COURSE DESCRIPTIONS

Bachelor's Degree in Civil Engineering

> ## 1st year

7357 CALCULUS

Topic 1. Real functions of real variable
Real numbers. Complex numbers. Limit of a function at a point and properties. Algebraic limits and operations. Calculation of limits. Infinity and infinite. Continuity and properties. Types of discontinuities. Theorems on continuity.

Topic 2. Derivation and applications
Concept and geometric interpretation. Derivatives and algebraic operations. Chain rule. Derivatives of some functions. Growth of a function at a point, relative ends and concavity. Theorems of derivable functions. Taylor's formula. Study and tracing of flat curves. Hyperbolic functions.

Topic 3. Calculation of primitives
Primitive of a function. Indefinite integral. General integration procedures.

Topic 4. Definite integral and applications
Definition and properties. Mean Value Theorem. Fundamental Theorem of Calculus. Barrow's rule. Change of variable. Integration by parts. Basic notions of improper integrals. Applications of the definite integral to the calculation of areas, lengths and volumes.

Topic 5. Numerical series and series of powers
Convergent, divergent and oscillating series. Geometric series. Convergence criteria for series of positive terms. Alternate series: Leibniz criterion. Any series of terms: absolute convergence. Power series: radius and convergence field. Development of a function by series of powers.

NUMERICAL CALCULUS
Topic 6. Numerical resolution of equations
Introduction. Bisection method. Iteration of fixed point. Newton's method. Secant method.

Topic 7. Polynomial interpolation

Introduction. Lagrange polynomial. Lagrange form. Newton's form: divided differences. Dimensioning the error. Segmental polynomial interpolation. Hermite interpolation.

Topic 8. Integration or numerical quadrature
The problem of the numerical square. Quadrature rules. Quadrature error. Complex integration. Complex integration rules. Error in compound rules.

7358 PHYSICS

Dimensional analysis
- Elements of dimensional analysis.
Particle mechanics
- Kinematics of the particle.
- Dynamics of the particle.
- Work and power.
- Kinematics and dynamics of particle systems.
Oscillatory and wave mechanics
- Oscillatory motion.
- Wave motion.
Fluid mechanics
- Fluid statics.
- Fluid dynamics.

7359 GRAPHICS AND COMPUTER AIDED DESIGN

METRIC GEOMETRY
Angles.
Proportionality and Power.
Geometric transformations.
Links and tangencies.
Conical curves.
Areas. Transformation in equivalent surfaces. Conditional division of surfaces.

TECHNICAL DRAWING
Object of technical drawing.
Normalization.
Application to normalized representation.
Views, cross-sections and sectional views.
Visualization: Perspective representations: axonometric, oblique projection, conic and others

CAD

Drawing entities.

Modification and edition of objects.

Layers, colors and line types.

Texts and dimension.

Presentation and printing.

7360 APPLIED GEOLOGY

Unit 1: BASIC GEOLOGY
TOPIC 1: GEOLOGIC TIME
1. Geologic time and processes in the history of the earth.
2. Geochronology: methods of dating rocks.
3. Divisions of geologic time.

TOPIC 2: STRUCTURE AND COMPOSITION OF THE EARTH
1. Physical characteristics of the earth.
2. Methods of research of the interior of the earth.
3. Structure and composition of the crust.
4. Cortical plates.

TOPIC 3: PLATE TECTONICS
1. Arguments in favor of continental drift.
2. Paleomagnetism: the final proof.
3. The concept of plate and plate tectonics.
4. Orogenies.

TOPIC 4: STRUCTURAL GEOLOGY
1. Mechanical behavior of rocks.
1.1 Theoretical behaviors and mechanical analogies.
1.2 Rock behavior in the laboratory.
1.3 Factors that influence the behavior of rocks.
2. Fragile behavior.
2.1 Coulomb-griffith failure criteria.
2.2 Mohr envelope. Influence of fluid pressure.
2.3 Creation and movement of faults.
2.4 Faults.
2.5 Joints.
3. Ductile behavior.
3.1 Fold mechanisms.
3.2 Folds.
3.3 Diapirs.

TOPIC 5: STRATIGRAPHY
1. Concept of stratigraphy.
2. Fundamental principles.

3. Objectives of stratigraphy.

4. Concept of stratum.

5. Stratification.

6. Facies.

7. Lithostratigraphic units.

8. Polarity criteria.

9. Stratigraphic sections.

10. Events in the stratigraphic record.

TOPIC 6: MINERALOGY AND PETROLOGY

1. Concept of mineral.

2. Notions of crystallography.

3. Mineral classification.

4. Concept of rock.

5. Rock classification.

6. Petrographic cycle.

Unit II: APPLIED GEOLOGY

TOPIC 7: IGNEOUS ROCKS - Classes, uses and problems

1. Concept.

2. Mineralogical composition of igneous rocks.

3. Igneous rock textures.

4. Igneous rock classes.

5. Main igneous rocks. Uses and problems in civil engineering.

* observation of igneous rocks to prepare the test exam 2
"Identification of Minerals and Rocks".

TOPIC 8: SEDIMENTARY ROCKS - Classes, uses and problems

1. Concept.

2. Mineralogical composition of sedimentary rocks.

3. Sedimentary rock texture.

4. Sedimentary rock classes.

5. Main sedimentary rocks. Uses and problems in civil engineering.

* observation of igneous rocks to prepare the test exam 2
"Identification of Minerals and Rocks".

TOPIC 9: METAMORPHIC ROCKS. Classes, uses and problems

1. Concept of metamorphism.

2 main metamorphic minerals.

3 types of metamorphism.

4 main metamorphic rocks. Uses and problems in civil engineering.

* observation of metamorphic rocks to prepare the test exam 2 "identification of minerals and rocks".

TOPIC 10: ROCK MASS

1. Weathering: mechanical, chemical, biological.

2. Discontinuities of the rock matrix: stratification, joints, faults.

3. Instabilities in the rock mass.

4. Rock mass characterization. Methodology.
5. Main geomechanical classifications.

TOPIC 11: METHODS OF GEOLOGICAL EXPLORATION
1. Indirect methods.
1.1 Photogeology and remote sensing.
1.2 Geophysical prospection: seismic, electrical, geo-radar, gravimetry.
2. Direct methods.
2.1 Geological surveys.
2.2 Exploration.
2.3 Wells.
2.4 Boreholes.

TOPIC 12: GEOMORPHOLOGY AND CLIMATOLOGY
1. Soil morphology. Climatology.
2. Analysis of drainage basins.
3. The erosion.
4. Transportation and sedimentation.
5. Rivers.
6. Civil work and geomorphology.
7. Geomorphological maps.

TOPIC 13: HYDROGEOLOGY
1. Concept of hydrogeology.
2. The presence of water in the subsoil.
3. Hydrogeological parameters.
3.1 Porosity.
3.2 Permeability.
3.3 Transmissivity.
3.4 Storage coefficient.
4. Aquifers.
4.1 Definition of aquifer.
4.2 Types of aquifers.
4.3 Water table level and piezometric level.
4.4 Geological formations such as aquifers.
4.5 Other: aquiclude, aquitard, aquifuge.

TOPIC 14: WATER IN ROCK MASS
1. Ground water.
2. Influence of ground water and works.
3. Treatment of rock mass waters.

TOPIC 15: GEOLOGY IN CIVIL WORKS
1. Dams.
2. Tunnels.
3. Open pit excavations.
4. Roads and railways.
5. Port works.

6. Channels and conduits.
7. Buildings.

Unit III: Applied Geology Practices
LABORATORY PRACTICES

- Practice 1: Calculation of directions and dips of planes. The three-pint problem. Apparent dips.
- Practice 2: Calculation of Powers and Cartographic Map of Strata.
- Practice 3: Fault problems. Calculation of Fault Jumps.
- Practice 4: Geological cross-section (4-1st part: Simple Cuts, 4-2nd part: Complex cuts)
- Practice 5: Geological History and Stratigraphic Sections
IDENTIFICATION OF MINERALS AND ROCKS: It will take place in the THEORY CLASSROOM, together with topics 6, 7, 8 and 9. Samples related to the preparation of TEST 2 will be displayed.

7361 COMPUTING IN CIVIL ENGINEERING

Unit A: Introduction to Computer science
1 Basic concepts. Information coding, computer architecture.
2 Introduction to Operating Systems.
3 Introduction to computer networks and the Internet.
4 Introduction to Programming.
5 History of Information Technology.

Unit B: Use of basic tools
6 Spreadsheets.
7 Word processing.
8 Generation of Presentations.

7362 ALGEBRA

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

Topic 2. Vector spaces and Euclidean vector spaces
Real vector space. Subspaces. -Linear combination: linear dependence and independence.
Linear -Generating system, bases and dimension. Coordinates and base change. Space of the rows of a matrix. Inner product. Standard and distance. Angles and orthogonality. Orthonormal base changes: Orthogonal matrices.

Topic 3. Linear applications

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

Topic 4. Diagonalization

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

7497 STATISTICS

Topic 1. Descriptive statistics

Statistical variable. Sample. Parameters of position, dispersion and asymmetry. Two-dimensional data analysis. Linear regression.

Topic 2. Probability and Random Variables

Events. Probability. Conditioned probability. Total Probability Theorem. Bayes' theorem. Discrete random variables. Continuous random variables. Position and dispersion measurements. Probability distribution models. Distributions associated with normal distribution.
Appendix: Combinatorial.

Topic 3. Estimation by Confidence Intervals

Random and Statistical Samples. Specific estimation. Sampling Distributions. Estimation by Confidence Intervals. Confidence intervals for the average. Confidence intervals for variance. Confidence intervals for the difference means. Confidence intervals for the variance coefficient. Confidence intervals for proportions.

Topic 4. Statistical hypothesis testing

Elements of a contrast. Parametric contrasts: hypothesis contrast for means, hypothesis contrast for variance, hypothesis contrast for the difference of means, hypothesis contrast for the coefficient of variances, hypothesis contrasts for proportions.

7363 APPLIED MECHANICS

BLOCK I. Systems of forces
THEME 1: Systems of forces
Introduction.
1.1.- Moment of a force with respect to a point.
1.2.- Moment of a force with respect to an axis.
1.3.- Characteristics of force systems.
1.3.1.- Resultant and resultant moment.
1.3.2.- System Invariants.
1.3.3.- Minimum moment and central axis.

1.4.- Types of force systems.

1.4.1.- Torque forces.

1.4.2.- Concurrent forces. Varignon's theorem

1.4.3.- Parallel forces.

1.4.4.- Coplanar forces.

1.5.- Equivalent force systems.

1.6.- Reduction of force systems.

BLOCK II: MASS GEOMETRY

Topic 2. Centres of gravity

Introduction.

2.1.- Centre of gravity of bodies.

2.2.- Static momentum of surfaces.

2.3.- Guldin-Pappus Theorem.

2.4.- Application: Distributed loads

Topic 3. Momentum of Inertia

Introduction.

3.1.- Moments of surface inertia.

3.2.- Product of surface inertia.

3.3.- Steiner's theorem. Axis transposition.

3.4.- Moment of Inertia with respect to rotated axes. Main axes of inertia.

3.4.1.- Momentum of Inertia with respect to a rotated axis.

3.4.2.- Main axes of inertia.

BLOCK III. APPLIED STATICS

Topic 4. Statics of a rigid solid body

Introduction.

4.1.- Rigid Body Concept.

4.2.- Degrees of freedom. Diminished degrees of freedom.

4.3.- Ligatures. Mechanical effects.

4.4.- Equilibrium of rigid bodies.

Topic 5. Rigid system static.

Introduction.

5.1.- Equilibrium of various solids.

5.2.- Articulated structures. Spatial and flat.

5.3.- Flat articulated structures.

5.3.1.- External, internal and overall equilibrium.

5.3.2.- Analytical methods of resolution.

Topic 6. Friction

Introduction.

6.1.- Mutual actions of contact between solids.

6.2.- Sliding friction.

Block IV: INTERNAL FORCES IN RIGID SOLIDS IN EQUILIBRIUM

Topic 7. Internal forces in solids

Introduction.

7.1.- Internal forces in a solid in equilibrium.

7.2.- Transversal section stress.

7.3.- Internal forces in a flat beam.

7.3.1.- Convention on signs.

7.3.2.- Equilibrium of a slice.

7.3.3.- Stress/strain diagrams.

7.4.- Study of beams.

Topic 8. Fundamentals of elasticity

Introduction.

8.1.- Elastic bodies. Hooke's Law.

8.2.- Longitudinal stresses.

8.2.1.- Traction and compression.

8.2.2.- Pure bending.

8.2.3.- Complex Bending.

BLOCK V: KINEMATICS AND DYNAMICS OF RIGID SOLIDS

Topic 9. Kinematics of rigid solids

Introduction.

9.1.- Kinematic rigidity condition.

9.2.- Translation and rotation motions.

9.3.- Velocity field of rigid solids.

9.4.- General motion of rigid solids.

9.5.- The field of accelerations of rigid solids**.**

Topic 10. Dynamics of rigid solids

Introduction.

10.1.- Angular moment of a solid in rotation.

10.2.- Fundamental equation of rotation dynamics around a fixed axis.

10.3.- Energetic aspects of the motion of a rigid solid.

10.4.- Rolling motion.

7364 ECONOMICS AND BUSINESS

Economy and business

Companies and economic activities.

Company and market.

Production and cost functions of companies.

Individual and market demand.

Market structure, competitive strategy and market failures

Behaviour of competitive industries.

Analysis of competitive markets.

Market imperfections: monopoly.

The construction sector

Construction markets and construction companies.

7365 DESCRIPTIVE GEOMETRY WITH 3D CAD

1. Representation Systems. Fundamentals and Geometric Relations

- Basics.

Projection methods.

Reference plans.

Measurement systems.

Perspective systems.

Representation of point, line and plane in the dihedral system and in the dimensional plan system.

Slope, module and slope.

Belonging.

Affinities between projections.

- Geometric relationships.

Intersection between planes.

Intersection between straight lines and planes.

Visibility.

Parallelism.

Perpendicularity and distances.

- CAD.

Generation of curved lines and surfaces in 3D.

Generation and manipulation of solids.

Presentation, rendering and printing.

2. Operations

Image folding, application of affinity.

Change of projection planes. Auxiliary views

Turns

As from this topic, all classes will use a CAD3D program.

3. Angles - Dihedral and Dimensioning in a simultaneous form

Angles between two lines.

Angle between straight lines and planes.

Angle between planes.

Definition of straight lines or planes that form known angles with the reference elements.

Trihedrons. Application to spherical trigonometry. Orthodromic.

4. Prismatic and pyramidal surfaces - Simultaneously dihedral and dimensioned

Straight and oblique lines.

Intersection with straight lines.

Sections by planes through the application of affinity or homology.

Developments and transformations.

5. Regular polyhedra - Dihedral and Dimensioned simultaneously

Main elements.

Dual polyhedra.

Representation of polyhedra from different data.

Main sections Singular sections.

Intersection with straight lines.

Developments. Geodesic and transformed**.**

6. Cylindrical surface -Simultaneously dihedral and dimensioned

Types. Elements.

Plane sections. Traces. Straight section.

Application of affinity.

Tangent planes**.**

Intersection with straight lines.

Developments and transformations.

7. Conical surface -Simultaneously dihedral and dimensioned.

Types. Elements.

Plane sections. Traces

Application of homology.

Tangent planes.

Intersection with straight lines.

Developments and transformations.

8. Sphere. Other surfaces - Simultaneously dihedral and dimensioned

Elements. Meridians. Parallel.

Flat sections.

Tangent planes.

Resolution given four elements (points and planes).

Intersection of straight lines.

Other surfaces.

Surfaces of revolution.

Second grade surfaces.

Ellipsoids. Hyperboloids. Paraboloids and other surfaces.

9. Intersection of surfaces

Generalities. Choice of auxiliary surfaces.

Intersection of regulated surfaces. Cone type, pyramid cylinder or prism between each other.

Intersection of polyhedron.

Determination of limit planes. Notable points

Intersection of cones, cylinders or spheres with any type of polyhedron.

10. Roofs

Elements of a roof.

Resolution of composite roofs by surface combinations.

With a line of inclined eaves, mixed and at different heights.

11. Terrains

Orographic configurations.

Lines of uniform slope.

Horizontal and inclined earthworks.

Surface agreements.

Longitudinal profile and transversal profiles. Cubication.

12. Shadows

Graphic concepts of the shadow. Virtual shadow.

Own shadows and cast from bodies.

Shadow of points or segments.

Shadow of a polygon on the planes of projection or on other planes.

Shadow of sphere or other bodies with focal or parallel light on other surfaces.

7366 MATERIALS ORIENTED CHEMISTRY

1. Introduction to chemical science

1.1 Basic concepts of Chemistry.

1.2 Stoichiometric calculations.

1.3 Study of chemical reactions.

2. Solid state and equilibria between phases

2.1 Types of solids and properties.

2.2 Solid-liquid phase diagrams.

3. Nature, behaviour and degradation of inorganic materials

3.1 Metallic materials: electrochemical corrosion, factors and methods of protection.

3.2 Other materials.

4. Nature, behaviour and degradation of organic materials

4.1 Introduction to Organic Chemistry.

4.2 Structure, properties and applications of polymeric materials.

7367 MATERIALS ORIENTED PHYSICS

Electrical and magnetic properties of matter

Electrostatics: field, potential and electrostatic properties of materials. 1.1 Electrical load. Coulomb's Law Electrostatic field. Electrostatic potential. 2.2 Electrostatic potential energy. Capacity and Capacitors. Permittivity.

DIRECT CURRENT

Electric current. Electric resistance and Ohm's law. Energy in electrical circuits. Laws of the circuits: association of resistance and Kirchhoff's Laws.

Magnetism: field and magnetic properties of materials.

Magnetic field. Effects of magnetic field. Sources of magnetic field. Classification of materials by their magnetism. Permeability.

Electromagnetic induction and alternating current

Faraday's and Lenz's Law. Self-induction Generators and engines. Series RLC circuit. Ohm's Power of an AC circuit. Transformers

Thermal properties of matter Heat and temperature

Heat and temperature

Temperature, Zeroth law of thermodynamics. Properties and thermometric scales: thermometers. Dilatation. Heat: conduction, convection, radiation. Calorimetry, heat capacity and specific heat. Phase changes. Thermodynamic equilibrium. Thermodynamic processes. Ideal gas.

First and second principles of the thermodynamics

Heat, work and internal energy. First law. Heat and ideal gas work in simple processes. Second law: thermal machines.

> ## 2nd year

7368 CONSTRUCTION MATERIALS

Topic 1. General information on Materials.
Topic 2. Rocks.
Topic 3. Lands.
Topic 4. Ceramic materials.
Topic 5. Gypsum and plaster.

Topic 6. Limes.
Topic 7. Cements. Part 1.
Topic 8. Aggregates.
Topic 9. Mortars and concretes. Part 1.
Topic 10. Metallic materials. Part 1.
Topic 11. Bituminous materials. Part 1.

7369 THEORY OF STRUCTURES

1. Effort Laws in Isostatic structures
1. - INTRODUCTION AND GENERAL REVIEW
Centres of gravity. - * Static Moment. - * Moments of Inertia. - * Steiner Theorem
. - * Other concepts
2.-ACTIONS AND EFFORTS
* General information. - * Concept of efforts. - * Forces acting in a prismatic piece:
Axial, Cutter, Bending Moments and torsion. - * System of connections and
movements. -* Isostatics and indeterminate statics.
3.- LAWS OF STRESS IN ISOSTATIC STRUCTURES.
* Support reactions and effort laws in brackets. - * Support Reactions and
efforts isostatic beam stress laws. - * Gerber Beams. -

2. Stress Analysis in flat sections
2.1. - ELASTICITY THEORY.
*Introduction The elastic solid. - * Concept of Tension. - * Tensile state in one-point environment: inner
equilibrium equations and equilibrium equations on the boundary. - * generalized Hooke's Law. - *
Relationship between landslides and Compatibility Equations. - * General approach to the problem of the
elastic body.
2.2. - INTRODUCTION TO THE STRENGTH OF MATERIALS.
* Definitions. - * Simplifying Hypotheses of Elasticity Theory. The Resistance of Materials. - * Concept of
Safety Coefficient. - * Hypothesis of calculation. - * Hooke's law. - * Compatibility conditions. - * Rethinking
the elastic body problem.
2.3. – STRESS STATE: AXIAL EFFORT.
* General definition: Traction and compression. - * Internal equilibrium Equation and
compatibility in deformations. - * Modulus of elasticity. - * Distribution of tension due to axial exertion.
2.4. – STRESS STATE: PURE FLEXION.
* General definition. Bending moment. - * Single-component bending moment. - *
Equations of equilibrium and compatibility in deformations. - * Distribution of voltages. - * Bending
moment with two components. Unsymmetrical bending. Distribution of Tensions. - * Resisting moment.
2.5. – STRESS STATE: COMPLEX BENDING.
* General definition. Overlapping of effects. - * Stress distribution. Neutral fibre. Compound tensile stress
or compression; compound flexion. - *Central core.
2.6. – STRESS STATE: SIMPLE BENDING.

* General definition. - * Relationship between bending Moment and shear force. - * Tangential stresses. Stress distribution.

2.7. – STRESS STATE: TORSION.

* The concept of the torsion moment. - * Stress distribution produced by a torsion moment. -* Analogy of the membrane. - * Torsion in thin sections: open profiles without branching, open branching profiles, closed profiles of one or more cells.

2.8. - GENERAL STATE OF VOLTAGES.

* Statement of the problem. - * Composition of tensions.

3. Deformations in Isostatic Structures.

3.1. - DEFORMATION OF AN ELEMENTAL SLICE.

*General information: Superposition Principle. - * Generalization of Hooke's Law. - * Elementary deformation produced by axial forces. - * elemental deformation produced by bending moment. - * elemental deformation produced by cutting stress
. - * elemental Deformation produced by thermal stress.

3.2.- MOHR'S THEOREMS.

*Deformation of the prismatic piece subjected to axial stress. - * Deformation of prismatic piece subjected to bending moment. - * First theorem of Mohr. - * Second theorem of Mohr. - * Deformation in brackets. - * Deformation in isostatic beams. - * Third theorem of Mohr. - Theorem of the conjugated beam.

3.3.- ELASTIC EQUATION

* Deformation Equation. -

3.4. - DEFORMATION ENERGY.

* General concept of deformation energy. - * Deformation energy by axial effort. - * deformation Energy per bending moment. - * deformation Energy by shear stress. - * Castigliano's Theorem.

4. Statically indeterminate structures

4.1. – STATICALLY INDETERMINATE STRUCTURES.

* General concepts. - * General Method of resolution of statically indeterminate structures. -

4.2. - CONTINUOUS BEAMS.

* General method of resolution. - * Theorem of the three moments.

5. Indirect actions: Decrease in support and thermal stress

5.1.- INDIRECT ACTIONS: REDUCTIONS IN SUPPORT.

* Indirect actions: Decrease in supports, supports and elastic embedding.

5.2.- INDIRECT ACTIONS: THERMAL STRESSES

* Thermal Efforts. * Constant temperature variation along the edge. - * Linear temperature Variation along the edge. * Deformation in cantilevers: Turns and slippage. - * Deformation in bi-supported beam: Rotation at the ends.

7370 HYDRAULICS

I. INTRODUCTION. PROPERTIES OF FLUIDS / INTRODUCTION. FLUID PROPERTIES

1.- INTRODUCTION

Definition. - Parts of Hydraulics. - Classification of substances: real and ideal solids, fluids (liquids and gases). - Concept of fluid. - Differences between liquids and gases. - Hypothesis of the continuous medium.

2.-PROPERTIES OF FLUIDS

Properties or characteristics of fluids. - Density. - Specific weight. - Volumetric module of elasticity. - Viscosity. - Newton's theory. - Absolute and kinematic viscosity. - Rheological diagram. - Surface tension. - Law of Laplace. - Capillarity. - Jurin's law. - Steam pressure. - Cavitation.

3.- PRESSURE

Pressure concept. - Units of pressure measurement: barye, bar, millibar, Pascal, Kp / m2, Torr or 1mmHg, mmwg, physical atmosphere, technical atmosphere. - Atmospheric pressure. - Absolute pressure. - Relative or manometric pressure. - Characteristics of the pressure in a fluid at rest in the terrestrial gravitational field.

II.- FLUID HYDROSTATICS / FLUID STATICS

4.- FUNDAMENTAL HYDROSTATIC EQUATION

Deduction. - Particularization for the terrestrial gravitational field. - Liquids. - Gases. - Distribution of pressures in a liquid. - Pascal's law. - Hydraulic press.

5.- LIQUID PRESSURES FOR A FLAT WALL

Resultant. - Coordinates of the Pressure Centre.

6.- PRESSURES OF A LIQUID ON CYLINDRICAL WALL OF HORIZONTAL GENERATRICES

Horizontal component. - Vertical component. Lines of action.

7.-PRESSURES OF A LIQUID ON CURVED SURFACES

General procedure. - Determination of the resultant and the resulting moment with respect to a point. - The Poincaré method. - Components of the resulting force. - Components of the moment with respect to the origin

III.- FLOTATION OF SOLID BODIES IN LIQUIDS / FUNDAMENTAL LAWS OF FLUIDS IN MOTION

8.- FLOTATION OF TOTALLY SUBMERGED BODIES

Archimedes' principle. - Centre of push. - Equilibrium of totally submerged bodies: stable, unstable and indifferent.

9.- FLOTATION OF PARTIALLY SUBMERGED BODIES

Concepts. - Flotation plane. - Flotation section. - Buoyancy. - Centre of buoyancy. - Flotation surface. - Surface of centres of buoyancy. - Euler's first theorem. - Dupin's theorem. - Euler's second theorem. - Metacenter. - Equilibrium of floating bodies: stable, unstable and indifferent.

IV.- FLUID KINEMATICS / VISCOUS FLOW IN DUCTS AND PIPE SYSTEMS

10.- FUNDAMENTAL CONCEPTS OF FLUID KINEMATICS

Definition of Kinematics. - Streamlines. - Pathlines. – Particle trajectory.- Pathlines. - Current surface. - Streaklines. - Control of volume concept. - Classification of regimes. - Permanent and Variable. - Uniform and Varied. - Laminar and Turbulent. - Rotational and irrotational. - Compressible and incompressible. - One-dimensional, two-dimensional and three-dimensional. - Flow or energy expenditure.

11.- CONTINUITY EQUATION

General deduction of the continuity equation. - Particularizations. - Permanent compressible flow. - Non-permanent incompressible flow. - Permanent incompressible flow. – Flux tube in a permanent regime. - Continuity equation in an elemental streamline. General flow

12.- ENERGY EQUATION FOR AN IDEAL FLUID

Fundamental equation of Hydrodynamics for an ideal fluid. Bernoulli's Trinomial.

13.- EQUATION OF THE AMOUNT OF MOTION

Equation of the amount of motion in a conduit. - Drive in a section. Average pressure. Coefficient of the amount of motion.- Equation of the dynamic according to the normal streamline. Equation of the amount of motion in an elemental streamline. Average pressure. Average pressure. Coefficient of the amount of motion.- Equation of dynamics according to the normal streamline.

14.- ENERGY EQUATION FOR AN IDEAL FLUID

Bernoulli's theorem according to a streamline.- Graphic representation of the Bernoulli's trinomial following a current line.- Application of Bernoulli's Theorem to the motion of an incompressible fluid in conduits.- Coriolis Coefficient.- Power of a liquid stream in a section.- Power of Hydraulic machinery.- Pump.- Turbine.

V.- FLOW IN PIPE

15.- PERMANENT AND UNIFORM MOTION OF LIQUIDS IN CONDUITS.

Working hypothesis.- Deduction of the equation.- Power slope.- Average tangential stress in the boundary.- Hydraulic radius.

16.- REYNOLDS' EXPERIMENT. LAMINAR AND TURBULENT MOTION

Reynold's experiment- Laminar and turbulent motion.- Representative parameter of the phenomenon.- Reynold's number.

17.- LAMINAR MOVEMENT. DETERMINATION OF LOSS OF UNITARY LOAD.

Working hypothesis.- Deduction of the Hagen-Poiseuille equation.- Laminar motion.- Average speed.- Power slope.- Tangential stress distribution.- Coefficient of the amount of motion.- Coriolis coefficient

18.- BASIC NOTIONS ON THE THEORETICAL STUDY OF TURBULENT MOTION.

Boussinesq theory of viscosity.- Prandtl's Mixing length model.- Prandtl's boundary layer theory.- Boundary layer concept.- Importance of the concept.- Evolution or development of the boundary layer.- Laminar boundary layer.- Turbulent boundary layer.- Viscous sublayer.

19.- CONTINUOUS LOSS OF LOAD IN PIPES. TURBULENT MOTION

Fundamental concepts of dimensional analysis. Vaschy–Buckingham π. Darcy-Weisbach equation. Absolute and relative roughness. Coefficient of friction.- Hydrodynamic criterion to determine if a tube is smooth or rough.- Distribution of speeds in a cross section under
turbulent regime.- Influence of roughness.- Equations of coefficient of friction f.- Blasius.- Nikuradse's experiences.- Theories of Karman and Prandtl.- Colebrook-White equation.- Moody's abacus.- Standard Problems.- Empirical formulas used for the calculation of pipes.- Advantages and disadvantages compared to the Blasius.- Turbu-slow rough: Manning.- Intermediate Hazen-Williams.- Relations between the diameter, the load loss and the
flow.- Average speed.- Aging of pipes.

20.- LOAD LOSSES LOCATED IN PIPES

General expression.- Equivalent length.- Number of equivalent diameters.-
Abrupt widening.- Input into a tank.- Gradual widening (diffusers). - Abrupt narrowing.- Mouth.- Gradual narrowing (nozzles) .- Elbows: rounded and mitered.- Branches: joints and bifurcations.- Valves: seat, sphere, gate, butterfly, retention.

21.- PIPLINE SYSTEMS

Simple pipe with key or nozzle at its end: service at the end.- Siphon.-Simple piping with intermediate derivation.- Simple piping with several branches.- Operation of the pipes.- Positions of the piezometric line with respect to the conduction.- Cavitation phenomenon in a pipeline. Pipe that distributes a uniformly distributed flow. Branched pipes.- Pipe with intermediate tap supplied by two tanks. - Branched pipes connected to tanks at different elevations.- The three tank problem. Pipes in series.- Equivalent pipe method.- Pipes in parallel.- Percentage method.- Flow adjustment in closed distribution networks. - Cross method.

VI.- FLOW IN OPEN CHANNELS
22.- FREE REGIME. INTRODUCTION

Introduction.- Liquid currents in open channels.- Free regime.- Channel cross- section.- Basic nomenclature.- Types of flow.- Distribution of speeds in a cross-section.- Isotach.- Pressure distribution.- Fundamental concepts in the study of channels.- Energy at a point in the cross-section.- Average current power.- Average energy.- Specific energy.- Energy losses per unit of length.

23.- UNIFORM MOTION IN CHANNELS

Characteristics of the uniform regime.- General equation of uniform motion in channels.- Empirical formulas.- Chézy.- Ganguillet-Kutter.- Bazin.- Darcy-Weisbach.- Manning.

24.- TYPES OF SECTIONS IN CHANNELS

Most common forms of sections.- Rectangular.- Trapezoidal.- Triangular.- Circular.- Parabolic.- Ovoid.- Mixed.- Capacity curve of a channel in uniform regime.- Flow in composite sections.- Optimal hydraulic section.- Optimal rectangular.- Optimal trapezoidal.- Composite sections.

25.- SLOW, CRITICAL AND RAPID REGIME

Varied motion.- Gradual and rapidly varied motion.- Normal draft.-Critical draft.- Variation of the specific energy with the draft at constant flow rate.- Current regime and Froude number.- Slow, critical and fast regime.- Variation of the flow with the draft at constant specific energy.- Variation of the draft with channel width.

26.- RAPIDLY VARIED REGIME - HYDRAULIC JUMP

Critical slope.- Transitions through critical draft in permanent regime.- Stationary hydraulic jump.- Jump equations in rectangular channel.- Conjugated drafts.- Loss of energy.- Length of jumps.- Behaviour of the jump according to the downstream draft.

27.- GRADUALLY VARIED REGIME - BACKWATER CURVE

Backwater curve concept.- Determination of the backwater curve by finite differences.- Classification of backwater curves.

28.- ORIFICES, GATES AND SPILLWAYS

Thin wall orifice. Torricelli's formula.- Coefficient of speed, contraction and drainage.- Loss of load in an orifice.- Large hole or small load.- Submerged orifice.- Drainage under gate.- Orifice in a thick wall.- Classification of spillways.- Free and submerged sheet.- Thin wall and thick wall.- With and without lateral contraction.- Normal, inclined, broken ... .- Thin wall weir with free sheet.- Rectangular without lateral contraction.- Rectangular with lateral contraction.- Triangular.- Trapezoidal.- Submerged thin wall weir.- Spillway in strict profile.- Creager profile.- Thick wall spillway.

VII.- LABORATORY PRACTICES

Session 1.

Properties of fluids. Verification of the Archimedes' Principle. Hydrostatic thrust on a surface plane. Pressure practices.

Session 2

Jet impact on surface. Flow measurement. Demonstration of Bernoulli's theorem.

Session 3

Pipe panel: friction losses. Pipe panel: Localized losses. Discharge through orifice.

Session 4

Thin wall weir study: Triangular weir. Variable slope channel.

Session 5

Numerical modelling of pipeline charges.

7371 CALCULUS II

CALCULATION OF MULTI-VARIABLE FUNCTIONS

Topic 1. Multi-variable functions - Differential calculus

Basic definitions. Real function of several variables. Limits and continuity. Partial derivatives. Differentiation. Tangent plane to a surface at a point. Vector functions of several variables. Chain rule. Relative extremes. Absolute extremes. Conditioned extremes.

Topic 2. Multiple Integrals - APPLICATIONS

Double integrals: geometric interpretation and variable change. Triple integrals. Variable change. Plane and spatial applications: centres of mass and moments of inertia. Momentum of Inertia.

DIFFERENTIAL EQUATIONS

Topic 3. First-order differential equations

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

Topic 4. First-Order Differential Equations

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

Topic 5. Complete Linear Differential Equation Systems

Basic concepts. Homogeneous linear SODE. Complete linear SODE.

7373 TOPOGRAPHY

1.- Introduction to Topography.

1.1.- Notions of Topography.

1.2.- Notions of Geodesy.

1.3.- Notions of Cartography.

1.4.- Topographic concepts.

2.- Measurement units and topographic representation systems.

2.1.- Units of measure. Angles. Scales.

2.2.- Representation systems.

2.3.- Errors.

3.- Topographic instruments.

4.- Surveys. Topographic methods.

4.1.- Altimetric methods.

4.2.- Planimetric methods.

4.3.- Tachometry.

5.- Topographic applications to engineering projects.

6.- Lay outs.

7376 CONSTRUCTION MATERIALS II

Topic 1.
Cements. Part I.
Topic 2.
Mortars. Part I.
Topic 3.
Concrete. Part I.
Topic 4.
Metallic materials. Part I.
Topic 5.
Bituminous materials. Part I.
Topic 6.
Plastics.
Topic 7.
Wood.

7377 ELECTROTECHNICS

UNIT 1: ELECTRICAL CIRCUITS
TOPIC 1: ELECTRICAL CIRCUIT THEORY.
TOPIC 2: ALTERNATING CURRENT CIRCUITS.
TOPIC 3: THREE-PHASE CIRCUITS.

UNIT 2: ELECTRICAL MACHINES
TOPIC 4: GENERAL PRINCIPLES OF ELECTRICAL MACHINES.
TOPIC 5: TRANSFORMER.
TOPIC 6: ASYNCHRONOUS OR INDUCTION MACHINES.
TOPIC 7: SYNCHRONOUS MACHINES.
TOPIC 8: DIRECT CURRENT MACHINES.

UNIT 3: ELECTRICAL INSTALLATIONS
TOPIC 9: ELECTRIC ENERGY SYSTEMS.
TOPIC 10: ELECTRICAL TECHNOLOGY.

UNIT 4: LABORATORY PRACTICES
PRACTICE 1: NOTIONS OF ELECTROMETRY.
PRACTICE 2: ELECTRICAL ELEMENTS.
PRACTICE 3: MEASUREMENT OF CURRENT, VOLTAGE AND POWER.
PRACTICE 4: CHECKING LAWS AND THEOREMS.

PRACTICE 5: ALTERNATING CURRENT CIRCUITS.
PRACTICE 6: THREE-PHASE CIRCUITS.
PRACTICE 6: TRANSFORMERS.
PRACTICE 8: ASYNCHRONOUS OR INDUCTION MACHINES.
PRACTICE 9: DIRECT CURRENT MACHINES.
PRACTICE 10: ELECTRICAL TECHNOLOGY.

7378 CAD APPLIED TO CIVIL ENGINEERING

Introduction to CAD environments
Coordinates, scales, formats, plans, etc. Design management.
Introduction to graphic design environments
General concepts.
Design of 3D objects.
Assemblies.
Presentation, plans, video, etc.
Introduction to cartographic environments
General concepts.
Cartography servers.
Data download and WMS connections.
Definition of 3D geometries applied to Civil Engineering.

7379 ENVIRONMENTAL CONCEPTS IN CIVIL ENGINEERING

1. Ecological balance
2. The water.
Composition, pollution and indicative parameters. Water Treatment. Air quality criteria.
3. The atmosphere
Regions and composition. Air pollution. Control of atmospheric contamination. Quality criteria
4. Soil and waste
Soil pollution. Characteristics and management of different types of waste

7380 SUSTAINABLE DEVELOPMENT IN CIVIL ENGINEERING.

1. Introduction.
2. Sustainable Human Development.
3. Environmental Dimension of Sustainable Development.
4. Sustainability in Engineering.

7381 ELECTRICAL INSTALLATIONS

UNIT 1: ELECTRICAL ENERGY

TOPIC 1: ELECTRIC ENERGY SYSTEMS.

UNIT 2: ELECTRICAL ENERGY SYSTEMS

TOPIC 2: ELECTRIC LINES.

TOPIC 3: ELECTRICAL ASSEMBLY.

UNIT 3: INSTALLATIONS OF ELECTRICAL SYSTEMS

TOPIC 4: CONNECTION INSTALLATIONS.

TOPIC 5: GROUNDING INSTALLATIONS.

UNIT 4: PROTECTIONS AND ELECTRICAL SAFETY

TOPIC 6: PROTECTION OF THE ELECTRICAL FACILITIES.

TOPIC 7: SAFETY IN THE ELECTRICAL FACILITIES.

UNIT 5: ELECTRICITY BILLING

TOPIC 8: BILLING OF ELECTRICAL ENERGY.

UNIT 6: ELECTRICAL PROJECTS

TOPIC 9: PROJECTS OF ELECTRICAL FACILITIES.

UNIT 7: LABORATORY PRACTICES

PRACTICE 1: NOTIONS OF ELECTRICAL FACILITIES.

PRACTICE 2: ELECTRICAL CABLES.

PRACTICE 3: ELECTRICAL ASSEMBLY.

PRACTICE 4: CONNECTION INSTALLATIONS.

PRACTICE 5: GROUNDING INSTALLATIONS.

PRACTICE 6: MEASUREMENT OF ELECTRICAL ENERGY.

7382 RENEWABLE ENERGIES

Topic 1. Resources, plants and environment
Topic 2. Solar radiation
Topic 3. Solar Thermal energy
Topic 4. Photovoltaic energy
Topic 5. The aeolian energy
Topic 6. Hydraulic power
Topic 7. The era of hydrogen

7383 HISTORY OF CIVIL ENGINEERING

1) Civil engineering and society.
2) Brief history of civil works in Spain.
3) Civil engineering beyond the technique: aesthetics, landscape, heritage and territory.

4) Some civil engineers. Their facts and sayings.

5) History of the energy and infrastructures and power facilities

6) History of public construction works.

7) History of maritime, harbour and lighthouse works.

8) History of land transport.

9) Bridges throughout history.

10) Singular structures. Historical examples.

7386 GEOLOGICAL FIELDWORK

UNIT 1: REGIONAL GEOLOGICAL HISTORY

Topic 1: Geological History

1. - Reconstruction of the geological processes that occurred in an area based on a geological cross-section or a geological map.

2. - Survey of stratigraphic columns based on a geological cross-sections.

UNIT 2: GEOLOGICAL CROSS-SECTIONS

Topic 2: Geological cross-sections: basic concepts

1. - Making of a geological cross-section of a zone based on the data offered in a geological map.

2. - Preparing geological cross-sections from simple maps.

3. – Preparing geological cross-sections from complex maps.

Topic 3: Geological Cross-sections: practical applications

1. - Reconstruction of layouts of tunnels from geological maps and geological cross-sections.

2. - Modification of layouts based on reconstructed geology.

UNIT 3: GEOLOGICAL SURVEYING

Topic 4: Geological Surveying.

1. – Field survey of Geological Columns.

2. - Geological mapping based on data obtained in the field.

3. - Structural Analysis of a rocky massif.

UNIT 4: GEOLOGICAL EXPLORATION

Topic 5: Photogeology.

Interpretation of photographs and stereoscopic images.

Topic 6: GEOPHYSICAL PROSPECTION

Geophysical prospecting by electrical and seismic refraction tomography.

7387 WORKPLACE ACCIDENT PREVENTION

1.- Prevention of Occupational Risks. Conceptual and normative framework

Work and health: professional risks. Damages resulting from work. Working conditions, risk factors and preventive techniques. Statistics of regulatory framework in matters concerning risk prevention in the workplace. Rights and risk prevention at work in Spain and the European Union.

2.- Specialties of the Risk Prevention in the workplace

Physical, Chemical and Biological Agents. Physical Load and Mental Load. Design of Posts.
Static and Dynamic Anthropometry. Manual handling of loads and the MSDs. Data Display Screens. Visual ergonomics and chromatic environment. Thermal Ergonomics and Vibrations.

3.- Risk-prevention promotion and techniques

Analysis and verification of training and information. Communication techniques, negotiation motivation. Risk Assessment. Main Methods. WT Fine Method, JSA Management Systems. Foundation, object and field of application.

➤ 3rd year

7396 GIS AND COMPUTER APPLICATIONS IN TOPOGRAPHY AND CARTOGRAPHY

1.-CARTOGRAPHY ON THE NET: DOWNLOAD

1.1. Download.
1.2. Management.

2.-COMPUTER TREATMENT OF TOPOGRAPHIC DATA

2.1. Data dump.
2.2. Data editing.
2.3. Modelling: TIN, DEM, etc.
2.4. Civil engineering: geometric design.
2.5. Lay outs.
2.6. Measurements
2.7. Photorealism.

3.- METADATA SERVERS

3.1. Concepts.

3.2. Operations.

3.3. Connections.

4.- GEOGRAPHIC INFORMATION SYSTEMS

4.1. General concepts: Context.

4.2. QGIS: interface, views, tables: edition.

4.3 Datum, prj files.

4.4. Connections to metadata servers.

4.5. Files: shp, dbf, shx, jpgw, asc, geotiff, ecw, dwg, etc.

4.6. Spatial queries.

4.7. Digital Models of the Land.

4.8. Operations with files: geoprocesses with vector files and raster files.

4.9. Maps.

4.10. Application algorithms: QGIS, SAGA, GRASS, etc.

4.11. Application of GIS in civil engineering

7398 PROCEDURES AND CONSTRUCTION MACHINERY

Procedures and Construction Machinery.

TOPIC 1. Earth movements.

TOPIC 2. Transportation and laying concrete.

TOPIC 3. Transportation and application of bituminous mixtures.

TOPIC 4. Execution of rigid and flexible pavements.

TOPIC 5. Execution of foundations.

TOPIC 6. Machinery for the treatment of the soil.

TOPIC 7. Machinery for railway works.

TOPIC 8. Machinery for underground works: tunnels.

TOPIC 9. Auxiliary equipment for construction.

> ➤ **4th year**

7404 CIVIL ENGINEERING PROJECTS

BLOCK I. STRUCTURE OF A PROJECT

Project Documents.

Report and appendices.

Plans.

Statement of specific technical requirements.
Budget.

BLOCK II. VALUATION OF PROJECTS AND WORKS

Valuation of works.

Study and justification of labour costs.

Study of on-site materials.

Study of the machinery and facilities for on-site use.

Break-down of unitary prices.

Earth works.

Masonry works.

Firming up.

Block III. MEASUREMENT OF WORKS PROJECTS

Practical measurement on the plan.

Soil volume estimation.

Measurement of masonry jobs

7412 COMPUTER AIDED SIMULATION OF URBAN TRAFFIC

1. Computer Applications for the Layout of Linear Works.

2. Digital Models of the Land.

3. Layout of the axis in plant.

4. Alignment of the axis in elevation.

5. The cross section.

6. Plans: of plant, longitudinal profiles, and transversal profiles.

7. The calculation of volumes and surfaces.

8. Listings of the plant axis, section, grades, profiles, visibilities, …

9. Advanced layout representation.

7413 GROUND IMPROVEMENT

1. INTRODUCTION ON TERRAIN IMPROVEMENT METHODS.

2. DESIGN OF VARIOUS METHODS OF IMPROVING THE TERRAIN.

2.1. Preloading or precompression.

2.2. Vibro-substitution.

2.3. Other methods.

7415 ADVANCED SOIL MECHANICS

1. INTRODUCTION TO BEHAVIOR MODELS.
2. COMPUTER APPLICATIONS TO GEOTECHNICS.
2.1. Plaxis 2D.

2.2. Geoslope.

7416 FUNDAMENTALS OF URBAN SERVICES

Introduction to Urban Services.
Urban Needs.
Types and Classes of Urban services.
The Residential Urban Activity.
The Urban Industrial Activity.
The Tertiary Urban Activity.
Coordination of Urban Services.
Introduction to design and layout.

7417 LIGHTING TECHNOLOGY

UNIT 1: LIGHTING CONCEPTS
TOPIC 1: FUNDAMENTAL CONCEPTS.

UNIT 2: LIGHTING EQUIPMENT
TOPIC 2: ELECTRIC LAMPS.
TOPIC 3: ELECTRIC LUMINAIRES.
TOPIC 4: AUXILIARY EQUIPMENT.

UNIT 3. LIGHTING SYSTEM
TOPIC 5: BASES OF LIGHTING DESIGN.
TOPIC 6: INTERIOR ILLUMINATION.
TOPIC 7: PROJECTION LIGHTING.
TOPIC 8: ROAD LIGHTING.
TOPIC 9: TUNNEL LIGHTING.
TOPIC 10: LIGHTING FACILITIES.

UNIT 4: LABORATORY PRACTICES
PRACTICE 1: LIGHTING ENGINEERING NOTIONS.
PRACTICE 2: ELECTRIC LAMPS.

PRACTICE 3: ELECTRIC LUMINAIRES.
PRACTICE 4: AUXILIARY EQUIPMENT.
PRACTICE 5: INTERIOR ILLUMINATION.
PRACTICE 6: INTERIOR ILLUMINATION.

7418 NEW MATERIALS IN CONSTRUCTION

New Materials.
Topic 1 - Introduction to the New Materials.
Topic 2 - Sustainable materials. Recycling of Construction materials.
Incorporation of waste.
Topic 3 - Special mortars.
Topic 4 - Special Concrete.
Topic 5 - Molten asphalt.
Topic 6 - New tendencies in bituminous materials.
Topic 7 - Advanced metals.
Topic 8 - New plastics.
Topic 9 - Other new materials.
Topic 10 - Other advances in construction materials.

7419 CONSTRUCTION OF HYDRAULIC WORKS

Fluvial activities.
Dam building.
Deposits, pipelines and irrigation.
Hydroelectric power plants.

7420 MANAGEMENT OF PORTS

1.- Maritime Transport in the European and Global Context.
2.-Ports and Maritime Policy.
3.-Vessels.
4.-Maritime Port Operations.
5.- Users of Maritime Transport
6.- Port Design and Planning.

7421 MARITIME WORKS

Dynamics of oceanic water bodies

> Physico-chemical characteristics of water.

> Oceanic water bodies.

> Variations in mean sea level.

> Oceanic Dynamics.

Waves and surge / Coastal waves and wave transformation

> Characteristic magnitudes of waves.

> Classification of waves by depth.

> Wave Equations.

> Wave propagation: phenomena in the propagation of waves.

Surge Characterization / Wave prediction

> Sources of information.

> Description of the Short-Term Surge.

> Description of the Long-Term Surge. Extreme characterization.

> ROM program.

EXTERNAL MARITIME WORKS / MARITIME STRUCTURES

Classification of External Maritime Works / Classification of maritime structures.

> Classifications.

> Stages in the process of design of a protection structure.

> Typological characteristics of maritime structures.

Slope Dam / Rubble-mound slopes

> Parts of the sloping face of a Dock.

> Advantages and disadvantages.

> Elements and Constructive Process.

> Breakdown criteria and damage parameter.

> Dimensioning of the main mantle and the filters.

> Sizing of submerged faces.

> Emerged components of dock face. The Shoulder.

Vertical and Mixed Dams / Vertical breakwaters

> Types of Vertical Wall Dams.

> Parts of a Dock Face.

> Constructive process.

> Advantages and Limitations.

> Failure modes.

> Calculation: Structural stability.

COASTAL ENGINEERING

The coast and its process.

> Definition and Classification of coasts.

> Sedimentary balance. Sea level oscillations.

> Coasts Law (Law 22/88 and Regulation 1471/89).

> Coastal forms.

7422 INDUSTRIALIZED CONSTRUCTION

1. Organization of management and conservation.

2. Deteriorations of pavements.

3. Auscultation and control of pavements.

4. Ordinary conservation actions.

5. Pavement rehabilitation. Recycling.

6. Pavement management systems.

7. Road infrastructure operation.

7425 TRANSPORTATION OF MATERIALS, INTERMODALITY AND LOGISTICS

Transportation of goods

1. Introduction to the Transport of Goods. General information.

2. Planning and Modelling of the Transport of Goods.

Intermodal transport

3. Intermodal transport. Concepts and main typologies.

4. Transport Terminals: Ports, Airports and Railway Stations.

5. Modal exchange logistic centres.

Transport logistics

6. Introduction to Transportation Logistics

7. Logistics of the Transport of Goods. Road, rail and combined
Transport.

8. Logistics of the Transport of Goods. Economic management of road
transport fleets.