve.
4. Sequence valve.
5. Balancing valve.
6. Brake valve.
7. Pressure reducing valve.
8. Applications.
9. Practices.

TOPIC 16. FLOW REGULATION

1. Types of flow regulators.
2. Types of speed regulation.
3. Practices.

TOPIC 17. ANTI-RETURNS

1.Anti-return.
2. Piloted anti-return.
3. Applications.
4. Practices.

6339 MACHINE BALANCING

TOPIC 1.-VIBRATIONS IN THE MACHINES

- Theory of free and forced mechanical vibrations.
- Damping. Types.
- Transmissibility and isolation of vibrations.
- Natural frequencies. Modal forms. Resonances.

TOPIC 2.-ALIGNMENT OF TREES

- Eccentricity and angularity.
- Alignment procedures.

TOPIC 3.-BALANCING OF ROTORS

- Static balancing of rotors. Methods.
- Dynamic balancing of rotors. Methods.
- Balancing of rotary engines.

TOPIC 4.-BALANCING OF ALTERNATIVE ENGINES

- Kinematics of the motor mechanism.
- Dynamics of the motor mechanism.
- Rotary balancing.
- Primary and secondary alternative balancing.
- FFT spectral analysis.

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TOPIC 5.-REGULATION OF MACHINES

- Cyclical irregularity of a machine.
- Inertia flywheels.
- Types of regulation classes. Stability.
- Determination of the PD2 of a machine.

6340 RENEWABLE ENERGIES AND THE ENVIRONMENT

ENVIRONMENT

Topic 1 - Natural water treatment

Composition and quality parameters of natural waters. Main contaminants to be eliminated in the purification of water. Quality criteria of natural waters. Water purification processes. Marine water desalination processes. Quality criteria for industrial waters.

Topic 2 - Wastewater treatment

Characterization of urban wastewater. Treatment of urban wastewater. Pretreatment and primary treatment. Secondary treatments. Tertiary treatments. Sludge treatment. Small purifier system. Reuse of treated wastewater. Water discharge of purified residuals. Landfill legislation: the discharge tax.

Topic 3 - Control / Treatment of air pollution

Main atmospheric pollutants and emission sources. Air quality criteria: emission and immission. Dispersion of pollutants in the atmosphere. Diffusion models. Meteorological conditions. Depuration of atmospheric pollutants: depuration of gaseous pollutants and depuration of particles. Control of pollutants in stationary foci. Transportation control. Pollution in interior environments. Pollution by energy sources: electromagnetic radiation.

Topic 4 - Urban waste management

Urban waste: composition and characterization. Treatments: landfill of non-hazardous waste, incineration, composting, recycling. Integral treatment plants.

Topic 5 - Hazardous waste management

Hazardous waste: characterization. Treatment: physical-chemical treatments, incineration, landfill of hazardous waste. Minimization techniques.

Topic 6 - Soil pollution and treatment techniques

Contaminated floors. Treatment techniques: thermal technologies, physical-chemical technologies, biological technologies.

Topic 7 - Environmental Management

Environmental Impact Evaluation. Urban Environmental Management. Environmental quality in the industry. Carbon and water footprint.

RENEWABLE ENERGY

Renewable Energies and the preservation of the Environment

Energy resources - Non-renewable resources: environmental problems - Renewable resources - Energy outlook for Spain and the world.

Solar radiation

Characteristics of solar radiation - Magnitudes - Movement of the Sun in the celestial vault - Insolation data. Solar maps. Solar thermal energy. Photothermal effect - The flat solar collector. - Efficiency curve – Low temperature installations.

Photovoltaic Solar Energy

Photovoltaic effect - Cells and photovoltaic modules - Photovoltaic installations - Applications.

Wind power

Winds: wind speed and energy - Wind machines – Three-blade wind turbine - Wind power installations.

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 thermochemical processes - Energy crops - Biofuels – Biogas.

Geothermal energy

Earth heat - Geothermal Manifestations - High temperature technologies - Medium and low temperature technologies - Very low temperature technologies: heat pump.