UNIVERSIDAD DE BURGOS

COURSE DESCRIPTIONS

Bachelor's Degree in Industrial Management Engineering

➢ 1st year

6200 CALCULUS

First block
Real numbers
Complex numbers
Second block
Real functions of real variable. Limits and continuity.
Derivatives and applications.
Third block
Indefinite integral.
Definite integral.
Improper integrals.
Fourth block
Sequences and number series.
Functional series.

6201 PHYSICS I

INTRODUCTION

TOPIC 1. SCALAR AND VECTORIAL MAGNITUDES - Physical units

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 unitary systems.

PARTICLE AND SOLID MECHANICS

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 reference systems

6203 BASIC COMPUTING

Introduction to Computer science.
History and Basic Concepts.
Office Automation.
Word processing.
Spreadsheets.
Presentations.
Introduction to Programming.
Basic concepts.
Advanced concepts.
Introduction to Operating Systems.
Project Management.
Memory management.
Management of Files and Users.
Computer Networks and Internet.
Networks.
Internet.

6205 ALGEBRA AND DIFFERENTIAL EQUATIONS

Topic 1. Basic notions
Linear systems. Gauss's method for the resolution of systems. Matrices. Gauss method for obtaining the inverse matrix. Determinants. Gauss's method for the calculation of determinants. Rank of a matrix. Determinants and systems of equations.

Topic 2. Vector spaces and Euclidean vector spaces
Real vector space. Subspaces. Linear combination: linear dependence and independence.

-Generating system, bases and dimension. Coordinates and change of base. Space of the rows of a matrix. Internal product. Standard and distance. Angles and orthogonality. Changes of orthonormal bases: orthogonal matrices.

Topic 3. Linear applications

Concept of linear application and properties. Image and nucleus of a linear map. Linear Matrix and equations of a linear map. Similarity of matrices.

Topic 4. Diagonalization

Eigenvalues and Eigenvectors. Characteristic polynomial. Diagonalization. Orthogonal diagonalization.

DIFFERENTIAL EQUATIONS

Topic 5. First Order Differential Equations

Basic concepts. First-order differential equations resolvable with respect to y'. First-order differential equations not resolvable with respect to y'. Orthogonal trajectory. Existence and uniqueness theorem.

Topic 6. Higher-order ordinary differential equations

Basic concepts. Higher order homogenous linear ODE. Higher order complete linear ODE.

Topic 7. Complete Linear Differential Equation Systems.

Basic concepts. Homogeneous linear SODE. Complete linear SODE.

6206 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 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 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 a 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.

6207 EXTENSION OF CALCULUS AND GEOMETRY

Differential and Integral Calculus in several variables

Differential calculus in several variables

Scalar and vector function of several real variables. Limit and continuity. Partial and directional derivatives. Differential. Tangent plane. Chain rule. Theorems of the implicit and the inverse function. Extremes of a real function of several variables.

Integral calculus in several variables

Double and triple integrals. Geometric interpretation. Fubini's theorem and change of variable. Applications.

Vector Calculus

Line and surface integrals

Basic definitions of curves and surfaces. Integration over curves. Conservative fields. Green's theorem. Integration on surfaces. Stokes' theorem. Gauss's theorem. Applications.

➢ 2nd year

6210 AUTOMATISMS AND INDUSTRIAL CONTROL

Automation 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).

6211 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 system.

6212 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 on planes parallel to a major axis.
2.3.2. Representation of stresses on any given 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 given 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. Stress diagrams.
4.4. Bar Structures.
4.4.1. Bar Structure Analysis.
4.4.2. Symmetry and antisymmetry.

Chapter 5: Traction/Compression.
5.1. Solution of the Elastic Problem in Traction or Compression.
5.1.1. Bernoulli'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 statically indeterminate Structures.
5.3. Calculation of tanks and rings under pressure.
5.3.1. Tanks.
5.3.2. Rings.

Chapter 6: Shearing.
6.1. Solution of the Elastic Problem in Shearing.
6.1.1. Simplifying Hypotheses
6.1.2. Stresses.
6.1.3. Deformations.
6.2. Bolted joints.
6.2.1. Behaviour of the shear 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-Bernoulli 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 statically indeterminate 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.

6213 FUNDAMENTALS OF ELECTRICAL ENGINEERING

ELECTRICAL CIRCUITS.
TOPIC 1. Introduction to electrical circuits.
TOPIC 2. Circuits in continuous current.
TOPIC 3. Circuits in alternating current.
TOPIC 4. Three-phase circuits. Low voltage electrical installations.
TOPIC 5. Low voltage electrical installations. Electric machines.

TOPIC 6. Introduction to electric machines. Electrical safety.
TOPIC 7. Electrical safety.

6214 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 for the energy of a fluid at rest. Equation of fluid energy in motion. Equation of the amount of motion. State equation.

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 tension. 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 INTERIOR PRESSURE OF A FLUID

Introduction. Pressure concept. Units. Ways of expressing pressure. Pressure manometric.
Pressure at a point. Fundamental Law of Hydrostatics. Balance 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 manometers. The manometer. The multi-fluid manometer. Measure of the pressure drop. The Barometer. Hydrostatics. Summary.

TOPIC 4.-STUDY OF PRESSURE FORCES EXERTED ON SUBMERED SURFACES - BUOYANCY-THRUST FORCES - STABILITY OF A BODY IN FLOTATION

Introduction. Geometric characteristics of surfaces. Study of the pressure forces exerted on flat surfaces. Horizontal wall. Sloping wall. Vertical wall. Study of pressure forces exerted on curved surfaces. Vertical component. Horizontal component. Gravity dams, forces of water on the dam. Gravity dams, slippage. Gravity dams, probability of overturning. Thrust 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 of fluid motion. Motion according to Lagrange. Motion according to Euler. Definitions. Streamlines, Streaklines. Mass flow rate. 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. Forces that act on a VC. 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. Operating principle of turbomachinery. Momentum moment.

TOPIC 7.- BERNOULLI 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. Applications of Bernoulli's equation. Torricelli's theorem applied to unloading speed in tanks. Venturi effect. Speed calculation, combining a differential pressure gauge. 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 centrifugal pumps. Principle of operation for centrifugal pumps. Net height. Net positive suction height NPSH. Available net positive suction head, NPSHd. Required net positive suction head, NPSHr. Aspiration Head, Ha. Performance. Operating point. Energy treatment for turbines. Principle of operation. Net height.
Hydraulic turbines. Performance.

TOPIC 9.- FLOW IN PIPE SYSTEMS. EFFECT OF VISCOSITY ON THE TRANSPORT OF FLUID 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. Moody'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 radio. Measurement of flow rate and speed. Obstruction flowmeters. Venturi tube. Orifice plate. Flow meter.

TOPIC 10.- COMPRESSIBLE FLOW.

Stagnation properties. Speed of sound and Mach number. Uni-dimensional isentropic flow. Isentropic flow in nozzles. Flow in conduit with energy transfer. Adiabatic flow in a conduit with friction.

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 fast 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. Optimal section for a trapezoidal channel.

TOPIC 12.- HYDRAULIC MACHINES

General information on hydraulic pumps. General information on hydraulic turbines.

LABORATORY PRACTICES

PRACTICE 1: COMPRESSIBLE FLOW-NOZZLE.
NOZZLE UNIT OF PRESSURE DISTRIBUTION.
PRACTICE 2: COMPRESSIBLE FLOW-TURBINE.
EXPERIMENTAL IMPULSION TURBINE.

LABORATORY PROBLEMS

PROBLEM 1: EES PROGRAM. GENERIC EXERCISES.
PROGRAM EES. GENERIC EXERCISES.
PROBLEM 2: STATIC FLUID EXERCISES- EESS.
FLUID STATICS EXERCISES – EES.
PROBLEM 3:
PRESSURE FORCE EXERCISES.
PRESSURE / BOUYANCY FORCES EXERCISES – EES.
PROBLEM 4: EXERCISES ON PRESSURE/FLOATABILITY
BUOYANCY EXERCISES – EES.
PROBLEM: EXERCISES ON FLUID DYNAMICS.
FLUID DYNAMICS EXERCISES – EES.
PROBLEM 6: LAW OF THE MOMENTUM EXERCISES.
FLUID DYNAMICS EXERCISES - EES
PROBLEM 7: EXERCISES WITH BERNOULLI'S EQUATION.
FLUID DYNAMICS EXERCISES – EES.
PROBLEM 8: FLOWS WITH FRICTION EXERCISES.
MEASURES OF FLOW EXERCISES – EES.
PROBLEM 9: EXERCISES ON TRANSPORT IN OPEN CHANNELS.
OPEN CHANNEL EXERCISES – EES.
PROBLEM 10: HYDRAULIC MACHINE EXERCISES.
OPEN CHANNEL EXERCISES – EES.

EXTRA EVALUATION

Laboratory practice reports.
Problem solving.

6215 GRAPHIC EXPRESSION II

Mechanical sets
Introduction to industrial drawing.
Advanced design of set drawings, disassemblies.
Representation-dimensioning of threads.
Advanced design of joints. Types of joints. Their representation.
Removable joints. Types of joints. Their representation.
Representation and designation of the normalized elements. Other elements.

Dimensioning with tolerances
Surface qualities.
Dimensional tolerances.
Geometric Tolerances.

Drawing and design of installations
Drawing of construction and installations with pipes. Representation of constructive elements in the plans
Drawing and design of pneumatic and electrical installations in construction and in Industrial facilities
Plant distribution.

Drawing and computer aided design
Drawing of plans and diagrams of 2D installations.
3D Modelling.
Assembly of 3D parts.
Animation and 3D simulation.
Creation of realistic scenes.

6216 STATISTICS AND NUMERICAL CALCULUS

Statistics

Descriptive statistics.

Statistical description of a variable.

Probability and Random Variables.

Probability. Discrete random variables. Continuous random variables. Models of probability distributions.

Confidence Intervals

Random and Statistical Samples. Specific estimation. Estimation by intervals.

Hypothesis testing

Elements of a contrast. Contrasts for normal populations. Contrasts for proportions.

Numerical analysis

Introduction to Numerical Analysis

Origins and objectives of the numerical analysis. Necessity of numerical analysis in engineering.

Errors. Operating cost and efficiency. Introduction to MATLAB.

Interpolation

Lagrange interpolation. Piecewise polynomial interpolation.

Quadrature and Numerical derivation

Introduction. Quadrature rules and degree of accuracy. Simple and complex quadrature rules.
Obtaining and errors of Numerical derivation.

Non-linear equations and resolution of systems.

Introduction. Methods using intervals: Iterative methods. Introduction to resolution of systems.

Introduction to numerical integration of differential equations

6217 THERMAL ENGINEERING

THERMODYNAMICS

TOPIC 1: ENERGY, TECHNOLOGY AND SOCIETY

Useful Power Production. Energy models in history. Power sources.
Power Production Systems. Thermal and nuclear power plants. Management
Energy Management in Industry. Energy and the 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 diagrams - Entropy, Enthalpy - Entropy and pressure – Enthalpy.

TOPIC 7: PROCESSES IN OPEN SYSTEMS

Discharge Processes. Valves, nozzles and diffusers. Heat Exchange Processes. Adiabatic work processes. Turbines, compressors and pumps. Work in non-adiabatic processes. Scaled compressions and expansions. Thermotechnology.

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: UNIDIMENSIONAL CONDUCTION IN A STATIONARY REGIME

Equation Fourier. Flat, cylindrical and spherical geometry. Analysis of one-dimensional conduction in a steady state: Flat symmetry; Cylindrical symmetry; Spherical Symmetry. Overall transfer coefficient.

TOPIC 10: FLUID MECHANICS 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 forced convection.
Natural convection. Heat transfer in phase changes.

TOPIC 11: HEAT EXCHANGERS

Classification of heat exchangers. Temperature profiles in exchangers. Mean Logarithmic Temperature Difference.

TOPIC 12: THERMAL RADIATION

Thermal radiation. Fundamental laws. Radiation in Nonabsorbent media.

TOPIC 13: COMBUSTION

Fuels and their Properties. Stoichiometry of combustion. Control of combustion. Environmental aspects of combustion.

6218 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.

6219 FUNDAMENTALS OF ELECTRONICS

Thematic Unit 1.

Introduction to digital electronics applications.

Introduction.

Applications.

Thematic Unit 2. Components - Diodes and transistors
Applications.
Passive components.
Diode semiconductor.
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 transmission means.
Transmission of signals.
Errors in the transmission.

➢ 3rd year

6220 QUANTITATIVE METHODS I

CHAPTER 0. Introduction
Introduction.

CHAPTER 1. Linear Programming
Linear programming.
Formulation of models. Graphic solution

CHAPTER 2. Sensitivity Analysis
Sensitivity Analysis.
Sensitivity Analysis.
Theory of Duality.
Application of sensitivity analysis.

CHAPTER 3. Simplex method. Troubleshooting
Simplex method.
Simplex method. Problem resolution.

CHAPTER 4. Problems and Practical Cases
Problems and Practical Cases.
Transportation problems.
Assignment Problems.
Other problems.

CHAPTER 5. Network Analysis
PERT-CPM.
PERT.
PERT-COST.
PERT- cost.

CHAPTER 6. Projects
Projects.
Planning, Programming, monitoring and Control of Projects.
Earned Value Technique.
Critical Chain.
Computerized Project Management.
Project Management Practice.

6222 INDUSTRIAL MARKETING

Industrial Marketing.
Introduction to business management.
Marketing function.
Market.
Product.
Price.
Distribution.
Communication.
Commercial investigation.
Sales force.
Customer satisfaction.
Marketing plan.
Social responsibility.

6223 ENTERPRISE STRATEGY AND POLICY

Strategy and strategic management.
Strategic analysis.
Strategic choice.
Strategic implementation.

Planning and strategic control.

6224 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 in axes. 3.2.2. Fundamental reference differences in holes. 3.2.3. Standard tables of tolerance positions. 4. Group of ISO nominal dimensions greater than 500 mm. 4.1. Fundamental tolerances. 4.2. Positions of tolerances 5. Designation of dimensions with tolerance. 6. Free measurement tolerances.

ADJUSTMENTS

1. Definition. 1.1. Mobile or game adjustment. 1.2. Fixed or interference adjustment. 1.3. Indeterminate adjustment. 2. Base-hole adjustment. 3. Base-axis adjustment. 4. Mixed system. 5. Adjustment normalization. 6. Calculation of normalized adjustment.

OPERATIONS WITH DIMENSIONS

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

MANUFACTURING PROCESS SELECTION

1. Introduction. 2. Stages in product design. 3. Factors influencing the selection of processes. 3.1. Materials. 3.2. Manufacturing Processes. 4 Strategy in the process selection. 5. Process information maps. 6. Selection of manufacturing process. 7. Information on raw materials. 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. Design of distribution systems. 2.3.1. Sprue 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. Interpretation of images.

3.2. Fizeau Interferometer. Measurement of Gauge blocks. 4. Edge patterns. 4.1. Gauge Blocks or Johansson blocks. 4.1.1. Qualities and characteristics of pattern blocks. 4.1.2. Materials and care of gauge blocks. 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. Comparison clock.

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. Tolerances of buffer calibres. 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 inter-comparisons.

INFLUENCE OF UNCERTAINTY ON MEASUREMENT

1. Qualities of measuring instruments. 2. Relationship between the tolerance of a dimension and the uncertainty of the measurement. 3. Relationship between uncertainty of measurement and scale division. 4. Selection of measuring instruments.

PRACTICES

PRACTICE 1. Measurement of a part with a calliper.
PRACTICE 2. Measurement of a part with an exterior micrometre.
PRACTICE 3. Measurement of a part 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. Systems P. 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.

6225 QUANTITATIVE METHODS II

DECISION ANALYSIS

Decision analysis.

SIMULATION

Simulation.

THEORY OF QUEUEING

Queueing theory. Introduction.
Exponential distribution.
Basic models of queues m / m / s.
Other queue models.
Application of queueing theory.
Application of queueing theory.

6226 QUALITY

Quality.
Introduction. Global vision of quality.
Relevant contributions.
EFQM model.
Management systems.
Six Sigma: DMAIC - DFSS.
Lean Manufacturing.
Tools for quality.
Personal productivity.

UNIVERSIDAD DE BURGOS

6229 ENVIRONMENT AND RENEWABLE ENERGIES

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. Desalination processes of marine waters. Quality criteria for industrial waters.

Topic 2 - Wastewater treatment

Characterization of urban wastewater. Treatment of urban waste water. Pre-treatment and primary treatment. Secondary treatments. Tertiary treatments. Sludge treatment. Small purifying systems. Reuse of treated wastewater. Discharge of treated wastewater. Landfill legislation: the discharge tax.

Topic 3 - Control / Treatment of Atmospheric Pollution

Main atmospheric pollutants and emission sources. Quality criteria of air: emission and immission. Dispersion of pollutants in the atmosphere. Models of diffusion. Meteorological conditions. Treatment of atmospheric pollutants: purification of gaseous pollutants and purification 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. Treatment: 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 soils. Treatment techniques: thermal technologies, physical-chemical technologies, biological technologies.

RENEWABLE ENERGY

Renewable Energies and the Preservation of the Environment

Energy resources - Non-renewable resources: environmental problems - Renewable resources - Energy panorama in Spain and in the world.

Solar radiation

Characteristics of solar radiation - Magnitudes - Movement of the Sun in the celestial vault - Insolation data. Solar maps

Thermal solar 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 - The three-bladed wind turbine - Wind installations.

Hydraulic energy

Hydroelectric power plants - Usable energy and power - Turbines and alternators – Pumped-storage plants – Mini power plants.

Biomass energy

Concept of biomass - Techniques based on combustion - 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

➢ 4th year

6230 TECHNICAL OFFICE

Background information
Professional resume.
Theoretical and practical knowledge.
Practices.
Basic concepts of the project and its classification.
Project documents.
Project environment.
Industrial project regulations.
1st case study. implementation and project study.
Industrial (specify during the course).
2nd case study. Implementation and project study.
Industrial (specify during the course).
Knowledge only in practical applications.
Practices.
Specific techniques for assuring the correct operation of the industrial product.
Analysis.
Preliminary risk analysis. Failure mode and effects analysis.
User demands. Product quality.
Quality function deployment.
Project management, planning and administration.
Multidisciplinary projects. "concurrent engineering".
Documentation-gathering work.

6231 INDUSTRIAL COMPLEXES AND PROJECTS

GENERAL THEORY OF PROJECTS
Phases of the project and methodology
Project life cycle.
Documentation.
Management.
Professional deontology.

APPLICATION OF DETAIL
Manufacturing outputs of an industrial project. The seven production systems. Conceptual review for project development. The six manufacturing levers. Miltenburg matrix applied to industrial projects. Competitive analysis. Selection of the best production system of the particular project. Level of manufacturing capacity. Design for the industrial project

PRACTICAL FRAMEWORK
Development of an industrial project

6232 MAINTENANCE MANAGEMENT

Introduction.
Maintenance in the early twenty-first century.
Theoretical framework.
Maintenance indicators.
What are maintenance audits?
Process of auditing maintenance.
Maintenance and human factor audits.
The process of continuous improvement applied to maintenance.
Practical framework.
Heuristics applied to maintenance.
Presentation of real maintenance cases.

6238 LOGISTICS

Introduction.
Supply chain (SC).
Flows and elements of the Supply Chain.
Supply flow.
Productive flow.
Distribution flow.
Economic flow.
Information flow.
Strategic aspects in the SCM.
Product design and unitization.
Information systems in the management of the SC.
Logistic nodes and strategic location.
Maintenance and storage.
Facilities.
Warehouse design.
Plant distribution.
Warehousing Techniques.
Picking, cross-docking & co-fabrication (and co-packing).
Shelves.
Means of maintenance.
Transport.

Air, Maritime, Railway and Maritime and Fluvial Transport.
Air.
Railway.
Highway.
Multimodal.
Distribution.
Network design.
Capillarity vs. costs.
Administration of the Supply Chain.
Supplies.
Prices and administration.
ICT's.
Coordination of the SC.

6233 ELECTRIC TECHNOLOGY

Spanish electrical system.
Electrical concepts.
Electrical risk.

6234 ENERGY TECHNOLOGY

TOPIC 1: CONCEPTS OF ENERGY TECHNOLOGY
Energy throughout history. Sources of energy. Final energies. Energy transformation. Energy efficiency. Energy in industry.

TOPIC 2: THERMAL ENERGY (I). HEAT GENERATION.
Generation of energy by combustion: combustion, burners, homes, fuels. Nuclear generation. Solar generation, geothermal. Thermal energy transport: fluids and transport networks. Applications: boilers, ovens, dryers. Thermal energy exchange: heat exchangers.

TOPIC 3: THERMAL ENERGY (II). COLD GENERATION AND AIR-CONDITIONING.
Refrigeration technology. Cold production systems. Applications. Cooling fluids Application to air conditioning.

TOPIC 4: TRANSFORMATION OF MECHANICAL ENERGY / THERMAL ENERGY (I). PUMPS, COMPRESSORS.
Energies associated with fluids. Hydraulic generating machines. Bombs. Thermal power generating machines. Compressors.

TOPIC 5: TRANSFORMATION OF MECHANICAL ENERGY / THERMAL ENERGY (II)

Hydraulic motor machines Thermal motor machines. Applications to transport and electricity generation. Cogeneration and trigeneration. Modes of operation and regulations.

TOPIC 6: ENERGY AND ENVIRONMENT.
Energy politics. Fuel energy markets. New fuels and energy sources. Energy service companies ESCOs. Energy and environmental planning.

6235 MECHANICS TECHNOLOGY

MECHANICAL TECHNOLOGY
FUNDAMENTALS OF PROJECT MANAGEMENT PROCESSES
1. Introduction. 2. The traction test. 2.1. Conventional or technological stress-strain curve. 2.2. Creep curve. 3. Plastic behaviour of metals. 3. Justification and objectives of plastic deformation processes. 4. Effect of temperature on deformation processes. 5. Effect of the deformation speed on plastic deformation processes. 6. Friction and lubrication.

FORGING
1. Description of the process. 2. Calculation of efforts in the forge. 2.1. Free forge. 2.2. Stamping 3. Upsetting and heading.

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

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

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

PLATE BENDING
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 bending efforts. 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 effort in die-cutting. 9. Calculation of punch buckling. 10. Structural classification of punches.

DEEP-DRAWING

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

MACHINING

1. Definition 2. Cutting conditions in machining. 3. General approach to machining. 3.1. We must know.. 3.1.1. Properties of cutting tools. 3.1.2. Cutting tool materials. 3.1.3. Geometry of cutting tools. 3.2. Should we fix or calculate? 3.2.1. Calculation of the depth of pass. 3.2.2. Cutting speed 3.2.3. Taylor's theory. 3.2.4. Generalized Taylor equation. 3.2.5. Kronenberg theory. 3.2.6. Minimum cost speed. 3.2.7. Maximum production speed. 3.2.8. Maximum benefit speed. 3.2.9. Speed of maximum economy, maximum production or maximum benefit in operations with variable cutting speed. 3.3. Calculation of advance. 3.3.1. Calculation of the advance in roughing operations. 3.3.2. Calculation of advance in finishing operations. 4. Cutting time. 5. Machinability. 6. Cutting fluids.

EVALUATION OF MEASURE UNCERTAINTY

1.Terminology. 2. Calibration. 3. Measurement methods. 4. Law of propagation of uncertainty or law of propagation of variances. 5. Evaluation of the measurement uncertainty of input estimates. Estimation of standard uncertainty. 5.1. Typical Type A evaluation of uncertainty. 5.2. Standard Type B uncertainty evaluation. 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 with the 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 measurement uncertainty around the calibration 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 measurements: dimensions and angles. 1.1. Dimensional measurements of known angles. 1.2. Calculation of angles of known dimensions. 1.3. Measurement of dimensions and angles by means of chocks. 2. Radius measurement. 2.1. Two-roll method. 2.2. Fixed roll probe method. 2.3. Method of three coordinates. 2.4. Chord deflection method. 2.5. Measurement of lenses with a spherometer. 3. Conicity and inclination. 3.1. Measurement and verification of cones.

PRACTICES

PRACTICE 1. CALLIPER CALIBRATION.

PRACTICE 2. CALIBRATION OF EXTERIOR MICROMETERS.

6236 INDUSTRIAL APPLICATIONS OF ELECTRONIC SYSTEMS

Electronic measurement systems.
Sensors and their conditioning.
Amplification.
Interferences and Noise.
Filtering.
Analog / Digital Conversion.
Microprocessor-based systems.
Digital systems.
Buses.
Automata.
Communication systems.
Communication networks.
Integration of electronic systems.
Electronic Equipment for Monitoring and Control of Industrial Processes.
Maintenance and Calibration of Electronic Equipment.
Communications Technology.

6237 WORKPLACE ACCIDENT PREVENTION

1.- CONCEPTUAL FRAMEWORK - LEGAL AREA

TOPIC 1.- Introduction to poh.
TOPIC 2.- Poh regulations.
TOPIC 3.- Responsibilities and sanctions. Poh organisms.

2.-SAFETY AT WORK

TOPIC 4.- Work accident. Work safety.
TOPIC 5.- Statistical analysis of the accidents. Safety techniques.
TOPIC 6.- Risk assessment.
TOPIC 7.- Analytical techniques.

3.- OTHER SPECIALTIES OF POH

TOPIC 8.- Work hygiene.
TOPIC 9.- Ergonomics and psychosociology.
TOPIC 10.- Health surveillance.
TOPIC 11.- Work medicine.