CONTENT OF COURSES

MECHANICAL ENGINEERING

UNIVERSIDAD NACIONAL DE TUCUMAN

ARGENTINA

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https://www.facet.unt.edu.ar/ingmecanica/plan-de-estudios/

Table of contents

01) CALCULUS I

OBJECTIVES: That the student achieves the formation of a system of knowledge and skills In the Differential Calculus of a variable, developing capacity of abstraction, Reasoning and application of knowledge in the resolution of exercises and problems.

CONTENTS

UNIT 1: ELEMENTARY ELEMENTS OF LOGIC: Propositions. Tables of Truth. Equivalence of propositions. Propositional functions. Quantifiers: Existential and Universal.

UNIT 2: NUMBERS: Basic properties of natural numbers. Extensions from natural to real. The Real Numbers: Sorting. Intervals. Inequalities. Correspondence between the real and points of the line.

UNIT 3: FUNCTIONS: Definition; Graphical representations. Classification of polynomial, rational, transcendent functions. Trigonometric Functions. The algebra of functions: addition, subtraction, multiplication, quotient. Composition of functions. Reverse function. Inverse trigonometric functions.

UNIT 4: LIMITS AND CONTINUITY: Limit of a function. Intuitive concept of limit. Definition of limit. Theorems about limit of functions. Lateral limits. Limits of trigonometric and inverse trigonometric functions. Trigonometric fundamental limit. Limit generalizations to infinite cases. Continuous functions. Fundamental properties of continuous functions. Discontinuities; Different types of discontinuities. Asymptotes: vertical and horizontal.

UNIT 5: DERIVED: Definition of tangent line of a curve at a point in the curve. The derivative of a function. Geometric and physical interpretation of the derivative. Side derivatives. Derivability and continuity. Referral rules. Derived from trigonometric functions. Derived from the composite function. Derivatives of higher order. Inverse functions and differentiation. Derived from inverse trigonometric functions. Implicit derivative. Reason to change. Differential.

UNIT 6: THEOREMS OF THE DIFFERENTIAL CALCULATION: Rolle's Theorem and Mean Value Theorem. Increasing and decreasing functions. Criterion for increasing and decreasing functions. Undetermined forms. Rule of Bernoulli - L'Hôpital.

UNIT 7: DERIVATIVE APPLICATIONS: Relative and absolute maximum and minimum values of a function. Necessary condition for the existence of a relative end. Sufficient condition. Optimization Issues. Concavity and inflection points of a curve. Application in plotting curves.

UNIT 8: POLINOMIC APPROACH OF FUNCTIONS: Mac Laurin Polynomial and Taylor Polynomial. Taylor's theorem. Lagrange formula of the rest. Estimation of error.

02) ALGEBRA AND ANALYTICAL GEOMETRY I

OBJECTIVES: That the student acquire skill in the management of vectors in Rn, study conics, deduce its properties, identify and graph lines and surfaces in R3, and acquire competencies over complex numbers and their applications in engineering problems.

CONTENTS

UNIT 1: VECTORS: Vectors in Rn: Definition. Equality. Sum. Product by a scalar. Properties. Scalar product. Parallelism. Orthogonality. Standard or module. Angle between vectors. Orthogonal vector projection and scalar projection. Vector product. Double mixed product. Properties

UNIT 2: VECTOR APPLICATIONS: Vector Applications to Analytical Geometry: Vector, parametric and Cartesian equations of the line. Straight by two points. General and segmental equation of the line in R2. Angle between two lines. Parallelism and orthogonality of lines. Vector and Cartesian equation of the plane. Parallelism and orthogonality of planes. Parallelism and orthogonality between straight lines and planes. Distances

UNIT 3: CONICAL: Conics: Circumference - Ellipse - Hyperbola - Parabola. Definition. Canonic and General Equation of conics with axes parallel to the coordinates. Properties of the conics. Straight Tangent to a conic. Cleavage rule

UNIT 4: SURFACE AND LINE VECTORS: Surface and Line: Definition. Conical Surfaces. Cylindrical Surfaces. Quadric: Spherical Surfaces - Ellipsoid - Hyperboloids of one leaf and two leaves - Paraboloides

UNIT 5: COMPLEX NUMBERS: Complex Numbers: Definition. Operations. Properties. Binomial form. Conjugate. Properties. Module. Properties. Polar shape. Power and Radiation of complex numbers. Exponential Form

03) SYSTEMS OF REPRESENTATION

OBJECTIVES: Learning to represent and interpret simple and complex volumes, both of flat surfaces and surfaces of revolution. Acquire knowledge of Descriptive Geometry to address structural design problems. To know the rules on representations

CONTENT

UNIT 1. INTRODUCTION: Knowledge of the tools to be used in drawing: paper, hardness of mines, etc. Usual scales. Calligraphy.

UNIT 2. PROJECTIONS: Representation systems: Monk Method. American system. 2.2). Projections with models in sight. Elemental solids with flat faces Formed from a hub (1: 1: 1), of a square base prism (1: 1: 2) and a parallelepiped (1: 2: 4). Projections without models in sight. Given two projections of flat faces, alone or forming together, execute the other projections that are indicated.

UNIT 3. PERSPECTIVES: Different types of perspectives and their choice for the representation of a volume. Dimming perspective of 7 °, 42 ° and vertical without model in sight. Rules. Projections and dimmetric perspectives of solids of flat faces previously treated, alone or forming sets. From two projections make the projections and perspectives that are indicated. Idem. With polyhedral bodies of different proportions to those mentioned in 2.2. Notions of ENTALLADURAS. Prismatic portions that are removed from a only extreme that overlap or not. Notches from opposing ends that intersect each other. Projections and perspectives.

UNIT 4. BODIES WITH CURVED SURFACES: Circumference and circle: its representation in dimetric perspective 7 °, 42 ° and vertical. Rules. Projections and perspectives of the right circular cylinder. Idem. For the straight circular cone. Prospects will be made in all possible positions, using axes in positions perpendicular to the planes of projections. Exercises of application with solids with an axis of revolution, formed by cylindrical, conical and flat surfaces. Idem. with bodies of two perpendicular axes, coplanar or not. Representation in projections and in dimmetric perspective of the sphere Application exercises: Solids with axes of revolution in three perpendicular directions of space, limited by cylindrical, conical, spherical and flat surfaces.

UNIT 5. BODY SECTION: Section through planes perpendicular to some of the projections, of polyhedral bodies. Projections and perspectives. Sections of cylinder, cone and sphere by oblique planes. Obtaining the ellipse, the hyperbola and the parabola. Dimetric projections and perspectives.

UNIT 6. INTERSECTIONS OF REVOLUTION SURFACES: Cylinder with cylinder: Projections and perspectives. Applications. Cylinder with cone: Projections and perspectives. Applications. Cylinder with sphere: Projections and perspectives. Applications.

UNIT 7. CUTTING THROUGH PARTS: Sections: Broken, slaughtered, auxiliary, details, rotated, displaced, etc. Rules.

UNIT 8. DESCRIPTIVE GEOMETRY DESCRIPTIONS: Representation of the point, line, plane and volume in the first quadrant. General and special positions. Changes of projection planes. Visibility. Problems: Determination of true magnitudes of lines, plane surfaces, plane angles and dihedral angles. Perpendicularity and distances between point and line, parallel and warped lines, and between point and plane. Intersections between straight and plane, and between planes between themselves. Developments. Election and execution of auxiliary views of first and second orders. Representation of bodies in necessary and sufficient projections according to Norms.

UNIT 9. INTRODUCTION TO ASSISTED DESIGN.

04) PHYSICS I

OBJECTIVES: Knowledge and understanding of the fundamental laws governing mechanical phenomena. Ability to use the models and laws of physics for the purpose of solving engineering problems. Capacity for abstraction and critical reflection. Metacognition.

CONTENTS

UNIT 1: INTRODUCTION. Observations and models in Physics. Laws and Theories. Magnitudes and physical quantities. Measurement is and units: the International system (SI) and the Argentine Legal Metric System (SIMELA). Significant figures and uncertainty or error. Propagation of errors. Scientific C notation. Dimensional homogeneity

UNIT 2: MOVEMENT OF THE MATERIAL POINT I: DYNAMICS OF THE PARTICLE. The particle model. Reference systems and coordinate systems. The position vector and the displacement vector. The mean velocity vector and the instantaneous velocity vector. The acceleration vector. Newton's laws of motion. Inertial reference systems. Kinematics and dynamics of movement in one dimension. The diagrams x (t), v (t) and a (t). Mass and weight of bodies. Contact forces: normal force and frictional force. Coefficients of friction: static and dynamic. Forces in the bonds ("reactions" of bond).

UNIT 3: MOVEMENT OF MATERIAL POINT II: DYNAMICS OF THE PARTICLE. Movement in the plane. Diagrams y (x). Oblique shot. Uniform and varied circumferential movement. Dynamics and angular kinematics. Angular speed, character. Vector illustration. Tangential velocity. Vector relation entrerr, ωr and v. Centripetal force and centripetal acceleration. Angular and tangential acceleration. Reference systems with Relative motion: Galileo transformation equations. System of References.

UNIT 4: LINEAL IMPULSE AND ENERGY OF A PARTICLE. ANGULAR PULSE OF A PARTICLE. MOMENT OF A FORCE OR ROTATION MOMENT. MOMENT OF INERTIA OF A PARTICLE. Linear impulse of a particle. Impulse of a force. Redefinition of force. Linear impulse conservation theorem. Cases of variable mass. Work as a scalar product of vectors. Work-kinetic energy theorem. The work of gravity and gravitational potential energy. Elastic forces and elastic potential energy. Conservative and dissipative forces. Mechanical energy: conservation theorem. Power. The angular impulse of a particle with respect to a point. Cartesian components of angular momentum L. Moment of a force or rotation. Theorem of conservation of the angular impulse. Central force. Reformulation of the dynamics of rotation of a particle. Moment of inertia. Fundamental equation of rotation dynamics. The work-energy theorem in rotation.

UNIT 5: PARTICLE SYSTEMS. Center of mass. Coordinates. Properties of the c.m .. Linear impulse and angular impulse of a system of particles. Conservation Theorem. The work-energy theorem. Conservative internal forces. Internal potential energy. Own energy. Internal energy. Angular impulse of a system of particles: internal and orbital. Two-particle systems. Reduced mass. Collisions: elastic central shock, plastic shock, semi elastic shock and explosive shock. Coefficient of restitution. Collisions in two dimensions.

UNIT 6: DYNAMIC AND STATIC OF THE RIGID BODY. The rigid body model. Center of mass and center of gravity. Properties. Degrees of freedom of movement. Rotation around a fixed axis passing through the center of mass. Moment of inertia. Calculation of moments of inertia. Steiner's theorem. Angular impulse of rigid body. Main axes of inertia. Fundamental equation of the rotation dynamics of the rigid body. Dynamic imbalance. Work and energy in the movement of a rigid body. Conservation Theorems. Rotational movement: rotation without sliding. Forces of friction in the Treads. Gyroscope. Precession. Nutation. Static rigid body: equilibrium conditions.

UNIT 7: GRAVITATION. Newton's Law of Universal Gravitation. Determination of the gravitational constant. Weight and gravitational force. Planetary systems and Kepler's Laws. The angular impulse and Kepler's Second Law. Law of gravity and movement of the planets. The gravitational field. Energy and gravitational potential. Energies and orbits.

05) CALCULUS II

OBJECTIVES: That the student achieve the formation of a system of knowledge and skills in the Integral Calculus of a variable, developing ability of abstraction, reasoning and application of knowledge in the resolution of exercises and problems.

CONTENTS

UNIT 1: INDEPENDENT INTEGRAL. Anti-derivative. Definition of indefinite integral. Properties of the indefinite integral. Chain rule for anti-differentiation.

UNIT 2: DEFINED INTEGRAL. Riemann's sum and the definite integral. Area of a flat region located below a curve. Properties of the definite integral. The fundamental theorem of Calculus. The mean value theorem for integrals. Second fundamental theorem of Calculus.

UNIT 3: TRANSCENDENT FUNCTIONS AND THEIR REVERSES. Definition of the natural logarithm function. Properties of logarithm. Existence of the inverse function. Derivation theorem of the inverse function. The exponential function. Hyperbolic Functions. Definitions, properties. Inverse Hyperbolic Functions. Inverse Trigonometric Functions.

UNIT 4: INTEGRATION. Integration methods: Substitution, integration by parts. Integrals that result in inverse trigonometric and inverse hyperbolic functions. Integration of powers of trigonometric and hyperbolic functions. Trigonometric and hyperbolic substitutions. Substitution by simple fractions and rational functions in sin and cosine. Miscellaneous substitutions. Numerical Integration.

UNIT 5: IMPROPER INTEGRALS. APPLICATIONS OF THE INTEGRAL. Improper Integrals: Infinite limits of integration, infinite discontinuities. Calculation of areas of regions in the plane. Length of a curve arc.

UNIT 6: SUCCESSIONS. Definition of a sequence as a function in N. Convergent and divergent sequence. Monotonous sequences. Limited events. Convergence criteria for monotonous and bounded sequences.

UNIT 7: SERIES OF REAL NUMBERS AND POTENCIES. Definition of series. Convergence and divergence of a series. Condition necessary for the convergence of a series. Geometric series. Properties of the series. The p. Convergence criteria for series of positive terms. Alternate series. Absolute and conditional convergence. Series of Powers. Convergence. Taylor series and Mc Laurin.

06) ELEMENTS OF LINEAR ALGEBRA

OBJECTIVES: Develop the ability to work systems of linear equations using Gauss Jordan, relating it to the range. Become familiar with the relationship between linear transformation matrix. Know, relate, integrate concepts to concrete situations.

CONTENTS

UNIT 1: MATRICES. Definition. Particular arrays. Operations: Sum, scalar product, product of matrices. Properties. Matrix transposed. Symmetric and antisymmetric matrices. Partition. Elementary row operations. Elementary matrix. Matrices equivalent per row. Matrix step reduced by row. Range of a matrix. Invertible matrices. Inverse of a matrix. Properties. Obtaining by Gauss-Jordan.

UNIT 2: LINEAR EQUATIONS SYSTEMS. Definition. Scalar and matrix expression of a system of linear equations. Definition of solution. Classification. Equivalent systems. Existence of solutions. Solution set. Compatibility and range. Gauss elimination method. Theorem of Rouché Frobenius.

UNIT 3: VECTOR SPACE. Vectorial Space: Definition - Linear Combination. Definition of Subspace - Necessary and sufficient condition. Dependence and linear independence of vectors. Consequences. Generator - Space Generated by a Set of Vectors - Base and Dimension - Coordinates - Change of base. Matrix of the base change.

UNIT 4: LINEAR TRANSFORMATION. Linear Transformation: Definition. Consequences. Algebra of linear transformations. The fundamental theorem. Core. Image. Matrix partner.

UNIT 5: DETERMINANTS. Determinants: Definition. Properties. Definition of Adjunct Matrix - Property. Matrix reversible and determinant. Applications to systems of linear equations.

UNIT 6: POLYNOMES. Polynomial in an indeterminate: Sum, subtract product and quotient. Ruffini's Rule. Theorem of the rest. Divisibility. Primal and compound polynomials. Zeros of a polynomial. Existence of zeros. The fundamental theorem of algebra. Multiple zeros. Factorization in $\Re$ [x] and in C [x]. Equations.

UNIT 7: VALUES AND VECTORS OWN OF A LINEAR OPERATOR. Values and eigenvectors of a linear operator. Own space associated with an eigenvalue. Own vectors associated with different eigenvalues. Values and eigenvectors of a matrix of order n. Own space associated with an eigenvalue of a matrix. Relationship between the values and eigenvectors of a linear operator with the values and eigenvectors of its associated matrix on a given basis. Matrix characteristic. Characteristic polynomial. Characteristic equation. Cayley-Hamilton Theorem. Algebraic multiplicity and geometric multiplicity of an eigenvalue, relationship between both.

UNIT 8: DIAGONALIZATION. Diagonalization of linear operators. Characteristic polynomial. Diagonalization of matrices. Applications.

07) PHYSICS II

OBJECTIVES: Knowledge and understanding of the fundamental laws governing mechanical phenomena. Ability to use the models and laws of physics for the purpose of solving engineering problems. Capacity for abstraction and critical reflection. Meta Cognition

CONTENTS

UNIT 1: DEFORMABLE BODY MECHANICS. Notions of elasticity. State of deformations. State of stress. Hooke's Law. Stress and modulus of elasticity: Traction. Torsion. Compression. Poisson's number. Potential elastic energy. Hydro and aerostatic: Ideal liquids. Pressure. Manometric pressure and atmospheric pressure. General theorem of the hydrostatic. Theorems of Pascal and Archimedes. Hydro and aerodynamics Current line. Stationary flow. Continuity equation. Bernoulli's Theorem. Viscous liquids. Laminar regime. Distribution of velocities and flow in a tube. Law of Poisseuille. Law of Stokes. Reynolds number. Surface Phenomena: Surface tension. Law of Laplace. Ascent capillary.

UNIT 2: OSCILLATIONS. Mass-spring system. Differential equation of motion. Simple harmonic oscillations. Simple pendulum. Physical Pendulum. Torsion pendulum. Superposition of simple harmonic motions. Damped oscillations. Forced oscillations. Resonance.

UNIT 3: MECHANICAL WAVES. Wave function. Longitudinal and transverse waves. Harmonic waves. Differential equation of the wave motion. Wave propagation speed. The principle of superposition. Wave interference. Pulsations. Reflection. Stationary waves. Intensity of the wave. Doppler effect. Acoustics: Sound characters. Height and frequency. Intensity. Level of intensity: the decibel. Sound sensation. Doorbell. Harmonics. Fourier analysis and synthesis. Sound pollution. Sound resonance.

UNIT 4: TEMPERATURE AND HEAT. GASES. Temperature, thermometers and scales. Thermal equilibrium and Zero Law of thermodynamics. Dilation and thermal stress. Hot. Specific heat and heat of transformation. Mechanisms of heat transfer. Action of heat in gases. State equation of ideal gases. Kinetic Theory of gases: specific heat and internal energy of an ideal gas. Real gas. Van der Waals equation.

UNIT 5: THERMODYNAMICS: FIRST PRINCIPLE. Thermodynamic systems. First principle of thermodynamics. Quasi-static processes. Calculation of work The internal energy. Adiabatic processes: Poisson equations. Cyclic processes: Carnot cycle. Thermodynamic performance. Refrigerating machines: efficiency.

UNIT 6: SECOND PRINCIPLE OF THERMODYNAMICS. Second principle of thermodynamics. Entropy function. Irreversible and reversible processes. Calculation of entropy variation. Entropy and its statistical formulation.

UNIT 7: PHASE CHANGES. Heat of transformation. Fixed points. Vaporization. Evaporation and boiling. Saturated steam pressure. Clausius-Clapeyron equation. Liquefaction of gases. Thompson-Joule Effect. Hygrometry.

UNIT 8: LABORATORY:

1) Simple measurement problems. Direct and indirect measurements. Calculation of errors.

2) Measurement of fundamental magnitudes: length, mass and time.

3) Two of the following practices: Density and thrust. Archimedes' principle. Oscillations. Mathematical pendulum Moment of inertia. Physical Pendulum. Conservation of angular momentum. Reversible pendulum. Viscosity. Elasticity of traction. Torsion elasticity. Determination of specific heats. Determination of latent heat. Mechanical equivalent of heat. Determination of Cp and Cv.

EXPERIMENTAL PRACTICES:

1- Introduction to basic notions (characteristics of metering systems, significant figures, experimental uncertainty, types of errors, Gauss theory of errors, planning of a measurement, scientific expression of the result of a measurement) through direct and indirect measurements Simple
2- Determination of viscosity coefficients. Comparative analysis of different methods. Funded selection of the design to be used. Analysis of sources of experimental uncertainty. Adjustment between theoretical models and experimental data. Conclusions.
3- Determination of specific heats. Method of the mixtures. Determination of molar heats and explanation of results. Determination of the mechanical equivalent of heat. Energy considerations. Analysis of sources of experimental uncertainty. Adjustment between theoretical models and experimental data. Conclusions. Freefall. Experimental determination of space-time and velocity-time relationships. Adjustment between theoretical models

and experimental data. Measurement of instantaneous speed as experimental limit of the average speed. Physical interpretation of the concept of limit. Conclusions.

4- Experimental study of different types of oscillating mechanical systems. Determination of the proportionality constant between forces and elongations for a mass-spring system. The free swing. Damped oscillatory motion. Adjustment between theoretical models and experimental data. Conclusions.

08) INFORMATICS

OBJECTIVES: To know the basic fundamentals of Informatics, its methodological and technical tools. Acquire capacity to analyze and pose problematic situations inherent to disciplinary environments related to Engineering.

CONTENTS

UNIT 1: INTRODUCTION TO COMPUTER CONCEPTS. Nature of the information. Informatics: definition. Data and information. Structure of the information. Type of data. Expressions: types of expressions, hierarchy, problem solving. Computer structure: historical perspective, Von Newman model. How information is measured. Numbering systems: conversion between systems, operations, complement to the base. Computer terminology.

UNIT 2: OPERATING SYSTEMS. Operating System: definition, classification, main functions: program execution, hardware management, file management. Windows operating system.

UNIT 3: APPLICATION SOFTWARE UNDER THE WINDOWS ENVIRONMENT. Editors and word processors. Spreadsheet

UNIT 4: PROGRAMMING AS PROBLEM SOLVING METHODOLOGY. Problems of computer interest. Stages in problem solving. Concept of algorithm. Characteristics of a computer algorithm. Modular programming. Structured programming: fundamental theorem, basic structures. Language of design. Design of algorithms. Graphical representation: flow diagram. Variables: concept. Allocation operation.

UNIT 5: PROGRAMMING LANGUAGES. Language: concept. Types of language from the computer point of view. Evolution of programming languages. The paradigms of programming. Introduction to Pascal Language: general structure of a Pascal language program, operators, basic structures.

09) FUNDAMENTALS OF GENERAL CHEMISTRY

OBJECTIVES: That the student acquires skill in the management of the bibliography and of the different materials and instruments of laboratory. Manage the relationship of chemistry with technological development. Use your own technical vocabulary fluently.

CONTENTS

UNIT 1: CHEMISTRY. Definition. Matter. Intensive and extensive properties. States of the material. Material mixtures: homogeneous, heterogeneous and inhomogeneous. Substances: simple and compound. Chemical elements. Basic atomic structure. Atomic number and atomic mass. Principal subatomic particles. Isotopes. Law of Avogadro. Molecule. Atomic and molecular weight. Atom and gram molecule. Mol. Chemical formula. Atomicity. Oxidation number. Chemical equivalent. Chemical equation. Stoichiometric coefficients. Stoichiometric calculations.

UNIT 2: PERIODIC CLASSIFICATION. Description. Basic characteristics of the chemical elements in the table. Electronic distribution in atoms. Periodic properties. Chemical links. Definition. Binding energy. Types of bonds: ionic, covalent and covalent electro. Covalent bonds: pure and polar. Polarity of the links. Electronegativity. Polar molecules and dipole moment. Hydrogen bridge.

UNIT 3: GAS STATE. Status variables. Pressure. Units. Ideal gases. Laws of Boyle and Mariotte and Charles Gay Lussac. Absolute temperature. General equation of state. Mixture of gases. Dalton's Law. Kinetic theory of ideal gases. Law of Graham. Real gas. Isotermas of Andrews. Critical parameters. Van der Waals equation. Association and dissociation by effect of Temperature.

UNIT 4: LIQUID STATE. Vapor pressure. Phase diagram of water and carbon dioxide. Solutions. Concentration of solutions: centesimal, normality, molarity, molality and molar fraction. Solutions of miscible liquids. Raoult's Law. Diluted solutions. Colligative properties: tensimetry, ebulloscopy, cryoscopy and osmotic pressure. Electrolyte Solutions: Van't Hoff Correction.

UNIT 5; CHEMICAL LINKS. Binding energy. Types of bonds: ionic, covalent: pure and polar, electrocovalent. Polarity of the links. Electronegativity. Evaluation of Pauling. Polar molecules and dipole moment. Hydrogen bridge.

UNIT 6: THERMODYNAMICS. Energy and heat. First Law of Thermodynamics. Work. Internal energy. Status function. Thermodynamic processes. Thermochemistry. Enthalpy. Thermochemical equation. Heat of formation, combustion and reaction. Heat power. Boards. Laws of thermochemistry: Lavoisier Laplace and Hess.

UNIT 7: KINETICS AND CHEMICAL AND IONIC BALANCE. Reaction speed. Order and molecularity. Reaction constant. Activation energy. Catalysis. Catalysts. Catalytic promoters and poisons. Chemical balance. Balance constant. Principle of Le Chatelier. Ionic balances. Strong and weak electrolytes. Base acid theories. Ionization of water. Ionic product of water. PH and pOH.

ELECTROCHEMICAL UNIT 8. Electrolytic dissociation. Electrolysis. Laws of Faraday. Specific conductivity and electrolyte equivalent. Strong and weak electrolytes. Batteries. Electrodes: classification. Normal potential of an electrode. Reference electrode. Potential tables. Nerstn formula. Voltage, Surge and Polarization. Dry batteries. Lead-acid accumulator. Corrosion. Cathodic protection. Corrosion classification. Speed of corrosion. Protection procedures. Corrosion in industrial plants.

PRACTICAL WORK: TROUBLESHOOTING: It is envisaged that the dictation of classes of problem solving of application, referring to the topics of developed theory and whose objective is to acquire mental speed and skill for the mathematical management of the chemistry, are an immediate continuity to the development of the theory.

PRACTICAL LABORATORY WORK:

The practical works developed in the Laboratory are related to the theoretical subjects so that the student can observe experiences from which to better understand the chemical phenomena and their connection with the studied laws and verify by mathematical calculations their compliance.

1 ° Nomenclature. Basic nomenclature evaluation

2 ° Measurements of liquid densities and solutions. Determination of the concentration of a solution by measuring its density.

3 ° Determination of the chemical equivalent of an element by displacement.

4 ° Determination of a colligative property in a diluted solution. Ebulloscopy.

5 ° Ionic equilibria in electrolytes. Ionic product of water. PH and pOH.

10) PHYSICS III

OBJECTIVES: The general objective of the course is to provide students with the basic aspects of electricity, magnetism and optics, emphasizing both the conceptual understanding of phenomena and the solution of problems through analytical and quantitative calculation.

Specific objectives: The Physics II course is designed so that, specifically, students can: 1. Assimilate and understand electromagnetic phenomena. 2. Acquire experience to reasonably assume, formulate hypotheses, model and solve a problem. 3. Achieve ability to obtain an analytical result and be able to see its scope and also its limitations. 4. Connecting ideas, previous and new, of physics and mathematics. 5. Link the issues that arise with everyday situations and in the context of contemporary scientific and technological applications.

CONTENTS

UNIT 1: ELECTROSTATIC INTERACTIONS. Physics and Technology. Electromagnetic Technology and its applications. Elementary particles, atom, molecule and material medium. Bohr's atomic model, energy states. Electrostatic interaction. Law of Coulomb. The physical concept of work. Electrical potential energy. Energy for the formation of a system of discrete point charges. Applications and Problems.

UNIT 2: THE ELECTRIC FIELD. Potential and electrostatic field of a point charge. Electric field flow. Gauss's Law. Difference of electrostatic potential. Relationship between field and electrical potential. Equipotential surfaces. Gravitational interaction. Analogies between the electrical and gravitational interactions. Types of load distributions. Discrete distributions: point charges. Continuous distributions: linear, superficial and volumetric, applications.

UNIT 3: MAGNETIC INTERACTION. Electric current. Electrical current associated with different distributions of moving loads. Magnetic field created by currents. Laws of Biot-Savart and Ampere. Magnetic field flux. Electromagnetic induction. Law of Faraday. Autoinduction. Mutual Induction. Generation of electromotive force. Interaction of the magnetic field with current circuits. Magnetic Moment. Engine torque. Force of Lorentz. Applications and Problems

UNIT 4: CONTINUOUS CURRENT ELECTRICAL CIRCUITS. Elements of Passive Circuits. Resistance. Capacity. Inductance. Serial and Parallel Connections. Batteries and DC Power Supplies. Ohm's law. Laws of Kirchhoff. Pure resistive circuits. Method of meshes and nodes. Circuits Series RL and RC. Transitory Regime. Dissipated energy and stored energy. Applications.

UNIT 5: ELECTRIC CURRENT CIRCUITS.RLC circuit with alternating voltage source. Natural frequency of the circuit. resonance. Fun oscillations. Cushioning. Travel current. RC circuit with continuous voltage source. Applications.

UNIT 6: MAXWELL EQUATIONS AND ELECTROMAGNETIC WAVES. Maxwell equations. Electromagnetic waves. Refractive index. Energy of an electromagnetic wave: Poynting vector. Superposition of electromagnetic waves. Polarization. Applications and Problems.

UNIT 7: OPTICAL SYSTEMS: MIRRORS, PRISMS, TRANSPARENT MEDIA. Law of reflection. Law of refraction. Flat surfaces. Mirrors. Prisms. Spherical mirrors. Spherical surfaces in transparent media. Applications and problems

UNIT 8: OPTICAL SYSTEMS: LENSES AND LENS COMBINATION. Thick lenses. Lens systems. Optical instruments: magnifying glass, microscope, telescope. Applications and problems.

UNIT 9: SUPERPOSITION PHENOMENA: DIFFRACTION, INTERFERENCE AND POLARIZATION. Diffraction. Interference. Young's experiment. Interference and diffraction. Diffraction networks. Interference in thin films. Polarization of Light. Retardant sheets. Applications and Problems

LABORATORY PRACTICES:

1. Dependence between applied voltage and current flowing through a conductor
2. Ohm's law. Adjustment between theoretical models and experimental data. Measurement of resistances. Direct method and compensation method. Comparative study of the different methods. Conclusions.
3. Determination of e / m by a filiform ray tube, measuring the electric and magnetic fields and the radius of the path of the electrons. Adjustment between theoretical models and experimental data. Conclusions.
4. Hall Effect. Curves of variation of the voltage Hall as a function of the intensity of current in the glass and of the magnetic induction. Adjustment between theoretical models and experimental data. Determination of the number of carriers per unit volume for a sample. Measurement of magnetic fields from Hall voltages. Comparative study with other methods to measure magnetic induction. Conclusions.
5. Transient. Loading and unloading of a capacitor C through a resistor R. Load and discharge curves for different values of C and R. Experimental determination of the time constant. Charging and discharge of an inductance L through a resistor. Adjustment between theoretical models and experimental data. Conclusions.
6. Experiences with concave and convex lenses and mirrors. Adjustment between theoretical models and experimental data. Determination of focal distances. Analysis of aberrations. Construction of optical instruments and determination of increase. Conclusions.
7. Laser source. Physical principles of laser emission. Spatial and temporal coherence. Comparison with conventional sources. Diffraction and interference by one or more openings. Patterns of intensity. Networks. Adjustment between theoretical models and experimental data. Conclusions.

11) CALCULUS III

OBJECTIVES: The student must know and manage the applications of differential and integral calculus in several variables, real functions and vector functions, with theoretical foundations of mathematical analysis.

CONTENTS

UNIT 1: FUNCTIONS OF SEVERAL VARIABLES. Real functions of several variables: Continuity, Limit, Partial Derivatives. Mapping curves and regions. Curves and surfaces and their parametric representations.

UNIT 2: VECTORS AND VECTORIAL FIELDS. Vector functions: Continuity, Limit and Derivative of vector functions-Straight tangent to a curve. Differential operations with vectors: gradient, divergence, rotor.

UNIT 3: DIFFERENTIAL CALCULATION OF FUNCTIONS OF SEVERAL VARIABLES. Directional derivative - Differential functions - Plane tangent to a surface - Total differential - Jacobian matrix f''(Po) - Mean value theorem of differential calculus - Subsequent partial derivatives - Composite functions - Chain rule - Taylor's theorem Of Taylor to locally approximate functions of several variables) - Implicit functions - Jacobian - inverse functions.

UNIT 4: EXTREMES OF FUNCTIONS OF SEVERAL VARIABLES. Maximum and minimum of functions of several variables: Absolute extremes and relative extremes - Critical points - Conditions for the existence of relative extremes: Necessary condition when partial derivatives exist - Sufficient condition. Linked ends - Lagrange multipliers.

UNIT 5: FUNCTIONAL INTEGRALS OF VARIOUS VARIABLES. Parametric integrals. Rule of Leibnitz- Double and triple integrals - Variable change - Multiple integrals applications: area of a flat region, volume of a solid.

UNIT 6: CURVILIUM INTEGRALS. Curvilinear integrals- Curvilinear integrals of real functions and vector fields Applications of curvilinear integrals: curve arc length, mass of a wire, work of a force.-Gauss-Green Theorem. Necessary and sufficient condition so that a curvilinear integral does not depend on c. Of int.

UNIT 7: SURFACE INTEGRALS. Surface integrals of real functions and vector fields. Applications of surface integrals: curved surface area, mass of a sheet, flow of a vector field. Theorems of Gauss-Ostrogradski and Stokes

12) TECHNICAL MECHANICS I

OBJECTIVE: Introduce the fundamental concepts of the mechanics of the rigid body in its state of static equilibrium, which serve as the basis for the analysis and design of structural and mechanical devices

CONTENTS

UNIT 1. GENERAL PRINCIPLES: Notions of Mechanics. Definitions and fundamental concepts. Units of measurement. Force. Concept and characteristics. Scalar and vectors. Vector operations with forces. Different types of Forces Systems. Composition and decomposition of forces. Analytically and graphically.

UNIT 2. EQUILIBRIUM OF A PARTICLE: (Forces concurrent in the plane and space). Equilibrium of a particle. Principles of mechanics (rigid body). Balance, graphical and analytical conditions that govern it. Free-Body diagram. Scalar and Cartesian vector notation. Method of projections. Analytical and graphical determination of the resultant of forces. Polygon of forces. Equilibrium, analytical conditions that govern the equilibrium of a system of concurrent forces in the plane and in space. Equations (scalar and Cartesian vector). Static moment of a force with respect to a point and an axis. Theorem of Varignon (Principle of the Moments). Torque. Properties. Simple structures and mechanisms. (Pulleys, Pulleys).

UNIT 3. BALANCE OF A RIGID BODY: (General case of forces in the plane and space). Types of bonds of rigid bodies in the plane and space. Characteristics and reactions of supports. Free-body diagrams. Plates. Degrees of freedom. General case of forces in the plane and space. Resultant force. Resultant torque. Equivalent systems. Analysis of previous cases. Balance. Analytical conditions governing the balance of a general system of forces in the plane and in space. Equations of equilibrium (scalar and Cartesian vector). Funicular polygon. Properties. Open and closed funicular polygons. Graphic conditions governing the equilibrium of a general system of forces in the plane. Structures and composite mechanisms

UNIT 4. RETICULADOS PLANS: Definition and types of lattices. Simple lattices. Your generation. Stiffness or non-deformability conditions of a simple lattice. Calculation of stresses in the bars. Method of knots and sections (analytical and graphical).

UNIT 5. FRICTION: Features. Types of resistance by friction. Theory of the dry friction (Coulomb): coefficient of friction, angle and cone of friction. Imminent movement. Balance. Types of friction problems. Slipping and overturning. Friction in machines: Wedges. Brakes. Screws. Bearings. Friction on bands. Rolling resistance

UNIT 6. FLUID PRESSURE: (Hydrostatic). Forces distributed in the plane. Intensity.

Charge diagram. Different types of load diagrams. Magnitude and location of the resulting force. Concept of pressure. Principle of Pascal. Fundamental principle of hydrostatics. Push. Archimedes' principle. Drawing of pressure diagrams. Hydrostatic pressure on submerged surfaces, flat plate and curved plate of constant width, flat plate of variable width. Types of problems.

UNIT 7. CENTER OF GRAVITY: Definitions. Center of gravity, center of mass and centroid of a body. Centroids of lines, surfaces and volumes. Figures and composite bodies. Theorems of Pappus Guldin. Types of problems.

UNIT 8. INERTIA MOMENTS: Definition of moment of inertia for areas, moment of inertia polar and product of inertia. Turn radius of an area. Moments of inertia of common plane figures. Use of tables. Theorem of Steiner (Theorem of the parallel axes). Moments of inertia of composite areas. Rotation of axes, main axes of inertia, Mohr circle of inertia.

13) MACHINE DRAWING

OBJECTIVE: Know and represent parts and machine parts. Elaborate and represent machines. Study and apply standards.

CONTENTS

UNIT 1: Definition of views - ISO method (E). Fundamental trihedral, sight, fundamental view, main and auxiliary views, correct location of the piece. According to Norms IRAM 4501.

UNIT 2: Basic standards in technical drawing, breaking lines, cuts and cut surfaces, partial and complete cuts. Nerve, arm and axle cuts. Saving views. According to Norms IRAM 4502 and 4507.

UNIT 3: Representations, schematic representations and conventional signs of threads, screws and Roblones. According to Norms IRAM 4520.

UNIT 4: Representations, schematic representations and conventional signs of Springs and Keys. According to Norms IRAM 4523 and 4535.

UNIT 5: Representations, schematic representations and conventional welding signs. According to Norms IRAM 4536.

UNIT 6: Representations, schematic representations and conventional signs of toothed Wheels and Transmissions. According to Norms IRAM 4522.

UNIT 7: Writing of dimensions: elements, fundamental principles and generalities. Applications in bodies with straight edges, holes, etc. Dimensions according to how the piece is worked. According to Norms IRAM 4513.

UNIT 8: Signs of surface termination, written indications, standards. Characteristic examples. According to Norms IRAM 4517.

UNIT 9: Geometric, position and shape tolerances. According to Norma IRAM 4515.

UNIT 10: Lifting of sketches and schemes of mechanisms in workshop or with mechanical models. Exploded and labelled. According to Norms IRAM.

UNIT 11: Reproduction of manufacturing drawings. Standard formats, folded for files. According to Norms IRAM 4504.

The practical work program will consist of 35 to 40 sheets A3 format made by hands, on application of IRAM standards. There will also be 6 sheets in A1, A2, A3 and A4 format, made in pencil, of mechanical elements and mechanisms such as: gears, valves, bearings, visors, vise tip, telescopes, speed reducer, etc. Two of the previous sheets will be made in the form of manufacturing drawings with the corresponding splints.

14) CALCULUS IV

OBJECTIVES: Interpret and solve dynamic mathematical models involving systems of linear differential equations. Represent functions through functional series.

CONTENTS

UNIT 1: ORDINARY DIFFERENTIAL EQUATIONS. General theory of linear differential equations: Linear differential operators. Linear differential equations. Equations of 1st order. Existence and uniqueness of the solutions. Initial value problem. Dimension of the solution space. The Wronskian. Abel's formula.

UNIT 2: ORDINARY DIFFERENTIAL EQUATIONS OF FIRST ORDER. Equations in separable variables. Equations with homogeneous coefficients. Equations reducible to equations with homogeneous coefficients. Exact equations. Reducible to exact equations. Numerical methods for 1st order ordinary differential equations.

UNIT 3: LINEAR DIFFERENTIAL EQUATIONS WITH CONSTANT COEFFICIENTS. Introduction. Homogeneous equations of 2nd order. Homogeneous equations of arbitrary order. Non-homogeneous equations. Method of variation of the parameters. Reduction of order. Method of indeterminate coefficients. Linear differential equations with variable coefficients that can be taken to linear differential equations with constant coefficients.

UNIT 4: LINEAR DIFFERENTIAL EQUATIONS SYSTEMS. General concepts. Systems of first order. Linear systems of first order. Values method for homogeneous linear systems. Method of indeterminate coefficients. Fundamental Matrices. Method of variation of the parameters. Numerical methods for systems of ordinary differential equations.

UNIT 5: FOURIER SERIES. Sequences and series of functions. Point convergence. Uniform convergence. Fourier series. Fundamental trigonometric series. Symmetry and mid-range development. Functions of arbitrary period.

UNIT 6: PARTIAL DIFFERENTIAL EQUATIONS. Introduction. Definitions. Classification. Contour problems. Linear partial differential equations in two independent variables. Partial differential equations of 2nd order. Linearity and overlap. Linear problems, properties. Method of separation of variables. Homogeneous Laplace equation in a rectangle, one-dimensional homogeneous wave equation and one-dimensional homogeneous heat equation. Homogeneous Laplace equation in a circle. . Numerical methods for differential equations in partial derivatives.

15) PROBABILITY AND STATISTICS

OBJECTIVES: 1. Extract and synthesize information from a data set. 2. Apprehend the concepts of randomness and probability. 3. Study the most important models of probability distribution. 4. Model processes and situations through a conceptual structure. 5. Identify the appropriate model for different situations. 6. Apply the methods of Statistics to the study of problems such as: calculation and propagation of errors, comparison of treatments or processes, process control, estimation of relations between variables.

CONTENTS

UNIT 1: DESCRIPTIVE STATISTICS. Types of variables. Diagram of points. Bar chart. Histograms. Rounding. Measures of position and dispersion. Coefficient of variation. Inequality of Tchebychev. Exploratory analysis of data. Bivariate frequency distributions. Marginal frequency distributions.

UNIT 2: CONCEPT OF PROBABILITY. Random experiment. Relative frequency of an event. Probability as a limit of the relative frequency. Mathematical model of a random experiment. Properties of probability. Conditional Probability. Product rule. Examples. Independent events. Examples.

UNIT 3: PROBABILITY DISTRIBUTION MODELS. Random variables. Discrete variables. Continuous variables. Distribution function. Transformation of a continuous random variable. Mathematical hope. Properties. Hope for a random variable function. Variance. Properties. Coefficient of variation. Quotation of Tchebychev. Mechanical interpretation of mean and variance. Mean and approximate variance of a random variable function.

UNIT 4: RANDOM VARIABLES WITH OWN NAMES. Bernoulli tests. Distribution of Bernoulli. Binomial distribution. Geometric distribution. The Poisson Process (= homogeneous chaos). Distribution of Poisson as Binomial Distribution Limit. Exponential Distribution. Normal distribution. Relationship between these distributions.

UNIT 5: DISTRIBUTION OF FUNCTIONS OF RANDOM VARIABLES. Joint distribution of variables. Marginal distributions. Example. Independent random variables. Hope for sums and products. Covariance. Correlation. Variance of sums. Approximate expectation and variance of functions of several variables. Theorem of Linear Combinations. Central Limit Theorem. Applications to the estimation of errors.

UNIT 6: INTRODUCTION TO STATISTICAL INFERENCE. Objective of statistical inference. Independent replicates of a random experiment. The Monte Carlo method to simulate replicates of a random variable. Identification of the model.

UNIT 7: ESTIMATION. Point estimate. Methods of moments. Distribution of x. Estimation of s2, s and the signal-to-noise ratio. Estimation by intervals. Confidence interval for the mean, for the mean difference. Approximate range for ratio.

UNIT 8: PROOFS OF HYPOTHESIS. Introduction. Types of hypotheses. Definition. Methodology. Types of errors. Test for a population: mean and proportion. Test for two populations: difference of means, independent samples with equal variances; Difference of means, paired dependent samples, difference of proportions.

UNIT 9: SIMPLE LINEAR REGRESSION. The simple linear regression model. Hypothesis. Estimate. Least Squares Method. Goodness of the model. Validity of the model. More complex models: polynomials and others. Identification of the appropriate model. Examples.

UNIT 10: QUALITY CONTROL. Introduction. Process under control. Tolerance intervals. Capacity of a process. Estimation of capacity. Capacity index. Interpretation Graphs of means and deviations. Control charts. Interpretation.

UNIT 11.- INTRODUCTION TO EXPERIMENT DESIGN. Introduction. Analysis of variance. Contrast of equal means. Multiple comparisons. Introduction to the design of experiments.

16) STABILITY I

OBJECTIVES: · Identify and analyse the behaviour of basic isostatic structural typologies, such as rigid bodies in equilibrium in the plane and in space. · Define and assess static loads acting on structures. · Determine the different loads caused by loads on isostatic structures, identifying the most requested sections. · Evaluate the incidence of mobile loads on isostatic structures, and determine the maximum possible stresses for different combinations of loads.

CONTENTS

UNIT 1. INTRODUCTION. Definition of Structure. Structural Engineering. The Structural Design Process. Structural analysis. Structural Forms. Simplifications for Analysis. Actions on Structures. Classification of loads. Most Common Structural Materials: Concrete, Steel and Wood.

UNIT 2. BALANCE OF EXTERNAL FORCES ON MULTI-PIECE FLAT STRUCTURES. Static Determination and Stability. Calculation of Reactions using the Equilibrium Equations. Principle of Overlap of Forces. Equations of Condition. Displacements. Work. Principle of Virtual Displacements. Calculation of reactions by Virtual Methods.

UNIT 3. RETICULATED PLANS. Idealization of the lattices. Generation and classification of lattices. Identification of Knots and Notation of efforts in the Bars. Convention of Signs and Representation of Efforts in the Bars. Crosslink Analysis. Methods of knots and sections. Determination of Internal Efforts by Application of the Principle of Virtual Jobs. Static Determination and Stability of Flat Lattices.

UNIT 4. BEAMS. PORTICOS. ARCOS. Beams and Porches. Internal Efforts in Elements Undergoing Flexion. Notation and Convention of Signs. Determination of Internal Efforts. Relationship between Load, Cut and Flector Moment. Cutting Diagrams, Normal and Flexor Moment. Detailed construction of Diagrams Q, N and M. Static Determination of Beams and Porches. Curved Shaft Structures. Articulated Triarticulated and Artirantados. Detailed Construction of Diagrams M, Q and N.

UNIT 5. SPACE STRUCTURES. Equilibrium Requirements. Specification of a Force. Conditions of Support. Types of links. Reaction forces. Static External Determination and Stability. Calculation of Reactions using Equilibrium Equations. Structures of Beams and Space Porches. Section Efforts. Torsor Moment. Notation of Efforts in the Bars and Convention of Signs.

UNIT 6. MOBILE UPLOADS. Justification of the Study of the Structural Response under Mobile Loads. Variations of the Response Function with the Position of the Load. Lines of Influence by Consideration of Equilibrium. Lines of Influence for Virtual Jobs. Principle of Muller-Breslau. Use of Influence Lines. Maximum Beam Response Functions. Concept of Maximum Effort Envelope.

17) TECHNICAL MECHANICS II

OBJECTIVE: Contextualize in the field of Mechanical Engineering, contents of Basic Physics.

CONTENTS

UNIT 1: INTRODUCTION: Subdivision of mechanics, magnitudes, vector calculus.

UNIT 2: KINEMATIC: Trajectory, speed, acceleration, holograph, equations of motion in Cartesian coordinates.

UNIT 3: STRAIGHT MOVEMENT OF A POINT: Uniform, uniformly accelerated, with acceleration as a function of the road, with acceleration as a function of trajectory and time, freefall from high altitude, acceleration as a function of speed, movement with resistance.

UNIT 4: CURVILINEAR MOVEMENT: In coordinates, Cartesian, oblique shot without resistance, natural decomposition of acceleration, circular movement, speed and angular acceleration, inclined shot with

resistance. Speed and acceleration in polar coordinates. Areolar speed, central movement.

UNIT 5: FORCED MOVEMENT: Influence of the trajectory as a guide on the movement, without friction and with friction, movement on any curve in the gravitational field.

UNIT 6: PLANE MOTION: state disk speed, momentary pole plane speed. State of acceleration of a disk, plane of accelerations. Acceleration pole, analytical study of the

movement. The mechanism crank - crank, movement by cams.

UNIT 7. COMPOSITION OF SEVERAL MOVEMENTS. Composition of translations, rotations composition, two turns, composition translation and rotation, planetary gears.

UNIT 8. ROTARY MOVEMENT. Absolute, relative and system velocities, translation movements, rotations movements, Coriolis acceleration, forced relative movement without and with friction.

UNIT 9. BASIC CONCEPTS OF DYNAMICS: Work, power, dynamic energy for translation and rotation, moments of inertia, ellipsoid of inertia.

UNIT 10. PRINCIPLE D'ALAMBERT. Deduction for movement without and with friction, for rotation, for compound movements, law of motion of the gravity centre, substitution of a mass for 2 or 3 material points, movement around a fixed point, fixed pendulum. Free rotation axes of a body.

UNIT 11. THE ENERGY INTEGRAL. For free, guided, without and with friction systems, energy conversion principle.

UNIT 12. THE DRIVE. Deduction of the law for translation and for rotation, moment of the drive

UNIT 13. THE LAW OF CONSERVATION OF MOVEMENT OF THE GRAVITY CENTER. General deduction, application to a mass system, conservation of momentum.

UNIT 14. SHOCK: straight central shock, plastic shock, shock coefficient, energy loss in elastic collisions, collision free.

UNIT 15. SWINGS MATERIAL POINT: Free damped and forced, with and without buffer.

18) COMPUTER AIDED DESIGN

OBJECTIVE: Systematize the process of graphing using the computer. Acquire knowledge and practice in the use of computer-aided design programs.

CONTENTS

UNIT 1.-BASIC CONCEPTS of drawing in AutoCad. Commands.

UNIT 2.-CREATION OF A DRAWING: Objects or Entities: Definition. Aids to drawing. Grid, Cursor Forcing, Orthogonal Selection Modes: Direct, Cyclic, Window, Capture, Polygon Window, Capture Polygon, Border, Previous, Last, All, Delete. Orders: Circle, Rectangle, Arc, Explode

UNIT 3.-INTRODUCTION OF POINTS: Use of rectangular and polar coordinate systems. Absolute and Relative Coordinates. Spherical and cylindrical coordinates. Direct distance input. Reference to the last point. Display of the

coordinates of the current cursor position: Dynamic, Static, Polar Relative. Reference to geometric points of objects: Selection of the Modes of Object references. Different Reference Mode options.

Use object reference for a single point and reference definition of implicit objects. Description and modification of object reference parameters.

UNIT 4.-CONTROL OF THE DRAWING SCREEN: Zoom. Options: Expansion factor relative to the original size of the drawing, magnification factor relative to the current display, All, Window, Preview, Extension, Dynamic, Magnify, Reduce, Center, Real-time. Frame. Options: In Real Time, Point, Right, etc. Using saved views. Storing saved views and recovering them. Orders: 2D Solid, Washer, Splice, Chamfer.

UNIT 5.-DRAWING IN LAYERS: Layers. Concepts. Creation and denomination of the layers. Color assignment, line type, line thickness, and stroke style to a layer. Creating simple lines. Enable and disable layers. Deprecating and reusing layers. Lock and unlock layers. Enabling and Disabling a Layer Printing Renaming and Deleting Layers. Converting a layer to the current one. Converting the layer of an object to the current one. Orders: Symmetry, Scale, Rotate, Extend, Trim

UNIT 6-.POLILINES AND MULTIPLE LINES: Polylines. General considerations, thickness, arc, close, length, etc. Edit polylines (Editpol): close, open, join, adapt curve etc. Multiline. How to create a style: Properties of the elements and the multiline. Draw multiline. Options: Justify, Scale, Style.

UNIT 7.-TEXTS: Creation of text styles. Modification of text style. Text on a line.

UNIT 8.-BLOCKS: Definition of Blocks. Different options. Base Point. Inserting a block. Insertion Point. Scales. Negative scales. Wblok rotation. Different options Insert any drawing file as a Block. Order Base.

Modification of a Block. Attributes: Definition of attributes. Modes: invisible, constant, check, preset. Insertion points. Modification of attributes.

UNIT 9.-PRINTING OR DRAWING OF A DRAWING. Setting up a printer. Configuring a layout style table Tracing. Description of "Trace Device" and "Print Parameters" Tabs. Orders: Matrix, stretch.

UNIT 10.-TABLETS: Creation of contours. Quick tab. Type of patterns. Angles. Scales. Intervals. Advanced tab: Island detection style, contours, contour set, island detection mode. Designation by point or by object. Delete islands. See selections. Inherit properties. Associative and non-associative.

UNIT 11.-CREATION OF A PRESENTATION: Use of Model Space and Paper Space. Creation of floating graphic windows. Switching between paper space and model space. Adjusting the display scale in windows. Lock a window.

UNIT 12.-ACKNOWLEDGMENTS: Basic notation on dimensions according to DIN and IRAM. How to create a Dimension Style. Chips: Lines and Extremes, Texts; Adjust, Main Units, Alternative Units, Tolerances. Dimensions: Linear, Aligned, Angled, Diameters, with Base Line, continued, Centre Mark, Coordinates, Tolerance. Modification of dimensions. Associative Quotas. Dimensions and Modelling in Paper Space. Adaptation of geometry and dimensioning scales in paper space.

UNIT 13.-WORK IN THE THREE-DIMENSIONAL SPACE: Introduction. Elevation and Height. Options for 3D visualization. Line Hiding Order 3D Face. Definition of a personal coordinate system. Options: 3 points, Origin, Rotation in X, Y, Z, Object, Vector Z, Universal, Face, View, Scroll, Previous. Saving of system of Coordinates Personal Creation of Solids. Predefined and Extructed Solids.

UNIT 14.-COMPOUND SOLIDS: Boolean Operations: Joining, Substrating, Intersection Creation of a Solid with Notch. Cut a solid. Creation of Solids by Revolution. Modeling of bodies with flat and round faces. Modelling of machine parts. Obtaining the different Orthogonal, Auxiliary, Section views and the dimmetric perspective, creating profiles using the "Solprof" command.

19) STABILITY II

OBJECTIVE: To study the resistance of solid materials under the different types of stresses to which they are subjected as structural elements. Provide a solid basis for the analysis of different structural elements.

CONTENTS

UNIT 1. EFFORT: Concept of effort. Equilibration of a deformable solid. Average normal effort. Examples. Axially loaded bar. Average shear stress. Examples. Permissible effort. Design of simple connections.

UNIT 2. DEFORMATION: Displacement in a deformable solid. Unitary deformation. Small deformations. Angular deformation.

UNIT 3. MECHANICAL PROPERTIES: Tensile and compression tests. Effort - unit strain diagram. Behavior strain deformation. Ductile and fragile materials. Hooke's Law. Deformation energy. Reason for Poisson. Shear diagram - angular deformation. Material Fault.

UNIT 4. AXIAL LOAD: Beginning of Saint Venant. Elastic deformation of an axially loaded element. Principle of overlap. Axially charged element statically indeterminate. Force method for the resolution of hyperstatic problems. Thermal stress. Concentration of efforts. Inelastic axial deformation. Residual stress.

UNIT 5. TORSION: Torsion deformation in circular bars. Torsion in full sections. Power transmission. Torsion angle. Statically indeterminate problems loaded with torsional pairs. Torsion in non-circular sections. Torsion in thin walled hollow bars (closed). Concentration of efforts. Inelastic torsion.

UNIT 6. FLEXION: Straight bending. Bending deformation. Asymmetric flexion. Composite beams. Reinforced concrete beams. Concentration of efforts. Inelastic Flexion. Loads of collapse. Residual effects.

UNIT 7. CROSS SHEARING EFFORT: Cutting forces on straight elements. Expression of Colignon. Shear flow in composite elements. Shear flow in thin wall sections. Cutting centre.

UNIT 8. GENERAL STATE OF TENSIONS: Efforts in a solid. Actions on a solid. Vector tension. Components of the voltage vector. Tension tensioner. Symmetry. Vector of tension in any plane. Transformation of the tensioner by turning the reference system. Main state of stress. Mohr's circle of tensions.

UNIT 9. GENERAL STATE OF DEFORMATIONS: Displacements in a solid. Deformations. Angular strain. Tensor of deformations. Interpretation. Transformations of the tensor by rotating the reference system. Main state of deformations. Mohr's circle of deformations.

UNIT 10. THEORIES OF BREAKAGE: Criteria of rupture. Criterion of Rankine. Guest Criteria. Specific work of deformation. Specific work of distortion. Criterion of Beltrami. Huber's Criterion - Mises - Henky.

UNIT 11. COMBINED LOADS: Thin wall containers under pressure. State of tensions under the combined actions. Flexotorsión, Flexocompresión. Flexotracción.

UNIT 12. FLEXION DEFORMATIONS AND ENERGETIC METHODS: Elastic. Slope of the elastic curve. Integration of the differential equation. Functions ofdiscontinuity. Displacement and slope of the curve by the moment area method. Superposition method. Arrows of statically indeterminate beams.

UNIT 13. DESIGN OF SYSTEMS: Design criteria. Bases for the design of beams. Efforts on a beam. Design of a prismatic beam. Limitations on travel.

UNIT 14 PANDEO: Critical load. Biarticulated column. Different conditions of support. Determination of the critical load. Design of columns.

20) FLUID MECHANICS

OBJECTIVE: To know, interpret and apply the laws of Mechanics that govern the state of rest or movement of fluids, for a later domination and exploitation of the interaction between them and their limits.

CONTENTS

UNIT 1. Foundations, definitions, postulates and laws of Mechanics. Concept of fluid. Physical properties of real fluids: density, specific volume, volumetric compressibility and viscosity. State equation for gases. Definitions of ideal fluid and perfect gas. The Laws of Mechanics. Concepts of continuous fluid, material point, fluid particle, body or system, volume and control surface. Impenetrability, non-slip and thermal compatibility in limits. Magnitudes, dimensions and units. Systems of units.

UNIT 2. Forces, efforts and tensions. Concepts of viscosity and pressure. Types of forces. Definitions of stress and tension. The tensor of tensions. Concepts of Symmetry and diagoanalization of tensor magnitudes. Invariance. Axes and main directions. Symmetry of the tensor of tensions. Pressure at one point. Hydrostatic pressure: principle of

isotropy or Pascal. Newton and Stokes laws of viscosity. Newtonian and non-Newtonian fluids. Brief introduction to Rheology. Other physical properties of real fluids: vapor pressure and surface tension.

UNIT 3. Hydrostatics and relative balance. Fundamental equation of hydrostatics. Equation of Torricelli. Hydrostatic paradox. Pressure measurement: manometer, piezometers, barometers. Absolute and relative pressure. Pressure units. Laminated fluids. Pressure forces on flat and curved open surfaces. Center of pressure. Pressure forces on submerged bodies: Principle of Archimedes. Center of thrust. Balance and stability of submerged and floating bodies. Metacentric and metacentric height. Relative equilibrium: liquids subjected to constant accelerations. Principle of D'Alembert. Linear accelerated and rotating (centrifugal) vessels: pressure and free-level equations.

UNIT 4. Hydrokinematics: The motion of the fluid particle: vectors position, velocity and acceleration. Description of fluid movement: Lagrange and Euler criteria. Reference systems. Trajectory and current lines. Power lines and flow tubes. Concepts of material or substantial derivatives, local and convective (advective). Definition of flow. Flow types: uniform, stationary, variable. Linear and angular deformations, dilation, translation and rotation of the fluid particle. Concepts of divergence, rotor and velocity gradients. Theorems of Gauss and Stokes. Concept of circulation. Compressible and incompressible, rotational and irrotational flows, viscous and non-viscous. One-dimensional, two-dimensional and three-dimensional flows.

UNIT 5. Hydrodynamics: Leibnitz's theorem applied to conservation laws. Principle of conservation of mass. Differential and integral equations. Continuity equation. Origin of forces on fluids. Dynamic (Darcy) equilibrium equation. Constitutive and Navier-Stokes equations. Stationary, incompressible and non-viscous flows: Equations of Euler and Bernoulli. Restrictions and fields of application. Flow or flow measurements: Pitot, Prandtl and Venturi. Integration of the Navier-Stokes equation for particular cases. Equation of Hagen-Poiseuille. Experiences of Reynolds and Hagen. Viscous laminar and turbulent flows. Speed profile. Concept of average speed and correction factors. Correction of the Bernoulli equation for losses in viscous flows. Generalization of the Bernoulli equation. The speed of sound, Mach number and incompressibility criteria.

UNIT 6. Laws of similarity and dimensional homogeneity: The principle of dimensional homogeneity. Bukingham's Theorem. Dimensional groups: utility and techniques of dimensionlessness. Dimensional matrix. Laws of dynamic and geometric resemblance. Brief introduction to model theory. Testing and experimentation in aerodynamic tunnels. Useful numerical numbers in Fluid Mechanics and others of frequent or generalized use. Limitations, compatibility and usage criteria.

UNIT 7. Internal flows (in ducts and pipes): The dimensional analysis applied to the flow of fluids in circular sections. Reynolds number. Concepts of boundary layer, input length and developed flows. Concepts of absolute and relative roughness and thickness of the boundary layer. The Moody diagram. Equation of Darcy-Weissbach. Losses in ducts, changes of section, of direction and in accessories. Coefficients of losses and equivalent lengths. Influences of corrosion and / or incrustations. Concepts of geodesic, piezometric and total heights: diagrams. Pumping power and useable in turbines. Flow through non-circular sections. Hydraulic diameter or equivalent. Equivalent pipes. Series, parallel, branched and pipeline network.

UNIT 8. Potential flows and flow networks: Irrotational flows and velocity potentials. Current function. The Laplace equation. Orthogonality of current and equipotential lines. Representation of the flow network. Incompressible, simple and compound potential flows. Sources, sinks, vortices, Doublets. Flow around a cylinder with and without circulation. Magnus effect and D'Alambert paradox. Correlation between potential theoretical flows and real viscous flows.

UNIT 9. External flows (around submerged bodies): Prandtl theory of boundary layer. Viscous uniform flow on a flat plate. Influence of pressure gradient. The phenomenon of separation or detachment of the boundary layer. Plane of flow and / or axialsimetric around cylinders, spheres and profiles. Formation of stelae. Aerodynamic forms: Kutta-Joukowski criterion. Theorem of Lord Kelvin or of the conservation of the circulation. Geometry of wing profiles and aerodynamic forces. Drag coefficients and drag or resistance. Polar diagram of aerodynamic profiles.

UNIT 10. Fluid-thermodynamics: Basic concepts on thermodynamics: state variables, processes. First Law of thermodynamics. Mechanical work on fluids. Internal, potential and kinetic energy. Mechanical energy equation. Viscous dissipation. Second principle of thermodynamics: entropy.

UNIT 11. Introduction to hydraulic machines: Principles of conservation of momentum and momentum of momentum. Forces on nozzles, curves, plates, pallets and / or blades and rotary members. Basic equation of hydraulic machines. Triangles of speeds. Applications in Pumps and turbines. Concept of cavitation.

21) GENERAL ELECTROTECHNICS AND LABORATORY

OBJECTIVES: Provide students with the basic aspects of electricity and magnetism, emphasizing both the conceptual understanding of phenomena and the solution of problems through analytical and quantitative calculation. Acquire experience to reasonably assume, formulate hypotheses, model and solve a problem. Achieve ability to obtain an analytical result and be able to see its scope and also its limitations. To train the student in the management of instruments and auxiliary devices starting from the principles of operation and limiting their scope in magnitudes and frequency with the values of expected accuracy. The student will incorporate the fundamental knowledge of Electrical Engineering and will know the basic principles of the generation of electric energy.

THEORETICAL PRACTICAL CLASSES: to develop theoretical aspects, solve some problems of application and the corresponding laboratory tests. This modality allows to approach the theory to its application.

CONTENTS

UNIT 1: Nature of electricity - Electric conductors - Amount of electricity - Current intensity - Current classes - Electrical voltages - Ohm law - Resistance and conductance - Units - Serial connection - Parallel connection - First and second law of Kirchoff - Electrical work - Electric power - Thermoelectricity - Electric current in electrolytes - Laws of Faraday - Batteries or accumulator elements.

UNIT 2: Magnetic Fields - Fundamental Phenomena - Magnitudes - Induction and Magnetic Flow - Immanence Curve - Magnetic Hysteresis - Magnetic Field Actions - Dynamic and Static Electromotive Force - Electromagnetic Induction Law - Autoinduction - Mutual Induction - Magnetic Field Energy - Resolution of magnetic circuits.

UNIT 3: AC circuits - F.e.m. - F.e.m. Senoidal - Cartesian and vector diagrams - Composition of sine waves - Arithmetical and quadratic mean value - Efficiency - Electric field - Density - Intensity - Capacity - Displacement - Dielectric constant - Coulomb law - Condensers - Capacity calculation - Serial and parallel connection - Receivers in alternating current circuits - Connections with: pure ohmic resistance, inductive reactance and capacitive reactance - Combination of connected elements in series and parallel - AC power - Active, reactive and apparent power - Power factor - Resonant circuits - Coupled circuits - Locations - Calculation methods with complex numbers - Impedance and Complex admittance - Complex power.

UNIT 4: Current circuits, three-phase alternation - Three-phase voltage production - Star connection - Triangle connection - Voltage and current diagram - Power in three-phase systems - Power calculation in balanced and unbalanced systems - Measurement methods.

UNIT 5: Methods of Resolution of Circuits - Meshes - Nodes - Overlap - Compensation - Maximum transfer of energy - Reciprocity - Thevenin Northon.

UNIT 6: Electrical Measurements - Overview of Measuring Instruments - Classification of Instruments - Voltage and current measurements - Use of multipliers and scope - Measurement of active, reactive and apparent powers - Measurement of resistances, reactances and capacitances.

LABORATORY:

1- Ammeter and Voltmeter Contrast
2- Vatmeter Contrast
3- Three Phase Power Measurement

22) MATERIALS TESTING

OBJECTIVES: To acquire the necessary knowledge to understand the process of deformation and rupture and of the metals under the action of different requests, conditions of time and temperature and to evaluate by means of standard laboratory tests the associated mechanical properties. Study the plastic materials, their physical and mechanical properties and applications in the field of Mechanical Engineering.

CONTENTS

UNIT 1.- Metals. Importance in mechanical constructions - Knowledge and Use - Crystalline state of metals - Concept of liquid and solid state - Amorphous state - Crystalline state - Isotropy - Anisotropy. Notions of crystallography - Constitution and structure of metals - Metal crystals - Special networks, cubic and hexagonal systems -

Crystallographic planes - Crystallographic directions - Miller-Brevais indexes - Compact structures. Crystalline defects: punctual, linear and superficial.

UNIT 2.- Study of the metallic materials - Knowledge of its mechanical properties General - Action of a load on a metal - Elastic and plastic deformation - Classification of the mechanical properties: strength, deformation, tenacity. Process of deformation and rupture. Elastic limit - Proportionality limit - Plastic deformation - Elasticity - Hooke's law - Rheology - Fluency - Acritude - Deformation work - Diagrams: nominal, real, Stead - Fundamental diagrams according to the properties of the metals: ductile, semiductile and fragile

UNIT 3.- Deformation of a monocrystal - Mechanism of elastic and plastic deformation - Sliding line - Plans and directions of easier slip - Critical shear - Deformation theories, imperfections in the crystals, deformation by means of mortar, theory of amorphism and theory Of dislocations - Origin and properties of dislocations in the cubic system and application of the theory of dislocations - Breaking of fragile and ductile mono crystals - Resistance to cohesion and deformation

UNIT 4.- Mechanical behavior of metals - General information on static tensile testing of ferrous and non-ferrous materials - Test standards - Type of specimens - Determinations - Modulus of elasticity E - Resistance to deformation and rupture - Mohr circle. Diagrams - Specific elongation - Stricture - Mechanical hardening by tensile and torsion - Types of fragile and ductile fractures. Slotting effect on static tensile stress. Sensitivity to notch - Influence of depth and notch angle on ductile and brittle metals - States of tensions and deformations - Resistance of technical cohesion. Diagram. Torsion application of metallic materials - Critical shear - Mohr circle. Diagrams - Fragile and ductile fractures - Transverse elastic modulus G - Testing - Determinations.

UNIT 5.- Hardness in metals - Definition - Methods of testing for determination: Brinell, Rockwell, Vickers, Shore - Penetrators - Hardness measurement - Range of application of different methods. Advantages and disadvantages - Testing Standards

UNIT 6.- Dynamic impact tests - Dynamic flexion - Resilience - Tests - Methods - Test conditions - Fracture.

UNIT 7.- Fatigue in metallic materials - Fatigue process - Fatigue requests - Tests - Fatigue resistance - Variation of fatigue limit according to the type of variable solicitation - Wholer, Goodman and Smith diagram - Fatigue limit according to nature Of stresses - Relationship between fatigue limit of steels and their other properties - Factors influencing the fatigue limit - Mechanical factors. About fatigue and sub-fatigue. Nature of stresses - Stresses - Periods of rest - Geometric factors - Metallurgical factors.

UNIT 8.- Long-term static tests - Hot traction - Tensile strength and hot extension limit - Effect of time and temperature on the deformation process - Constant loading runoff processes - Creep or creep.

UNIT 9.- Knowledge of the properties of metals Non-destructive tests - Methods of magnetic particles, penetrating liquids, industrial radiography, electromagnetic technique, vibration resonance technique and ultrasound

UNIT 10.- Plastic materials - General - Classification thermoplastic and thermostable - Plastic materials of greater application in mechanical constructions - Mechanical, thermal, electrical, acoustic properties, etc. - Graphic Essays

23) KNOWLEDGE OF MATERIALS

OBJECTIVES: Know and control the properties of metals and alloys, as well as other materials used in the activity of the mechanical engineer: ceramics, plastics.

CONTENTS

UNIT1. FOUNDATIONS. Types of materials. Relationship structure - properties - processing, Atomic Structure. Atomic bonds in solids. . Structure of solids Crystalline Cell unit; Polymorphism and; allotropy. Non-crystalline solids. Crystalline defects. Impurities in solids. Punctual imperfections: a) thermal production of point defects; And b) mass transfer mechanisms. Stationary and non-stationary diffusion.

UNIT 2. METALS.

1- Ferrous Metals. Production of pig iron and sponge iron. Production of steel. Casting of steel, ingot defects.
2- Solidification of pure metals and alloys. Phase diagrams. Phases. Solid solutions. Compounds. Solubility limit. Microstructure. Phase Equilibrium. Binary equilibrium diagrams: a) isomorphic systems; B) eutectic systems; C)

systems with intermediate phases; And d) systems with eutectoid and peritectic reactions. Applications: Fe - CFe3 diagram; Fe - C diagram

3- Iron and its alloys. Carbon steel and alloy. Classification. Application.

1. Mechanical properties. Standardization.

4- Heat treatment of ferrous alloys: a) annealing; B) normalized; C) temper; D) tempering; Phase transformations in metals. Kinetics of reactions in solid state. Changes in the microstructure and in the properties of the iron - carbon alloys: I) isothermal transformation diagrams; And II) transformation diagram by continuous cooling e) treatment of Surface hardening and thermochemical. Temperament.

2. 5 - Iron foundries. Classification. Microstructure. Properties. Standardization. Foundations of the development of iron foundries. Manufacture of castings.

5- Mechanical metalworking: a) forging; B) lamination; C) extrusion; And d) stretching of wire and bars.

6- Processing of metallic powders (powder metallurgy).

7- Non-ferrous metals: a) Copper and its alloys; And b) aluminum and its alloys. Hardening. Properties. Classification according to standards

UNIT 3. CERAMICS

1. Introduction. Classification of ceramics. Applications.

1- 2- Ceramics formed by silicates. Imperfections. Ceramic phase diagrams. Properties of ceramics.

2- Processing of products of clays: a) raw materials; B) manufacturing techniques; And c) drying and baking.

3- Processing of advanced ceramic products and cermets: a) preparation of materials; B) formed; C) sintered; And d) finished.

4- Glass processing. Preparation and fusion of the raw material. Conformation of glass products. Heat treatment and finishing. Vitreous ceramics

UNIT 4. POLYMERS

1. Introduction. Polymeric molecule. Weight, shape, structure and molecular configuration. Copolymers. Crystallinity of polymers.
2. Thermomechanical characteristics of the polymers. Thermoplastic and thermoset polymers. Other mechanical characteristics.
3. Conformation of the polymers. Extrusion. Production of films and films. Production of filaments and fibers. Coating processes. Injection molding. Compression and transfer molding. Blowing and rotational molding. Casting of plastics. Processing and forming of foams. Plastics reinforced with fiberglass.

LABORATORY: There are also five laboratory experiments in which the student is familiar with the use of heat treatment furnaces, metallographic microscope, durometer, micro durometer, Jominy test equipment and other complementary equipment of the Metallurgy and Foundry laboratory. The student produces a report of the activity developed that is also later evaluated.

24) THERMODYNAMICS

OBJECTIVE: At the end of the course the student will be able to interpret and apply the fundamental laws that govern the transformations of energy and its effects on matter, and the production of Heat and Work and their valuation in those processes that make them possible.

CONTENTS

UNIT 1. GENERALITIES. Thermodynamic system. Energies, potentials and resistances. Principles of thermodynamics and equilibrium. Matter. Thermodynamic state. Status change and status function. Status variables of pure substances, state surfaces, orthogonal state diagrams, dependent and independent variables, vapors titer.

UNIT 2. State equation, state changes and thermodynamic processes. Equation for: liquid, moist steam, superheated steam and ideal and real gases. Constant of the gases. Compressibility factor. Mixture of gases. Reversible and irreversible state changes.

UNIT 3. THE FIRST PRINCIPLE OF THERMODYNAMICS. Forms of energy. General equation for the control volume. Equation for open and closed systems. Methodology for solving problems in open, closed and cyclic processes.

UNIT 4. CALCULATION OF THE CALORIC VARIABLES. True specific and specific heat. Caloric equations and relation with specific heats. Specific heat of any transformation. Calculation of amount of heat by means of specific heats. Average specific heat. Heat of solids, liquids, ideal and real gases, and gas mixtures.

UNIT 5. ENTROPY and entropy diagrams. Function entropy and thermodynamic temperature. Entropy in reversible processes. Entropy balances. Absolute and reference entropy. Entropic diagrams, construction and method of use.

UNIT 6. REVERSIBLE STATE CHANGES IN PURE SUBSTANCES. Transformations. Changes in polytopic state in ideal gases. Calculation of work, heat and entropy variation in processes with ideal gases. Absolute and technical work, specific heat and heat. Entropy in the changes of state. Transformations in real gases. Changes of state in diagrams.

UNIT 7. EXERGY. Balance and equalization. Exergy and anergy. Exergy of systems in imbalance with the environment. Calculation of exergy of potential, kinetic, electrical, chemical and mechanical energy. Exergy of the heat. Factor of Carnot. Exergy of friction work.

UNIT 8. THE SECOND PRINCIPLE OF THERMODYNAMICS. Irreversibility. Relationship between generated entropy and lost exergy, internal and external irreversibility. Behavior of the entropy function, influence of the second principle. Calculation of entropy variation in irreversible processes. Evaluation of energy processes, yields and efficiencies.

UNIT 9. GAS COMPRESSION. Definition. Compression processes. Systems of compression, sorting. Reciprocating compressors. Multi-stage compression.

UNIT 10. HEAT TRANSMISSION. Mechanisms of transmission. Conductivity. Coefficient Of conductivity. Laplace differential parameter. Conductivity in flat wall and hollow cylinders and superposed layers, wall temperature. Convection. Coefficient of film. Transmission between fluids with varying temperatures. Circulation in the same sense, in different directions and with cross currents. Radiation. Fundamental concepts. Law of Stefan and Boltzman. Coefficient of total radiation. Emissive power. Intensity of radiation. Radiation of the black body and its coefficient. Law of Lambert. Emission ratio. Radiation heat exchange. Radiation through layers of air. Radiation of gases.

UNIT 11. REACTIVE PROCESSES. Definition. Studies necessary for the analysis of reactive processes. Complete and incomplete combustion. Balance sheets for the combustion of: solids, liquids and gases. Rule of 3T. Control by gas analysis. First principle for reactive processes. Enthalpy and internal energy training. Enthalpy and internal energy of reagents and products. Heat power. Exergy of fuels. Enthalpy of combustion gases. Diagram I - t. Second principle for reactive processes.

UNIT 12. ADIABATIC RUNOFF PROCESSES. General equation. Accelerated and decelerated run. Speed of sound. Run on pipes of constant and variable section. Fanno curves, sonic pressure. Shock wave. Rayleigh curve. Nozzles. Current function. Ideal gas flow. Nozzle spills with variable back pressure. Application in flow measurements.

UNIT 13. CYCLICAL PROCESSES. Thermal performance. Thermodynamic average temperatures. Feasibility of the Carnot cycle with vapors. Clausis cycle - Rankine in moist steam zone. Rankine cycle improvements due to steam overheating, intermediate reheating and regenerative preheating of feed water. Clausis cycle - irreversible Rankine. Cycle of Joule - Brayton. Regenerative preheating. Ericsson Cycle. Combined cycles. Alternate engine cycles. Inverse cycles. Coefficient of efficiency. Reversible and irreversible refrigerating machine. Absorption Cycles

25) INDUSTRIAL ELECTRONICS

OBJECTIVE: Manage methods and terminologies in electronic applications in industrial environments. Analyse and design electronic systems for general process control. Recognize and use basic electronic components. Introduction in the handling of the elements of last generation and principles of the industrial automatisms.

CONTENTS

UNIT 1-BASIC ELECTRONICS: Basic elements and laws: ideal generator of voltage, ideal generator of current. Ohm's law, Thevenin's theorem, Norton's theorem, superposition theorem. Cuadripolos. Examples and application exercises. Testing laboratory tests

UNIT 2- ELEMENTAL COMPONENTS: Diodes, definition of the ideal diode. Diode symbol. Functioning. Characteristic curves. Actual operating limitations. Basic circuits with diodes: Half-wave rectifier. Peak rectifier. Full-wave rectifier. Power supplies. Examples and application exercises. Testing tests in laboratory. Transistor: Symbol of the transistor.

Characteristic input and output curves. Work areas. The transistor as an amplifier. The transistor as a key. Testing in laboratory. Thyristors: Symbol. Characteristic curves. Functioning. Limitations. Testing tests in laboratory.

UNIT 3- BINARY ALGEBRA: Logical states. Positive logic. Negative logic. Logical gates: AND, symbol and table of truth, O, symbol and table of truth, NO-Y (NAND), symbol and table of truth, NO-O (NOR), symbol and table of truth, OR EXCLUSIVE (XOR), symbol and truth table. Investor. Implementation of each of the different logic gates using diodes and transistors. Practical check in the laboratory.

UNIT 4- INTEGRATED CIRCUITS: Operational Amplifier: Symbol and definition. Functioning. Basic configurations: Inverter amplifier. Non-inverting amplifier. Adder. Integrator, Differentiator. Digital integrated circuits. Analog / digital and digital / analog converter.

UNIT 5- INDUSTRIAL AUTOMATIONS: General diagram of an automation system. Basic elements involved in automatism. Man - machine relationship.

UNIT 6- DIGITAL SENSORS. Purposes of race. Inductive proximity switches, Capacitive proximity switches Photoelectric proximity switches. Ultrasonic proximity switches. Pressure switches and vacuum gauges Operation. Use and selection of each. Verification of the operation in laboratory of some sensors.

UNIT 7- ANALOG SENSORS: Normalized voltage and current levels in the control systems. Thermocouple. Thermo resistance. Charging cells Analog proximity switches. Operation and selection. Test of sensors in laboratory.

UNIT 8- ACTUATORS: Contactors. Electro valves. Soft starters. Basic principle of operation. Variable speed drives for AC motors. Basic principle of operation. Selection criteria. Laboratory test of these elements

UNIT 9- SIGNAL PROCESSING ELEMENTS: PLCs. Basic operation. Programming Languages: Ladder, Boolean, Grafcet. Basic language elements (internal bits, input and output bits, timers, counters). Input and output modules, digital and analog. Configuration. Addressing. Structured Function Blocks.

26) MACHINE ELEMENTS AND PROJECTS

OBJECTIVE: The objective of this course is for students to acquire the following skills: - Ability to calculate and design different machine elements. - Ability to evaluate and design mechanical PROJECTS. - Ability to use computer tools for mechanical design and calculation. - Oral and written communication skills. - Capacity for teamwork. - Ability to create, innovate and keep up to date.

CONTENTS

UNIT 1: TRANSMISSION BY FLEXIBLE ORGANS: Transmission by flat belts: used materials and their characteristics. Forces acting in the transmission. Determination of belt width. Common provisions. Tensioning roller. Transmission by V-belts. Advantages and disadvantages. Practical procedure for your selection. Transmission by chains. Usual forms. Applications. Procedure for sizing.

UNIT 2: TOOTHED WHEELS: Tooth Toothed Wheels: Generalities. Geometry. Basic Law of Engagement. Shape of the flanks of the teeth. Module and Pitch. Dimension of teeth to flexion, combined strength and surface pressure. American procedure. Inclined Toothed Wheels: Generalities. Geometry. Calculation. Conical sprockets: General. Geometry. Common provisions. Sizing. Reactions in the bearings. Curved teeth. Planetary gears. Hypoidal gears. Helical wheels that link axes that intersect in space: generalities and geometry. Worm-crown: general, geometry, gear ratio.

UNIT 3: COUPLINGS AND CLUTCHES: Couplings. Purpose. Types: Rigid. Of compensation, elastic. Gradual start. Cardanics. Selection and calculation criteria. Characteristic values. Clutches: Clutches with friction discs. Conical clutches. Forces acting, materials used. Different types of clutches for industrial purposes and cars with elastic elements. Clutches of plates. Electromagnetic clutches. Hydraulic clutches and coupling transformers.

UNIT 4: MECHANICAL TRANSMISSIONS: Generalities. Comparison between the different transmissions. Different possibilities of application. Draft.

UNIT 5: ELASTICS AND SPRINGS: Elastics. Tension and deformation of the single leaves, overlapping leaves and semi-elliptic elastics. Used materials. Springs: Applications. Cylindrical springs: tensions and deformations. Spring index. Voltage factor. Conical springs. Used materials. Torsion bar. Disc elastics: relation between applied load and axial deformation. Maximum tensions of internal and external contours. Combined provisions.

UNIT 6: AXES AND TREES: Generalities. Combined tension in shafts and shafts subjected to combined stress state. Shock factors and notch stresses, stress concentration factors. Tensions of Fatigue. Smith's diagram. Used materials and their qualities. Transmission trees. Provision. Calculation Simplified to torsion. Calculation of its dimensions due to resistance and deformation, critical speed of trees and axes. Oscillations caused by bending and torsion. Rules. General rules for its disposal. Flexible trees. Shafts of machines. Simplified calculation to flexion. Calculation. Practical forms.

UNIT 7: FRICTION AND ROLLING BEARINGS: Friction bearings. Radial and axial bearings. Lubrication method. Hydrodynamic lubrication. Theory of the film. Bearing module. Dry friction. Liquid and semi-liquid friction. Viscosity. Permissible pressure. Characteristic values. Rolling bearings. Advantages and disadvantages. Main types. Radial and axial bearings. Rules for assembly. Selection and calculation. Capacity of load, duration, number of revolutions. Lubrication and sealing. Recommended settings.

UNIT 8: ELEMENTS OF UNION: Roblonadura: Generalidades. Way of roblonar. Standards for nibbles. Layout in structures. Welding applications. Comparison between welded and crimped joints. Welding classes. Arc welding. Forms of joints. Resistance to static and dynamic load. Methods of calculation. Inspection. Electrodes. Pressure vessels. Unions of trees and cubes: Keys and Tabs, different types, shapes and norms. Cross keys. Striated axes, multiple keys. Rules. Tolerances. Bolts and pins. Cylindrical, smooth and grooved pins or pins. Conical pins. Articulation bolts. Screws. Classification, different kinds of threads. Rules. Fixing screws. Calculation. Forced unions. Diagram effort-elongation. Fatigue in threads. Classic screws. Elastic screws. Nuts and washers.

UNIT 9: MACHINERY PROJECT: Study and knowledge of the problem to solve and its requirements. Proposed solutions. Pre-dimensioning. Evaluation of possible solutions. Selection of one of them. Preliminary draft, elaboration, plans and sketches in proportion and scale. Design and optimization. The Project: Final calculations and verifications, general plan and detail plans. Scales, position numbers, necessary dimensions, labelling number of plane and list of parts. Exploded views: dimensions, dimensions and tolerances, surface symbols, tolerances of positions and shapes. Descriptive memory. Memory of Calculations. Cost determination Modifications, notice of changes, plan according to work.

27) ELECTRICAL MACHINES

OBJECTIVES: That students acquire a broad and clear concept of electrical machines of greater use and application in industries and electrical systems, clearly understand how to create a rotating alternating field and know the basic functions of alternators.

CONTENTS

UNIT 1- TRANSFORMERS: Magnitudes and units - Basic laws-Magnetic circuits, constructive forms. Coil with air core and iron core - Losses in iron - Scatterplots - Losses in copper - Performance - Phasor diagram and equivalent circuit - Ideal and real transformer in vacuum and with different types of loads (ohmic-inductive - Capacitive) - Triangle of Kapp - Analysis with different types of loads - Transformer in vacuum and in short circuit - Three-phase transformers - Connections: triangles-star-zic-zac.- Group of connections.-Parallel of transformadores.-Tests of vacuum and in shortcircuito.- Auto transformer.- Transformers of measurement: current-tension. Problems-Examples-Norms.

UNIT 2- THE ASYNCHRONIC MACHINE: Generalities-Constructive aspects and different types of rotors.-Principle of operation of the machine-Rotating field and slip-Equivalent electric circuit and phasor diagram-Heyland circular diagram-Power and moment-Construction of circular diagram -Curves characteristics of the machine-Start-up methods, different types. External feature and speed regulation-Double-cage rotors and deep grooves-The single-phase asynchronous motor-Problems-Examples-Standards.

UNIT 3-THE SYNCHRONIZED MACHINE: Generalities-Constructive aspects and different types of rotors-Induced tension-Rope and zone factors-Vacuum and load operation, characteristics-Armature reaction, dispersion field-Vector diagram and equivalent circuit -Curvas most important characteristics, determination of the synchronous impedance-Potier Triangle, trials. Excitation for a state of charge-Locus of currents and active power. Curves in V-Behavior of the synchronous machine connected in parallel to the public network.

UNIT 4- THE CONTINUOUS CURRENT MACHINE: General and constructive aspects - The DC generator - Principle of operation - different types of windings - Induced voltage and armature reaction. Poles for switching and winding

compensation-Generators with: Independent excitation-Derivation-Series-Compaund- Running under vacuum and with load-Start and speed regulation-Operating characteristic.-Examples-Norms.

28) MECHANICAL AND MANUFACTURING TECHNOLOGY

OBJECTIVES: Knowledge and use of instruments for dimensional meteorology. Knowledge of machine tools and manufacturing procedures for machine parts with chip removal, welding, cold deformation, EDM.

CONTENTS

UNIT 1: DIMENSIONAL METROLOGY. Differences between measurement and verification. Measurement units. Measurement errors. Influence of temperature, personal factor, etc. Measurements of length. Pattern elements. Measuring instruments: rulers, calipers, micrometers. Measurements of exterior, interior and depth. Angular measurements, measuring instruments. Instruments of verification and control: compasses, square, level, marble, prismatic calibres. Comparators of mechanical, electrical and pneumatic amplification. Profiler of profiles. Interferometry. Optical planes. Control of threads and gears, instruments and methods. Plot, field of application. Trace tools and procedures.

UNIT 2: INTERCHANGEABILITY OF PARTS. Notions, characteristics. Tolerance in the manufacture of mechanical parts. Nominal size. Upper and lower discrepancy. Maximum and minimum measurement of the part. Fit between pieces. Unique shaft system and unique hole. Types of adjustment, mobile, indeterminate and pressed. Standard form of limiting axes and holes. Practical applications. Gauges passes, does not pass. Surface roughness. Methods of measurement.

UNIT 3: MACHINE TOOLS, GENERAL. Interaction of the tool - part pair. Geometry of cutting tools, angle of detachment, cutting edge and incidence. Penetration and advancement. Chip section. Cutting speed. Materials of the cutting tools. Low alloy and carbon steels, fast steels, sintered carbides, ceramics and diamonds.

UNIT 4: HOW TO CUT THE CHIP. Types of chip that give the different materials. Optimal cutting conditions, tool wear and cutting edge. Cutting cooling, advantages and disadvantages. Cutting force. Cutting power and drive in the lathes.

UNIT 5: DRIVES IN MACHINE TOOLS. Speed boxes with steps in arithmetic and geometric progression. Standardized steps. Diagrams. Basis of calculation. Drives without stepping, mechanical, electrical, hydraulic.

UNIT 6: PARALLEL LATHES. Constructive principles. Functioning. Main and secondary movements. Spindle, bed, speed box, Norton box, counterpoint, longitudinal and transverse car, etc. Main turning operations. Lathes revolver. Lathes, multi-spindle. Semi-automatic and automatic lathes. Vertical lathes. Lathes, copying. Lathes with numerical control computerized (CNC).

UNIT 7: UNIVERSAL, VERTICAL AND SPECIAL MILLING MACHINES. Constructive forms. Functioning. Tools. Milling operations. Cutting speed, penetration and feed rate. Power of drive. Carving of spur gears with the universal splitter. Machines for the carving of cogwheels by milling screw Pfauter system, kinematics of the Generation of the teeth. Carving of gears with circular tool system Fellows. Carving of gears with toothed comb Maag system.

UNIT 8: SLITTING AND PLANING MACHINES. Constructive forms. Mechanical and hydraulic drive. Tools. Cutting speed, penetration and feed rate. Power of drive. Broaching machines. Functioning. Scope. Shape and characteristic angles of broaching tools. Calculation and design of brushes. Cutting speed and drive power. Shapers. Constructive forms. Functioning. Tools.

UNIT 9: DRILLING MACHINES. Functioning. Types of machines. Tools, shapes, angles and materials. Cutting speed, chip section. Power of drive. Boring machines. Scope. Types of machines. Tools for boring. Scared. Application. Fixed and adjustable reamers. Threaded. Threaded with males and tapers. Threading machine. Threaded by lamination.

UNIT 10: GRINDING MACHINES. Machinery and how to start material. Grinding machines. Types of machines. Scope. Exterior and interior grinding. Grinding without center. Grinding with shape wheel. Grinders. Characteristics and choice of the grinding wheels according to the work to be done. Precautions during assembly and during work.

UNIT 11: WELDING. Concepts and applications. Autogenous welding, necessary equipment. Oxicorte. Electrical resistance welding, equipment. Electric arc welding, types of processes. Welding with coated electrodes. Equipment.

Welding cord with material and area affected by heat. Preparation of joints. Weldability of steels. Carbon equivalent. Welding processes under dust and low gas.

UNIT 12: SHEAR CUTTING OF THE SHEET. Guillotines. Cut with circular knives. Cutting by punching. Punzón, matrix and fastener, constructive forms. Play between punch and die. Cutting force. Folding of the plate. Inlay. Dies for punching and sausage of the plate. Efforts in the sausage. Action of the fastener and pressure exerted on the plate. Machines for working sheet metal. Seals, presses. Manufacture of tubes with seam

29) STEAM TURBINES

OBJECTIVES: To know the basic concepts of design and selection of steam turbines, study of the thermal cycles and the operation of the turbines of power generation plants and industrial turbines used in cogeneration of power and steam for heating processes .

CONTENTS:

UNIT 1.- The development of steam turbines from De Laval and Parsons. Current status: large turbines for thermoelectric power plants, nuclear power plants, industrial backpressure turbines, turbines for boats. Industrial backpressure and condensation steam turbines for processes. Cogeneration of electrical energy and steam for processes. Steam relief for processes with pressure reducing valves. Turbine superimposed.

UNIT 2.- The energetic transformations in steam thermal power plants. The second principle of thermodynamics and the ideal cyclic process of Carnot. The ideal cycle of Clausius Rankine in the T-S diagram and in the h-S. Relationship between initial pressure and temperature of the steam and the title of the same at the outlet of the turbine. Simple and double intermediate steam superheat. Thermal cycle with regenerative preheating of the feed water by means of steam extractions in different stages of the turbine. Factors that limit the number of heating stages.

UNIT 3.- Combined cycles: gas turbine - steam turbine. Open and simple cycle of the gas turbine. Thermal performance of the ideal cycle as a function of the pressure ratio. Real cycle without heat exchanger. Total performance or degree of goodness of a gas turbine without a heat exchanger as a function of the pressure ratio and the gas temperature for given compressor and turbine yields. Influence of these yields on total yield. Combined process with introduction of the turbine output gases as combustion air in a steam generator. Process combined with heat exchanger for the production of steam without additional fuel consumption.

UNIT 4.- The expansion of steam in the diagrams h-S, T-S and p-v, with and without losses. Comparison between the alternative steam engine and the turbine. General concept about the size of the last stage of expansion of large turbines. Laval nozzle: its design and calculation. Expansion of the vapor in the oblique cut, deviation of the jet of steam and its simplified calculation with the formula of Forner - Baehr. Straight compression shock, Fanno and Rayleigh curves

UNIT 5. - Elemental theory of the axial turbomachine. Directed and mobile grids, speed triangles. Performance of the grids and speed coefficients. Change of steam status in stage. Degree of reaction. Peripheral performance. Influence of the output angle on the peripheral performance. Stage with a small degree of reaction.

UNIT 6.- The basic forms of steam turbines. Constant pressure stage, action wheel and / or regulation. Curtis wheel, speed ranges. Group of constant pressure stages, chamber turbine. Group of reaction stages, drum turbine. Graphs of the pressure variation, specific static enthalpy volume and absolute velocity of the steam in a stage or in groups of these. Radial turbines, Ljungstrom turbines.

UNIT 7.- Partial and total admission; Degree of admission, steam volume and length of the blades. Loss by friction and ventilation. Protection of the sector without steam admission. The different empirical formulas for their calculation.

UNIT 8.- Losses by interstices in chamber and drum turbines. Losses by mazes, their calculation, admissible and inevitable leaks. Closure steam for vacuum labyrinths. Losses by the axial thrust compensation plunger. Mechanical and radiation losses.

UNIT 9. The Stodola vapor cone; The Flügel equation and its applications. Change of the distribution of pressures in the stages of the turbine as the load changes. Variation of the pressure of the steam in the chamber of the control wheel as a function of the load. The axial thrust and its compensation. Axial thrust in action turbines. Danger of partial obstruction by salt deposits.

UNIT 10.- Regulation of turbines: regulation by quality of steam or lamination and by quantity or group of nozzles. Calculation of the characteristic measurements of a control valve. Mechanical, mechanical-hydraulic, hydraulic and electronic regulation. Emergency closing of the steam in cases of excessive speed, low oil pressure or rotor displacement.

UNIT 11.- Isolated problems of design; Choice of the number of stages of the turbine; First stage or control wheel; Number of revolutions, direct coupling, turbines with speed reducer. Relationship between wheel diameter, pallet length and steam volume. Characteristics of turbines or stages; The old Parsons number and the modern figures.

UNIT 12.- Systems of condensation by means of water and air, Heller system. Condenser size, number of tubes, heat transfer coefficient. Theoretical and practical vacuum.

30) THERMODYNAMIC MEASUREMENTS

OBJECTIVES: To train the student in the measurement of thermal magnitudes, carrying out the study of methods and instruments for the execution of the same, the application of the norms for the installation and use of them. Test and calibration of instruments.-

CONTENTS

UNIT 1.- The Measurement.- Foundations and definitions of most used terms. Argentine Legal Metric System. Elementary and Secondary Elements. Characteristics of measuring instruments. Range, Span, Error, Accuracy, Precision, Deadband, Sensitivity, Repeatability, Hysteresis, Turn Down. Instrument testing and calibration. Traceability. Validation. Uncertainty of measurement. Transmitters.

UNIT 2. - Measurement of pressure.- Dimensions. Absolute and effective pressure. Static, dynamic and total pressure. Manometers and vacuum gauges; Classification: metal with Bourdon tube, with diaphragm, with bellows; Of liquid column. Micromanometers. Measuring instruments. Pressure transmitters. Selection and installation of pressure gauges. Measurement of vacuum. Barometric pressure. Methods of testing and calibrating gauges and gauges.

Tests: Test of a manometer in the hydraulic balance and in the hydraulic press. Test of a vacuum gauge, a test meter and a micromanometer.

UNIT 3.- Measurement of temperature.- Methods of temperature measurement and its field of application. Thermal expansion thermometers. Thermocouples. Thermometers of electrical resistance. Pyrometers of radiation. Pyrometric cones. Thermistors. Pencils and pyrometric paints. Temperature transmitters. Choice and installation of temperature measuring instruments. Methods of testing and calibration.

Tests: Recorder thermometer test with glass thermometer in an oil bath. Test of a thermocouple of an electric oven.

UNIT 4. - Measurement of flow. - Flow of liquids, gases and vapors. Measurement of liquid flow in tanks with level. Rotary counters for liquids and gases. Turbines. Prandtl tube. Annubar. Rotámetros. Measurement of flow of liquids, gases and vapors through orifice plate, nozzle and venturi tube, according to established standards. Methods of calculation. Requirements for placement. Pressure fittings according to standards. Calculation of an installation. Differential pressure meters. Inductive Method. By ultrasound. Flow meters. Other methods. Transmitters.

Tests: Differential pressure gauge test.

UNIT 5.- Determination of the calorific value of fuels.-

1. Solid fuels.- Upper and lower calorific power. Definition. Calorimeter pump. Description of equipment and test. Calorimeter constant. Tests: Determination of the calorimeter constant. Determination of the calorific value of a solid fuel.
2. Gaseous fuels.- Junkers calorimeter. Description of equipment and test. Normal gas state.

Tests: Determination of the calorific value of natural gas.

UNIT 6. - Analysis of combustion gases. - Losses due to the combustion gases. Sensitive heat losses. Losses due to latent heat. Different types of analyzers: Chemical, Electrical, Mechanical, Magnetic, Radiation. Analyzer by absorption of infrared rays.

Tests: Analysis of a gas sample with a Testo 325 analyzer. Demonstration of analysis of a gas sample with the Orsat apparatus. Calculation of the losses to the chimney based on a flue gas analysis.

UNIT 7. - Level measurement.- Principle of operation. Different technologies. Forms of transmission. Selection and installation. Glass windows. By differential pressure. Floating. Scroller. Radar. Ultrasound. Capacitive. Inductive. Systems of bubbling, etc.

Tests: Determination of the level of a container in a factory plant.

31) HYDRAULICS AND PNEUMATICS

OBJECTIVE: To understand and interpret the technique of the use of compressed fluids, applied to the generation, transmission, transformation and control of movements of machines and mechanical devices.

CONTENTS

OLEOHIDRAULIC

UNIT 1: INTRODUCTION: Concepts, principles and fundamental physical laws applied to the Oil-hydraulic technique.

UNIT 2: HYDRAULIC FLUID: Characteristic properties. The viscosity. Special qualities. Additives. Contaminants.

UNIT 3: BASIC CIRCUIT: Symbols and methods of representation of components. Power and command circuits. Identification of actuators, control, regulation, control and accessories. Characteristics of the oil-hydraulic circuits.

UNIT 4: HYDRAULIC CYLINDERS: single and double acting, divers, telescopic, double rod, force or movement converters. Compressed, Approach, Fast Forward Cylinders. Cushioning.

UNIT 5: PUMPS: Classification according to design, function and pressure level. Of fixed or variable flow. Characteristic curves. Multiple pumps.

UNIT 6: HYDRAULIC MOTORS: Classification according to design. Of fixed or variable flow. Characteristic curves. Variation of speed and reversal of travel.

UNIT 7: DRIVES: Characteristic components. Valves, filters, tanks, accumulators. Particularities emerging from the heating and contamination of the hydraulic fluid. Suction, pressure and return pipes. Seals and seals

UNIT 8: CIRCUIT ANALYSIS: Operability, productivity, efficiency and security of service. Enlistment, start, unexpected stops, restart.

PNEUMATICS

UNIT 1: INTRODUCTION: Concepts, principles and basic physical laws applied to the pneumatic technique.

UNIT 2: AIR: Atmospheric air. Compressed air and its contaminants. Production, accumulation, distribution and conditioning of compressed air.

UNIT 3: BASIC CIRCUIT: Symbols and methods of representation of components and circuits. Elements of control, actuation, regulation and control ..

UNIT 4: PNEUMATIC ACTUATORS: Single and double acting cylinders. Cushioning. Cylinders of various positions, tandem, impact and special.

UNIT 5: DIRECTIONAL VALVES: Classification according to design, function, drive. Sliding and seat valves. Manual, mechanical, pneumatic and electric control.

UNIT 6: CONTROL VALVES AND AUXILIARY: Liming, regulating, unidirectional, quick escape, timing. Group of valves.

UNIT 7: PNEUMATIC DRIVES: Simple, multiple, simultaneous, sequential, conditional, repetitive. Introduction to automatic and semiautomatic cycles. Pneumatic memories.

UNIT 8: CIRCUIT DESIGN: Analysis of operability, productivity, efficiency and safety of operation. Enlistment, emergency, restart.

32) HEATING, VENTILATION AND AIR CONDITIONING TECHNOLOGY

OBJECTIVES: To provide the basic technical knowledge related to the production of cold in industrial processes and human comfort.

CONTENTS

UNIT 1.- Moist air.- Water content, relative humidity. Degree of saturation Specific volume. Molar weight. Diagram (i, x) of Mollier. Enthalpy of humid steam. Saturation curve. Fog zone. American Psychometric Diagram. Processes in moist air. Added heat and humidity. Direction of transformation. Cooling of moist air. Mixtures of moist air. Evaporation of water in the air, limiting cooling. The psychrometer. Drying.

UNIT 2.- Heat and humidity exchange between water and moist air.- Cooling towers and air washing machines. Balance of matter and energy. Dalton's Law and Lewis's Law. Markel's Law. Calculation of a cooling tower or a washer. Operation under conditions other than calculation. (Variable load, variable water concentration).

UNIT 3.- Air conditioning.- Interior design conditions. Air conditioning for human comfort and health. Regulation of the temperature of the human body. Comfort. Climate components influencing thermal well-being, peer influence and joint influence. Comfort scales. The katatermometer. Other factors on the feeling of thermal well-being. Local air impurities. Air renewal. Air conditioning for industrial use. Climate components. Impurities.

UNIT 4.- Exterior design conditions: Weather and climate. Temperature, humidity, wind and solar radiation. Local energy gains and losses. Actual or actual load. Estimation of conditioning or refrigeration load. External and internal loads. Sensitive and latent load. Total load.

UNIT 5.- Compensation of the sensitive and latent loads of conditioning .- The air supply. Line of transformation of the premises. The sensible heat factor. Preparation of the supply air. Summer and winter conditioning. Conditioning systems: all - round systems, water - air systems, water systems and direct expansion.

UNIT 6.- The distribution of the supply air.- Inflation or impulse mouths. The behavior of the inflated current. Induction. Dispersion. Fall or elevation. Guide fins. Location of the drive mouths. Types of drive mouth. Return grilles. Air ducts. Classification. Driving laws. Elements of the ducts. Plotting and calculation. Condensation in the ducts.

UNIT 7.- The cold technique.- Object. Production of the cold source, by: Cold mix. Expansion. Evaporation. Absorbers - absorbers. Expulsion of the gas into a liquid. Dry ice. Evaporation of a liquid in the atmosphere. Electrical and magnetic processes. Cyclic cooling processes. Coefficient of efficiency. Cooling cycles with vapors. Humid and dry regime. Compression in stages with intermediate cooling. Cooling chamber with different temperatures with two compressors valve and intermediate separator. Refrigeration at very low temperatures. Real process of cold production.

UNIT 8.- Refrigerating fluids.- Ideal cooling fluid conditions. More used refrigerating fluids. Thermal properties. Chemical and physiological properties. Action on lubricating oils, and metals. Handling and transferring of refrigerating fluids. Bank of cargo.

UNIT 9.- Elements of refrigeration installations by compression.- Compressors. Summary of different types. Calculation. Evaporators. Different types and calculations. Conduit of liquids and gases. Calculation.

UNIT 10.- Operation and regulation of refrigeration installations by compression.- Operation and manual regulation. Devices for safety of service and automatic regulation. Security valve. Filters. Oil separator. Windows of observation. Discharge and startup valve. Retention valve. Magnetic valve. Thermostats. Bimetal. Pressure switches. Pressure valves, etc. Thermostatic expansion valve. Test. Liquid distributor. Low and high pressure floating valve. Capillary tube and orifice plates. Overflow valve Water valves. Example of operation and automatic regulation.

33) HYDRAULIC MACHINES

OBJECTIVES: Analyse fluids in motion. Use physical laws and mathematical tools suitable for calculation, design and recalculation or verification of industrial application equipment such as pumps, fans and hydraulic turbines

CONTENTS

UNIT 1: INTRODUCTION: Classification of rotary pumps and water turbines.- Determination of the lifting height for pumps.

UNIT 2: HYDRODYNAMIC THEORY OF RADIAL PUMPS: Deduction of the law of Euler.- Theory of the current wire of one dimension .- Law of Euler transformed to the two-dimensional theory.- Degree of reaction.- The rotary whirlpool and the formula of Pfleiderer .- Influence of the thickness of the pallets.- Losses and yields .-

UNIT 3: DESIGN OF THE ROTOR: Calculation of the principal dimensions. - Design of the pallets by circle arc and calculated by points. - Optimal number of blades.-

UNIT 4: THE BODY OF THE PUMP: Calculation and design of the spiral box.- Calculation and design of the guide vanes.- Inverter channels and inverting pallets in multi-stage pumps.-

UNIT 5: HIGH FLOW PUMPS: Pallets with entrance edges on the suction elbow. - The design of special pallets (palettes of Francis type) .-

UNIT 6: AXIAL PUMPS: The two-dimensional theory and support profiles as pallets.- Calculation and design of rotors and directional paddles.- The influence of lattice and its calculation according to methods of A. Betz and E. Eckert.-

UNIT 7: THE THEORY OF SIMILARITY: Deduction of Formulas of Similarity. The unit speed. Classification of bombs on the basis of similarity.- Model laws.-

UNIT 8: SERVICE OF THE PUMPS: Lines and characteristic fields. - The installation set and pumps. - Pumps in parallel and in series. - The cavitation and the height of aspiration.

UNIT 9: WATER TURBINES: Their characteristics and their classification.- Fields of application.- The height of gross and net fall. The deduction of the law of Euler for turbines.- The yields and losses.- The losses of exit.-

UNIT 10: THE FRANCIS TURBINE: Classification and determination of main dimensions.- Design of rotor blades.- Directional blades.- Power regulation.- Characteristic field.-

UNIT 11: THE KAPLAN TURBINE: Determination of its main dimensions. - Design of the pallets. - Calculation of limits by cavitation. - Characteristic field.

UNIT 12: THE PELTON WHEEL: The hydraulic operation of the buckets.- Main dimensions.- The design of the buckets and determination of their number.- Mechanical and regulation problems.-

UNIT 13: THE SERVICE OF THE TURBINES: Height of aspiration and the cavitation.-

34) ELECTRICAL INSTALLATIONS

OBJECTIVES: That the student acquires a broad and clear concept of:

- The Low Voltage Electrical Installations, calculations of their pipes according to the requirements of the new regulation of the SAA in force in the Argentine Republic.
- Clearly understand the guidelines of calculations of drivers, their installation factors, customer requirements from the point of view of the voltage drop, the components involved in the always maintaining the coordination and selectivity between them getting The safe operating conditions that every facility must meet.
- Regarding the other facilities that exist in a building: very low voltage and general services - the professional future must have a general knowledge of its existence and its use, in independent pipes of low voltage networks, Which will allow it to participate in the design, to know the form of its execution according to the regulation in force and its relations with the other services.

CONTENTS

UNIT 1- RULES AND REGULATIONS: The norms and regulations in force in the Argentine Republic - with the application in projects and execution of electrical installations of lighting and driving force in residential and / or industrial properties. A) -Norms IRAM - VDE. B) -Regulation for the design and execution of electrical installations in buildings - Asociación Electrotécnica Argentina - AEA.

UNIT 2 - ELECTRIC TANK CALCULATIONS OF B.TENSION: a) Calculations of single-phase and three-phase low-voltage AC power lines for buildings. . Power line-main line-sectional line-circuit line. B) Calculations of low voltage AC lines for industrial plants. Power line-main line-sectional line-circuit line. With application to lighting circuits and electrical

machines. C) Calculations of distribution networks of single-phase alternating current - three-phase destined to the feeding of set of houses or neighbourhoods.

UNIT 3 - THREE-PHASE LINES IN MEDIA TENSION: a) -General concepts about three-phase installations in medium voltage - components: columns - insulators - conductors - fittings - accessories. B) - Three-phase public distribution system in the medium voltage in the Argentine Republic - aerial and / or subterranean - general guidelines - radial power from the Transformer Stations. C) -Brief summary on calculation guidelines of three-phase medium voltage lines.

UNIT 4 - PROTECTION OF ELECTRICAL NETWORKS: a) General concepts and calculations of single-phase and three-phase short-circuit current in overhead and / or underground electric networks. B) -Protection of electrical networks and monobasic circuits, three-phase - selectivity - coordination of protections, action curves. C) - Protection elements: fuses-switches. Characteristics of the different types of protection. D) -Protection of buildings and / or industries against atmospheric discharges.

UNIT 5 - VERY LOW VOLTAGE ELECTRIC SYSTEMS: Brief description of the most common installations of very low voltage.

UNIT 6 - GENERAL SERVICES IN PROPERTIES: 1. Electro water pumps. 2. Electro pump for sewage. 3. Trash Compactors. 4. Air conditioning equipment: individual-central. 5. Lifts.

UNIT 7 - EMERGENCY SYSTEM FOR BUILDINGS: - Basic knowledge for the selection and start-up of generator sets for: 1. Residential buildings. 2. Office buildings. 3. Buildings of public services: sanatoriums-hospitals-etc. 4. Industrial plants.

UNIT 8- INTEGRATED WORK OF KNOWLEDGE. --Applications of the general knowledge acquired during the dictation of the subject - in a practical development: 1. Project of a complete installation of a house of 1 or 2 Floors (with pool-barbecue - green space). 2. Project of an electrical installation of lighting and driving force of a workshop or small industrial plant.

35) STABILITY III

OBJECTIVES: To introduce the students in the analysis of tensions and deformations in elements frequently used in the construction of machines. Analyse qualitatively and quantitatively, design and optimize designs.

CONTENTS

UNIT 1: Symmetrical axial stresses and strains. General differential equations: a) Cylinders with thick walls. Differential equation. Formulas of calculation for the different cases applying the different formulas of rupture. Applications. B) Rotating cylinders. Differential equation. Formulas for dimensioning. Disc of variable thickness. Disc of equal strength. Influence of corona and pallets.

UNIT 2: Bend of curved axis: Deformation hypothesis. Determination of stresses. Determination of the constant Z. Curved hyper-static bars. Introduction to plastic calculation. Load of collapse.

UNIT 3: Torsion: Hypothesis on the deformation. Actuating stresses. General statement of the problem. Conditions of the torsion function at the free edges of the cross section. Solve circular, elliptic and rectangular sections. Tables for other sections. Analogy with the function of Prandtl. Torsion in hollow sections of thin walls.

UNIT 4: Plates and membranes: a) Membranes. Differential equation of tensions in a membrane. Membrane forces. Membranes of translation and revolution. Resolution of some typical cases. B) Plates. Theory of flexion in plates. Hypothesis on deformations. Obtaining the differential equation of landslides in a direction perpendicular to the median plane of the plate. Equation of Germain-Lagrange. Edge conditions. Calculation of some typical cases. Calculation of moments. Determination of thickness. Verification of the maximum arrow. Use tables and graphs for complicated cases.

UNIT 5: Contact stresses: Hypothesis to determine tensions and deformations. Method for its calculation for point and linear loads in bodies of different curvature. Coefficients of security. Hypothesis of rupture. Surface thermal treatments. Importance of the same.

36) CONTROL SYSTEMS

OBJECTIVES: To provide students with basic concepts, terminologies and techniques for process control. The young engineer must have at his disposal tools that allow him to understand and develop control techniques in his professional career.

CONTENTS

UNIT 1: INTRODUCTION. Generalities. Overview of control systems. Feedback. Closed loop and open loop control systems. Concepts. Examples.

UNIT 2: MATHEMATICAL MODELS. Representation in linear differential equations. Transfer function: definition. Mechanical and electrical examples. Cascade element transfers function. Block diagrams. Representation of a closed loop in block diagrams. Closed loop systems subject to a disturbance. Block algebra. Procedures. Operation.

UNIT 3: CONTROL ACTIONS. Algorithms. Concepts. Control actions: a) Of two positions or bell; B) Proportional (P); C) Integral (I); D) Derivative (D); E) Combinations: (P + I), (P + D), (P + I + D). Proportional control of a first order system. Effects of derivative and integral action on the behavior of systems. Effects of feedback.

UNIT 4: ANALYSIS OF TRANSITIONAL RESPONSE. Typical test signals. Transient and stationary response. Absolute stability. Relative stability and steady error. Systems of first and second order: responses to various inputs. Transient response specifications. Stability analysis in the complex plane. Routh stability criterion.

UNIT 5: FREQUENCY RESPONSE. Response to a sinusoidal input. Bode, polar and module diagrams depending on the phase. Stability analysis. Nyquist stability criterion. Other criteria.

UNIT 6: ELEMENTS OF INDUSTRIAL AUTOMATIC CONTROLS. Classification. Self-acting controls. Components of automatic controllers. Pneumatic elements: nozzle - fin mechanism, pneumatic relays. Hydraulic elements: hydraulic servomotor, shock absorbers. Mechanical elements: Centrifugal or Watt regulator. Combinations. The centrifugal regulator as an automatic speed controller. Components of control systems. Pneumatic control valve. Positioners. Auxiliary elements in control systems. Relays.

UNIT 7: CONTROL SYSTEMS. Symbology. Norma IRAM. Cascade control systems: concept; advantage; Conditions of application; blocks diagram; Examples. Control feedforward: concepts; terms; Block diagrams; Examples. Relationship control: concepts; terms; Block diagrams; Examples. Restriction control: concepts; terms; Block diagrams; Examples Other types of control.

UNIT 8: USUAL SCHEMES OF CONTROL SYSTEMS. Automatic controls in steam boilers. Automatic control of dome level: control systems of one, two and three elements. Control of energy balance. Home control. Air - fuel ratio. Control of pressure and temperature of steam. Other controls.

37) VIBRATION AND MACHINE FOUNDATION

OBJECTIVES: Introduce the students in the analysis of the movement and determination of amplitudes of oscillation in free and forced vibratory systems. Analyze the transmission of forces to the foundation.

CONTENTS

UNIT 1: Systems with a degree of freedom. Non-damped free oscillation. Vector rotation. Complex representation. Free damped oscillation. Critical damping. Mass suspended from an animated spring of a harmonic motion. Forced oscillations with or without damping. Graphic resolution. Resolution using complexes. Work produced in harmonic motion. Electrical analogy.

UNIT 2: Systems with two degrees of freedom. General equation. Discussion. Vibration absorber without damping. Absorsor Frahm. Natural frequencies. Maximum amplitude for equal frequencies of the absorber and the main mass. Centrifugal absorsor. Vibration absorber with damping. Resolution using complexes. Determination of the gauge and the most favorable damping. Absorsor Lanchester. Graphs for the calculation of the different types.

UNIT 3: Systems with varying degrees of freedom. Equation of motion for a system with links. Generalized coordinates and forces. Free vibrations. Several discs. Determining the frequencies. Free vibrations with flexion. Shaft with several supports and masses. Determination of frequencies.

UNIT 4: Shaft bending oscillations. A mass. Critical angular speed. Several masses and two supports. Dunkerley and Kull formulas. Stodola procedure. Axles with three supports. Application of the Castigliano principle. Torsional vibrations. Shaft with several masses. Determination of frequencies and modes of vibration according to Holzer. The reduced shaft. Reduction of masses. Inertial moments and equivalent elasticity.

UNIT 5. Isolation of machines against vibrations. Vertical vibration. Maximum amplitude and effort transmitted to the foundation. Rigid and floating foundations. Determination of the desired insulation. The concept of mechanical impedance. His intervention in the design of the foundation. Calculation of the impedance at a point of the foundation. Insulation of: buildings, railways, test benches and test machines, sensitive machinery and equipment, piston and screw compressors, equipment used in shipbuilding, gas and diesel generators, rotary printers, metal forming machines, textile machines, pipes, fans and air conditioners.

UNIT 6: Foundations of machines: Block type. Type cells. Of walls. Porticadas. With piles. On elastic supports. Insulators type elastomers. Of springs. Springs with viscous damping. General concepts for the foundation of a diesel engine, turbine frames. Machines subject to irregular shocks. Free-fall or air-driven or steam-powered booms.

38) ELEVATION AND TRANSPORT MACHINES

UNIT 1: General.- 1.- Introduction. 2.- Classification: a) According to how to work: Discontinuous and continuous. B) According to the matter to be moved: Transport of matter in bulk, loose parts, people. C) According to management. D) According to mobility. E) Depending on your drive. 3.- General technical and economic criteria for choosing the most suitable equipment. 4.- Economic importance of transportation in industry and in the country 5.- Design of transport system. Definitions. Design engineering. Morphology of the design.

UNIT 2: Motors. 1.- Types of drives: hand drive, by hydraulic transmission - pneumatic - steam - by internal combustion engine - electric. Types of engines - control devices. Regulation. Safety, braking. 2.- Determination of the power of the lifting motor taking into account the static and dynamic forces. 3. - Characteristics of the load to which it is subjected. Relative duration of work.

UNIT 3: Typical elements and organs. A) Elements for the transmission of force and movement: 1.- Cables of vegetal fibers. 2.- Of steel wires: cables of Movement and bearings, types - calculation of cables. 3.- Cable ties and splices. 4.- Chains; Cable pulleys. 5.- Wheels for chains. 6.- Drums for cables and chains. B) Elements for the suspension of load: 1.- Hooks; Simple, double, closed. 2.- Electromagnets. 3.- Tongs. 4.- Common spoons and self-priming. 5.- Polyps. 6.- Excavator buckets. 7.- Cubes.

UNIT 4: Safety devices. A) Ratchets: 1.- General. 2.- Yields when lowering the load. Moment of recoil force. 3. Types of ratchets and their calculation. 4.- Special forms of ratchets: internal, lateral, combined with brakes, controlled to friction. B) Brakes: 1.- General. 2.- Subdivision according to its construction and its function. 3.- Moment of braking taking into account static and dynamic forces. 4.- Types of brakes: a) Shoe brakes: single and double; Counterweight and spring. Lifting of the brake by electromagnet and by electro - hydraulic device. B) Belt brake. C) Miscellaneous: combined with ratchets. Thrust brakes. Plate brakes. Centrifugal force brakes. 5.- Verification of the brake by the equivalent thermal power.

UNIT 5: Various lifting devices. 1.- Cats: zipper, hydraulic screw. 2.- Single and double hoists. 3.- Armatures for the hook. 4.- Rigging with fixed and mobile pulleys. Rigging by hand with endless and planetary wheels. Electrical equipment. 5.- Hand lathes for cable. Lathes, mechanical. Electric winch for independent use. Lathes for single and double gears for rotary cranes. Lathes for sliding crane cars. Lathes with clutches. Lathes for self-priming, single-engine and twin-engine ladles. Lathes for lifts and forklifts. 6.- Winches.

UNIT 6: Cranes - Types of cranes - Rotating cranes: wall, mast, rotating column, fixed column, monorail, rotating platform, fixed and mobile. Retraction mechanisms for the boom. 2.- Sliding cranes: Layout, cart shapes. Mechanisms with several speeds of lifting loads. Forms of the bridge. 3 .- Gantry cranes: Common. 4.- Funicular cranes: Classic applications in workshops and courtyards. 5.- Mechanisms of translation: Rails, wheels, resistance to motor movement; Moment of the brake.

UNIT 7: Metal structures of the cranes: 1.- DIN 120 standard: Compensation and shock factors. Load cases. Forces that intervene. Allowable materials and voltages. 2.- Beams of full, simple and armed soul: calculation by tension and by deformation. Usual constructive organizations. 3.- Lattice beams: determination of the forces in the bars coming from the permanent loads and the moving load. Typical constructive forms.

UNIT 8: Continuous conveyors. 1.- Generalities. 2.- Classification and enumeration of types of conveyors. 3.- Continuous transport for bulk materials: General principles - Classification of materials. 3.1. Propellers or worms. 3.2. Oscillating and vibrating conveyors. 3.3. Lifts to buckets. 3.4. Conveyor belts. 3.5. Pneumatic transport. 4.- Continuous transport for packages and parts. Description of the most common types.-

39) INDUSTRIAL ORGANIZATION

OBJECTIVES: At the end of the course the student will be able to apply the basic tools to efficiently manage a company dedicated to the development of products and / or services.

CONTENTS

UNIT 1: Industrial Organization. Current importance. Evolution of the Business Organization. Main precursors of the Industrial Organization. Organization: Authority - Responsibility - Duty. Types of Organization: Taylor, Fayol, Line and Staff. Committees. Organization chart. Types. Matrix structure. The Company as a system. Importance of coordination of subsystems. Business skills.

UNIT 2: Planning Department. Production planning and control. Relationship between Production - Sale - Stock. Documentation required for the manufacture: technical drawing, roadmap, operation sheets. Department of Production Engineering. Productivity. Types of Productivity.

UNIT 3: Fixed costs, variable costs. Representation of unit costs. Expenses and income. Breakeven. Diagram P. G. Selection and renewal of production equipment. Relationship with the production process. Points to consider. Representation of total costs as a decision tool.

UNIT 4: Depreciation. Causes. Amortization. Different systems of depreciation. Maintenance of production assets; Classes: corrective, preventive, predictive, Detective. Characteristics. Methodology RCM, TPM.

UNIT 5: Models. Types of models. Mathematical Model of the Economic Lot; Graphical and analytical calculation. Transformation of a sales forecast into a production program. Manufacturing just in time. Elements. Kanban. Poka Yoke. SMED.

UNIT 6: Production control systems. Gantt charts. Characteristics. Types of graphs. Critical Path Method. Stages. Application. Control panel. Types of indicators. Balanced Scorecard (BSC). If-then analysis. Matrix Board. KPIs. Inductors.

UNIT 7: Study of working methods. Goals. Forms. Preparation of worksheets for the current and proposed method. Diagram Man - Machine. Study of movements. Purpose. Bi-manual diagram. Economy of movements. Ordering of the work area. Gilbreth and the therbligs. Micromovements. Simogram.

UNIT 8: Work measurement. Purpose. Time studies by timing, by calculation and by predetermined times. Supplements. Determination of the number of cycles to be controlled.

UNIT 9: Statistical Quality Control. Need and fundamentals. Quality of design and product quality. Assignable and non-assignable causes. Relationship between quality and costs. Control by variables and attributes. Critical control points. Quantity of parts to be controlled. Fate of defective parts. Graphical control methods: distribution curves and Shewhart charts.

UNIT 10: Quality Management. Concept. ISO 9001: 2000 standard. Considerations about it. Generalities. Description. Total Quality Management System. Quality Circles. Quality tools

UNIT 11: Localization of industries. Classification of industries: continuous-Repetitive - intermittent. Distribution of equipment by process and by product. Factors involved. Practical way of performing a layout study. Diagram of threads. Basics of automatic factories. Economic and social effects of automation. Concepts about lean manufacturing (Lean) and agile manufacturing. Clusters.

40) LEGAL ENGINEERING

OBJECTIVES: With the theoretical-practical concepts transmitted to the students, the aim is to contribute to their integral training based on the analysis and study of the legal institutes of greater application in the scope of their professional practice contributing elements that are fundamental for their better development.

CONTENTS

UNIT 1: ENGINEERING IN RELATION TO THE LAW. The law and morality. The Engineering in relation to the Law: location, scope and importance of the subject in the integral formation of the Engineer. Norms governing human activity: technical ethical standards. Classification of ethical standards: Moral and legal norms. Law: concept, relations with related sciences. Natural law. Right from an objective and subjective point of view. Patrimonial and extra-patrimonial rights. Public Law and Private Law.

UNIT 2: ARGENTINE CIVIL CODE. Rules. Custom. The law. Argentine Civil Code: laws of substance and form. Incorporation and coding systems. Background and orientation of the Argentine Civil Code. Structure. Sources of Law. The Law: concept, formation, effects, ignorance, resignations. The norm and its hierarchies. Public order. Custom: uses and technical practices. Jurisprudence. Doctrine. The time intervals in law. The federal political system and legislation. Administrative levels. Powers reserved, delegated and concurrent.

UNIT 3: SUBJECT OF LAW: natural and legal persons. Subject of law: people. Classification: people of visible existence and ideal existence. Physical persons: birth, existence and purpose. Attributes of the personality: name, address, capacity, marital status and heritage. Capacity of right and de facto. People of public law and private law. Principles governing them. Birth and extinction. Colleges and Professional Councils. Business partnerships.

UNIT 4: OBJECT OF THE LEGAL RELATIONS: the things and the goods. Object of legal relations: things and goods. Concept. Classification of things in themselves and in relation to people. Goods of the public domain of the State: concept and characters. Enumeration. Private property of the State. Heritage: composition. Patrimonial rights: creditor rights, real rights and intellectual rights. The patrimony as a common pledge of creditors. Different classes of creditors. Privileges. Routes of execution and liquidation.

UNIT 5: CREDENTIAL RIGHTS. Obligations. Obligations: concept. Notions on the sources of obligations. Rights Credits: concept and characters. Classifications of obligations. Effects and extinction. Facts and legal acts. Unlawful acts. Vices of will and unlawful acts. Criminal offense and civil offense. Causals of Imputability and Imputability. Objective responsibility. Damage and prejudice.

UNIT 6: CONTRACTS. Concept and essential characters. Classification. Object, form and test. Effect of contracts. Covenant Pact. Theory of contractual unpredictability. Sign or draw. Penalty clause. Extinction. Litigation limitation in respect of professional fees. Administrative contracts. Insurance contract: generalities.

UNIT 7: BUILDING CONTRACT. Obligations and responsibilities. Privileges. Contract of Work Location: concept, characters, object, form and test. Intervening subjects. Obligations and responsibilities of the parties before and after the work is received. Privileges. Lien. Documentary parts that make up the contract: contract and specifications. General specifications: clauses dealing with the object of the contract. Unplanned and additional work, project modifications. Reception of the work. Termination of contract. Technical specifications, essential requirements.

UNIT 8: INTELLECTUAL LAW - Law 11.723. Concept of intellectual production. Provisions of Law 11.723. Its application to engineering works. Scope of intellectual rights: generalities. Consequence of the legal protection of intellectual production. Intervention and comptroller by municipal, provincial and national agencies in intellectual production. Patents.

UNIT 9: ROYALTIES. Real Rights: Concept, creation, characters and enumeration. Real rights on the thing itself, the foreign thing and guarantee. Possession and tenure: concept and differences. Protection of possession. Possessory actions.

UNIT 10: RIGHT OF DOMINION AND RIGHT OF CONDOMINIUM. Concept, attributes and characters. Inherent faculties and extension of property rights. Guarantee. Evolution of the domain concept. The domain as a social function. Modes of acquiring the domain: appropriation; accession; Alluvium and ablution, edification, planting and planting: diverse situations. Tradition. Acquisition prescription. Extinction of the domain. Condominium: definition

and characters. Legal nature. Different kinds of co-properties: divisible (ordinary), indivisible and boundary confusion.

UNIT 11: DOMAIN LIMITATIONS. Restrictions. Limitations to the Domain: concept and thesis of the Argentine Civil Code. Restrictions: concept and characters. Restrictions imposed by the public interest and private interest. Administrative restrictions.

UNIT 12: SERVITUDE. Forced servitudes and administrative easements. Bondage: concept and characters. Classification. Forms of constitution. Compensation. Extinction. Types of civil servitudes. Types of administrative easements.

UNIT 13: EXPROPRIATION FOR CAUSE OF PUBLIC UTILITY. Expropriation because of public utility: concept, object and fundamentals. Constitutional and civil provisions that govern it. Requirements. Expropriation and the social concept of property rights. Legal system and national and provincial. The classification by Law: different types. Legal effects of expropriation. Administrative and judicial procedure. Deferred expropriation. Compensation: its practical valuation. Improvement of expropriation.

UNIT 14: ADMINISTRATIVE LAW. Administrative Law: concept, characters. Administrative and administrative acts. Notions about public services, police power and public domain. Administrative contracts: concept, characters, elements, training, tests. Forms of contracting.

UNIT 15: PUBLIC WORKS CONTRACT. Legal nature, definition and characteristics of the contract. Difference with the concession of public works. Subjects and object of the contract. Public tender: principles that govern this system of selection of the contractor. Certificates of work. Provisional and definitive reception. Rescission. Professional and business responsibility. National and provincial legislation on the subject.

UNIT 16: CONTRACT OF WORK. The Duty of Security. Contract of Work: concept, modalities, rights and obligations of the parties, social benefits. Extinction of the contract. Compensation. Conditions and working environment: concept. Risk: definition. Classification of risk factors. Maximum permissible levels. Occupational diseases and accidents at work. Pre-occupational examinations. Safety and Hygiene at Work: Law 19,587.

UNIT 17: ENVIRONMENTAL LAW. Concept, subjects, object. Criteria, principles and institutions specific to Environmental Law. Background. Constitutional Guarantees. Civil Code: Limitations to the Domain. Administrative Restrictions. Police Power. Responsibility of the State. Environmental damage. Environmental impact. Environmental Impact Assessment. Responsibility. Compensation. Comparative legislation.

UNIT 18: PROCEDURAL LAW. Procedural Law: concept. Procedural rules: organic and procedural. Stages of an ordinary process. Means of proof. Expert witness. Arbitration proceedings.

UNIT 19: LEGAL NORMS THAT REGULATE THE PROFESSIONAL FUNCTIONS. Professional ethics. Legal norms that regulate the professional functions of the engineer: legal nature of the professional functions. Legislation regulating professional practice. Professional responsibility. Professional ethics. Professional fees. Tariffs, prescription.

41) STEAM GENERATORS AND THERMODYNAMIC INSTALLATIONS

OBJECTIVES: To transmit to the student the necessary knowledge for the analysis, selection or design and rational use of steam generators, their parts and other heat exchange equipment. The knowledge for the economic design of fluid conduction installations in industrial plants.

CONTENTS

UNIT 1. INTRODUCTION. Production of energy in the world based on oil, natural gas, coal, hydro and nuclear; Reserves and alternative sources.

UNIT 2. FUELS. Classification and valorisation according to their properties (calorific value, content of volatile substances, humidity, ashes, etc.), related to its use in the steam generator. Particular characteristics of the main fuels used in the world and in the region.

UNIT 3. COMBUSTION. Analysis of the development of the combustion, influence of the physical and chemical phenomena that participate in the different stages of the same (temperature, turbulence, chemical reactions, etc.) and its incidence in the necessary time. The theoretical combustion and with excess of air, calculation of the

minimum air, volume of the flue gases; Incomplete reactions, analysis of the Ostwald and Bunte triangles. I-t diagram for different fuels without and with preheating of air. Uses of the diagram.

UNIT 4. THE HEAT TRANSFER IN THE STEAM GENERATORS. A) Radiation transmission, fundamental concepts and laws (Black and Gray Body, Planck's Law, Stefan-Boltzmann's and Kirchhoff's Law). Radiation between solids separated by a non-absorbing medium, geometric factor. Selective radiation of gases and water vapor, flame radiation. Heat transmitted by radiation in the combustion chambers; Simplified calculation methods according to Wohlemberg and Broido, refrigeration figure; Temperature of the exhaust gases of the combustion chamber. B) Heat transfer by convection: Formulas for calculating the coefficients in the cases: B1) From gas to tube walls (outer and inner parallel circulation), b2) To steam in steam superheaters, b3) To water in boiling state, influence of caloric load and pressure, critical flow , Leydenfrost phenomenon. C) Transmission of heat by conduction in metals and layers of incrustations, ash, and soot; Global coefficient of heat transfer, for flat, cylindrical and extended surfaces (flap tubes); Transmitted total heat and temperature steps; Limit for the application of certain simplifications of calculation.

UNIT 5. CHARACTERISTICS OF HOUSEHOLDS FOR DIFFERENT FUELS. Main dimensions in order to allow efficient combustion, adequate heat transfer and minimize the emission of solids to the atmosphere. Equipment for the combustion of solid, liquid (fuel-oil) and gaseous fuels; Alternatives to reduce the emission of polluting gases.

UNIT 6. CUTTING. Justification, natural draft (chimney) and artificial, fans: a) choice of the same (characteristics, specific number of revolutions, power absorbed, regulation); B) location: balanced shot (forced and induced), pressurized combustion chamber. Formulas for calculating loss of runoff by friction, deflection, by changes of sections, and by ascending forces.

UNIT 7. THE CIRCULATION OF WATER IN STEAM GENERATORS. Their need, classification (recirculation and forced passage). Natural recirculation, laying out the basic equations for a simple system and its analysis, minimum speed in the down tubes, recirculation in tube bundles, conditions to ensure a good recirculation. Forced recirculation, La Mont boilers; And forced passage, boilers Benson and Sulzer - monotube.

UNIT 8. SPECIAL BOILERS. Velox boiler and recovery boiler for cycles Combined.

UNIT 9. STEAM SUPERHEATERS. Rationale and generalities (location, arrangement, staging, etc.) Classification (vertical, horizontal, radiation, convection, etc.), calculation, regulation and commissioning

UNIT 10. AIR PREHEATERS. Justification and generalities (location, temperature limits, etc.) Classification (recuperative: of tubes, of plates, and regenerative: Ljungstroem, Qpipes) and calculation of the surface necessary for the transmission of heat.

UNIT 11. SAFETY VALVES. General (location, characteristic pressures, number of valves, discharge pipe, etc.), types of valves (with spring, with weights, with auxiliary power), description, characteristics.

UNIT 12. MATERIALS FOR STEAM GENERATORS AND THEIR HEAT RESISTANCE. Creep, characteristic values and formulas for calculation of wall thickness for domes and tubes, fixation of tubes to domes and manifolds, hydraulic test.

UNIT 13. Treatment and chemical control of boiler and feed water. Its necessity and analysis of the elements to treat, external and internal treatment according to characteristics of the steam generators and the working pressure; Purity of steam, separation equipment in the dome and water traps.

UNIT 14. Steam pipes. A) Loss of load. B) Elasticity and resistance: cold pretension, compensation of thermal expansion, b1) artificial (bellows), b2) natural (calculation of stress in flat and spatial systems); Verification of the pipe to the combined state of stresses (own weight, internal pressure, thermal stresses, etc. c) Thermal insulation. D) Remove heaters, water separators, steam traps.

42) INTERNAL COMBUSTION ENGINES

OBJECTIVES: To acquire the conceptual bases, methods and criteria for the full knowledge and management of internal combustion engines, as well as knowledge for fuel testing and testing of engines in test benches, capable of interpreting the results obtained in said tests. essays. Encourage research on these issues.

CONTENTS

UNIT 1 - INTRODUCTION: Thermal machines. Internal combustion engines and external combustion engines. Differences. Historical summary. Lenoir, Otto-Langen, Nikolaus A. Otto, Daimler, Rudolph Diesel. Operating cycles of 2 and 4 stroke engines.

UNIT 2 - THEORETICAL CYCLES: The ideal cycles and their adaptability to the different machines. The perfect engine. Carnot, Clausius-Rankine and Otto in the i-s and p-v diagrams. Performance. The optimal cycle according to the natural limits. The mixed or Sabathé cycle. Comparisons and conclusions.

UNIT 3 - ACTUAL CYCLES OF THE RECIPROCATING ENGINES: The indicated cycles. The real engine. Degree of goodness and medium pressures. Indicated power, mechanical performance and average friction pressure. Effective mean pressure. Effective power.

UNIT 4 - CYCLES ECONOMY: Fuel power and mix energy. Dilution factor. Fuel consumption, power and specific consumption. Volumetric and gravimetric yield. Determination of the average effective pressure as a function of yields.

UNIT 5 - CHARACTERISTIC VALUES: General dimensions of an internal combustion engine. Average piston speed. Race / diameter ratio. Speed Limits. The power per litter and per cylinder. Conceptions of the different engines. Determination of displacement.

UNIT 6 - MOTORS OTTO (1^{ST} PART): Formation of the mixture and the combustion. Requirement of service. Power regulation. Carburettor feed system. The elemental carburettor. Corrections to the elementary carburetor to adapt to the requirements of the service. Fuel injection system. Requirements. Direct and indirect injection. Modern systems.

UNIT 7 - OTTO MOTORS (2^{ND} PART): The ignition of the mixture. Regulation. The ignition advance. Energy needed. Spark feature. Ignition circuits. Powered by battery, magnet and electronic. Static ignition. Spark plugs. Abnormal combustion. Chopped. Requirements for fuel. Octane "Motor" and "Research". Your determinations. Different types of fuels used in the Otto engine. Additives and conditions.

UNIT 8 - GAS ENGINES: Motor combustion from gaseous fuels. Minimum air. Calorific power of the mixture. Comparisons. Spontaneous ignition temperature and combustion rate. Influence on yields. Energy equivalence. Scheme of facilities.

UNIT 9 - DIESEL ENGINES (1^{ST} PART): General. Combustion in the diesel engine. Parameters for the macromix. Penetration and spraying. The ignition delay. Fuels; Ignition quality. The Cetano No. and his determination. Diesel Index. The total injection process. Delay of injection and opening. Dynamic considerations.

UNIT 10 - DIESEL ENGINES (2^{ND} PART): The combustion chambers. Direct injection and indirect injection. Injection pumps and their regulation. Requirements to be covered. Different systems. Regulators and drive devices. Electronic management. Modern high pressure direct injection systems.

UNIT 11 - ATMOSPHERIC POLLUTION: Theoretical and real emissions of leaks. Contents of CO, NOx, CxHy, particulate, SOx and their dependencies. Methods to reduce harmful emissions. Anti-pollution devices; EGR system; Catalytic converters. Filters of particles.

UNIT 12 - THE DISTRIBUTION IN 4 STROKE RECIPROCATING ENGINES: Different arrangements. Valve operation. The section of passage and its dimensioning. The cams and the layout of the approximate theoretical profile. Considerations. The load of the spring. Desmodromic systems.

UNIT 13 - THE DISTRIBUTION IN 2 STROKE ALTERNATING ENGINES: Sweeping systems. Theoretical limits of the eviction sweep and the mixture. Practical values. Calculation of the sweep ports. Power of the sweeping pump. Optimization. Calculation of preescape. Verifications. Practical size of ports. Conclusions.

UNIT 14 - SUPERCHARGING: Different procedures. Mechanical or turboplast system. Thermodynamic bases. Influence on pme, density and different yields. Load change period. The mechanically coupled supercharger. The turbocharger supercharger of exhaust gas at constant pressure and by pressure pulses. Interference and ignition orders. Balance of the supercharger group. Turbocharger overcharging considerations in 2 and 4 stroke engines.

UNIT 15 - AUXILIARY CIRCUITS AND TESTS: Refrigeration. Different types. Heat to extract. Cooling liquid pumps. Radiators. Fans. Regulating devices. Lubrication of engines. Characteristics of lubricating oils. Lubrication systems.

Startup in internal combustion engines. Different types and calculation of electric starters or compressed air. Test of motors. Characteristic curves. Correction of values. Rules.

UNIT 16 - DYNAMICS OF THE RECIPROCATING ENGINES: Accelerations in the crank-crank system. The distribution of the masses. Form of the crankshafts and order of ignition. Forces of inertia of different orders of the oscillating masses; Their compensation. Compensation of the turning moments of 1st order. Transverse moments. Your compensation.

UNIT 17 - GAS TURBINES: Thermodynamic cycles of open systems. Theoretical yields. Losses and performances of the compressor, the combustion chamber and the turbine. The effective performance. Optimization of the actual cycle with exchangers. Turbine cycles with compression and expansion in stages. Terrestrial applications. The compressor. The combustion chamber. The turbine. The materials. Vehicular applications.

UNIT 18 - GAS TURBINES IN AVIATION: Applications of the gas turbine in aviation. Considerations of propeller propulsion. The turbojet. Thermodynamic cycle in the i-s diagram. The push. Flight performance. Total yield. Gas turbines such as double flow turbojet engines. Derivation index.

LABORATORY TESTS: Intended to strengthen theoretical and practical knowledge. Test benches for alternative engines and turbines, fuel test engines, gas analyzers, etc.

43) MACHINE AND THERMODYNAMIC INSTALLATION TESTING

CONTENTS

UNIT 1.- TEST OF A COMPRESSOR.- Test methods. Stationary test. Tests loading a closed container. Theoretical Considerations. Diagram P-V of Ideal and Real compression. Isothermal, adiabatic, volumetric and gravimetric yields. Installation and test measurements loading a closed container. Calculations, graphs and test reports.

UNIT 2.- TEST OF A VACUUM PUMP.- Definition of Vacuum. Differences between a vacuum pump and a compressor to plunger. The vacuum pump in Industry. Testing a vacuum pump by evacuating a closed vessel from atmospheric pressure to a certain vacuum. Theoretical Considerations. Installation and test measurements. Calculations, graphs and test reports.

UNIT 3.- TEST OF A DRYER.- Schematic of the installation. Instrumental and measurements. Flow, humidity, initial and final temperature of the product. Consumption of heating fluid. Flow, humidity, initial and final temperature of drying air. Thermal Balance.

UNIT 4.- ONE FAN TEST.- Determination of the characteristics of a fan. Installation diagram for the test, with the measurements to be carried out. Calculation of plates orifices. Reduction of the values obtained at a nominal number of revolutions per minute. Calculations, graphs and test reports.

UNIT 5.- TEST OF A CENTRIFUGAL PUMP.- Determination of the characteristic of a pump. Elevation height, flow rate, cavitation through the calculation of NPSHr (Net Positive Suction Head requested). Installation Scheme for the test. Power absorbed by the pump and useful power. Performance. Reduction of the values to a nominal number of revolutions per minutes. Calculations, graphs and test reports.

UNIT 6.- TEST OF A STEAM GENERATOR.- Standards. Methods of testing: direct or indirect. Scheme of the installation and measurements to be made in the direct method. Scheme of the installation and measurements to be made in the indirect method. Loss of Heat. Performance. Calculation of the theoretical temperature of combustion. Calculation and Report of the Essay.

UNIT 7.- TEST OF A GAS TURBINE.- Installation diagram Measurements for the test. Performance. Specific consumption. Calculations, graphs and final report of the test.

UNIT 8.- TEST OF A STEAM TURBINE.- Purpose of the test Installation Scheme and measurements for the test of a condensation turbine for the purpose of checking the manufacturer's warranty data.

44) INDUSTRIAL ECONOMICS

OBJECTIVES: That at the end of the study of the subject the students:

1. Understand the basic characteristics of an economic problem by distinguishing the problems related to macroeconomics from those related to microeconomics and the relationships between them.
2. Be able to understand the basic concepts of microeconomic analysis. I.e. Demand, supply with its determinants and the functioning of markets both perfect and imperfect.
3. Be able to understand the basic concepts of macroeconomic analysis. I.e. Are able to conceptually differentiate the relationships between different economic aggregates.
4. Be able to interpret both macroeconomic and sectoral economic reports.
5. Be able to plan and evaluate an investment project correctly.

CONTENTS:

UNIT 1. THE PRINCIPLES OF ECONOMICS. Economic models. The production-possibility frontier. Positive analysis versus normative analysis. Interdependence and gains from trade: absolute advantage and comparative advantage.

UNIT 2. PERFECT COMPETITION MODEL. Demand and demand curve. Law of diminishing marginal utility. The individual and aggregate demand curve. Relationship between price and quantity demanded. Displacement of the demand curve. Well Normal and well inferior. Substitutes and supplements.

UNIT 3. SUPPLY AND SUPPLY CURVE. The law of supply. Derivation of the supply curve. Marginal cost and profit. The offer of the company and the aggregate supply. Determinants of supply. Changes in the quantity offered and changes in the supply. Price elasticity of supply. Determinants of elasticity. Calculation of elasticity.

UNIT 4. MARKET AND BALANCE. Price and quantity of balance. Excess supply and demand. Changes in balance. Displacement of curves versus movements along curves. Surplus and welfare economics: Consumer surplus and producer surplus. Efficiency of balance.

UNIT 5. MARKET INTERVENTION: effects on welfare. Regulated prices: Effects of a maximum price and effect of a minimum price. The costs of taxation and subsidies: Tax / subsidy on producers or on consumers and Effects on efficiency and surplus. Determinants of the unrecoverable loss of efficiency: Elasticities and tax / fiscal distortion and incidence of tax / subsidy.

UNIT 6. THE COSTS OF PRODUCTION. Different cost measures. Short and long term costs. The company in a competitive market. Market Power: Monopoly. Why they arise, How they behave, Loss of efficiency.

UNIT 7. EXTERNALITIES. Positive and negative externalities. Externalities in production and consumption. Solution to externalities: Private solutions; Coase Theorem. Public policies (taxes, subsidies, regulation). Public goods and common resources. Exclusion and rivalry. The free-rider problem.

UNIT 8. MACROECONOMIC DATA. Income and expenditure of the economy. Measurement and components of GDP. Real and nominal GDP. The Consumer Price Index and the GDP deflator. Correction of economic variables to consider inflationary effects.

UNIT 9. THE REAL ECONOMY IN THE LONG TERM. Production and economic growth. Productivity: its role and its determinants. Economic growth and economic policy. Saving and Investment in national accounting. The market for loanable funds.

UNIT 10. THE MONETARY SYSTEM. The meaning of money. Money in modern economies. Banks and the money supply. The classical theory of inflation: the price level and the value of money; The supply and demand of money and the monetary balance. The inflationary tax. The costs of inflation.

UNIT 11. FORMULATION AND EVALUATION OF INVESTMENT PROJECTS. The basic elements for an investment. Stages in the formulation of an investment project. The Net Present Value. The NPV and the decision criterion. The Internal Rate of Return. The flow of funds.

45) HYGIENE, INDUSTRIAL SECURITY AND ENVIRONMENTAL CONTROL

OBJECTIVES: Acquire knowledge to identify, value and control occupational hazards. Familiarize the student in relation to their professional activity with the Health and Safety at Work Act (Law No. 19587), as well as the impact they have on the environment. Acquire knowledge to identify, assess and control environmental pollution related to industrial activity. Acquire knowledge about the laws, norms and policies in force in the labor and environmental field and their trends. Develop an integrative vision in the analysis of situations.

CONTENTS:

UNIT 1: INTRODUCTION TO THE WORKING CONDITIONS AND ENVIRONMENT (CYMAT). Evolution of the traditional conception to the renewal of the notion of the CYMAT. Risk factorS. Classification. Accidents. Incidents. Diseases of work. Work Medicine.

UNIT 2: THE PHYSICAL WORKING ENVIRONMENT. Noise and vibrations. Illumination. Thermal load. Ventilation. Ionizing and non-ionizing radiation. Your determination in work environments.

UNIT 3: CHEMICAL AND BIOLOGICAL CONTAMINANTS. Classification. Industrial toxicology.

Particles, gases and vapors. Toxic, corrosive and explosive substances. Your determination in work environments.

UNIT 4: THE WORKLOAD. Physical fatigue. Mental load The organization of work. The working day. Circadian cycle. The pace of work. The communication. The style of command.

UNIT 5: SAFETY CONDITIONS. Prevention of fire and explosion risks. Electric risk. Mechanical risk. Machines and tools. Manipulation, transport and storage of materials. Devices that develop internal pressure.

UNIT 6: PERSONAL PROTECTION ITEMS. Criteria for adoption and selection. Protection of head and eyes. Hearing protection. Respiratory protection. Protection of hands and feet. Protection of the torso and extremities. Elements of collective protection.

UNIT 7: LAWS AND NORMS IN RELATION TO THE HYGIENE AND SECURITY IN THE WORK. National health and safety at work law. National Labor Risk Law. Functions of the Superintendency of Labor Risks. Functions of the insurers of Labor Risks. Aspects of the labor contract law related to occupational health and safety. Expertise. Occupational health and safety management systems. Standard BS 8800. Standard IRAM 3800.

UNIT 8: ENVIRONMENT AND DEVELOPMENT. Population growth. Industrialization.

Urbanization. Energy. Quantification of energy use. Environmental impacts produced by the use of energy. Environmental disturbances of human origin. Acid rain. Greenhouse effect. Ozone layer destruction. Environmental Impact Assessment. Methodologies.

UNIT 9: WATER RESOURCE. Pollution and water pollutants. Indicators of contamination. Water purification process. Sewage treatment.

UNIT 10: AIR RESOURCE. Structure and composition of the atmosphere. Sources of natural and anthropogenic pollution. Types of air pollution. Primary and secondary contaminants. Control of air pollution.

UNIT 11: WASTE. Classification. Urban waste. Industrial waste. Dangerous residues. Treatment of urban waste. Management of industrial and / or hazardous waste.

UNIT 12: PROVINCIAL AND NATIONAL ENVIRONMENTAL LAWS AND REGULATIONS. Environmental management systems. ISO 14001 standard. Integration of quality management, environmental management and occupational health and safety standards.