Module Handbook

Bachelor's degree in Mechanical Engineering

Faculty of Exact Sciences and Technology

National University of Tucumán

Argentina

Last revision: February 2023

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Modules

CALCULUS I

OBJECTIVES:

That the student achieves the formation of a system of knowledge and skills in Differential Calculus of one variable, developing the capacity for abstraction, reasoning and application of knowledge in the resolution of exercises and problems.

HOURLY LOAD:
Total hours: 96 hours
Total hours of applied problem solving: 32

CONTENTS:

- **THEMATIC UNIT 1: ELEMENTARY NOTIONS OF LOGIC**
  Propositions. Truth Tables. Equivalence of propositions. Propositional functions. Quantifiers: Existential and Universal.
- **THEMATIC UNIT 2: NUMBERS**
  Basic properties of the natural numbers. Extensions from the natural numbers to the real numbers. The real numbers: Ordering. Intervals. Inequalities. Correspondence between the real numbers and points on the number line.
- **THEMATIC UNIT 3: FUNCTIONS**
  Definition; graphical representations. Classification of polynomial, rational, transcendental functions. Trigonometric functions. The algebra of functions: addition, subtraction, multiplication, quotient. Composition of functions Inverse function. Inverse trigonometric functions.
- **THEMATIC UNIT 4: LIMITS AND CONTINUITY**
  Limit of a function. Intuitive notion of limit. Definition of limit. Theorems on the limit of functions. Lateral limits. Limits of trigonometric and inverse trigonometric functions. Fundamental trigonometric limit. Generalisations of limit to infinite cases
- Continuous functions. Fundamental properties of continuous functions. Discontinuities; different types of discontinuities. Asymptotes: vertical and horizontal.
- **THEMATIC UNIT 5: DERIVATIVES**
  Definition of tangent line of a curve at a point on the curve. The derivative of a function. Geometric and physical interpretation of the derivative. Lateral derivatives. Derivability and continuity. Derivative rules. Derivative of trigonometric functions. Derivative of the composite function. Higher order derivatives. Derivative of the inverse function. Derivative of inverse trigonometric functions. Implicit derivative. Rate of change. Differential.
- **THEMATIC UNIT 6: THEOREMS OF DIFFERENTIAL CALCULUS**

Rolle's Theorem and Mean Value Theorem. Increasing and decreasing functions. Criterion for increasing and decreasing functions. Indeterminate forms. Bernoulli - L'Hôpital rule.

- **THEMATIC UNIT 7: APLICATIONS OF THE DERIVATE**
  Relative and absolute maximum and minimum values of a function. Necessary condition for the existence of a relative extrema. Sufficient condition. Optimisation problems. Concavity and inflection points of a curve. Application in curve tracing.
- **THEMATIC UNIT 8: POLYNOMIAL APPROXIMATION OF FUNCTIONS**
  Mac Laurin's polynomial and Taylor's polynomial. Taylor's Theorem. Lagrange's form of the remainder. Error estimation.

ANALYTICAL DESCRIPTION OF PRACTICAL ACTIVITIES:

The practical assignments are structured in such a way that they contain:

1) Exercises that contribute to the assimilation of theoretical knowledge, and
2) Exercises to reinforce the following mathematical procedures: graphing, interpretation, calculation, identification, approximation and,
3) Exercises to model problem situations and solve them.

Students carry out some of the exercises in the practical class itself, individually or in groups, sometimes at the blackboard, under the supervision of the professor. There are also exercises, which the professor solves on the blackboard, with the active participation of the students.

4) The chair offers tutoring hours, which are used by students to ask questions or to check the resolution of exercises in the practical assignments and the texts.

BIBLIOGRAPHY:

- Calculus with Analytic Geometry – Vol. 1 - Larson, Roland E. Hostetler, Robert P. Edwards, Bruce H. – 1989.
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- Calculus I with Analytic Geometry Vol I - Larson, Roland E. Hostetler, Robert P. Edwards, Bruce H.- Mc Graw – Hill – 2006.

Methodology and form of evaluation:

- The assessment of the curricular activity is carried out in the manner established by the regulations in force. To be able to writte the final exam, the student must attend at least 80% of the practical classes and pass two mid-term exams. In case of failing one or both of them, a second opportunity is offered for each of them. Once this is achieved, the student must pass a final oral exam, which is a comprehensive evaluation of the content of the subject, within twelve months of course completion.
- Students who do not achieve completing the regular track of the course have the opportunity to directly request a final exam on the two dates established by the chair: the last date of the July-August and February-March shifts. In order to pass this examination, the internal regulations of the Faculty require the passing of two written exams on the practical content with a grade of at least 7. This is followed by the oral examination.

ALGEBRA AND ANALYTIC GEOMETRY

OBJETIVES:

That the student: Acquires skills in the handling of vectors in R^n, studies conics, deduces their properties, identifies and graphs lines and surfaces in R^3, acquires competences on complex numbers and their applications in engineering problems.

Hourly load: 96 horas
Total hours of applied problem solving: 32

CONTENTS:

THEMATIC UNIT 1: VECTORS
Vectors in R^n : Definition. Equality. Addition. Product by a scalar. Properties. Scalar product. Parallelism. Orthogonality. Norm or modulus. Angle between vectors. Orthogonal vector projection and scalar projection. Vector product. Double mixed product. Properties.

THEMATIC UNIT 2: APPLICATIONS OF VECTORS
Applications of Vectors to Analytic Geometry: Vector, parametric and Cartesian equations of the line. Straight line through two points. General and segmental equation of the line in R^2. Angle between two straight lines. Parallelism and orthogonality of straight lines. Vector and Cartesian equation of the plane. Parallelism and orthogonality of planes. Parallelism and orthogonality between lines and planes. Distances.

THEMATIC UNIT 3: CONICS
Conics: Circumference - Ellipse - Hyperbola - Parabola. Definition. Canonical and General Equation of conics with axes parallel to the coordinates. Properties of the conics. Tangent line to a conic. Rule of unfolding.

THEMATIC UNIT 4: SURFACE AND LINE VECTORS
Surface and Line: Definition. Conical Surfaces. Cylindrical Surfaces. Quadric: Spherical Surfaces - Ellipsoid - Single and double sheet hyperboloids - Paraboloids.

THEMATIC UNIT 5: COMPLEX NUMBERS
Complex Numbers: Definition. Operations. Properties. Binomial form. Conjugate. Properties. Modulus. Properties. Polar form. Power and Radication of complex numbers. Exponential Form.

ANALYTICAL DESCRIPTION OF THEORETICAL AND PRACTICAL ACTIVITIES:

THEORETICAL PRACTICAL LESSONS: The necessary theoretical aspects are developed and problems of application of each topic are solved.
PRACTICAL LESSONS: The student works with printed material, provided by the professors in charge of the subject, with which it is intended that they will be able to consolidate the new concepts acquired. This material is a booklet with the problems to be developed in the practical classes and additional problems to be solved by the student in an autonomous way and which can then be discussed in the consultation hours. The practical classes are compulsory.
Tutoring hours are organised outside class hours so that students can clear up any doubts about theoretical and practical aspects.
The student is provided with printed material containing the analytical syllabus, approval system, teachers involved in the teaching. Chalk and blackboard are used for teaching.

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Geometría Analítica del Plano y del Espacio y Nomografía - Donato Di Pietro - Alsina- Buenos Aires – 1975.
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Algebra lineal - Kolman, Bernard; Hill, David R. - Pearson Educación-Prentice Hall. - 2006.

Methodology and form of evaluation:

The evaluations make it possible to quantify the degree to which students have acquired and can manage the knowledge. In order to pass the course, students must pass two written mid-term exams consisting of four or five practical exercises, each of which can be rewritten only once. They are taken in the 8th and 16th week respectively.

In order to pass the course, students must take a final conceptual and integrative exam. They take this final oral or written exam once they have passed the curricular activity. The student has two hours to take it.

The requirements to pass the course and conditions of approval are known by the students on the first day of classes of the term and are published in the practical work booklet.

SYSTEMS OF REPRESENTATION

OBJECTIVES

Learn to represent and interpret simple and complex volumes, both of plane faces and surfaces of revolution. Acquire knowledge of Descriptive Geometry to tackle structural design problems. Know the standards for representation

HOURLY LOAD

Total hours: 80
Total hours of applied problem solving: 48

ANALYTICAL PROGRAMME

1. INTRODUCTION

1.1. Knowledge of the tools to be used in drawing: paper, hardness of leads, etc. Usual scales. Calligraphy.

2. PROJECTIONS

2.1. Representation systems: Monge's method. American system.

2.2. Projections with visible models. Elementary solids with flat faces formed from a cube (1:1:1), from a prism with a square base (1:1:2) and a parallelepiped (1:2:4).

2.3. Projections without models in sight. Given two projections of flat-faced solids, alone or as a set, execute the other projections indicated.

3. PERSPECTIVES

3.1. Different types of perspectives and their choice for the representation of a volume.

3.2. 7°, 42° and vertical dimetric perspective without model in view. Standards.

3.3. Dimetric projections and perspectives of solids with flat faces treated previously, alone or forming sets. From two projections, make the projections and perspectives indicated. Similarly with polyhedral bodies of different proportions to those mentioned in 2.2.s

3.4. Notions of NOTCHES. Prismatic portions that are withdrawn from a single overlapping or non-overlapping end. Notches from opposite ends that cross each other. Projections and perspectives.

4. BODIES WITH CURVED SURFACES

4.1. Circumference and circle: their representation in 7°, 42° and vertical dimetric perspective. Standards.

4.2. Projections and perspectives of the straight circular cylinder. Similarly for the right circular cone. Perspectives made in all possible positions, using axes in perpendicular positions to the projection planes.

4.3. Application exercises with solids with of revolution, formed by cylindrical, conical and flat surfaces.

4.4. Similarly for bodies with two perpendicular axes, coplanar or not.

4.5. Representation in projections and in dimetric perspective of the sphere Application exercises: Solids with axes of revolution in three perpendicular directions in space, bounded by cylindrical, conical, spherical and flat surfaces.

5. BODY SECTIONING

5.1. Sectioning by means of planes perpendicular to one of the projections of polyhedral bodies. Projections and perspectives.

5.2. Sections of the cylinder, the cone and the sphere by means of oblique planes. Obtaining the ellipse, the hyperbola and the parabola. Projections and dimetric perspectives.

6. INTERSECTIONS OF SURFACES OF REVOLUTION

6.1. Cylinder with cylinder: Projections and perspectives. Applications. 6.2.

Cylinder with cone: Projections and perspectives. Applications.

6.3. Cylinder with sphere: Projections and perspectives. Applications.

7. CUTS THROUGH PARTS

7.1. Sections: Broken, folded, auxiliary, detail, rotated, offset, etc. Standards.

8. NOTIONS OF DESCRIPTIVE GEOMETRY

8.1. Representation of the point, line, plane and volume in the first quadrant. General and special positions.

8.2. Changes of projection planes. Visibility. Problems: Determination of true magnitudes of straight lines, plane surfaces, plane and dihedral angles. Perpendicularity and distances between point and line, parallel and warped lines, and between point and plane. Intersections between straight lines and planes, and between planes and each other. Developments.

8.3. Choice and execution of auxiliary first and second order views. Representation of bodies in necessary and sufficient projections according to Standards.

9. INTRODUCTION TO ASSISTED DESIGN

PROGRAM OF PRACTICAL WORK

Practical Work Nº 1: Line Drawing Training
Practical Work Nº 2: Freehand drawing, practice of projections on a plane. Proportions.
Practical Work Nº3: Calligraphy Practice.
Practical Work Nº4 and 5: Drawing four projections of a body with a model in view.
Practical Work Nº6: Drawing the projections of a set of two superimposed bodies

(model in sight).

Practical Work Nº7**:** Drawing the projections of a set of two juxtaposed bodies

(model in sight).

Practical Work Nº8: Making standardised labelling.

Practical Work Nº9 and 10: Drawing the perspective of a body of a model at sight. 7º to the left and to the right.

Practical Work Nº11, 12 13 and 14: Solve the third projection and draw a perspective of a body, given in two projections.

Practical Work Nº15 and 16: Solve the third projection and draw a perspective of a set of two bodies, given in two projections.

Practical Work Nº20 and 21: Solving the third projection, sectioning and drawing a perspective of a body, given in two projections.

Practical Work Nº22: Solve the third projection, the sectioning of one of them and draw a perspective of a set of two bodies, given in two projections.

Practical Work Nº23**:** Descriptive Geometry. Make two plane changes of a given body.

Practical Work Nº24 y 25: Descriptive Geometry. Solve problems of true magnitude of lines, planes and angles, distances, intersections.

Practical Work Nº26 y 27: Drawing the perspective of cylinders and pure cones with axes of revolution Vertical and at 7º.

Practical Work Nº28: Solve the third projection, the sectioning of two of them and a perspective of a set of three bodies, given in two projections.

Practical Work Nº 29: Problems with cylinder with perspective details with axis at 42º.

Practical Work Nº30: Projections and perspective of a cylindrical body with two parallel axes.

Practical Work Nº 31: Projections and perspective of the sphere

Practical Work Nº32: Projections and perspective of a cylindrical body with two perpendicular axes.

Practical Work Nº33: Projections and perspective of a cylindrical body with three axes.

Practical Work Nº34: Cylinder sectioning projections and perspective.

Practical Work Nº35: Cone sectioning projections and perspective.

Practical Work Nº36: Cylinder-cylinder intersection projections and perspective.

Practical Work Nº 37: Projections and perspective of a combined cylinder-cylinder-cone intersection problem.

Practical Work Nº38: Projections and Perspective of Sphere Sectioning. Sphere-Cylinder Intersection.

Practical Work Nº39: Projections of a combined body with displaced axes.

Practical Work Nº40: Perspective of Practical Work Nº39.

Practical Work Nº41: Projections and perspective of a combined body with displaced axes.

Practical Work Nº 42: 1st Order Auxiliary View.

Trabajo Práctico Nº 43: Vista Auxiliares de 2do. Orden

Trabajo Práctico Nº44: Resolver las proyecciones de un cuerpo con trayectoria de sección indicada

Trabajo Práctico Nº45: Solving the projections of a body with a trajectory of indicated cross-section.

Trabajo Práctico Nº46: Solving the projections of a body using ½ view and ½ cut-perspective removing ¼ by the diametrical planes.

Trabajo Práctico Nº47: Folded Broken Sections.

Trabajo Practico Nº 48: Carry out Practical Work Nº 4 and 5, using Autocad software.

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Graphic Expression in Engineering. Introduction to Industrial Drawing: Perez Diaz,

J. L. y Palacios Cuenca, S. 1998

Graphic Science. Engineering Drawing. Descriptive Geometry. Graphical Solutions. French, Thomas & Vierck, Charles. 1958

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IRAM Manual of Standards for Technical Drawing. 2008 Technical Descriptive: Leighton Weellman- 1957

Technical Drawing: Spencer-Novar-Dygon-2009

METHODOLOGY AND FORMS OF EVALUATION

In order to regularise the course, students must meet the following conditions:

1.Have at least 80% attendance to theoretical and practical classes.
2.Pass 80% of the Practical Works.
3.Pass the two mid-term exams. If the student fails one of the tests, he/she will make it up with an exam on the same subject; if the student fails, a comprehensive test will have to be taken together with those who have failed two mid-term exams. In order to obtain the Final Exam Exemption, students must pass both mid-term exams and their average must be equal to or higher than 7 (seven). Students who meet the conditions set out in points 1, 2, 3, may sit for the Final Examination in the time and format

established in the regulations in force. The "free" exams consist of three tests which cover the topics of the whole subject syllabus.

PHYSICS I

OBJECTIVES:

- Knowledge and understanding of the fundamental laws governing mechanical phenomena. Capability to use the models and laws of physics to solve engineering problems. Ability of abstraction and critical reflection. Metacognition.

Hourly load: 96 hours
Total hours of applied problem solving: 32

CONTENTS:

- **THEMATIC UNIT 1: INTRODUCTION**
  Observations and models in Physics. Laws and Theories. Physical magnitudes and quantities. Measurements and units: the International System (SI) and the Argentine Legal Metric System (SIMELA). Significant figures and uncertainty or error. Error propagation. Scientific notation. Dimensional homogeneity.
- **THEMATIC UNIT 2: MOVEMENT OF THE MATERIAL POINT I: PARTICLE DYNAMICS**

  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 motion in one dimension. Diagrams **x(**t), **v**(t) and **a**(t). Mass and weight of bodies. Contact forces: normal force and friction force. Friction coefficients: static and dynamic. Forces in bonds (bond "reactions").

- **THEMATIC UNIT 3: MOTION OF THE MATERIAL POINT II: PARTICLE DYNAMICS.**
  Motion in the plane. y(x) diagrams. Oblique shot. Uniform and varied circumferential motion. Angular dynamics and kinematics. Angular velocity, its vector character. Tangential velocity Vectorial relationship betweenr,ωr and **v**. Centripetal force and centripetal acceleration. Angular and tangential acceleration. Reference systems with relative motion: Galileo transformation equations. Non-inertial reference systems
- **THEMATIC UNIT 4: LINEAR IMPULSE Y ENERGY OF A PARTICLE. ANGULAR IMPULSE OF A PARTICLE. MOMENTUM OF A FORCE OR**

MOMENT OF ROTATION. MOMENT OF INERTIA OF A PARTICLE. Linear impulse of a particle. Impulsion of a force. Redefinition of force. Theorem of conservation of linear momentum. Cases of variable mass. Work as a scalar product of vectors. The work-energy theorem. Work of weight and gravitational potential energy. Elastic forces and elastic potential energy. Conservative and dissipative forces. Mechanical energy: conservation theorem. Power. The angular momentum of a particle with respect to a point. Cartesian components of angular momentum L. Momentum of a force or rotation. Theorem of conservation of angular momentum. Central force. Reformulation of the rotational dynamics of a particle. Moment of inertia. Fundamental equation of rotational dynamics. The work-energy theorem for rotation.

- **THEMATIC UNIT 5: PARTICLE SYSTEMS**
  Center of mass. Coordinates. Properties of the center of mass. Linear and angular impulse of a particle system. Conservation theorem. The work-energy theorem. Conservative internal forces. Internal potential energy. Self-energy. Internal energy. Angular impulse of a particle system: internal and orbital. Two-particle systems. Reduced mass Collisions: central elastic shock, plastic shock, semi-elastic shock and explosive shock. Coefficient of restitution. Collisions in two dimensions.
- **THEMATIC UNIT 6: RIGID BODY DYNAMICS AND STATICS**
  The rigid body model. Centre of mass and centre of gravity. Properties. Degrees of freedom of motion. Rotation about a fixed axis passing through the centre of mass. Moment of inertia. Calculation of moments of inertia. Steiner's theorem. Angular impulse of a rigid body. Principal axes of inertia. Fundamental equation of rigid body rotation dynamics. Dynamic imbalance. Work and energy in the motion of a rigid body. Conservation theorems. Rotational-translational motion: rotation without sliding. Friction forces in rolling. Gyroscope. Precession. Nutation. Rigid body statics: equilibrium conditions.
- **THEMATIC UNIT 7: GRAVITATION**
  Newton's law of universal gravitation. Determination of the gravitational constant. Weight and gravitational force. Planetary systems and Kepler's Laws. Angular momentum and Kepler's Second Law. The law of gravity and the motion of the planets. The gravitational field. Gravitational energy and potential. Energies and orbits.

ANALYTICAL DESCRIPTION OF PRACTICAL ACTIVITIES:

The Problem Solving Practical Work booklet is a collection of different types of activities on the topics included in the analytical syllabus of the subject, which the student must carry out during the course.

It includes:
a) Problem situations, which are solved during the theoretical-practical classes, with the participation of the students, as far as possible. These problems are even designed as "triggers" for the theoretical subject to be addressed in the classes, and are generally of a qualitative nature.
b) Problems of application of the theoretical contents: they can be qualitative or quantitative problems, to be solved in Practical Work classes.
c) Problems and/or conceptual questions, or application questions to be solved, compulsorily outside class time.
d) Exercise problems at the end of each Programme Unit.

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- Physics - Volume I - P. A. Tipler - Reverte - 1976.
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- Introduction to the study of mechanics, matter and waves - Ingard, Kraushaar - Reverte - 1966.
- General Physics, Principles with applications - Giancoli - Giancoli - 1994.
- College Physics - Sears, Francis W.; Zemansky, Mark W.; Young, Hugh D.; Freedman, Roger A. - Pearson Education - 2004.

Methodology and form of evaluation:

- There are 2 mid-term tests in which conceptual and procedural contents are evaluated in the eighth and sixteenth week of the course. Each partial evaluation must be passed with at least a mark of 4 (four) and has

the possibility of a second exam in case of failure. For students who have failed both mid-term exams or their second exams, an integral exam is provided.

- Once the subject has been passed, the student must prepare to sit the exam using the bibliography (texts) recommended by the lecturer in order to achieve an integrated view of the course, which is assessed in the final written exam, which is primarily conceptual in nature. On some occasions, questions are included that require minimal calculations to find the correct answer.
- Exceptionally, and generally for work-related reasons, students are allowed to sit the exams as "free" students, in which the student is allowed to directly write the final exam, in accordance with FACET's internal regulations.

CALCULUS II

OBJECTIVES:

- That the student achieves the formation of a system of knowledge and skills in Integral Calculus of one variable, developing the capacity for abstraction, reasoning and application of knowledge in the resolution of exercises and problems.

HOUR LOAD:
Total workload: 80 hours
Total hours of applied problem solving: 32

CONTENTS:

- **THEMATIC UNIT 1: INDEFINITE INTEGRAL**
  Anti derivative. Definition of indefinite integral. Properties of the indefinite integral. Chain rule for anti-differentiation.
- **THEMATIC UNIT 2: DEFINITE INTEGRAL**
  Riemann sum and the definite integral. Area of a plane region under a curve. Properties of the definite integral. The fundamental theorem of calculus. The mean value theorem for integrals. Second fundamental theorem of calculus.
- **THEMATIC UNIT 3: TRANSCENDENTAL FUNCTIONS AND THEIR INVERSES**
  Definition of the natural logarithm function. Properties of the logarithm. Existence of the inverse function. Theorem of derivation of the inverse function. The exponential function. Hyperbolic functions. Definitions, properties. Inverse hyperbolic functions. Inverse trigonometric functions.
- **THEMATIC UNIT 4: INTEGRATION**
  Methods of integration: Substitution, integration by parts. Integrals resulting in inverse trigonometric and inverse hyperbolic functions. Integration of powers of trigonometric and hyperbolic functions. Trigonometric and hyperbolic substitutions. Substitution by simple fractions and of rational functions in sine and cosine. Diverse substitutions. Numerical integration.
- **THEMATIC 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 an arc of a curve.
- **THEMATIC UNIT 6: SUCCESSIONS**
  Definition of a sequence as a function in N. Convergent sequence and

divergent. Monotone sequences. Bounded sequences. Convergence criteria for monotone and bounded sequences.

- **THEMATIC UNIT 7: SERIES OF REAL AND POWER NUMBERS**
  Definition of series. Convergence and divergence of a series. Necessary condition for the convergence of a series. Geometric series. Properties of series. The series p. Convergence criteria for series of positive terms. Alternating series. Absolute and conditional convergence. Power series. Convergence. Taylor and Mc Laurin series.

ANALYTICAL DESCRIPTION OF PRACTICAL ACTIVITIES: The practical assignments are structured in such a way as to contain:

1) Exercises that contribute to the assimilation of theoretical knowledge,
2) Exercises to reinforce the following mathematical procedures: graphing, interpretation, calculation, identification, approximation,
3) Exercises to model problem situations and solve them.

Students carry out some of the exercises in the practical class itself, individually or in groups, sometimes at the blackboard, under the supervision of the teacher. There are also exercises, which the teacher solves on the blackboard, with the active participation of the students.
The chair offers consultation hours, which are used by students to ask questions or to check the resolution of exercises in the practical assignments and the texts.

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- The Calculus with Analytic Geometry - Part I - Louis Leithold - Harla- Mexico - 1982.
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- Calculus I with Analytic Geometry Vol I - Larson, Roland E. Hostetler, Robert P. Edwards, Bruce H.- Mc Graw - Hill - 2006.

Methodology and form of evaluation:

- The assessment of the curricular activity is carried out in the manner established by the regulations in force. In order to be able to write the final exam, the student must attend at least 80% of the practical classes and pass two mid-term exams. In case of failing one or both of them, a recovery opportunity is offered for each of them. The final exam is an oral exam, which is a comprehensive evaluation of the content of the subject, that the student must pass within twelve months of the end of the lectures.
- Students who do not achieve the completion of the necesary conditions to write the final exam, have the opportunity to request a "free exam" on the two dates established by the chair: the last date of the July-August and February-March shifts. In order to pass a free examination, the Faculty's internal regulations require the passing of two written exams on the practical content with a grade of at least 7. This is followed by the oral examination.

ELEMENTS OF LINEAR ALGEBRA

OBJECTIVES:

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

Hourly load: 80 hours
Total hours of applied problem solving: 32

CONTENTS:

- **THEMATIC UNIT 1: MATRICES**
  Matrices. Definition. Particular matrices. Operations: Addition, product by scalar, product of matrices. Properties. Transposed matrix. Symmetric and antisymmetric matrices. Partitioning. Elementary row operations Elementary matrix. Row equivalent matrices. Reduced row echelon matrix. Range of a matrix. Invertible matrices. Inverse of a matrix. Properties. Obtaining by Gauss-Jordan.
- **THEMATIC UNIT 2: SYSTEMS OF LINEAR EQUATIONS**
  Systems of linear equations: 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. Gaussian elimination method. Rouché Frobenius theorem.
- **THEMATIC UNIT 3: VECTOR SPACE**.
  Vector Space: Definition - Linear Combination. Definition of Subspace - Necessary and sufficient condition. Linear dependence and independence of vectors. Consequences. Generator - Space Generated by a Set of Vectors - Basis and Dimension - Coordinates - Change of basis. Change of basis matrix.
- **THEMATIC UNIT 4: LINEAR TRANSFORMATION**
  Linear Transformation: Definition. Consequences. Algebra of linear transformations. Fundamental theorem. Kernel. Image. Associated matrix.
- **THEMATIC UNIT 5: DETERMINANTS**
  Determinants: Definition. Properties. Definition of Adjoint Matrix - Property. Invertible matrix and determinant. Applications to systems of linear equations.

- **THEMATIC UNIT 6: POLYNOMIALS**
  Polynomial in an indeterminate: Addition, subtraction, product and quotient. Ruffini's rule. Remainder theorem. Divisibility. Prime and compound polynomials. Zeros of a polynomial. Existence of zeros. Fundamental theorem of algebra. Multiple zeros. Factorization in $\Re$ [x] and in C [x] . Equations.
- **THEMATIC UNIT 7: EIGENVALUES AND EIGENVECTORS OF A LINEAR OPERATOR**

  Eigenvalues and eigenvectors of a linear operator. Eigenspace associated to an eigenvalue. Eigenvectors associated to different eigenvalues. Eigenvalues and eigenvectors of a matrix of order n. Eigenspace associated with an eigenvalue of a matrix. Relationship between the eigenvalues and eigenvectors of a linear operator with the eigenvalues and eigenvectors of its associated matrix in a given basis. Characteristic matrix. Characteristic polynomial. Characteristic equation Cayley-Hamilton theorem. Algebraic multiplicity and geometric multiplicity of an eigenvalue, relationship between the two.

- **THEMATIC UNIT 8: DIAGONALISATION**

  Diagonalisation of linear operators. Characteristic polynomial. Diagonalisation of matrices. Applications.

Analytical description of theoretical and practical activities:

- THEORETICAL-PRACTICAL LESSONS: The necessary theoretical aspects are developed and application problems of each subject are solved.
- PRACTICAL LESSONS: The student works with printed material, provided by the staff in charge of the subject, with which it is intended that they will be able to consolidate the new concepts acquired. This material is a booklet with the problems to be developed in the practical classes and additional problems to be solved by the student in an autonomous way and which can then be discussed in the consultation hours. The practical classes are compulsory.
- CONSULTATION CLASSES: Meetings are organised outside class hours so that students can clear up any doubts about theoretical and practical aspects. Students are provided with printed material which includes an analytical syllabus, a system of approval and the teachers who take part in the course. Chalk and blackboard are used for teaching.

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- Introduction to Algebra Linear Algebra - Serge Lang - Addison-Wesley Iberoamericana, - 1990.
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- Geometría Analítica con vectores y matrices - Murdoch - Limusa- Wiley- México - 1981.
- Limusa- Wiley- Mexico - Armando Rojo - El Ateneo- Buenos Aires - 1975.
- Algebra I - Volume I - Armando Rojo - El Ateneo - Buenos Aires - 1978.
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- Algebra I - Volume II - Armando Rojo - El Ateneo - Buenos Aires - 1987.
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- Calculus and GeometryAnalytical -Sherman Stein - McGraw-Hill, Mexico-Buenos Aires 1984 - 1984.
- Calculus and Analytic Geometry Vol II - Sherman Stein - McGraw-Hill, Santafé de Bogotá - 1995.
- Linear Algebra - Kolman, Bernard; Hill, David R. - Pearson Education-Prentice Hall. -2006.

Methodology and form of evaluation:

- The evaluations make it possible to quantify the degree to which students have acquired and managed their knowledge. In order to pass the course, students must pass two written mid-term exams consisting of four or five practical exercises, each of which has the possibility of a recovery exam. They are taken in the 8th and 16th week respectively.

- In order to pass the course, students must take a final conceptual and integrative exam. They take this final oral or written exam once they have passed the curricular activity. The student has two hours to take it.
- The requirements to be able to take the final exam and conditions of approval are known by the students on the first day of classes of the term and are published in the practical work booklet.

PHYSICS II

OBJECTIVES:

- Knowledge and understanding of the fundamental laws governing mechanical phenomena. Ability to use the models and laws of physics to solve engineering problems. Ability of abstraction and critical reflection. Meta cognition

Hourly load: 96 hours
Total hours of applied problem solving: 32
Total hours of experimental practical work: 32

CONTENTS:

- **THEMATIC UNIT 1: MECHANICS OF DEFORMABLE BODIES**
  Notions of elasticity. State of deformation. State of stresses. Hooke's law. Stresses and modulus of elasticity: Traction. Torsion. Compression. Poisson's number. Elastic potential energy.
  Hydro and aerostatics: Ideal liquids. Pressure. Manometric pressure and atmospheric pressure. General theorem of hydrostatics. Pascal's theorem and Archimedes' theorem.
  Hydro and aerodynamics. Streamline. Stationary flow. Continuity equation. Bernoulli's theorem. Viscous liquids. Laminar regime. Distribution of velocities and flow in a tube. Poisseuille's law. Stokes' law. Reynolds number. Surface phenomena: Surface tension. Laplace's law. Capillary rise.
- **THEMATIC 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.
- **THEMATIC UNIT 3: MECHANICAL WAVES**
  Wave function. Longitudinal and transverse waves. Harmonic waves. Differential equation of wave motion. Velocity of wave propagation. The principle of superposition. Wave interference. Pulsations. Reflection. Standing waves. Wave intensity. Doppler effect.
  Acoustics: Characteristics of sound. Pitch and frequency. Intensity. Intensity level: the decibel. Sound sensation. Timbre. Harmonics. Fourier analysis and synthesis. Sound pollution. Sound resonance.
- **THEMATIC UNIT 4: TEMPERATURE AND HEAT. GASES**.

Temperature, thermometers and scales. Thermal equilibrium and the Zero Law of Thermodynamics. Thermal expansion and thermal stresses. Heat. Specific heat and transformation heats. Mechanisms of heat transfer. Heat action in gases. Equation of state of ideal gases. Kinetic theory of gases: Specific heat and internal energy of an ideal gas. Real gases. Van der Waals equation.

- **THEMATIC UNIT 5: THERMODYNAMICS: FIRST PRINCIPLE**
  Thermodynamic systems. First principle of thermodynamics. Quasi-static processes. Calculation of work. Internal energy. Adiabatic processes: Poisson's equations. Cyclic processes: Carnot cycle. Thermodynamic efficiency. Refrigeration machines: efficiency.
- **THEMATIC 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.
- **THEMATIC UNIT 7: PHASE CHANGES**
  Transformation heat. Fixed points. Vaporisation. Evaporation and boiling. Saturated vapour pressure. Clausius-Clapeyron equation. Liquefaction of gases. Thompson-Joule effect. Hygrometry.
- **THEMATIC UNIT 8: LABORATORY**
  1) Simple measurement problems. Direct and indirect measurements. Calculation of errors.
  2) Measurement of fundamental quantities: 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. Tensile elasticity. Torsional elasticity. Determination of specific heats. Determination of latent heats. Mechanical heat equivalent. Determination of Cp and Cv.

ANALYTICAL DESCRIPTION OF PRACTICAL ACTIVITIES:

The Problem Solving Practical Work booklet is a collection of different types of activities on the topics included in the analytical syllabus of the subject, which the student must carry out during the course.
It includes:
a) Problem situations, which are solved during the plenary theoretical and practical classes (theoretical and practical), with the participation of the students, as far as possible. These problems are even designed as "triggers" for the theoretical theme to be addressed in the classes, and are generally of a qualitative nature.
b) problems of application of the theoretical contents: they can be qualitative or quantitative problems, to be solved in Practical Work classes.

c) Problems and/or conceptual questions, or application questions to be solved, compulsorily outside class time.

d Exercise problems at the end of each Programme Unit.

ANALYTICAL DESCRIPTION OF PRACTICAL EXPERIMENTS:

Introduction to basic notions (characteristics of measuring systems, significant figures, experimental uncertainty, types of errors, Gaussian error theory, planning a measurement, scientific expression of the result of a measurement by performing simple direct and indirect measurements.

Determination of viscosity coefficients. Comparative analysis of different methods. Informed selection of the design to be used. Analysis of sources of experimental uncertainty. Fit between theoretical models and experimental data. Conclusions.

Determination of specific heats. Method of mixtures. Determination of molar heats and explanation of results. Determination of mechanical equivalent of heat. Energy considerations Analysis of sources of experimental uncertainty. Fit between theoretical models and experimental data. Conclusions.

Free fall. Experimental determination of space-time and velocity-time relationships. Fit between theoretical models and experimental data. Measurement of instantaneous velocity as an experimental limit of the mean velocity. Physical interpretation of the limit concept. Conclusions.

Experimental study of different types of oscillating mechanical systems. Determination of the constant of proportionality between forces and elongations for a mass-spring system. Free oscillation. Damped oscillatory motion. Fit between theoretical models and experimental data. Conclusions.

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- Physics - Volume I - P. A. Tipler - Reverte - 1976.
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- University Physics - Sears, Zemansky, Young - Inter-American Fund - 1986.
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- General Physics, Principles with Applications - Giancoli - Englewoods Cliffs - 1994.
- College Physics - Sears, Francis W.; Zemansky, Mark W.; Young, Hugh D.; Freedman, Roger A. - Pearson Education - 2004.

Methodology and form of evaluation:

- There are two partial tests of problem solving corresponding to the different subjects covered, and two evaluations of the experimental work actually carried out in the laboratory. Partial evaluations that are not passed can be retaken. The final exam is written and is primarily of a conceptual and integrative nature of the knowledge imparted. In order to prepare for the exam, students must necessarily consult the recommended bibliography, because the course does not offer notes, with the aim of developing critical reading skills of the different recommended texts.

INFORMATICS

OBJECTIVES:

Know the basic fundamentals of informatics, its methodological tools and techniques. Acquiring the ability to analyse and pose problematic situations inherent to disciplinary environments related to Engineering.

Hourly load: 64 hours
Computer hours: 32 hours
Theoretical hours: 32 hours

CONTENTS:

Unit 1: Introduction to IT concepts
Nature of information. Informatics: definition. Data and information. Structure of information. Types 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, base complement. 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 Windows environment
Editors and word processors. Spreadsheets.
Unit 4: Programming as a problem-solving methodology
Problems of computer science interest. Stages in problem solving. Concept of algorithm. Characteristics of a computer algorithm. Modular programming. Structured programming: fundamental theorem, basic structures. Design language. Design of algorithms. Graphical representation: flowchart. Variables: concept. Assignment operation.
Unit 5: Programming languages
Language: concept. Types of language from a computer science point of view. Evolution of programming languages. Programming paradigms. Introduction to Pascal language: general structure of a Pascal language program, operators, basic structures.
Analytical description of practical activities:

Practical classes in front of a PC: The teacher explains the conceptual aspects and the student carries out the work with the continuous assistance of assistants. In class, standard problems are developed, leaving the students to solve the proposed problems individually or in groups, under supervision.

TP No	CONTENTS
1	Basic computer concepts. Windows Explorer.
	E-Spreadsheet: Addresses. Formula Replication
	Electronic Spreadsheet: Simple, Stacked and Stacked Percentage Column Charts. Auxiliary axes. Pie charts. Graphing mathematical functions using Column Graphs. Line Graphs.
	Electronic Spreadsheet: Scatter Charts. Function Graphing.
5	Electronic Spreadsheet: Logical Functions. Solver tool. Functions defined by sections. Periodic functions.
	Problem solving. Algorithm design.
	Structured Programming: Flowcharts. Control structures.
8	Structured Programming: Working with Arrays: Vectors and Matrices.
	Structured Programming: Implementation of User Functions.
10	Structured Programming: Implementation of Procedures.

BIBLIOGRAPHY:

- Introduction to Computing - Peter Norton - Mc Graw-Hill - 2006.
- Fundamentals of Programming - Luis Joyanes Aguilar - Mc Graw-Hill - 1996.

- General Introduction to Computer Science. Peripherals and Local Networks - Mario C. Ginzburg - Ediciones de autor - 2007.
- Computer Science. Present and future, Sanders, D H, Mc Graw-Hill, 1983.
- Software for Science and Engineering, Heilborn, J., Osborne/McGraw Hill, 1982.
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Methodology and form of evaluation:

There are 2 partial evaluations where conceptual and training aspects are evaluated. Each evaluation has a possibility of recovery. Having passed the 2 evaluations, the student passes the course. The only thing left to do is to review everything seen in order to have a unified vision of the course, which is evaluated in the final exam in front of the PC. In addition, the subject has a promotion regime when the student passes both mid-term exams with a minimum mark of 6. The "free" exam is in accordance with the current regulations of the academic unit.

FUNDAMENTALS OF GENERAL CHEMISTRY

OBJECTIVES:

- That the student acquires skills in the handling of the bibliography and the different laboratory materials and instruments. Manage the relationship between chemistry and technological development. Use the proper technical vocabulary fluently.

Hourly load: 80 hours
Total hours of experiential training: 16
Total hours of applied problem solving: 32

CONTENTS:

- **THEMATIC UNIT 1: CHEMISTRY**
  Definition. Matter. Intensive and extensive properties. States of matter. Material mixtures: homogeneous, heterogeneous and inhomogeneous. Substances: simple and compound. Chemical elements. Basic atomic structure. Atomic number and atomic mass. Principal subatomic particles. Isotopes Avogadro's law. Molecule. Atomic and molecular weight. Atom and molecule gram. Mole. Chemical formula. Atomicity. Oxidation number. Chemical equivalent. Chemical equation. Stoichiometric coefficients. Stoichiometric calculations.
- **THEMATIC UNIT 2: PERIODIC CLASSIFICATION.**
  Description. Fundamental characteristics of the chemical elements in the table. Electronic distribution in the atoms. Periodic properties. Chemical bonds. Definition. Binding energy. Types of bonds: ionic, covalent and electro-covalent. Covalent bonds: pure and polar. Polarity of bonds Electronegativity. Polar molecules and dipole moment. Hydrogen bonding.
- **THEMATIC UNIT 3: GASEOUS STATE.**
  State variables. Pressure. Units. Ideal gases. Boyle's and Mariotte's and Charles Gay Lussac's laws. Absolute temperature. General equation of state. Mixture of gases. Dalton's law. Kinetic theory of ideal gases. Graham's law. Real gases. Andrews isotherms. Critical parameters. Van der Waals equation. Association and dissociation due to temperature effect.
- **THEMATIC UNIT 4: LIQUID STATE.**
  Vapour pressure. Phase diagram of water and carbon dioxide. Solutions Concentration of solutions: centesimal, normality, molarity, molality and mole fraction.

Solutions of miscible liquids. Raoult's law. Dilute solutions. Colligative properties: tensimetry, ebulloscopy, cryoscopy and osmotic pressure. Electrolyte solutions: Van't Hoff correction.

- **THEMATIC UNIT 5; CHEMICAL BONDS.**
  Binding energy. Types of bonds: ionic, covalent: pure and polar, electro-covalent. Polarity of bonds. Electronegativity. Pauling's scale. Polar molecules and dipole moment. Hydrogen bridge.
- **THEMATIC UNIT 6: THERMODYNAMICS**
  Energy and heat. First law of thermodynamics. Work. Internal energy. State function. Thermodynamic processes. Thermochemistry. Enthalpy. Thermochemical equation. Heat of formation, heat of combustion and heat of reaction. Calorific value. Tables. Laws of thermochemistry: Lavoisier Laplace and Hess.
- **THEMATIC UNIT 7: CHEMICAL AND IONIC KINETICS AND EQUILIBRIUM.**
  Reaction rate. Order and molecularity. Reaction constant. Activation energy. Catalysis. Catalysts. Catalytic promoters and poisons. Chemical equilibrium. Equilibrium constant. Le Chatelier's principle. Ionic equilibria. Strong and weak electrolytes. Acid-base theories. Ionisation of water. Ionic product of water. pH and pOH.
- **THEMATIC UNIT 8 ELECTROCHEMISTRY.**
  Electrolytic dissociation. Electrolysis. Faraday's laws. Specific and equivalent conductivity of electrolytes. Strong and weak electrolytes. Batteries Electrodes: classification. Normal potential of an electrode. Reference electrode. Potential tables. Nerstn's formula. Voltage, overvoltage and polarisation. Dry cells. Lead accumulator. Corrosion. Cathodic protection. Corrosion classification. Corrosion rate. Protection procedures. Corrosion in industrial plants.

- **PRACTICAL WORK: PROBLEM SOLVING**
  It is foreseen that the application problem-solving classes, which are related to the topics of the developed theory and whose objective is to acquire mental speed and skills for the mathematical handling of chemistry, will be an immediate continuation of the development of the theory.

- **PRACTICAL LABORATORY WORK**
  The practical work carried out in the laboratory is related to the theoretical topics so that the student can observe experiences from which to better understand chemical phenomena and their link with the laws studied, and verify their fulfilment by means of mathematical calculations.
  1°.- Nomenclature. Basic evaluation of nomenclature
  2°.- Density measurements of liquids 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 dilute solution. Ebulloscopy.
5°.- Ionic equilibria in electrolytes. Ionic product of water. pH and pOH.

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- Basic Principles of Chemistry - Gray Haigth - Reverte - 1980.
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METHODOLOGY AND FORM OF EVALUATION:

- This is a one term course. The periodical evaluation consists of two partial tests, each one has its own recovery possibility and there is a integrative recovery. These are written tests with semi-structured questions of different levels of complexity, on topics developed in the theoretical classes and in the practical work. The practical work and problems are continuously assessed on the basis of the reports and questionnaires that students must submit and pass. With the passing of the partial tests, the presentation of the complete portfolio of practical work and reports, the student achieves: "regularity", with which is able to take the final exam or is "promoted" if the marks obtained are higher than seven and has passed all the laboratory evaluations. The final assessment consists of an oral examination or a semi-structured written test.

PHYSICS III

OBJECTIVES:

General objectives:

The general aim of the course is to provide students with the basics of electricity, magnetism and optics, with emphasis on both the conceptual understanding of the phenomena and the solution of problems by means of analytical and quantitative calculation.

Specific objectives:

The Physics II course is specifically designed to enable students to:

1. Assimilate and understand electromagnetic phenomena.
2. Acquire experience in making reasonable assumptions, formulating hypotheses, modelling and solving a problem.
3. To achieve the ability to obtain an analytical result and to be able to see its scope and also its limitations.
4. Connecting previous and new ideas in physics and mathematics.
5. Link the topics presented to everyday situations and in the context of contemporary scientific and technological applications.

HOUR LOAD
Total hours: 128 hours
Total hours of experimental practice: 32 hours
Total hours of applied problem solving: 32

CONTENTS:

- **THEMATIC 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. Coulomb's law.
  The physical concept of work. Electrical potential energy. Energy for the formation of a system of discrete point charges. Applications and problems.
- **THEMATIC UNIT 2: THE ELECTRIC FIELD**
  Electrostatic potential and electrostatic field of a point charge. Electric field flow. Gauss's law. Electrostatic potential difference. Relationship between

electric field and potential. Equipotential surfaces. Gravitational interaction.
Analogies between electrical and gravitational interactions. Types of charge distributions. Discrete distributions: point charges. Continuous distributions: linear, surface and volumetric, applications.

- **THEMATIC UNIT 3: MAGNETIC INTERACTION**
  Electric current. Electric current associated with different distributions of moving charges. Magnetic field created by currents. Biot-Savart and Ampere's laws. Magnetic field flow. Electromagnetic induction. Faraday's law. Self-induction. Mutual induction. Electromotive force generation. Interaction of the magnetic field with current circuits. Magnetic momentum. Motor Torque. Lorentz force. Applications and Problems
- **THEMATIC UNIT 4: D.C. ELECTRICAL CIRCUITS**
  Passive Circuit Elements. Resistance. Capacitance. Inductance. Series and Parallel connections. Batteries and Direct Current Sources. Ohm's Law. Kirchhoff's Laws. Pure resistive circuits. Mesh and node method. RL and RC series circuits. Transient regime. Dissipated energy and stored energy. Applications.
- **THEMATIC UNIT 5: A.C. ELECTRICAL CIRCUITS**
  RLC circuit with alternating voltage source. Natural frequency of the circuit. Resonance. Stalled oscillations. Damping. Displacement current. RC circuit with DC voltage source. Applications.
- **THEMATIC UNIT 6: ECUATIONS FROM MAXWELL Y ELECTROMAGNETIC WAVES**
  Maxwell's equations. Electromagnetic waves. Index of refraction. Energy of an electromagnetic wave: Poynting vector. Superposition of electromagnetic waves. Polarisation. Applications and problems.
- **THEMATIC 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.
- **THEMATIC UNIT 8: OPTICAL SYSTEMS: LENSES AND LENS COMBINATIONS**
  Thick lenses. Thin lenses. Lens systems. Optical instruments: magnifying glass, microscope, telescope. Applications and problems.
- **THEMATIC UNIT 9: SUPERPOSITION PHENOMENA: DIFFRACTION, INTERFERENCE AND POLARISATION**
  Diffraction. Interference. Young's experiment. Interference and diffraction. Diffraction gratings. Interference in thin films. Polarisation of light. Retarder films. Applications and problems.

Analytical Description of Practical Work assignments

Practical assignments are prepared according to the following criteria:

- They are a study guide in close connection with the theoretical and practical classes.
- The language used is simple, clear and specifically technical in nature.
- The international system of units is used.
- The concepts introduced are reviewed through questions and problem situations.
- The problems are ordered from least to most complex.
- Figures and graphs are included for clarity of communication.
- Tables of constant values and experimental values are used.
- The principle of operation of current technological applications is analysed.
- Typical problems are solved and possible variations and solutions are analysed.
- It proposes the representation of objects by means of two- and three-dimensional drawings.

ANALYTICAL LABORATORY PRACTICAL PROGRAMME

Dependence between the applied voltage and the current flowing through a conductor. Ohm's law. Fit between theoretical models and experimental data. Measurement of resistances. Direct method and compensation method. Comparative study of the different methods. Conclusions.

Determination of e/m using a filiform ray tube, measuring the electric and magnetic fields and the radius of the electron path. Fit between theoretical models and experimental data. Conclusions.

Hall effect. Hall voltage variation curves as a function of current in the crystal and magnetic induction. Fit 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 for measuring magnetic induction. Conclusions.

Transients. Charging and discharging of a capacitor C through a resistor R. Charging and discharging curves for different values of C and R. Experimental determination of the time constant. Charging and discharging of an inductance L through a resistor. Fit between theoretical models and experimental data. Conclusions.

Experiments with concave and convex lenses and mirrors. Fit between theoretical models and experimental data. Determination of focal lengths. Analysis of aberrations. Construction of optical instruments and determination of magnification. Conclusions.

Laser source. Physical principles of laser emission. Spatial and temporal coherence. Comparison with conventional sources. Single and multi-aperture diffraction and interference. Intensity patterns. Networks. Fit between theoretical models and experimental data. Conclusions.

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- Optics. Vol. 3 - Sears. F. - Aguilar - 1967.
- Physics - Volume II - P. A. Tipler - Reverté - 2000.
- Physics fundamentals and applications vol. 2 - Eisberg R. and L. Lerner - Mc Graw Hill - 1984.

Methodology and form of evaluation:

- There are two options for the evaluation system: with and without final oral examination. The system of direct promotion without final exam - consists of the sum of continuous conceptual evaluations and a test of integrated problems, while the system with final oral exam requires the integrated approval of problem solving with which the "regularity" in the subject is obtained. In both cases, the set of laboratory experiences must be completed and approved. If they opt for direct promotion, they agree the working conditions with the lecturer responsible for their group of practicals and present their evaluations upon completion of a theoretical subject.
- The evaluations must be 100% passed, and there is no limit to their presentation. The grade that must be obtained in the integrative test is greater than or equal to six. The "free" examination is regulated by the Faculty.

CALCULUS III

OBJECTIVES:

- To ensure that the student: Knows and handles the applications of differential and integral calculus in several variables, of real functions and vector functions, with theoretical foundations of mathematical analysis.

Hourly load: 96 hours
Total hours of applied problem solving: 32

CONTENTS:

- **THEMATIC UNIT 1: FUNCTIONS OF SEVERAL VARIABLES.**
  Real functions of several variables: Continuity, Limit, Partial Derivatives. Mapping of curves and regions. Curves and surfaces and their parametric representations.
- **THEMATIC UNIT 2: VECTORS AND VECTOR FIELDS.**
  Vector functions: Continuity, Limit and Derivative of vector functions- Tangent line to a curve. Differential operations with vectors: gradient, divergence, rotor.
- **THEMATIC UNIT 3: DIFFERENTIAL CALCULUS OF FUNCTIONS OF SEVERAL VARIABLES.**
  Directional derivative- Differentiable functions- Plane tangent to a surface- Total differential- Jacobian matrix $f''(_{P_0})$- Mean value theorem of differential calculus- Successive partial derivatives- Composite functions- Chain rule- Taylor's theorem- (Taylor's development for locally approximating functions of several variables) - Implicit functions- Jacobians- Inverse functions.
- **THEMATIC UNIT 4: EXTREMES FROM FUNCTIONS OF SEVERAL VARIABLES.**
  Maxima and minima of functions of several variables: Absolute extrema and relative extrema - Critical points - Conditions for the existence of relative extrema: Necessary condition when partial derivatives exist - Sufficient condition. Lagrange multipliers.
- **THEMATIC UNIT 5: INTEGRALS OF FUNCTIONS OF SEVERAL VARIABLES.**
  Parametric integrals. Leibnitz's rule- Double and triple integrals- Change of variables- Applications of multiple integrals: area of an integral plane

region, volume of a solid.

- **THEMATIC UNIT 6: CURVILINEAR INTEGRALS.**
  Curvilinear integrals - Curvilinear integrals of real functions and vector fields. Applications of curvilinear integrals: arc length of curve, mass of a wire, work of a force - Gauss-Green theorem. Necessary and sufficient condition for a curvilinear integral not to depend on the c. of int.
- **THEMATIC UNIT 7: SURFACE INTEGRALS**
  Surface integrals of real functions and vector fields - Applications of surface integrals: curved surface area, mass of a sheet, flux of a vector field. Gauss-Ostrogradski and Stokes theorems.

ANALYTICAL DESCRIPTION OF THEORETICAL AND PRACTICAL ACTIVITIES:

- In the theoretical lectures, the concepts are explained in detail, the corresponding geometrical interpretations are deduced and examples of application are given.
- Practical Classes: the teachers develop some of the problems of the Practical Works, leaving the rest for the exercise of the students who can work in group or individual form and can make consultations, during the classes or in the additional schedule for consultations. The practical work assignments from Nº 1 to Nº 8 are focused on Differential Calculus and the practical work assignments from Nº 9 to Nº 14 on Integral Calculus.

BIBLIOGRAPHY:

- Advanced calculus with applications to engineering and physics - Amázigo, Rubensfeld - Mc Graw Hill- Mexico- Buenos Aires - 1983.
- Vector Function Calculus - Richard E. Williamson, Richard H. Crowell /and/ Hale F. Trotter - Prentice- Hall- Internacional- Bogotá-Buenos Aires - 1973.

Methodology and form of evaluation:

- In order to pass the subject, students must pass two partial evaluations, each with the possibility of recovery at the end of the term, and a final exam. The status of regular student is achieved by passing the partial exams. Only regular students have access to the final exam. The 1st evaluation covers the topics of differential calculus covered in the first eight assignments and the 2nd evaluation covers the integral calculus topics. Both exams are written.

- The final exam is a concept exam on any of the points of the programme developed in theoretical and practical classes. It is taken orally. At the beginning of the term, students are aware of the requirements for passing the subject. "Free" exams are authorised by the lecturer in charge, in accordance with current regulations.

ANALYTICAL PROGRAMME "TECHNICAL MECHANICS I"

Contents:	**1. GENERAL PRINCIPLES:** Notions of Mechanics. Definitions and fundamental concepts. Units of measurement. Force. Concept and characteristics. Scalars and vectors. Vector operations with forces. Different types of force systems. Composition and decomposition of forces. Analytically and graphically. **2. EQUILIBRIUM OF A PARTICLE: (**Concurrent forces in the plane and space). Equilibrium of a particle. Principles of mechanics (rigid body). Equilibrium, graphical and analytical conditions governing it. Free body diagram. Cartesian scalar and vector notation. Method of projections. Analytical and graphical determination of the resultant of forces. Polygon of forces. Equilibrium, analytical conditions governing the equilibrium of a system of concurrent forces in the plane and in space. Equations (Cartesian scalar and vector). Static momentum of a force with respect to a point and an axis. Varignon's Theorem (Theorem of Moments). Couple or pair of forces. Properties. Simple structures and mechanisms (connecting rods, pulleys). **3. BALANCE OF A RIGID BODY:** (General case of forces in the plane and space). Types of links 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 in space. Resultant force. Resultant coupling. Equivalent systems. Analysis of the previous cases. Equilibrium. Analytical conditions governing the equilibrium of a general system of forces in the plane and in space. Equilibrium equations (scalar and vector Cartesian). Funicular polygon. Properties. Open and closed funicular polygons. Graphical conditions governing the equilibrium of a general system of forces in the plane. Composite structures and mechanisms. **4. FLAT GRIDS:** Definition and types of grids. Simple reticules. Their generation. Conditions of stiffness or non-deformability of a simple lattice. Calculation of stresses in the bars. Method of nodes and sections (analytical and graphical). **5. FRICTION:** Characteristics. Types of frictional resistance. Theory of dry friction (Coulomb): coefficient of friction, angle and cone of friction. Impending motion. Equilibrium. Types of friction problems. Sliding and overturning. Friction in machines: wedges. Brakes. Screws. Bearings. Friction on belts. Rolling resistance. **6. FLUID PRESSURE:**(Hydrostatic). Forces distributed in the plane. Intensity. Load diagram. Different types of load diagrams. Magnitude and location of the resultant force. Concept of pressure. Pascal's principle. Fundamental principle of hydrostatics. Thrust. Archimedes' principle. Plotting pressure diagrams. Hydrostatic pressure on submerged surfaces, flat plate and curved plate of constant width, flat plate of variable width. Types of problems. **7. CENTRE OF GRAVITY:** Definitions. Centre of gravity, centre of mass and centroid of a body. Centroids of lines, surfaces and volumes. Composite figures and bodies. Pappus Guldin theorems. Types of problems. **8. MOMENTS OF INERTIA:** Definition of moment of inertia for areas, polar moment of inertia and product of inertia. Radius of gyration of an area. Moments of inertia of common plane figures. Use of tables. Steiner's Theorem (Parallel Axes Theorem). Moments of inertia of composite areas. Rotation of axes, principal axes of inertia, Mohr's circle of inertia.

	List of Practical Assignments **No. 1** Composition and decomposition of forces. **No. 2** Equilibrium of a particle. **No. 3** General force systems in the plane **No. 4** Composite structures and mechanisms **No. 5** Space structures **No. 6** Flat cross-linked systems **No. 7** Distributed loads **No. 8** Hydrostatics
Objectives *(in terms of competences):*	To introduce the fundamental concepts of rigid body mechanics in its static equilibrium state, which serve as a basis for the analysis and design of structural and mechanical devices.
Analytical description of theoretical and practical activities:	The teaching consists of theoretical classes on each subject lasting two clock hours. The practical classes are held in the subsequent class, with the theoretical-practical modality and compulsory attendance. Classes are taught according to the following modality: • We use an amphitheatre for the theory sessions. • Four classrooms in the Civil Engineering block are used for practical work. The practical work is prepared on the basis of the theory taught. The students are divided into four committees, two for Civil Engineering and two for Mechanical Engineering. Each committee occupies a classroom and is attended by an assistant. In these classes, example problems are developed and each student continues to solve their practical work, supervised by the lecturers and student assistants. For access to the practical work statements, the chair's website was created http://www1.herrera.unt.edu.ar/mectec/ in which the following information is available: 1. Subject syllabus, bibliography, and details of the chair. 2. Summarised theoretical concepts and tables to be used during the course. 3. Practical work with the problems to be solved, solved and additional examples, The student must attend 80% of the theoretical and practical classes. Practical assignments must be presented and 100% approved before each midterm exam. The two mid-term exams are written and consist of theoretical questions and practical exercises with a duration of three hours. Consultations hours with teachers and student assistants are given throughout the year, morning and evening, covering different timetables.
Charge hourly:	64 hours (4 hours per week)
Distribution of activities:	Theoretical-practical classes: 60 hours Evaluations: 4 hours

Basic bibliography:	Statics - J.L. Meriam - Reverté S.A. Technical Mechanics - Timoshenko-Young - Hachette
Other recommended reading:	Mechanical Engineering - Statics - R. C. Hibbeler- Prentice-Hall Vector Mechanics for Engineers - Beer - Johnston- McGraw-Hill Lessons in Graphical Statics - Ing. H. Meoli- Tomàs Palumbo Mechanics for Engineers - T.C. Huang - Inter-American Educational Fund Stability I - E. Fliess - Kapelusz
Evaluation system:	Regular students: (80%) of attendance to theoretical and practical classes. (10) Corrected practical work. Control of the practical work by means of a revision from the assistants. They must then be corrected and presented. (2) Written mid-term exams with theoretical questions and problems to be solved. (2) Written recovery, (of a mid-term exam) at the middle and end of the period. With two or three problems to solve. Promotion: With an average of 7 (seven), they cannot fail mid-term exams, they must present all the Practical Assignments and they comply with the compulsory attendance. Regularisation: With two passed or recovered mid-term exams. "Free" students: Development and presentation of all the Practical Works with different topics assigned, after passing the practical stage, a final written exam.

Dr. José Guillermo Etse
Full Professor

ANALYTICAL PROGRAMME "MACHINE DRAWING"

Contents:	***Thematic 1:*** Definition of views - ISO Method (E). Fundamental trihedron, view, fundamental view, main and auxiliary views, correct location of the part. According to IRAM 4501 Standards. ***Thematic 2:*** Fundamental rules in technical drawing, break lines, cuts, and cut surfaces, partial and complete cuts. Cutting of ribs, arms and axes. Saving of views. According to IRAM Standards 4502 and 4507. ***Thematic 3:*** Representations, schematic representations and conventional signs of threads, screws and bolts. According to IRAM 4520 Standards. ***Thematic 4:*** Representations, schematic representations and conventional signs of springs and keyways. According to IRAM Standards 4523 and 4535. ***Thematic 5:*** Representations, schematic representations and conventional welding signs. According to IRAM 4536 Standards. ***Thematic 6:*** Representations, schematic representations and conventional signs of gearwheels and transmissions. According to IRAM 4522 Standards. ***Thematic 7:*** Dimensioning: elements, fundamental principles and generalities. Applications in bodies with straight edges, holes, etc. Dimensioning according to the way the part is worked. According to IRAM 4513 Standards. ***Thematic 8:*** Signs of surface finishing, written indications, Standards. Characteristic examples. According to IRAM 4517 Standards. ***Thematic 9:*** Geometric, position and shape tolerances. According to IRAM 4515 Standard. ***Thematic 10:*** Drawing up sketches and diagrams of mechanisms in the workshop or with dimensioned mechanical models. Quartering and labelling. According to IRAM Standards. ***Thematic 11:*** Reproduction of manufacturing drawings. Standard formats, foldings for archiving. According to IRAM 4504 Standards. The practical work programme will consist of 35 to 40 freehand A3 sheets on the application of IRAM standards. There will also be 6 drawings in A1, A2, A3 and A4 format, made in pencil, of mechanical elements and mechanisms such as: gears, valves, bearings, vises, lathe tools, steady rests, speed reducers, etc. Two of the above drawings shall be in the form of manufacturing drawings with corresponding exploded views.

Objectives	Indicate the objectives expressed in terms of competences to be achieved by the students and/ or activities for which the training provided qualifies them Knowing and representing parts and machine parts. Design and represent machines. Study and apply standards.
Analytical description of theoretical and practical activities	The classes consist of two stages: the first is a theoretical introduction to the subject to be developed and a practical work guide by the associate lecturer. The second: the application of the theory in representation problems, at this stage the students are under the supervision of the graduate assistants and also have the collaboration of 2 student assistants for possible doubts of interpretation. At the end of the class, the student must hand in the practical work for evaluation. This evaluation is carried out in the following way: the practical work is approved or disapproved by the graduate assistants and the assistant professor. In case of rejection, students have 15 days to submit the practical work.
Charge hourly:	128 hours
Distribution of activated	Theoretical and practical classes: 120 hours Evaluations: 8 hours
Basic bibliography:	- Elements of Machines - Nieman, G. - Engineering Design-Shigley, JED - Machine Builder's Manual-Dubbel
Other bibliography	- Maschinenteile 5Ta Ed-Khöeler und Rögnitz - Maschinenelemente-Deckel K H - Maschinenelemente-Rolof Matek - Fundamental standards-DIN standards
Evaluation system:	Approval of the mid-term exams. Attendance of at least 80% of the classes. Passing at least 80% of the practical work. Approval of the final project.

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Ing. Horacio Francisco Ferrer

Full Professor

Chair of Machine Drawing

CALCULUS IV

OBJECTIVES:

- Interpret and solve dynamic mathematical models involving systems of linear differential equations. Represent functions by means of functional series.

Hourly load: 96 hours
Total hours of applied problem solving: 32

CONTENTS:

- **THEMATIC 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 solutions Initial value problem. Dimension of the solution space. The Wronskian. Abel's formula.
- **THEMATIC UNIT 2: ORDINARY DIFFERENTIAL EQUATIONS OF THE FIRST ORDER.**
  Equations in separable variables. Equations with homogeneous coefficients. Equations reducible to equations with homogeneous coefficients. Exact equations. Equations reducible to exact equations. Numerical methods for 1st order ordinary differential equations.
- **THEMATIC 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 parameters. Reduction of order. Method of indeterminate coefficients. Linear differential equations with variable coefficients that can be converted to linear differential equations with constant coefficients.
- **THEMATIC UNIT 4: SYSTEMS OF LINEAR DIFFERENTIAL EQUATIONS.**
  General concepts. First order systems. First order linear systems. Eigenvalue method for homogeneous linear systems. Method of indeterminate coefficients. Fundamental matrices. Method of variation of parameters. Numerical methods for systems of ordinary differential equations.
- **THEMATIC UNIT 5: FOURIER SERIES.**
  Successions and series of functions. Pointwise convergence. Uniform convergence.

Fourier series. Fundamental trigonometric series. Symmetry and half-range development. Arbitrary period functions

- **THEMATIC UNIT 6: PARTIAL DIFFERENTIAL EQUATIONS.**
  Introduction. Definitions. Classification. Boundary problems. Linear partial differential equations in two independent variables. 2nd order partial differential equations. Linearity and superposition. 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 on a circle. Numerical methods for partial differential equations in partial derivatives.

ANALYTICAL DESCRIPTION OF THEORETICAL AND PRACTICAL ACTIVITIES:

- In the theoretical-practical classes, the topics are presented on the basis of a problematic situation in order to raise the need for the new concept to be incorporated, and others in which the teacher encourages students to participate by asking questions about previous classes related to the topic being developed and the previous knowledge they should have. At the end of each class, students are informed about the theme of the next class in order to encourage participation.
- The practical classes consist of two parts: a lecture given by the teacher in which different exercises and problems are exposed, and individual work by the students. In order to resolve doubts and queries, consultation hours are offered by the teachers.

BIBLIOGRAPHY:

- Fourier Analysis - Hsu - Addison Wesley Iberoamericana - 1987.
- Fourier Analysis - Hsu - Inter-American Educational Fund - 1973.
- Differential Equations - Kreider, Kuller and Ostberg - Fondo Educativo Interamericano S.A. - 1973.
- Introduction to Linear Analysis - Volume I - Kreider, Kuller, Ostberg and Perkins - Fondo Educativo Interamericano S.A. - 1971.
- Advanced Mathematics for Engineering - Volume I - Kreyszig - Limusa - 1967.
- Advanced Mathematics for Engineering - Volume II - Kreyszig- Limusa - 1976.
- Advanced Mathematics for Engineering - Volume II - Kreyszig - Limusa - 1967.

- Advanced Mathematics for Engineering - Volume I - Kreyszig - Limusa S.A - 1977.
- Advanced Engineering Mathematics - Volume I - Kreyszig - Limusa- Wiley - 2004.
- Advanced Mathematics for Engineering - Volume II - Kreyszig - Limusa- Wiley - 1970.
- Advanced Engineering Mathematics - Volume II - Kreyszig - Limusa- Wiley - 2004.
- Fourier Series and Contour Problems - Churchill - Mc Graw-Hill - 1977.
- Differential Equations and Frontier Value Problems - Nagle - Pearson Education - 2001.
- Elementary Differential Equations with Applications - Edwards & Penney - Prentice-Hall - 1986.
- Linear Spaces in Engineering - Fazlollah Reza - Reverté - 1977.
- Linear Algebra and Differential Equations using MATLAB - Golubitsky - Golubitsky - 2001.

Methodology and form of evaluation:

- During the term, two partial evaluations are carried out on dates set by the faculty, which consist of exercises similar to those included in the practical work. Each of them is passed with a mark higher than or equal to four. Each evaluation has the possibility of a recovery at the end of the term.
- In order to be able to take the final exam, the student must pass each partial exam or its respective recovery. In order to pass the course, the student must take an oral exam integrating the knowledge acquired. The evaluations measure the students' performance and their results serve to provide feedback to both teachers and students.
- The possibility of recovery exams provides a new opportunity to achieve an understanding of the subjects and to reach the proposed goals. "Free" exams are held in accordance with the regulations in force in the Academic Unit.

PROBABILITY AND STATISTICS

OBJECTIVES:

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

HOUR LOAD

Total hours: 80
Total hours of applied problem solving: 32

ANALYTICAL PROGRAMME

1.-DESCRIPTIVE STATISTICS
Types of variables. Point diagram. Bar diagrams. Histograms. Rounding. Measures of position and dispersion. Coefficient of variation. Tchebychev's inequality. Exploratory data analysis. Bivariate frequency distributions. Marginal frequency distributions.

2.-CONCEPT OF PROBABILITY
Randomised 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.

3.- PROBABILITY DISTRIBUTION MODELS
Random variables. Discrete variables. Continuous variables. Distribution function. Transformation of a continuous random variable. Mathematical expectation. Properties. Expectation of a function of a random variable. Variance. Properties. Coefficient of variation. Tchebychev's coefficient. Mechanical interpretation of mean and variance. Approximate mean and variance of a function of random variable.

4.-RANDOM VARIABLES WITH PROPER NOUNS
Bernoulli tests. Bernoulli distribution. Binomial distribution. Geometric distribution. Poisson Process (= homogeneous chaos. Poisson Distribution as a limit of the Binomial Distribution. Exponential Distribution. Normal Distribution. Relationship between these distributions.

5.-DISTRIBUTION OF FUNCTIONS OF RANDOM VARIABLES
Joint distribution of variables. Marginal distributions. Example. Independent random variables. Expectation of sums and products. Covariance. Correlation. Variance of sums. Approximate expectation and variance of functions of several variables. Linear Combinatorial Theorem. Central Limit Theorem. Applications to error estimation.

6.-INTRODUCTION TO STATISTICAL INFERENCE
Objective of statistical inference. Independent replicates of a randomised experiment. Monte Carlo method for simulating replicates of a random variable. Model identification.

7.-ESTIMATION
Point estimation. Methods of moments. Distribution of x. Estimation of s^2, s and signal/noise ratio. Interval estimation. Confidence interval for the mean, for the mean difference. Approximate interval for the proportion.

8.-HYPOTHESIS TESTING
Introduction. Types of hypotheses. Definition of hypotheses. Methodology. Types of errors. Tests for one population: mean and proportion. Tests for two populations: difference of means, independent samples with equal variances; difference of means, paired dependent samples, difference of proportions.

9.-SIMPLE LINEAR REGRESSION
The simple linear regression model. Hypotheses. Estimation. Method of Least Squares. Goodness of fit of the model. Validity of the model. More complex models: polynomial and others. Identification of the appropriate model. Examples.

10.- QUALITY CONTROL
Introduction. Process under control. Tolerance ranges. Capacity of a process. Capacity estimation. Capacity index. Interpretation. Mean and variance plots. Control plots. Interpretation.

11.- INTRODUCTION TO THE DESIGN OF EXPERIMENT
Introduction. Analysis of variance. Contrast of equality of means. Multiple comparisons. Introduction to design of experiments.

PROGRAMME OF PRACTICAL CABINET WORK

The lectures are theoretical and practical, alternating theory with application problems organised in the following order.

Topics	Exercises Primer 2
U1: Introduction. Data handling. Frequency distributions. Graphical Representation of Data	Unit 1: 1 to 6
Histogram. Measures of position and dispersion.	Unit 1: 7,8abc, 9abcd.
Symmetry - outlying values. Box diagram. Stem and leaf. Joint frequency distribution.	Unit 1: 8d,9e, 10 to 15
U2: Concept of Probability. Axiomatic definition of Probability. Properties. Conditional Probability. Rule of Product. Independence of events.	Unit 2 Complete
U3: Probability Distribution Models. Definition of Random Variable. Classification of random variables. Cumulative distribution function. Transformation of r.v. (without the continuous-continuous case).	U3: 1,2,3,4
Transformation of r.v. cont-cont case. Characteristics of r.v. Expectation. Variance. Chebychev inequality	U3: 5 to 8, 10, 11
Expectation and approximate variance. U4: Bernoulli dist. Binomial. Geometric.	U3: 9,12, 13, 14; U4 1 to 2
Poisson process. Poisson dist. Approx. Binomial to Poisson. Exponential. Relationship between Exp. and Poisson. Uniform.	U4: 3 to 7
Normal. Standard Normal.U5: Jointed dist. Independence of r.v. Expectation of a function. Properties of hope.	U4: 8 to 10 U5: 1 to 3ab
Covariance. Properties. Correlation coefficient. Properties. Random sample. Linear Comb. Teor.	U5: 3c to 7
Central limit theorem. Approx. Binom to Normal. Poisson to Normal. Summary of approx.	U5: 8 to 12
Measurement errors. Rounding. Truncation. Error of a function of one r.v. and two r.v.	U5: 13 to 19
U6: Inference. Monte Carlo. Theor. Integral Tranf.	U6: 1 to 7
Model identification	U6: 8 to 12
U7: Point estimation. Methods of moments. Distribution of the mean. Properties of $\hat{\sigma}$	U7: 1 to 4a, 5ab, 9, 11ab
Interval estimation for the mean with known and unknown σ.	U7: 4b, 5c, 6, 11c
Interval for the difference of two means and for the proportion	U7: 7, 8, 10

U8: Hypothesis testing. Definition. For the mean and for the proportion	U8: 1 to 5
Hypothesis test for 2 populations. Mean for 2 populations. Paired means. Two proportions. Relationship between confidence interval and test. Errors.	U8: 6 to 10
U9: RLS. Least squares. Estimation of 2. Properties of $\hat{\alpha}$ and $\hat{\beta}$. Prediction.	U9: 1, 2, 3abc
Model validation. Goodness of fit. R2. Other models. U10: Quality Control. Process Under Control	U9: 3d to 8
Tolerance range. Process capability. Capacity Index. Determination of Process Capability. Graph for means. For deviations. Estimation of Process Capability.	U10 complete
Interpretation of control plots. U11: Anova	U11 complete

BIBLIOGRAPHY:

- Statistics. Modelos y Métodos. Tomo I - Peña Sánchez de Rivera, D. - Editorial Alianza - 2000.
- Statistics. Modelos y Métodos. Tomo II - Peña Sánchez de Rivera, D. - Alianza - 1987.
- Probability and Statistics for Engineers - Miller, I.R., Freund, J.E. and Johnson, R. - Prentice Hal - 1992,
- Probability and Statistical Applications - Meyer, P. L. - Inter-American Educational Fund -1973.
- Probability and Statistics - Walpole, R. E. and Myers, R. H. - McGraw - Hill - 1992.
- Probability and Statistical Applications - Walpole, R. E. and Myers, R. H. - Addison-Wesley - 1992.
- Applied Statistics and Probability for Engineers - Montogomery, D. C. and Runger - John Wiley - 1994.

METHODOLOGY AND FORM OF EVALUATION

- "Free" student: oral and written exam with practical and theoretical contents.
- Regular student: Presentation of Practical Works, a mid-term exam in week No. 8, a mid-term exam in week No. 15. Mid-term average grade must be higher or equal to 4 and the second mid-term must be passed, an integral recovery in week No. 16 is offered. Once that is completed, the student must take the final exam, except for the case that the student fullfills the conditions to promote the subject.
- Promoted student: equal to the regular student plus the average mark of mid-term exams higher or equal to 7 and the last mid-term exam higher or equal to 6. The student has to be taking the course for the first time.

- The condition of regularity that the student must have passed the second midterm exam, or the condition of promotion that the student must have a passing grade higher or equal to 6 in the second mid-term exam is due to the integrative content of the subject.
- The condition of promotion, that the student takes the course is necessary in order to promote students who are dedicated to their studies and career, and it also suggests to the student how to make efficient use of their time. On the other hand, it optimises the work of the teaching staff.

ANALYTICAL PROGRAMME OF THE SUBJECT
STABILITY I

OBJECTIVES:

- Identify and analyse the behaviour of basic isostatic structural typologies, as rigid bodies in equilibrium in the plane and in space.
- Define and assess the static loads acting on structures.
- Determine the different stresses that loads produce on isostatic structures, identifying the most stressed sections.
- Assess the impact of moving loads on isostatic structures, and determine the maximum possible stresses for different load combinations.

MINIMUM CONTENT:

Loads on constructions. Analysis of reticulated and full web structures in 2D and 3D. Influence lines and maximum stresses due to the effect of moving loads.

ANALYTICAL PROGRAMME:

CHAPTER I. 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 Timber.

CHAPTER II. EQUILIBRIUM OF EXTERNAL FORCES ON MULTI-PART PLANAR STRUCTURES

Static Determination and Stability. Calculation of Reactions using the Equilibrium Equations. Principle of Superposition of Forces. Equations of Condition. Displacements. Work. Principle of Virtual Displacements. Calculation of Reactions by Virtual Methods.

CHAPTER III. PLANAR RETICULATES

Idealisation of Reticulates. Generation and classification of reticulated structures. Identification of Knots and Notation of Efforts in Bars. Convention of Signs and Representation of Stresses in Bars. Analysis of Reticulates. Node and section methods. Determination of Internal Forces by Application of the Principle of Virtual Works. Static Determination and Stability of planar reticulates.

CHAPTER IV. BEAMS.GANTRIES. ARCHES

Beams and frames. Internal forces in elements subjected to bending. Notation and Sign Convention. Determination of Internal Forces. Relationship between Load, Shear and Bending Moment. Shear, Normal and Bending Moment Diagrams. Detailed construction of Q (shear), N (normal) and M (moment) diagrams. Static determination of beams and frames. Bent Axis Structures.

Tri-articulated and cable-stayed arches. Detailed construction of M, Q and N diagrams.

CHAPTER V. SPATIAL STRUCTURES
Equilibrium Requirements. Specification of a Force. Support Conditions. Types of links. Reaction Forces. External Static and Stability Determination. Calculation of Reactions using Equilibrium Equations. Spatial Beam and Gantry Structures. Section Stresses. Torsional Moment. Bar Stress Notation and Sign Convention.

CHAPTER VI. MOBILE CHARGES
Rationale for the Study of Structural Response under Moving Loads. Variations of the Response Function with Load Position. Lines of Influence by Consideration of Equilibrium. Lines of Influence by Virtual Works. Muller-Breslau Principle. Use of Influence Lines. Maximum Response Functions in Beams. Concept of Maximum Stress Envelope.

BASIC BIBLIOGRAPHY

- Mechanical Engineering. Statics. Hibbeler, R.C.
- Structural Mechanics I
  Piscitelli, Genaro
- Structural Analysis
  Hibbeler, R.C.
- Analysis of Structures. An Integration of Classical and Modern Methods.
  Harry H. West

ANALYTICAL SYLLABUS "TECHNICAL MECHANICS II"

Contents:

THEMATIC UNIT 1 Introduction
Subdivision of mechanics, quantities, vector calculus.

THEMATIC UNIT 2 Kinematics
Trajectories, velocity, acceleration, holo, equations of motion in Cartesian coordinates.

THEMATIC UNIT 3 Rectilinear motion of a point
Uniform, uniformly accelerated, acceleration as a function of path, acceleration as a function of path and time, free fall from a great height, acceleration as a function of speed, movement with resistance.

THEMATIC UNIT 4 Curvilinear motion
In Cartesian coordinates, oblique pull without resistance, natural decomposition of acceleration, circular motion, angular velocity and acceleration, inclined pull with resistance. Velocity and acceleration in polar coordinates. Areolar velocity, central movement.

THEMATIC UNIT 5 Forced movement
Influence of the trajectory as a guide on the motion, without friction and with friction, motion on any curve in the gravitational field.

THEMATIC UNIT 6 The flat movement
Velocity state of a disc, momentary pole, velocity plane. State of acceleration of a disc, plane of accelerations. Acceleration pole, analytical study of the movement. The crankshaft-rod mechanism, movement by cams.

THEMATIC UNIT 7 Composition of several movements
Composition of translations, composition of rotations, torque, composition of translation and rotation, planetary gears.

THEMATIC UNIT 8 Rotary motion
Absolute, relative and system velocities, translational motions, rotational motions, Coriolis acceleration, forced relative motion with and without friction.

THEMATIC UNIT 9 Basic concepts of Dynamics
Work, power energy, dynamic energy for translation and rotation, moments of inertia, ellipsoid of inertia.

THEMATIC UNIT 10 D'Alambert Principle
Deduction for translational motion without and with friction, for rotation, for compound motion, law of motion of the centre of gravity, substitution of a mass by 2 or 3 material points, motion around a fixed point, fixed pendulum. Axes of free rotation of a body.

THEMATIC UNIT 11 The energy integral
For free, guided, friction and frictionless systems, principle of energy conversion.

THEMATIC UNIT 12 The drive
Deduction of the law for translation and for rotation, moment of impulsion

THEMATIC UNIT 13 The law of conservation of motion of the centre of gravity
General deduction, application to a system of masses, conservation of the impulse momentum.

THEMATIC UNIT 14 The shock
Straight central shock, plastic shock, shock coefficient, energy loss in elastic shocks, free shock.

THEMATIC UNIT 15 Material point oscillations
Free and damped, forced, with and without damping.

List of Practical Works

Objectives *(in terms of of competences):*	Contextualise the contents of Basic Physics in the field of Mechanical Engineering.
Analytical description of theoretical and practical activities:	Theoretical and practical classes are given. Theoretical lectures develop the concepts of Classical Mechanics and examine the calculation tools necessary to tackle the problems of kinematics and dynamics in the field of mechanical engineering. In the practical classes, representative problems of the topics covered in the corresponding theoretical classes are analysed, posed and developed, with the participation of all students in the search for solutions. Once this first step has been completed, the students must focus on looking for numerical results with data that are the same for all students, allowing analysis in groups of three or more students working together, favouring the discussion of results. All problem statements, explanatory graphs and diagrams are given to the student in a booklet, which is made available to the student at the beginning of the course and consists of 60 selected problems.
Hourly load:	96 hours
Distribution of activities:	Theoretical classes: 45 hours Practical classes: 45 hours Evaluations: 6 hours
Basic bibliography:	- S. Timoshenko - D, H, Young - **Technical Mechanics** - J. L. Meriam - **Technical Mechanics (Dynamics)**
Other recommended reading:	T. Poschel- **Technical Mechanics** T. C. Huang - **Mechanics for Engineers (Vol. II) Dynamics** F.P. Beer Russell Johnston, Jr - **Vector Mechanics for Engineers - Dynamics**
Evaluation system:	System with compulsory attendance at 80% of the practical classes. To be able to write the final exam of the subject, the student must pass 2 partial evaluations of problems or their respective recovery exams and present 100 % of the problems presented in the blooklet solved. A final written examination must be passed to pass the course.

Ing. Ramón R. Martínez Zuccardi
Associate Professor
Technical Mechanics II

ANALYTICAL PROGRAMME "COMPUTER-AIDED DESIGN"

Contents:

1.-BASIC CONCEPTS
Starting a drawing section in AutoCad. Screen description. Bars of: Menu, Standard Tools, Properties of Objects, Status, Floating Tools, Command Window. Drawing area. Crosshair Graphic Cursor. System icon.
Creating new files: Using a wizard for quick, advanced and default settings.
Drawing Boundary Adjustment. Unit Format: Decimal, Engineering, Architectural, Fractional, Scientific. Accuracy.
Order entry. From the: Keypad, Pull-down Menu, Toolbars and Toolboxes, Pushbutton Menu, Dashboard. Commands: Line, Delete, Save, Open.

2.-CREATION OF A DRAWING
Objects or Entities: Definition.
Drawing aids. Grid, Cursor Forcing, Orthogonal
Selection modes: Direct, Cyclic, Window, Capture, Window Polygon, Capture Polygon, Border, Previous, Last, All, Delete. Commands: Circle, Rectangle, Arc, Explode

3.-INTRODUCTION OF POINTS
Use of Rectangular and Polar coordinate systems. Absolute and Relative Coordinates. Spherical and Cylindrical coordinates.
Direct introduction of distance. Reference to the last point.
Display of the coordinates of the current cursor position: Dynamic, Static, Relative Polar.
Reference to geometric points of objects: Selection of object reference modes. Different Reference Mode options.
Use of single point object reference and implicit object reference definition. Description and modification of object reference parameters.

4.-DRAWING SCREEN CONTROL
Zoom. Options: Magnification factor relative to original drawing size, Magnification factor relative to current display, All, Window, Preview, Extend, Dynamic, Zoom In, Zoom Out, Centre, Realtime.
Framing. Options: Real Time, Dot, Right, etc.
Use of saved views. Saving and retrieving saved views. Orders: 2D Solid, Washer, Splice, Chamfer.

5.-DRAWING IN LAYERS
Layers. Concepts.
Creating and naming layers. Assigning colour, line type, line thickness and stroke style to a layer.
Creation of simple lines.
Activation and deactivation of layers. Disabling and reusing layers. Locking and unlocking layers. Activating and deactivating the printing of a layer.
Renaming and deleting layers. Converting a layer into the current layer. Conversion of an object layer into the current layer.
Commands: Symmetry, Scale, Rotate, Extend, Crop.

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

7.-TEXTOS
Creation of text styles. Modification of text styles. Assigning fonts. Adjusting text height. Relationship between width and height of letters. Adjusting the angle of obliquity. Effects. Text on one line. Justify options: align, adjust, centre, middle, right, BL, BC, BR, ML, MC, MR, TL, TC, TR. Assigning a style to a line of text. Diameter, degree, underline, etc. symbols. Multi-line texts. How to create a multi-line text.
Option: height, justify, line spacing, rotation, style, width. Tabs:
characters, properties, line spacing, search/replace. Text
modification. Text display control.

8.-BLOCKS
Definition of Blocks. Different options. Base Point. Insertion of a block. Insertion point. Scales. Negative scales. Wblok rotation. Different options.
Insert any drawing file as a Block. Base Order.
Modification of a Block. Attributes: Definition of attributes. Modes: invisible, constant, verify, predefined. Insertion points. Modification of attributes.

9.-PRINTING OR TRACING OF A DRAWING
Configuration of a printer. Setting up a plot style table.
Plotting. Description of "Plotting Device" and "Printing Parameters" tabs Commands: Matrix, Stretch.

10.-TREAMS
Creation of outline patterns. 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. Eliminate islands. View selections. Inherit properties. Associative and Non-Associative traits.

11.-CREATING 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 the windows. Locking a window.

12.-ACCEPTANCES
Basic notions on dimensioning according to DIN and IRAM Standards.
How to create a dimensioning style. Tabs: Lines and Ends, Texts; Fitting, Main Units, Alternative Units, Tolerances.
Dimensioning: Linear, Aligned, Angle, Diameter, Baseline, Continuation, Centre Mark, Coordinate, Tolerance.
Modification of dimensions. Associative dimensions. Dimensioning in Model Space and Paper Space. Adequacy of geometry and dimensioning scales in paper space.

13.-WORKING IN THREE-DIMENSIONAL SPACE
Introduction. Elevation and Height.
Options for 3D visualisation. Hiding Lines. Order 3D Face.
Definition of a personal coordinate system.
Options: 3-point, Origin, Rotate in X, Y, Z, Object, Vector Z, Universal, Face, View, Offset, Preview.
Saved Personal Coordinate System
Solids Creation. Predefined and by Extruction Solids

	14.-COMPOUND SOLIDS Boolean Operations: Join, Subtract, Intersection Creating a Solid with Notching. Cutting a solid. Creation of Solids by Revolution. Modelling of bodies with flat and round faces. Modelling of machine parts. Obtaining the different Orthogonal, Auxiliary and Section views and the dimetric perspective, creating the profiles using the "Solprof" (solprofile) command.
Objectives *(in terms of of competences)*:	Systematise the process of graphic representation using the computer. Acquire knowledge and practice in the use of computer-aided design programmes.
Analytical description of theoretical and practical activities:	PROGRAMME OF PRACTICAL LABORATORY WORK Practical Work Nº1: Exercise to get to know the AutoCad work environment, use of the commands Line, Delete and drawing aids. Practical Work Nº2: Training exercise on the introduction of orders, grid modification and coordinate forcing. Practical Work Nº3: Exercise for training in the use of geometric object references and Circle order. Practical Work Nº4: Training exercise in the order Arc, Split, Washer, Solid. Practical Work Nº5: Training exercise of commands Arc, Symmetry, Copy, Scale, Layers. Practical Work Nº6: Given two projections of a body, solve the third one and draw them using the known orders. Practical Work Nº7: Drawing a label and creating the label block. Practical Work Nº7b: Draw the boxes of DIN A3 and DIN A4 formats, and insert in both the label drawn in TPNº 7a, creating a template to be used in all the Practical Tasks. Insert the template and print the seven completed jobs. Practical Work Nº8: Draw three projections by surveying the given ones, creating all the necessary layers and types of lines. Practical Work Nº9: Given the floor plan and façade of a house, draw the standardised plan at a scale of 1:1. Create a library of furniture symbols and insert them into the plan. Make a 1:50 scale presentation. Practical Work Nº10. Given the projections of a machine part, draw them by making a section and dimensioning it. On paper represent it in the requested scale, correcting the geometry of the dimensioning. Practical Work Nº11: Model a prismatic body with notches and section it. Represent on paper space the projections and the most convenient dimetric perspective. Practical Work Nº12: Model a composite body formed by prismatic and solid of revolution, intersected by solids of revolution and planes. Represent in paper space the projections and the most convenient dimetric perspective.
Charge hourly:	64 hours

Distribution of activities:	Practical workload: 32 hours Theoretical workload: 32 hours
Basic bibliography:	Autocad 2000-Practical; Jordi Cros. Autocad 2000-Advanced; Jordi Cros. Autocad 2002-Harrington, Burchard and Pitzer. The Autocad 2007 bible; George Omura.
Other recommended reading	Tratado de Dibujo con Autocad 2005; J. Ferrer-Muñoz. Autocad 2004/2005-Advanced course; López Fernández-Tajadura Zapirain.
Evaluation system:	In order to pass the course, students must fulfil the following requirements: Pass 100% of the Practical Assignments. Attendance at theory classes must be equal to or greater than 80%. Once the above requirements have been fulfilled, the student will be able to take a final assessment at the examination times established by the Faculty. The student is evaluated with an oral questioning in the use of the software and in practice with the resolution of a problem. Students can choose to take three mid-term exams (two on the theoretical aspect of the software and one practical). Students who pass all three mid-term exams with an average grade equal to or higher than 7 are exempted from taking the Final Examination.

Miguel Ángel Salazar
Head of Department

ANALYTICAL PROGRAMME "STABILITY II"

Contents:	**EFFORT** Concept of stress. Equilibrium of a deformable solid. Average normal stress. Examples. Axially loaded bar. Average shear stress. Examples. Allowable stress. Design of simple connections. **DEFORMATION** Displacements in a deformable solid. Unit deformation. Small deformations. Angular deformation. **MECHANICAL PROPERTIES** Tensile and compression tests. Unitary stress-strain diagram. Stress-strain behaviour. Ductile and brittle materials. Hooke's law. Strain energy. Poisson's ratio. Shear stress - angular strain diagram. Material failure. **AXIAL LOAD** Saint Venant's principle. Elastic deformation of an axially loaded element. Principle of superposition. Statically indeterminate axially loaded element. Force method for solving hyperstatic problems. Thermal stresses. Stress concentration. Inelastic axial deformation. Residual stress. **TORSION** Torsional deformation in circular bars. Torsion in filled sections. Power transmission. Torsion angle. Statically indeterminate problems loaded with torsional torques. Torsion in non-circular sections. Torsion in thin-walled hollow bars (closed). Stress concentration Inelastic torsion. **FLEXION** Bending of straight bars. Deformation by bending. Asymmetric bending. Composite beams. Reinforced concrete beams. Stress concentration. Inelastic bending. Collapse loads. Residual forces. **TRANSVERSE SHEAR STRESS** Shear forces in straight elements. Colignon expression. Shear flow in composite elements. Shear flow in thin-walled sections. Shear centre. **GENERAL STATE OF TENSIONS** Stresses in a solid. Actions on a solid. Stress vector. Components of the stress vector. Stress tensor. Symmetry. Tension vector in any plane. Transformation of the tensor by rotating the reference frame. Principal state of stresses. Mohr's circle of stresses. **GENERAL STATE OF DEFORMATION** Displacements in a solid. Deformations. Angular deformation. Deformation tensor. Interpretation. Transformations of the deformation tensor by rotating the reference frame. Principal state of deformations Mohr's circle of deformations. **FAILURE THEORIES** Failure criterion. Rankine criterion. Guest's criterion. Specific work of deformation. Specific work of distortion. Beltrami criterion. Huber - Mises - Henky criterion.

	COMBINED LOADS Thin-walled vessels under pressure. Stress state under combined actions. Flexotorsion, Flexocompression. Flexotraction. **BENDING DEFORMATIONS AND ENERGETIC METHODS** The elastic curve. Slope of the elastic curve. Integration of the differential equation. Discontinuity functions. Displacement and slope of the curve by the area moment method. Superposition method. Deflections of statically indeterminate beams. **SYSTEM DESIGN** Design criteria. Basis for beam design. Stresses in a beam. Design of a prismatic beam. Limitations on displacements. **BUCKLING** Critical load. Bi-articulated column. Different support conditions. Determination of the critical load. Design of columns.
Objectives	Study the strength of solid materials under the different types of stresses to which they are subjected as structural elements. To provide a solid basis for the analysis of different structural elements.
Analytical description of theoretical and practical activities	Student participation is encouraged during the theoretical and practical classes through conceptual questions on the topics explained, and students participate in solving problems similar to typical ones. This ensures that students effectively apply the concepts explained in class and also allows the teaching team to monitor the learning process, assimilation and understanding of the topics explained. In addition, students are provided with problems proposed by the teaching team in order to cover a wide range of situations in which it is possible to apply the concepts explained in class. Theoretical and practical classes are complemented by hours of consultation with the teaching staff so that students can follow the course of the subject without difficulty. Part of the content of the course is developed by means of blackboard expositions and for some subjects with multimedia support.
Hourly load:	128 hours
Time distribution:	Theoretical-practical classes: 116 hours Evaluations: 12 hours
Basic bibliography:	- Resistance of Materials Guzmán A. - Hibeler Material Mechanics - Strength of Materials Timoshenco -
Other bibliography	- Hirschfeld Building Statics - Maschinenelemente-Deckel K H - Advanced course in strength of materials. Seely and Smith

Evaluation system:	The teaching process is evaluated by means of 3 partial exams, each comprising a partial content of the subject. The possibility of promotion is also contemplated for those students who obtain an average of 7 (seven) or more in the mid-term exams and pass an integrative oral mid-term exam at the end of the course. This last exam allows the evaluation of the student's ability in the exposition and correct use of the vocabulary. Students who pass the course must take a final oral exam in order to pass the course. The condition for the approval of regular students is to have passed the 3 mid-term exams, the complete portfolio of practical work and to pass the final exam. The condition for the approval of "free" students is to take three written exams of practical problems covering all the subjects of the course, and an oral theory exam once the practical exams have been passed.

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Francisco Segura
Associate Professor
Stability II Chair

ANALYTICAL PROGRAMME "FLUID MECHANICS"

Contents:	**1. Fundamentals, definitions, postulates and laws of mechanics.** Concept of fluid. Physical properties of real fluids: density, specific volume, volumetric compressibility and viscosity. Equation of state 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 at boundaries. Magnitudes, dimensions and units. Systems of units. **2. Forces, stresses and strains. Viscosity and pressure concepts.** Types of forces. Definitions of stress and strain. The stress tensor. Concepts of symmetry and diagoanalysis of tensor magnitudes. Invariance. Principal axes and directions. Symmetry of the stress tensor. Pressure at a point. Hydrostatic pressure: isotropy principle or Pascal's principle. Newton's and Stokes' laws of viscosity Newtonian and non-Newtonian fluids. Brief introduction to rheology. Other physical properties of real fluids: vapour pressure and surface tension. **3. Hydrostatics and relative equilibrium.** Fundamental equation of hydrostatics. Torricelli's equation. Hydrostatic paradox. Pressure measurement: manometers, piezometers, barometers. Absolute and relative pressure. Units of pressure. Stratified fluids. Pressure forces on flat and curved open surfaces. Centre of pressure. Forces of pressure on submerged bodies: Archimedes' principle. Centre of thrust. Equilibrium and stability of submerged and floating bodies. Metacentre and metacentric height. Relative equilibrium: liquids subjected to constant accelerations. D'Alembert's principle. Linearly accelerated and rotating vessels (centrifuges): pressure and free level equations. **4. Hydrokinematics.** The motion of the fluid particle: position, velocity and acceleration vectors. Description of fluid motion: Lagrange and Euler criteria. Reference systems. Path and streamlines. Streamlines and stream tubes. Concepts of material or substantial, local and convective (advective) derivatives. Definition of flow. Types of flow: uniform, steady, variable. Linear and angular deformations, dilation, translation and rotation of the fluid particle. Concepts of divergence, rotor and velocity gradients. Gauss and Stokes theorems. Concept of circulation. Compressible and incompressible, rotational and irrotational, viscous and non-viscous flows. One-dimensional, two-dimensional and three-dimensional flows. **5. Hydrodynamics.** Leibnitz theorem applied to conservation laws. Principle of conservation of mass. Differential and integral equations. Continuity equation. Origin of forces on fluids. Dynamic equilibrium equation (Darcy's). Constitutive and Navier-Stokes equations. Stationary, incompressible and non-viscous flows: Euler and Bernoulli equations. Constraints and fields of application. Flow measurements: Pitot, Prandtl and Venturi devices. Integration of the Navier-Stokes equation for particular cases. Hagen-Poiseuille equation. Reynolds and Hagen experiments. Laminar and turbulent viscous flows. Velocity profile. Concept of mean velocity and correction factors. Correction of the Bernoulli equation for losses in viscous flows. Generalisation of the Bernoulli equation. The speed of sound, Mach number and incompressibility criteria. **6. Laws of similarity and dimensional homogeneity.** The principle of dimensional homogeneity. Bukingham's theorem. Dimensionless groups: usefulness and dimensionless techniques. Dimensional matrix. Dynamic and geometric similarity laws. Brief introduction to model theory. Wind tunnel testing and experimentation. Dimensionless numbers useful in Fluid Mechanics and others of frequent or generalised use. Limitations, compatibility and criteria of use.

Contents	**7. Internal flows (in ducts and pipes).** Dimensional analysis applied to fluid flow in circular sections. Reynolds number. Concepts of boundary layer, inlet length and developed flows. Concepts of absolute and relative roughness and boundary layer thickness. The Moody diagram. Darcy-Weissbach equation. Losses in ducts, changes of section, changes of direction and in fittings. Loss coefficients and equivalent lengths. Influences of corrosion and/or fouling. Concepts of geodetic, piezometric and total heads: diagrams. Pumping and usable power in turbines. Flows through non-circular sections. Hydraulic or equivalent diameter. Equivalent piping. Series, parallel, branched and branch pipes and pipe networks. **8. Potential flows and flow networks.** Irrotational flows and velocity potentials. Current function. Laplace's equation. Orthogonality of streamlines and equipotentials. 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's paradox. Correlation between theoretical potential flows and real viscous flows. **9. External flows (around submerged bodies).** Prandtl's theory of the boundary layer. Viscous uniform flow on a flat plate. Influence of the pressure gradient. The boundary layer separation or detachment phenomenon. Plane and/or axially symmetric flow around cylinders, spheres and profiles. Wake formation. Aerodynamic shapes: Kutta-Joukowski criterion. Lord Kelvin's theorem or conservation of circulation theorem. Airfoil geometry and aerodynamic forces. Lift and drag coefficients or resistance. Polar diagram of airfoils. **10. Fluid-thermodynamics.** Basic concepts of thermodynamics: state variables, processes. First principle of thermodynamics. Mechanical work on fluids. Internal, potential and kinetic energy. Mechanical energy equation. Viscous dissipation. Second principle of thermodynamics: entropy. **11. Introduction to hydraulic machines.** Principles of conservation of the linear and angular momentum. Forces on nozzles, curves, plates, vanes and/or blades and rotating parts. Fundamental equation of hydraulic machines. Velocity triangles. Applications to pumps and turbines. Concept of cavitation.
Objectives	Know, interpret and apply the laws of mechanics that govern the state of rest or movement of fluids, in order to subsequently master and take advantage of the interaction between them and their boundaries.
Analytical description of theoretical and practical activities	Theoretical and practical classes are given, from which the students make their own notes. As the syllabus of the subject, even with its minimal contents, is very extensive in relation to the time allotted for the teaching of the subject. Problem solving is done entirely in class, but with the active participation of the students. For the proposed problems, each student receives specific numerical data; the results and their interpretation are personal work, which, when reviewed, allows to evaluate the level of understanding and learning of each topic. Additionally, by means of a subsequent questioning on each practical work, the student must demonstrate that he/she has sufficient knowledge to pose and solve similar cases. Each practical work is approved with the presentation in due time and form of its written resolution, in addition to the satisfactory approval of the corresponding interrogation. The student is provided with the necessary tables, graphs, nomograms, etc. and also with the necessary bibliographic references specific to each work.

Hourly load:	96 hours
Time distribution:	Theoretical and practical classes: 90 hours Evaluations: 6 hours
Basic bibliography:	White, Frank M., Fluid Mechanics, McGraw-Hill. Fox - McDonald, Introduction to Fluid Mechanics, McGraw-Hill. Streeter, Victor L., Fluid Mechanics, McGraw-Hill.
Other bibliography	Shames, Irving H., The Mechanics of Fluids, McGraw-Hill Streeter - Wylie - Bedford, Fluid Mechanics, McGraw-Hill. Potter - Wiggert - Honzo, Fluid Mechanics, Prentice Hall. Daugherty - Ingersoll, Mecánica de los Fluidos, Edit. Hispanoamericana S.A. Baloffet-Gotelli-Meoli, Hidráulica, Biblioteca EDIAR de Ingeniería. Kay, J.M., Fluid Mechanics and Heat Transfer, Marcombo, Marcombo. Mataix, Claudio, Mecánica de los Fluidos y Máquinas Hidráulicas, HARLA, Mexico. Kundu, Pijush K., Fluid Mechanics, Academic Press. Whitaker, Stephen, Introduction of Fluid Mechanics, Prentice Hall, The New York Times. Wen-Hsiung Li - Sau-Hai Lam, Principles of Fluid Mechanics, Addison-Wesley.
Evaluation system:	The evaluation of each regular student is carried out by means of an oral and public examination on theoretical and practical subjects. The examination topic is chosen without taking into account the order of the balls in the syllabus of the subject. In the case of "free" students, they must pass a previous written exam consisting of the resolution of a series of problems of similar complexity to those developed during the regular course. The results and grades are communicated immediately to the student, informing the correct answers and mistakes.

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Ing. Jorge Francisco Koehle
Associate Professor

ANALYTICAL PROGRAMME "GENERAL ELECTROTECHNICS AND LABORATORY"

Contents:	**THEMATIC UNIT 1:** Nature of electricity - Electrical conductors - Quantity of electricity - Current intensity - Types of currents - Electric voltages - Ohm's law - Resistance and conductance - Units - Series connection - Parallel connection - Kirchoff's first and second laws - Electric work - Electric power - Thermoelectricity - Electric current in electrolytes - Faraday's laws - Batteries or accumulator elements. **THEMATIC UNIT 2:** Magnetic Fields - Fundamental Phenomena - Magnitudes - Magnetic Induction and Flow - Magnetisation curve - Magnetic Hysteresis - Magnetic Hysteresis Curve - Magnetic Field Actions- Dynamic and Static Electromotive Force - Law of the Electromagnetic Induction - Self Induction - Mutual Induction - Energy of the Magnetic Field - Solving Magnetic Circuits. **THEMATIC UNIT 3:** Alternating current circuits - Production of electromotive force. - Sinusoidal electromotive force - Vector and Cartesian diagrams - Composition of sine waves - Arithmetic and quadratic mean value defasement - RMS value - Electric field - Density - Intensity - Capacitance - Displacement - Dielectric constant - Coulomb's law - Capacitors - Calculation of capacitance - Series and parallel connection - Receivers in alternating current circuits - Connections with: pure ohmic resistance, inductive reactance and capacitive reactance - Combination of elements connected in series and parallel - Energy of alternating current - Active, reactive and apparent power - Power factor - Resonant circuits - Coupled circuits - Geometric locations - Calculation methods with complex numbers - Impedance and complex admittance - Complex power. **THEMATIC UNIT 4:** Three-phase, alternating current circuits - Three-phase voltage production - Star connection - Delta connection - Voltage and current diagram - Power in three-phase systems - Calculation of power in balanced and unbalanced systems - Measurement methods. **THEMATIC UNIT 5:** Circuit Solving Methods - Meshing - Nodes - Superposition - Compensation - Maximum energy transfer - Reciprocity - Thevenin Northon. **THEMATIC UNIT 6:** Electrical measurements - General information on measuring instruments - Classification of instruments - Voltage and current measurements - Use of multipliers and ranges - Measurement of active, reactive and apparent power - Measurement of resistances, reactances and capacitances.
Objectives *(in terms of of competences)*:	To provide students with the basics of electricity and magnetism, with emphasis on both conceptual understanding of the phenomena and problem solving by means of analytical and quantitative calculation. Acquire experience in making reasonable assumptions, formulating hypotheses, modelling and solving a problem. To achieve the ability to obtain an analytical result and to be able to see its scope and also its limitations. To train the student in the handling of instruments and auxiliary devices starting from the principles of operation and limiting their ranges in magnitudes and frequency with the expected accuracy values. The student will acquire the fundamental knowledge of electrical engineering and will learn the basic principles of electrical energy generation.

Analytical description of theoretical and practical activities:	**List of Practical Assignments** Nº 1: Variation of Resistance with Temperature - Direct Current Nº 2: Electromagnetism - Electromagnetic Circuits Nº 3: Alternating Current Circuits - Power - Power Factor Nº 4: Three-Phase Systems Nº 5: Instruments - Problems on Errors Nº 6: (laboratory): Contrast of Ammeter and Voltmeter Nº 7: (laboratory): Contrast of Wattmeter Nº 8: (laboratory): Three Phase Power Measurement
Hourly load:	Total hours: 112 hours
Distribution of activities:	Total hours of experimental practice: 40 hours Total hours of application problem solving: 40 hs
Basic bibliography:	Electric and Magnetic Circuits, Spinadel Enrico Circuit Theory, Ras Enrique
Other recommended reading:	Electrical Engineering, García Trasancos José Electrical Engineering, Alcalde San Miguel Pablo Circuitos Eléctricos 1, Pueyo Héctor O. Circuitos Eléctricos 2, Pueyo Héctor O. Fundamentals of Electrical Circuits, Cogdell J.R. Electrical Circuits, Edminister Modern Electronic Instrumentation and Measuring Techniques, William D. Cooper, Albert Helfrick Electrical measurement technology, Moeller - Werr
Evaluation system:	In order to regularise the subject, students must: a) Be enrolled in the subject. b) Have at least 75% attendance at practical classes. c) Pass the 2 evaluations with 50% or more of the maximum score assigned. In case of non-compliance, a recovery test is taken. In order to pass the subject, an oral examination is taken in which the student must present his or her practical and theoretical knowledge of the different topics on the syllabus. The evaluation is recorded in the student's notebook. The free examination consists of a written examination (theoretical and practical) and a final oral examination. In all cases, "free" exams were given to those students who, having passed the subject, lost their regularity because they missed the deadline to take the final exam.

Salvador Eduardo Gallo
Senior Lecturer Head
of Chair

ANALYTICAL PROGRAMME "MATERIALS TESTING"

Analytical Materials Testing Programme Contents:	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 - Metallic crystals - Special lattices, cubic and hexagonal systems - Crystallographic planes - Crystallographic directions - Miller-Brevais indices - Compact structures. Crystalline defects: point, linear and surface defects. 2.- Study of metallic materials - Knowledge of their mechanical properties. Generalities - Action of a load on a metal - Elastic and plastic deformation - Classification of mechanical properties: resistance, deformation, tenacity. Process of deformation and failure. Deformation of a metal by tensile stress: elastic deformation - Elastic limit, limit of proportionality - Plastic deformation - Elasticity - Hooke's law - Rheology - Creep - Acrimony - Work of deformation - Diagrams: nominal, real, Stead - Fundamental diagrams according to the properties of metals: ductile, semi-ductile and brittle. 3.- Deformation of a single crystal - Mechanism of elastic and plastic deformation - Slip line - Planes and directions of easiest slip - Critical shear - Theories of deformation, crystal imperfections, deformation by twinning, amorphism theory and dislocation theory. Origin and properties of dislocations in the cubic system and application of dislocation theory - Brittle and ductile monocrystal fracture - Deformation and cohesion resistance. 4.- Mechanical behaviour of metals - General information on static tensile tests on ferrous and non-ferrous materials - Testing standards - Type of specimens - Determinations - Modulus of elasticity E - Deformation resistance and breaking strength - Mohr's circle. Diagrams - Specific elongation - Neck region -Mechanical hardening by tension and torsion - Types of brittle and ductile fractures. Effect of notching on static tensile stress. Notch sensitivity - Influence of notch depth and notch angle in ductile and brittle metals - Stress and strain states - Technical cohesive strength. Diagram. Torsional stress of metallic materials - Critical shear - Mohr's circle. Diagrams - Brittle and ductile fractures - Transverse modulus of elasticity G - Testing - Determinations. 5.-Hardness in metals - Definition - Test methods for its determination: Brinell, Rockwell, Vickers, Shore - Penetrators - Hardness measurement - Range of application of the different methods. Advantages and disadvantages - Testing standards 6.- Dynamic impact tests - Dynamic bending - Resilience - Tests - Methods - Test conditions - Fracture. 7.- Fatigue in metallic materials - Fatigue process - Fatigue stresses - Tests - Fatigue resistance - Fatigue limit variation according to the type of variable stress - Wholer, Goodman and Smith diagram - Fatigue limit according to the nature of the stresses - Relationship between the fatigue limit of steels and their other properties - Factors influencing the fatigue limit - Mechanical factors. Fatigue and sub-fatigue. Nature of stresses - Stresses - Rest periods - Geometrical factors - Metallurgical factors. 8.- Long-term static tests - Hot tensile tests - Tensile strength and hot yield strength - Effect of time and temperature on the deformation process - Creep processes with constant load - Creep. 9.- Knowledge of the properties of metals non-destructive testing - Magnetic particle methods, liquid penetrant, industrial radiography, electromagnetic technique, resonance vibration technique and ultrasound. 10.- Plastic materials - Generalities - Classification of thermoplastics and thermosets - Plastic materials of major application in mechanical constructions - Mechanical, thermal, electrical, acoustic, etc. properties. - Graphic tests.

	List of Practical Assignments **Nº 1.** Introduction to materials testing **Nº 2.** METALS. Crystalline Structure **N° 3.** METALS. Mechanical properties **Nº 4.** STEELS. Process of deformation and failure **Nº 5.** STEELS. Tensile test **Nº 6.** STEELS. Real stress diagram **Nº 7.** STEELS. Mechanical hardening **Nº 8.** STEELS. Torsion test **Nº 9.** STEELS. Triaxiality - Notching **Nº 10.** STEELS. Hardness tests **Nº 11.** STEELS. Shock test **Nº 12.** NON-DESTRUCTIVE TESTING **Nº 13.** METALS. Effect of time and temperature **Nº 14.** FATIGUE **Nº 15.** PLASTICS
Objectives	To acquire the necessary knowledge to understand the process of deformation and failure of metals under the action of different stresses, time and temperature conditions and evaluate the associated mechanical properties by means of standardised laboratory tests. Study plastic materials, their physical and mechanical properties and applications in the field of Mechanical Engineering.
Analytical description of theoretical and practical activities:	The course is developed through theoretical and practical classes (theory, problem solving and laboratory tests) and evaluations. Course website: http://www1.herrera.unt.edu.ar/faceyt/ensayo-materiales THEORETICAL AND PRACTICAL CLASSES: 2 weekly classes of 2 hours to develop theoretical aspects, solve some application problems and the corresponding laboratory tests. Multimedia equipment is used for theory and testing equipment in the Materials Testing Laboratory. This modality allows to bring theory closer to its application. Students must complete the Practical Work Guide, complementing it with a questionnaire on the theory of the different subjects. EVALUATION: students must take three evaluations.
Hourly load:	64 hours
Distribution of activities:	Theoretical-practical classes: 58 hours Evaluations: 6 hours
Basic bibliography:	• Metales y Aleaciones - TomoII- RafaelCalvo Rodés- Instituto nacional de Técnica aeronáutica Esteban Terradas- Madrid • Materials Testing - Aaron Helfgot • Ensayos Industriales (González A. y Palazón A.- Editorial: Talleres Gráficos Buschi S.R.L.) • Plastics for Industrial Use - John Sassó
Other recommended bibliography:	• Engineering Materials and their Applications (Flinn Trojan Mc Graw-Hill Latinoamericana, S.A.) • Nature and Properties of Engineering Materials (2nd edition Jastrzebski, Z. Interamericana S.A.)

Evaluation system:	***Regularity: Conditions*** • Be regular in the subject Stability I • 80% attendance at theory classes • 100% attendance at practical laboratory classes. • Approval of the portfolio of practical work properly submitted on time. • Passing the mid-term exams with a mark higher than or equal to 4. The recovery grade must be averaged with the grade obtained and this average must be greater than or equal to 4. ***Promotion: Conditions.*** • Have passed Stability I • 80% attendance at theory classes • 100% attendance at practical laboratory classes. • Approval of the portfolio of practical work properly submitted on time. • Passing the mid-term exams with a mark higher than or equal to 7. In order to obtain promotion, a recovery exam may be taken as long as the mark is between 4 (four) and 7 (seven). The recovery grade must be averaged with the grade obtained and this average must be greater than or equal to 7.

Msc. Ing. Silvia Palazzi
Full Professor

ANALYTICAL PROGRAMME "KNOWLEDGE OF MATERIALS"

Contents:

THEME I ***BASICS***

Types of materials. Relationship structure - properties - processing, Atomic structure. Atomic bonds in solids. . Structure of crystalline solids. Unit cell; polymorphism and allotropy. Non-crystalline solids. Crystalline defects. Impurities in solids Point imperfections: a) thermal production of point defects; and b) mass transfer mechanisms. Steady-state and non-steady-state diffusion.

THEME II ***METALS***

1- *Ferrous Metals*. Production of pig iron and sponge iron. Steel production. Steel casting, ingot defects.
2- Solidification of pure metals and alloys. Phase diagrams. Phases. Solid solutions. Compounds. Solubility limit. Microstructure. Phase equilibria. 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 and alloy steel. Classification. Application. Mechanical properties. Standardisation.
4- Heat treatment of ferrous alloys: a) annealing; b) normalising; c) quenching; d) tempering; Phase transformations in metals. Kinetics of solid state reactions. Changes in the microstructure and properties of iron-carbon alloys: I) isothermal transformation diagrams; and II) continuous cooling transformation diagram e) surface hardening and thermochemical treatment. Hardenability.
5- Iron castings. Classification. Microstructure. Properties. Standardisation. Fundamentals of the manufacture of iron castings. Manufacture of castings.
6- Mechanical metal working: (a) forging; (b) rolling; (c) extrusion; and (d) wire and bar drawing.
7- Processing of metal powders (powder metallurgy).
8- Non-ferrous metals: (a) copper and its alloys; and (b) aluminium and its alloys. Hardening. Properties. Classification according to standards.

THEME III ***CERAMICS***

1- Introduction. Classification of ceramics. Applications.
2- Ceramics formed by silicates. Imperfections. Phase diagrams of ceramics. Properties of ceramics.
3- Processing of clay products: (a) raw materials; (b) manufacturing techniques; and (c) drying and firing.
4- Processing of advanced ceramic products and cermets: (a) material preparation;
(b) forming; (c) sintering; and (d) finishing.
5- Glass processing. Raw material preparation and melting. Forming of glass products. Heat treatment and finishing. Vitreous ceramics.

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	THEME IV ***POLYMERS*** 1- Introduction. Polymer molecule. Weight, shape, structure and molecular configuration. Copolymers. Crystallinity of polymers. 2- Thermo-mechanical characteristics of polymers. Thermoplastics and thermosets polymers. Other mechanical characteristics. 3 - Formation of polymers. Extrusion. Film and foil production. filament and fibre production. Coating processes. Injection moulding. Compression and transfer moulding. Blow and rotational moulding. Melting (casting) of plastics. Processing and forming of foams. Glass fibre reinforced plastics.

Objectives *(in terms of competences)*:	To know and control the properties of metals and alloys, as well as other materials used in the activity of the mechanical engineer: ceramics, plastics, etc.
Analytical description of theoretical and practical activities:	Theoretical and practical classes are given. The problems are analysed, posed and developed entirely in class, seeking the participation of all students. Individual data require different analyses and individual solutions. It is organised as follows: Theoretical classes: During the theoretical classes, technical and scientific advances are discussed in order to motivate the students, and application problems are posed, analysed and solved with the aim of clarifying the theoretical topics dealt with. Basic bibliographical information is provided, at the same time as the student is encouraged to search for and investigate new sources of information. Practical Classes: Five practical assignments are foreseen in which the student designs, analyses processes, solves problems, extracts data from manuals and brochures, etc., which are subsequently assessed for approval. Five laboratory experiments are also carried out in which the student becomes familiar with the use of heat treatment furnaces, metallographic microscope, hardness tester, microhardness tester, Jominy test equipment and other complementary equipment in the Metallurgy and Foundry laboratory. The student prepares a report on the activity carried out, which is also subsequently evaluated.

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Hourly load	112 hours
Distribution of activities	Theoretical and practical classes: 112 hours
Basic bibliography	**INTRODUCTION TO MATERIALS SCIENCE AND MATERIALS ENGINEERING,** WILLIAM D. CALLIESTER, Jr , EDITORIAL REVERTE S. A. **INTRODUCTION TO MATERIALS SCIENCE FOR ENGINEERS.** JAMES F. SHACKELFORD, PRENTICE HALL **INTRODUCTION TO PHYSICAL METALLURGY.** SIDNEY H. AVNER, Mc GRAW - HILL **GENERAL METALLURGY.** F. R. MORRAL - E. JIMENO - P. MOLERA, EDITORIAL REVERTE S. A. **FABRICACION DE HIERROS, ACEROS Y FUNDICIONES (2 volumes).** JOSE APRAIZ BARREIRO, EDICIONES URMO **CERAMIC MATERIALS.** EDUARDO A. MARI, ALSINA BOOKSHOP AND PUBLISHING HOUSE **INDUSTRIA DEL PLASTICO - PLASTICO INDUSTRIAL,** EDITED BY HOWARD E. BOYER - TIMOTHY L. GALL, AMERICAN SOCIETY FOR METALS
Other recommended reading:	**FUNDAMENTALS OF MODERN MANUFACTURING.** MIKELL P. GROOVER, PRENTICE - HALL HISPANOAMERICANA, S. A. **PHYSICAL METALLURGY FOR ENGINEERS.**DONALD S. CLARK - WILBUR VARNEY,AMERICAN BOOK. VAN NOSTRAND. REINHOLD **METALS HANDBOOK DESK EDITION,** EDITED BY HOWARD E. BOYER - TIMOTHY L. GALL, AMERICAN SOCIETY FOR METALS
Evaluation system	In order to regularise the subject, the student must: • Attend 80% of the classes given during the term. • Properly submit practical assignments on time as they are carried out. • At the end of the course, the student must have all the practical exercises presented and passed. A final oral exam must be passed in order to pass the course.

Ing. Ricardo R. Collado

Associate

Professor of Materials Knowledge.

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ANALYTICAL PROGRAMME "THERMODYNAMICS"

Contents:	THEMATIC UNIT 1: General information. Thermodynamic system. Energies, potentials and resistances. Principles of thermodynamics and equilibrium. Matter. Thermodynamic state. Change of state and state function State variables of pure substances, state surfaces, orthogonal state diagrams, dependent and independent variables, title of vapours. THEMATIC UNIT 2: Equation of state, changes of state and thermodynamic processes. Equation for: liquid, wet vapour, superheated vapour, ideal and real gases. Gas constants. Compressibility factor. Mixture of gases. Reversible and irreversible changes of state. THEMATIC 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 and closed systems and cyclic processes. THEMATIC UNIT 4: Calculation of caloric variables. Specific and true specific heat. Heat equations and relation with specific heat. Specific heat of any transformation. Calculation of heat quantity by means of specific heat. Average specific heat. Heats of solids, liquids, ideal and real gases and gas mixtures. THEMATIC UNIT 5: Entropy and entropic diagrams. Entropy function and thermodynamic temperature. Entropy in reversible processes. Entropy balances. Absolute and reference entropy. Entropic diagrams, construction and use. THEMATIC UNIT 6: Reversible changes of state in pure substances. Transformations. Polytropic changes of 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 changes of state. Transformations in real gases. Changes of state in diagrams. THEMATIC UNIT 7: Exergy. Equilibrium and equalisation. Exergy and anergy. Exergy of systems in disequilibrium with the medium. Calculation of exergy of potential, kinetic, electrical, chemical and mechanical energy. Exergy of heat. Carnot factor. Exergy of frictional work. THEMATIC UNIT 8: The second principle of thermodynamics. Irreversibility. Relationship between generated entropy and lost exergy, internal and external irreversibility. Behaviour of the entropy function, influence of the second principle. Calculation of the entropy variation in irreversible processes. Evaluation of energy processes, performances and efficiencies. THEMATIC UNIT 9: Gaseous compression. Definition. Compression processes. Compression systems, classification. Alternative compressors. Multi-stage compression. THEMATIC UNIT 10: Heat transmission. Transmission mechanisms. Conductivity. Coefficient of conductivity. Laplace's differential parameter. Conductivity in flat wall and hollow cylinders and in overlapping layers, wall temperature. Convection Film coefficient. Transmission between fluids with varying temperatures. Circulation in the same direction, in different directions and with cross currents. Radiation. Fundamental concepts. Stefan's and Boltzman's law. Total radiation coefficient. Emissive power. Radiation intensity Black body radiation and its coefficient. Lambert's law. Emission ratio. Radiation heat exchange. Radiation through layers of air. Radiation from gases. THEMATIC UNIT 11: Reactive processes. Definition. Necessary studies for the analysis of reactive processes. Complete and incomplete combustion. Balances of matter for the

	combustion of: solids, liquids and gases. 3T rule. Control by gas analysis. First principle for reactive processes. Enthalpy and internal energy of formation. Enthalpy and internal energy of reactants and products. Calorific value. Exergy of fuels. Enthalpy of combustion gases. I - t diagram Second principle for reactive processes. THEMATIC UNIT 12. Adiabatic flow processes. General equation. Accelerated and decelerated flow. Speed of sound. Flow in pipes of constant and variable cross-section. Fanno curves, sonic pressure. Shock wave. Rayleigh curve Nozzles. Current function. Ideal gas flow. Spills in nozzles with variable back pressure. Application in flow measurements. THEMATIC UNIT 13. Cyclic processes. Thermal performance. Thermodynamic average temperatures. Feasibility of the Carnot cycle with vapours. Clausis - Rankine cycle in wet steam zone. Improvements of the Rankine cycle by steam superheating, intermediate reheating and regenerative preheating of the feed water. Clausis - Rankine irreversible cycle. Joule - Brayton cycle. Regenerative preheating. Ericsson cycle. Combined cycles. Reciprocating engine cycles. Inverse cycles. Efficiency coefficient. Reversible and irreversible refrigeration machines. Absorption cycles. **List of Practical Works** 1. Thermodynamic systems and their properties. 2. Equation of State and Gas Mixture. 3. The first principle of thermodynamics. 4. Calculations with specific heats. 5. Changes of state with ideal gases. 6. Entropic diagrams and Exergy. 7. Capsular compression. 8. Heat exchanger project. 9. Balance of matter for combustion. 10. Use of the (I-t) diagram. 11. Adiabatic flow. 12. Clausius-Rankine cycle with superheated steam and condensation.
Objectives *(in terms of of competences)*:	At the end of the course, the student will be able to interpret and apply the fundamental laws governing the transformation of energy and its effects on matter, and the production of heat and work and their evaluation in those processes that make them possible.
Analytical description of theoretical and practical activities:	The course is developed through theoretical and practical classes (theory and problem solving) and evaluations. Theoretical and practical classes: two 3-hour classes per week and one 2-hour class per week to develop theoretical aspects and solve some application problems. The subjects are presented with the help of a blackboard, copies of notes, tables, diagrams, plans, technical catalogues and possible projections of transparencies, and the problems and their methods of resolution are explained. Students can also ask questions on theoretical or practical subjects outside class hours. Assessment: students must take, on pre-established dates during the course, practical work with the corresponding theoretical subjects and a final integrative exam.
Hourly load:	128 hours
Distribution of activities:	Theoretical-practical classes: 124 hours Evaluations: 4 hours
Basic bibliography:	- Modern Treatise on Thermodynamics - Hans Baehr - Montesó. 1965 - Thermodynamic Engineering - F. Huang - C.E.C.S.A. 1994

Other recommended reading:	- Technical Thermodynamics - Kirillin and Sichev - Mir. 1976. - Thermodynamics - Abbott and Van Ness - Mc Graw-Hill. 1975. - Elements of thermodynamics and heat transfer - Obert - Young - Continental.1965 - Elements of thermodynamics and heat transfer - Obert - Young - Continental.1962 - Thermodynamics - J. P. Holman- Mc Graw Hill. 1975 - Heat transfer - J. P. Holman - Mc Graw Hill. 1997 - Theory and problems of thermodynamics - Abbott and Van Ness - Mc Graw Hill. 1975
Evaluation system:	In order to regularise the subject, the student must: • Attend 80% of the classes given during the term. • Properly submit practical assignments on time as they are carried out. • Pass the practical work, on a date to be set in the first week of classes, and an oral evaluation of the practical work or its respective recovery. A final oral examination must be passed in order to pass the course.

Ing. Jorge Ramón Pisa
Associate Professor Head
of Chair

ANALYTICAL PROGRAMME "INDUSTRIAL ELECTRONICS"

Contents:	**1- Basic electronics** Basic elements and laws: ideal voltage generator, ideal current generator. Ohm's law, Thevenin's theorem, Norton's theorem, superposition theorem. Quadrupole. Examples and application exercises. Laboratory verification tests. **2- Elementary components** Diodes, definition of the ideal diode. Diode symbol. Operation. Characteristic curves. Real operating limitations. Basic circuits with diodes: Half-wave rectifier. Peak rectifier. Full-wave rectifier. Power supplies. Application examples and exercises. Laboratory verification tests. Transistor: Transistor symbol. Input and output characteristic curves. Working areas. The transistor as an amplifier. The transistor as a key. Laboratory verification tests. Thyristors: Symbol. Characteristic curves. Operation. Limitations. Laboratory verification tests. **3- Binary algebra** Logical states. Positive logic. Negative logic. Logic gates: AND, symbol and truth table, OR, symbol and truth table, NAND, symbol and truth table, NOR, symbol and truth table, OR EXCLUSIVE (XOR), symbol and truth table. Inverter. Implementation of each of the different logic gates using diodes and transistors. Practical testing in the laboratory. **4- Integrated circuits** Operational amplifier: Symbol and definition. Operation. Basic configurations: Inverting amplifier. Non-inverting amplifier. Adder. Integrator, differentiator. Digital integrated circuits. Analogue/digital and digital/analogue converter. **5- Industrial Automation** General diagram of an automation system. Fundamental elements involved in automation. Man-machine relationship. **6- Digital sensors** Limit switches. Inductive proximity switches, Capacitive proximity switches Photoelectric proximity switches. Ultrasonic proximity switches. Pressure switches and vacuum gauges Operation, use and selection of each one of them. Verification of the operation of some sensors in the laboratory. **7- Analogue sensors** Standard voltage and current levels in control systems. Thermocouple. Thermo-resistance. Load cells. Analogue proximity sensors. Operation and selection. Laboratory testing of sensors. **8- Actuators** Contactors. Solenoid valves. Soft starters. Basic principle of operation. Variable speed drives for AC motors. Basic principle of operation. Selection criteria Laboratory testing of these elements. **9- Signal processing elements** Programmable Logic Controllers (PLC). Basic operation. Programming languages: Ladder, Boolean, Grafcet. Basic language elements (internal bits, input and output bits, timers, counters). Input and output modules, digital and analogue. Configuration. Addressing. Structured function blocks.

	PRACTICAL WORK and LABORATORY PROGRAMME • Electrical circuits and application of theorems • Diode circuit problems and laboratory tests • Transistor circuit problems and laboratory tests • Power supply testing • Problems and tests of operational amplifier circuits • Problems and laboratory verification of sensors • Troubleshooting and laboratory verification of actuators (contactors) • Ladder programming problems
Objectives *(in terms of of competences)*:	Handle methods and terminologies in the applications of electronics in industrial environments. Analyse and design electronic systems for process control in general. Recognising and using basic electronic components. Introduction to the handling of the latest generation elements and principles of industrial automatisms.
Analytical description of theoretical and practical activities:	**Theoretical-Practical Classes**: During these classes, the content of the syllabus is developed, with a theoretical presentation and practical application problems. The lectures are developed using a blackboard, a projector and a PC. **Practical classes - Laboratory:** During these classes, application problems are posed and exercises are proposed to be solved by the students. The presentation of the Practical work is compulsory, in addition to laboratory work involving the assembly and testing of basic circuits.
Hourly load:	96 hours
Distribution of activities:	Theoretical-practical classes: 48 hours Practical classes and laboratory: 48 hours Evaluations: During the practical hours
Basic bibliography:	Electronics - Circuit Theory, R. Boylestad and L. Nashelsky, 6th edition Electronic Circuits and Devices, J. Millman and C. Halkiasky, 6th edition. Halkias
Other recommended reading:	Thyristors and Triacs, H. Lilen Theory and Problem of Electrical Circuits". J. A. Edminister. Ed Mac Graw-Hill Modern Industrial Electronics". Timothy J. Maloneyh. Ed. Pearson Education. Year 2006 Principles of Electronics". Albert P Malvino. Ed. Mac Graw-Hill Interamericana. Year 1993 Automation and Control Laboratory Practices". Teachers: González, Manzano Herrera, Sandoval Benítez, Vázquez López. Ed. Mac Graw-Hill Interamericana. Year 2004 General Electronics". Pablo Alcalde San Miguel. Ed. Thomson - Paraninfo. Year 2003 Analysis and Design of Electronic Circuits". Donald. A. Reaman. Ed. Mac Graw-Hill Interamericana. Year 1999 Microelectronic Circuits". Adel S. Sedra - Kenneth C. Smith. Oxford University Press. Year 1999 Telemecanique Global Detection Manuals

Evaluation system:	There are two written tests of partial evaluations, with an integral recovery, as well as the approval of the portfolio of practical work that includes the laboratory tests and their report, all of which is required to regularize the subject. Final assessment: Those students who have passed both partial assessment tests with an average of 75% or more, may choose to take a final exam or the elaboration and approval of a final project.

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Ing. Carlos Andrés Ivan
Associate Professor
Chair of Industrial Electronics (Mechanical Engineering)

ANALYTICAL PROGRAMME

"MACHINE ELEMENTS AND PROJECTS 2017"

Thematic unit 1: Flexible Organ Transmission:
Flat belt drive: materials used and their characteristics. Forces acting on the transmission. Determination of the width of the belts. Usual arrangements. Tension roller. V-belt drive. Advantages and disadvantages. Practical procedure for their selection.
Chain transmission. Usual forms. Applications. Sizing procedure.

Thematic unit 2: Toothed wheels:
Spur gears: general. Geometry. Fundamental law of gearing. Shape of tooth flanks. Modulus and pitch Dimension of teeth under bending, combined strength and surface pressure. American procedure. Inclined toothed gears: general Geometry. Calculation. Bevel gears: General. Geometry. Usual arrangements. Dimensioning. Bearing reactions. Curved teeth. Planetary gears.
Hypoid gears. Helical gears linking spatially intersecting shafts: general and geometry. Worm-screw gears: general, geometry, transmission ratio.

Thematic unit 3: Couplings and Clutches:
Couplings. Purpose. Types: Rigid. Compensating, elastic. Gradual start-up. Cardan couplings. Selection and calculation criteria. Characteristic values.
Clutches: Friction disc clutches. Conical clutches. Acting forces, materials used. Different types of clutches for industrial and automotive purposes with elastic elements. Plate clutches. Electromagnetic clutches Hydraulic clutches and coupling transformers.

Thematic unit 4: Mechanical Transmissions:
General. Comparison between different transmissions. Different application possibilities. Project.

Thematic unit 5: Elastics and Springs:
Elastics. Tension and deformation of single sheets, overlapping sheets and semi-elliptical elastics. Materials used. Springs: applications Cylindrical springs: stresses and deformations. Spring rate Tension factor Conical springs. Materials used. Torsion bar Disc springs: relationship between applied load and axial deflection. Maximum internal and external contour stresses. Combined arrangements

Thematic unit 6: Shafts and Axles:
General. Combined stresses in shafts and axles subjected to combined state of stresses. Shock factors and notch stresses, notch factors, stress factors

stress concentration. Fatigue stresses. Smith diagram. Materials used and their qualities. Transmission shafts. Arrangement. Simplified torsional calculation. Calculation of its dimensions as a result of resistance and deformation, critical speed of shafts and axles. Oscillations caused by bending and torsion. Standards. General rules for their arrangement. Flexible shafts. Machine shafts. Simplified bending calculation. Calculation. Practical forms.

Thematic unit 7: Plain and Roller Bearings:
Plain and axial bearings. Radial and axial bearings. Method of lubrication. Hydrodynamic lubrication Film theory Bearing modulus Dry friction Liquid and semi-liquid friction Viscosity Permissible pressure. Characteristic values Rolling bearings. Advantages and disadvantages. Main types. Radial and axial bearings. Mounting rules. Selection and calculation Load capacity, life, number of revolutions. Lubrication and sealing. Recommended settings.

Thematic unit 8: Elements of Union:
Roblonadura: Generalities. Way of riveting. Standards for riveting. Arrangement in structures.
Welding applications. Comparison between welded and brazed joints. Types of welding. Electric arc welding. Joint shapes. Static and dynamic load resistance Calculation methods Inspection. Electrodes. Pressure vessels.
Shaft and hub connections: Keyways and splines, different types, shapes and standards. Transverse keys. Splined shafts, multiple keyways. Standards. Tolerances. Pins and pins. Cylindrical, smooth and slotted pins or dowels. Taper pins. Hinge pins.
Screws. Classification, different kinds of threads. Standards. Fastening screws. Calculation. Forced connections. Stress-elongation diagram. Fatigue in threads. Classic bolts. Elastic bolts. Nuts and washers.

Thematic unit 9: Machine Project:
Study and knowledge of the problem to be solved and its requirements. Proposal of solutions. Pre-dimensioning. Evaluation of possible solutions. Selection of one of them. Preliminary project, preparation, plans and sketches in proportion and scale. Design and optimisation. The Project: Definitive calculations and verifications, general plan and detailed plans. Scales, position numbers, necessary coordinates, drawing number labelling and list of parts. Exploded drawings: dimensioning, dimensional adjustments and tolerances, surface symbols, position and shape tolerances. Descriptive Memory. Calculation Memorandum. Determination of cost Modifications, notice of changes, as-built drawing.

Objectives

The aim of this course is for students to acquire the following skills:

- Ability to calculate and design various machine elements.
- Ability to evaluate and design mechanical PROJECTS.
- Ability to use computer tools for mechanical design and calculation.
- ORAL AND WRITTEN COMMUNICATION SKILLS
- TEAMWORKING skills
- Ability to create, innovate and keep up to date

List of Practical Assignments

1- V-belts
2- Roller chains
3- Toothed wheels
4- Couplings
5- Mechanical Transmissions
6- Transmission Shaft
7- Adjustment Tabs
8- Bearings
9- Welded Joints
10- Bolted joints

List of Projects

Design of a mechanical transmission to drive a machine of which the power consumption, rotational speed and service factor are known.

Analytical Description of Activities

The development of the course is organised into the following activities: Theoretical classes - Participative practical classes. Group oral classes developed by the students. Projects. Consultations. Final exam. Study trips.

Theoretical - Practical classes: During these classes, the teachers develop the most important contents of the subject as well as the practical work. They use a blackboard, a projector with a PC and support notes, which include: tables, figures, graphs, formulas and concepts and videos of the subject.
It is of vital importance to create an environment in which the learner can actively participate in the lessons.

Group Oral Classes: students will be assigned theory classes which they will have to present to their classmates as part of their learning of oral expression and teamwork.

Projects: the aim of assigning a project to each student is to enable them to acquire the conceptual bases, methods and criteria for carrying out machine projects. Knowing, analysing and calculating mechanical devices and components, and the main elements of machines. The project consists of a power transmission, where electric motors are used,

couplings, belts, chains, speed reducers, auxiliary shafts, bearings, gears, screws and lugs. In addition to calculating, selecting and verifying all these elements, the student must design the support structure for all these elements, called the "Unifying Base", and draw up all the corresponding drawings for the assembly and specific drawings for the manufacture of non-standard components.

Field trip: Every year, a visit to an industrial site is scheduled for at least two days. The aim is to enable the students to observe all moving machine elements as well as mechanical assemblies. During these trips, teachers and pupils get to know each other and get to know the real workings of a first-class company, whether it is local or from another province.

Course regulations

The course will be taught on a semester basis during the first semester of the year.
Conditions for the course of the subject:

Passed: English Language Proficiency Test
Technical Mechanics
II Materials Testing
Machine Design
To have Regular: Stability II and Knowledge of Materials.

Department of Mechanical Engineering

Hs/ Days	Wednesday	Thursday
08 - 12	Theoretical/Practical	Theoretical/Practical

REGULARISATION:
To pass the course, students must have at least 80% of the classes attended, have passed the two mid-term exams of the practical part, the group oral class and the mechanical project assigned in due time.

ATTENDANCE:
Class attendance is of vital importance for the student as it is the ideal situation in which to learn the different contents of the subject.
During the course of the classes, the theoretical and practical aspects of the subject will be developed, and support material will be provided in PDF format, which will make the use of time in the learning process more efficient. Practical work will also be developed in class, which the student will then have to solve individually. The presentation of these assignments is not compulsory.

MID-TERM EXAMS:
The passing of the mid-term exams of the practical part will be with a minimum mark of 5(FIVE) on a scale of 1(one) to 10(ten) and will be held approximately on the dates indicated below:

- 1st Midterm: Wednesday 10 May

- 2nd Midterm: Thursday 28 June

The mid-term exams will consist of solving two problems similar to those done in class and their average mark will be taken into account for the final oral exam of the course.
In the case of a postponement in any of the mid-term courses, the student will be able to make it up immediately in order to regularise the same.

ORAL CLASS - GROUP:
All students will be assigned a group oral class which will be presented to their classmates and teachers and will be part of the learning of oral expression and teamwork. It will be graded from **5 (five) to 10 (ten).**

MECHANICAL PROJECT:
All students will be assigned a Mechanical Project that must be passed after passing the midterm and the oral-group class, it will be graded from **5 (five) to 10 (ten)** and will also be taken into account for the final grade.
The deadline for project approval is **Thursday 10 August 2017.**

APPROVAL or FINAL EVALUATION:
Regular students, who have a class attendance equal or higher than **80%,** who have passed the mid-term exams or their recuperations, the group oral class and who have also passed the assigned Mechanical Project, will have the right to take the final oral exam of the subject.

FINAL mark = average of marks: MIDTERMS, ORAL GROUP LESSON, MECHANICAL PROJECT and FINAL EXAMINATION.

RECURSING STUDENTS: they have the same obligations as first-time students, especially with regard to **attendance** to theoretical and practical classes.

FREE EXAMS: Students who wish to take the subject freely, must first take a written integral of the practical part, they must also have passed the Mechanical Project assigned in due time and finally they will take an oral exam.

Workload: 128 hours (8 hours per week)

Distribution of the active: Theoretical classes - practical classes: 110 hours
Evaluations: 18 hours

Basic bibliography: - Elements of Machines -Nieman, G.
- Engineering Design-Shigley, JED
- Machine Builder's Manual-Dubbel

Other bibliography: - Maschinenteile 5Ta Ed-Khöeler und Rögnitz
- Maschinenelemente-Deckel K H

- Maschinenelemente-Rolof Matek

- Fundamental standards-DIN standards

Internet:

http://www.skf.com/ar/index.html - SKF- Bearings and transmission elements
http://www.engracor.com.ar/ - ENGRACOR S.A - Chains
http://www.angellarreina.com/ - ANGEL LARREINA - Transmission elements
http://www.tecnongroup.com/ - TECNON GROUP - Couplings
http://www.optibelt.com/en.html - OPTIBELT - Transmission belts
http://www.schaeffler.com.ar/ - FAG - Bearings http://www.sumitomodrive.com/ - SUMITOMO - Drives/Reducers
http://www.sew-eurodrive.com.ar/ - SEW EURODRIVE - Drives/Gearboxes
http://www.lentax.com/ - LENTAX - Drives/Gearboxes
http://www.mercomarve.com.ar/ - MERCO MARVE - Speed reducers
http://www.acindar.com.ar/es - ACINDAR - Long steels
http://www.thyssenkrupp.com/ - STEELS
http://www.klockmetal.com/ - STEELS

Website of the Chair:

https://www.facebook.com/ElementosYProyectosDeMaquinasImUnt

Associate Professor - Head of Chair in
Machine Elements and Design
Mechanical Engineering
FACET - UNT

ANALYTICAL PROGRAMME "ELECTRICAL MACHINES"

Contents:	**Topic 1- TRANSFORMERS** Magnitudes and units - Fundamental laws - Magnetic circuits, constructive forms - Air-core and iron-core coil - Iron losses - Scattering fields - Copper losses - Efficiency - Phasor diagram and equivalent circuit - Ideal and real transformer in no-load and with different types of loads (ohmic-inductive - capacitive) - Kapp's triangle - Analysis with different types of loads - The transformer in no-load and short-circuit - Three-phase transformers - Connections: three-angles-star-zic-zac - Connection group - Three-phase transformers - Three-phase transformers - Connections: three-angles-star-zic-zac - Connection group - Three-phase transformers -Three-phase transformersThe no-load and short-circuit transformer.-Three-phase transformers.-Connections: triangles-star-zic-zac.- Connection group.-Parallel transformers.-No-load and short-circuit tests.-Auto transformer.- Measuring transformers: current-voltage. Problems-Examples-Standards. **Topic 2- THE ASYNCHRONOUS MACHINE** General - Constructional aspects and different types of rotors - Operating principle of the machine - Rotating field and slip - Equivalent electrical circuit and phasor diagram - Heyland circular diagram - Power and torque - Construction of the circular diagram - Characteristic curves of the machine - Starting methods, different types - External characteristics and speed regulation - Double cage and deep groove motors - The single-phase asynchronous motor - Problems - Examples - Standards. **Topic 3-THE SYNCHRONOUS MACHINE** Generalities - Constructive aspects and different types of rotors - Induced voltage - Chord and zone factors - No-load and loaded operation, characteristics - Armature reaction, stray field - Vector diagram and equivalent circuit - Most important characteristic curves, determination of the synchronous impedance - Potier's triangle, tests - Excitation for a state of charge - Geometric location of the currents and active power - V-curves - Behaviour of the synchronous machine connected in parallel to the public grid. **Topic 4- THE CONTINUOUS CURRENT MACHINE** General and constructional aspects - The DC generator - Principle of operation - Different types of windings - Induced voltage and armature reaction - Switching poles and compensating winding - Generators with : Independent excitation - Derivation - Series -Compund - No-load and loaded operation - Starting and speed control - Operating characteristics - Examples - Standards.
Objectives *(in terms of of competences)*:	The student acquires a broad and clear concept of the most widely used and applied electrical machines in industry and electrical systems, a clear understanding of how a rotating alternating alternating field is created and the basic functions of alternators.
Analytical description of theoretical and practical activities:	**PRACTICAL TASKS** TPNº1 - Magnetic Circuits TPNº2 - Air-core and iron-core coils - magnetisation curves. TPNº3 - Transformer problems. TPNº4 - Transformers - regulation. TPNº5 - Transformer and motor problems. TPNº6 - Problems of asynchronous machines. TPNº7 - Problems of asynchronous and synchronous machines. TPNº8 - Questions on synchronous machines.
Charge hourly:	96 hours
Distribution of activities:	Theoretical classes: 64 hours Practical classes: 32 hours

Basic bibliography:	The Theory of Current Machines-Alexander Langsdorf-McGraw-Hill 1967 Alternating and Direct Current Machines-Moeller-Labor-1967
Other bibliography recommend to:	General and Applied Electrical Engineering-Moeller- Labor-1967
Evaluation system:	Regularisation is obtained with : 1. Passing two (2) mid-term exams which will be made up - Passing is with a mark of four (4) or more and a final oral or written exam. 2. To have 100% of the practical work APPROVED. 3. Have at least 80% attendance in theory classes.

Ing. Venancio Mauro Carlorosi
Associate Professor

ANALYTICAL PROGRAMME "MECHANICAL TECHNOLOGY AND MANUFACTURING"

Contents:	THEME 1 Dimensional metrology. Differences between measurement and verification. Units of measurement. Measurement errors. Influence of temperature, personal factors, etc. Length measurements. Standard elements. Measuring instruments: rulers, calipers, micrometers. Exterior, interior and depth measurements Angular measurements, measuring instruments Checking and control instruments: compasses, square, level, marble, prismatic calipers. Mechanical, electrical and pneumatic amplification comparators. Profile projector. Interferometry. Optical planes. Thread and gear control, instruments and methods. Tracing, field of application Tracing tools and procedures. THEME 2 Interchangeability of parts. Notions, characteristics. Tolerance in the manufacture of mechanical parts. Nominal dimensions. Upper and lower discrepancy. Maximum and minimum part size. Adjustment between parts. Single shaft and single hole system. Types of fit, movable, unfinished and pressed. Standardised way of dimensioning shafts and holes. Practical applications. Through and non-through gauges. Surface roughness Measuring methods. THEME 3 Machine tools, general information. Tool-workpiece pair interaction. Geometry of cutting tools, rake angle, cutting edge and incidence. Penetration and feed. Chip sectioning. Cutting speed. Cutting tool materials. Carbon and low alloy steels, high speed steels, sintered carbides, ceramics and diamonds. THEME 4 How swarf cutting is produced. Types of chips produced by different materials. Optimum cutting conditions, tool wear and edge life. Cutting cooling, advantages and disadvantages. Cutting force. Cutting power and drive on lathes. THEME 5 Drives on machine tools. Speed gearboxes with arithmetical and geometrical progression stages. Standardised stages. Diagrams. Fundamentals of calculation. Stepless, mechanical, electrical and hydraulic drives. THEME 6 Parallel lathes. Construction principles. Operation. Main and secondary movements. Spindle, bed, speed box, Norton box, tailstock, longitudinal and transverse slide, etc. Main turning operations. Turning lathes. Multi-spindle lathes. Semi-automatic and automatic lathes. Vertical lathes. Copying lathes. Computer Numerical Controlled Lathes (CNC). THEME 7 Universal, vertical and special milling machines. Constructive forms. Operation. Tooling. Milling operations. Cutting speed, penetration and feed. Drive power Cutting of spur and helical gears with the uni- versal dividing unit. Machines for gear hobbing with Pfauter system screw cutter, kinematics. of the generation of teeth. Gear hobbing with Fellows system circular tool.

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Gear hobbing with Maag system toothed comb.

THEME 8

Filing and planing machines. Constructive forms. Mechanical and hydraulic drive. tools Cutting speed, penetration and feed rate Drive power. Broaching. Operation. Field of application Shape and characteristic angles of broaching tools. Calculation and design of broaches. Cutting speed and drive power. Mortising machines Constructive forms. Operation. Tooling.

THEME 9

Drilling machines. How it works. Types of machines. Tools, shapes, angles and materials. Cutting speed, chip section. Drive power. Boring machines. Field of application. Types of machines. Boring tools. Reaming. Application. Fixed and adjustable reaming. Tapping. Tapping with taps and taps. Threading machine. Threading by rolling.

THEME 10

Grinding machines. Machines and the way in which material is removed. Grinding machines. Types of machines. Field of application. External and internal grinding centreless grinding Grinding with shaped grinding wheel. Grinding wheels. Characteristics and choice of grinding wheels according to the work to be carried out. Precautions to be taken during assembly and work.

THEME 11

Welding. Concepts and applications. Autogenous welding, necessary equipment. Oxy-fuel cutting. Electric resistance welding, equipment. Electric arc welding, types of processes. Welding with coated electrodes. Equipment. Welding bead with material input and heat affected zone. Joint preparation Weldability of steels Equivalent carbon Welding processes under powder and gas.

THEME 12

Sheet metal shearing. Guillotines. Cutting with circular blades. Cutting by punching. Punch, die and clamp, constructive forms. Clearance between punch and die. Cutting force. Folding of sheet metal. Punching. Dies for punching and drawing of sheet metal. Stresses in the drawing. Clamping action and pressure exerted on the sheet metal. Machines for sheet metal working Rocker arms, presses Manufacture of seamed tubes.

List of Practical Assignments

1- Metrology. Measuring and Verification Instruments, Parts, Operation, Exercises.
2- Tolerances and adjustments. Exercises
3- Characteristic diagrams of gearboxes. Calculations according to Standards, Determination of the optimum working area, different materials.
4- Gearbox. Project and drawing according to standards
5- Threading on parallel lathe. Exercises on different types of thread
6- Gear hobbing universal milling machine. Using the universal splitter, Exercises
7- Gear hobbing with the gear shaping machine. Straight teeth and inclined teeth, Exercises
8- Sheet metal cutting and pressing. Dies project

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Objectives *(in terms of com-* **The)**	Knowledge and use of instruments for dimensional meteorology. Knowledge of machine tools and procedures for the manufacture of machine parts with start-up. chip removal, welding, cold forming, electrical discharge machining (EDM)
An ana- lytical description of the theoretical and practical activities:	The development of the course is organised into the following activities: Theoretical classes. Practical classes. Projects. Consultations. **Theoretical classes**: During these classes, the lecturers develop the content of the subject syllabus, which are carried out by the lecturers with the support of the graduate teaching assistants. **Practical classes:** During these classes, application problems are posed. The results are evaluated by the teachers and approved or rejected. There is a practice in di- mensional metrology. There are 7 Practical Assignments. Students who attend 80% of the practical classes and pass all the practical work are considered regular students.
Hourly load	128 hours
Distribution of activities	Theoretical and practical classes: 128 hours
Bibliography bas ic	"MÁQUINAS HERRAMIENTAS MODERNAS, MÁQUINAS HERRAMIENTAS MODERNAS, Tomos I y II". Rossi, Mario. Editorial Hoepli (year 1.971). "COLD STAMPING OF PLATE " Rossi, Mario. Editorial Hoepli (year 1.971). "MECHANICAL TECHNOLOGY, Volumes I and II". Pezzano, P. A. Editorial Alsina (year 1.971). "MACHINE BUILDER'S MANUAL, Volumes I and II". Dubbel. year 1.971) "METROLOGY". Carlos González, Ramón Zeleny. Editorial Mc Graw Hill (year 1.995). "MANUFACTURING ENGINEERING". Stewart Black, Vic Chiles, A. J. Lissaman, S. J. Martin. Editorial CESCA. (year 1.999) "FUNDAMENTALS OF MODERN MANUFACTURING". Mikell P. Groover. Editorial Prentice Hall (year 1997). "SCIENCE AND TECHNIQUE OF WELDING, Volumes I and II". Jose Augusto Palma, Raul Timerman. Editorial Conarco (year 1.983). "WELDING APPLICATIONS AND PRACTICES". Henry Horwitz. Editorial Alfaomega (year 1997). "GUIDE TO THE NUMERICAL CONTROL OF MACHINE TOOLS". R. Intartaglia, P. Lecoq. Editorial Paraninfo (year 1989).
Evaluation system	**In order to regularise the course**, students must be enrolled in the course, be a regular student, have a minimum of 80% attendance at the Practical Assignments and have approved the Practical Assignments portfolio. These assignments must be presented on the dates scheduled, corrected and approved by the lecturers of the course. **Eligibility:** In order to be eligible to take the Examination, regular students must have

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	(Practical Work Approval Slip). **The examination** is oral and takes place in front of a board consisting of the teacher of the subject and a teacher from the area. .

Ricardo R. Collado
Associate Prof.
Chair: Mechanical and Manufacturing Technology

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ANALYTICAL PROGRAMME "TURBOMACHINERY"

Contents:	**CHAPTER I.** The development of steam turbines since De Laval and Parsons. Current status: large turbines for thermal power plants, nuclear power plants, industrial back-pressure turbines, ship turbines. Industrial back pressure and condensing turbines with process steam extraction. Cogeneration of electrical energy and process steam. Process steam supply with pressure reducing valves. Superimposed turbine. **CHAPTER II.** Energy transformations in steam thermal power plants. The second principle of thermodynamics and the ideal cyclic Carnot process. The ideal Clausius Rankine cycle in the T-S and h-S diagrams. Relationship between initial steam pressure and temperature and the steam head at the turbine outlet. Single and double intermediate reheating of steam. Thermal cycle with regenerative feedwater preheating by means of steam withdrawals at different stages of the turbine. Factors limiting the number of heating stages. **CHAPTER III.** Combined cycles: gas turbine - steam turbine. Open and simple gas turbine cycle. Thermal efficiency of the ideal cycle as a function of pressure ratio. Real cycle without heat exchanger Total efficiency or efficiency of a gas turbine without heat exchanger as a function of pressure ratio and gas temperature at given compressor and turbine efficiencies. Influence of these efficiencies on the total efficiency. Combined process with introduction of turbine exhaust gases as combustion air into a steam generator. Combined process with heat exchanger for steam production without additional fuel consumption. **CHAPTER IV.** Steam expansion in h-S, T-S and p-v diagrams, with and without losses. Comparison between the reciprocating steam engine and the turbine. General concept of the size of the last expansion stage of large turbines. Laval nozzle: its design and calculation. Steam expansion in oblique shear, steam jet deflection and its simplified calculation with the Forner - Baehr formula. Straight compression shock, Fanno and Rayleigh curves. **CHAPTER V.-** Elementary theory of axial turbomachinery. Guiding and moving gratings, velocity triangles. Grating efficiencies and velocity coefficients. Change of state of the vapour in the stage Reaction rate Peripheral efficiency Influence of exit angle on peripheral efficiency. Stage with a small degree of reaction.

Contents	**CHAPTER VI.** The basic forms of steam turbines. Constant pressure stage, action and/or regulation wheel. Curtis wheel, speed steps. Constant pressure stage group, chamber turbine. Reaction stage group, drum turbine. Graphs of pressure variation, specific volume, static enthalpy and absolute velocity of steam in a stage or groups of stages. Radial turbines, Ljungstrom turbines. **CHAPTER VII.** Partial and total intake; degree of intake, vapour volume and vane length. Friction and ventilation losses. Protection of the sector without steam admission. The different empirical formulae for their calculation. **CHAPTER VIII.** Interstitial losses in chamber and drum turbines. Labyrinth losses, their calculation, admissible and unavoidable leakages. Sealing steam for vacuum labyrinths. Axial thrust compensation plunger losses. Mechanical and radiation losses **CHAPTER IX.** Stodola's steam cone; Flügel's equation and its applications. Change of pressure distribution in the turbine stages with varying load. Variation of steam pressure in the control wheel chamber as a function of load. Axial thrust and its compensation Axial thrust in action turbines. Danger of partial clogging by salt deposits. **CHAPTER X.-** Turbine regulation: regulation by steam quality or lamination and by quantity or group of nozzles. Calculation of the characteristic dimensions of a control valve. Mechanical, mechanical-hydraulic, hydraulic and electronic regulation. Emergency steam shut-off in the event of excessive speed, low oil pressure or rotor displacement. **CHAPTER XI.** Isolated design problems; choice of number of turbine stages; first stage or regulating wheel; speed, direct drive, turbines with speed reducer. Relationship between wheel diameter, blade length and steam volume. Characteristic figures for turbines or stages; the old Parsons number and modern figures. **CHAPTER XII.** Water-air condensing systems, Heller system. Condenser size, number of tubes, heat transfer coefficient. Theoretical and practical vacuum. **List of Practical Assignments** No. 1: Application problems; calculation of a nozzle; compression shock. No. 2: Forces in curved channels. No. 3: C-R cycle, improvements and combined TG and TV cycle. No. 4: Calculation of the peripheral efficiency of a single-acting wheel and a R. Curtis. No. 5: Calculation of the optimum diameter of a C.R. No. 6: Calculation of TV mazes. No. 7: Calculation of the limiting vacuum of a condensing TV. 2 lessons No. 8: Application of Flügel's equation in the test of a TV. No. 9: Calculation of the regulating valve of a TV. No. 10: Selection of an industrial TV for CHP. Video of a TV.

Objectives	Knowledge of the basic concepts of design and selection of steam turbines, study of thermal cycles and the operation of turbines in electricity generation plants and industrial turbines used in the cogeneration of motive power and steam for heating processes.
Analytical description of theoretical and practical activities	The classes consist of presentations by the teacher on the blackboard, with the projection of transparencies and analysis of catalogues and plans. In the practical sessions, students solve problems with the teacher's assistance. **Theoretical classes:** all the topics contained in the course syllabus are covered in these classes. The blackboard is used, complemented by the projection of transparencies. Work is done on turbine drawings and catalogues and students receive printed notes on the main topics, extracted and translated from the German bibliography detailed below. **Practical classes:** (minimum compulsory attendance of 80%) in which students must solve the problems contained in the programme, after receiving a guide and explanation of each topic. Students consult with lecturers on theoretical and practical issues during and outside class hours. Each student must present a portfolio with all the practical work developed and with it take an evaluation exam prior to the final oral exam.
Hourly load:	128 hours
Distribution of activity	Theoretical and practical classes: 120 hours Evaluations: 8 hours
Basic Bibliography:	"Turbomachines" - **Luccini** "Steam Turbines" - **Church** "Steam Turbines" - **A. V. Schegliaiev** "Thermodynamics" - **H. D. Baehr** Lecture Notes and TV and TVA TVA
Other bibliography	"Thermische Kraftanlagen" - **H. J. Thomas** "Dampfturbinen" - **Frietz Dietzel** "Dampfturbinen" - **H. W. Roemer** "Thermische Turbomaschinen" - **W. Traupel** "Turbines a Vapeur et a Gas" - **Stodola** "Dampfturbinen" - **Zietemann** "Thermal Turbomachines" - **Claudio Mataix**
Evaluation system:	Students must take the preliminary examination to evaluate their practical work. Once passed, they can access the certificate of approval of practical work (regularity in the subject). Once this requirement has been fulfilled, the student may sit the final oral exam, which must be passed with an evaluation mark of 4 to 10, on a scale of 1 to 10. The exam consists of a presentation of a previously chosen topic and answering questions from the examining professors. The questioning is essentially conceptual and the student may consult his or her notes or folders in case he or she needs to refer to a mathematical expression difficult to memorise.

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Ing. Roberto Lauro Andina
Associate Professor
Chair of Turbomachines

ANALYTICAL PROGRAMME "THERMAL MEASUREMENTS"

Contents:	**TOPIC 1.- Measurement -** Fundamentals and definitions of the most commonly used terms. Argentine Legal Metric System. Primary and Secondary Elements. Characteristics of measuring instruments. Measurement field (Range), Range (span), Error, Accuracy, Precision, Dead Zone, Sensitivity, Repeatability, Hysteresis, Turn Down. Instrument testing and calibration. Traceability. Validation. Measurement uncertainty. Transmitters. **TOPIC 2.- Pressure measurement -** Dimensions. Absolute and effective pressure. Static, dynamic and total pressure. Pressure gauges and vacuum gauges; classification: metallic with Bourdon tube, with diaphragm, with bellows; liquid column. Micromanometers Pull gauges. Pressure transmitters Choice and installation of pressure gauges Vacuum measurement. Barometric pressure Test methods and calibration of pressure gauges and vacuum gauges. **Tests:** Testing of a manometer on the hydraulic balance and hydraulic press. Testing of a vacuum gauge, a pull gauge and a micromanometer. **TOPIC 3.- Temperature measurement -** Temperature measurement methods and their field of application. Thermal expansion thermometers. Thermocouples. Electrical resistance thermometers. Radiation pyrometers. Pyrometric cones. Thermistors. Pyrometric pencils and paints. Temperature transmitters. Choice and installation of temperature measuring instruments. Test methods and calibration **Tests:** Test of a recording thermometer with a glass thermometer in an oil bath. Test of an electric furnace thermocouple. **TOPIC 4.- Flow measurement -** Flow of liquids, gases and vapours. Flow measurement of liquids in tanks with level. Rotary meters for liquids and gases. Turbines. Prandtl tube. Annubar. Rotameters. Flow measurement of liquids, gases and vapours by means of orifice plate, nozzle and Venturi tube, according to established standards. Calculation methods. Requirements for their installation. Pressure intakes according to standards. Calculation of an installation. Differential pressure gauges. Inductive method. Ultrasonic. Mass flow meters. Other methods. Transmitters. **Tests:** Differential pressure gauge test. **TOPIC 5.- Determination of the calorific value of fuels.** **I.- Solid fuels -** Upper and lower calorific value. Definition. Calorimetric pump. Description of equipment and test Calorimeter constant. **Tests:** Determination of the calorimeter constant. Determination of the calorific value of a solid fuel. **II.- Gaseous fuels -** Junkers calorimeter. Description of equipment and test. Normal state of the gas. **Tests:** Determination of the calorific value of natural gas. **TOPIC 6. - Flue gas analysis -** Losses due to flue gas. Sensible heat losses. Losses due to latent heat. Different types of analysers: Chemical, Electrical, Mechanical, Magnetic, Radiation. Infrared absorption analyser. **Tests:** Analysis of a gas sample with a Testo 325 analyser. Demonstration of the analysis of a gas sample with the Orsat apparatus. Calculation of flue gas losses on the basis of a flue gas analysis. **TOPIC 7. - Level measurement -** Principle of operation. Different technologies. Forms of transmission. Selection and installation. Glass sight glasses. By differential pressure. Floating. Displacer. Radar. Ultrasonic. Capacitive. Inductive. Bubbling systems, etc. **Tests:** Determination of the level of a vessel in a manufacturing plant.
Objectives *(in terms of competences)* **:**	To train the student in the measurement of thermal magnitudes, studying the methods and instruments for their execution, the application of the standards for their installation and use. Testing and calibration of instruments.

Correlative:	Thermodynamics (regular to take and passed to pass) Fluid Mechanics (regular to be taken and passed to be taken)
Analytical description of theoretical and practical activities:	Theoretical and practical classes. Lectures by teachers. Guided individual problem solving. Group work is allowed, but presentations are individual. Laboratory work for visualisation and manipulation of instruments. Group work with individual presentation. Printed class notes are available where the student has all the information on each thematic unit: specific objectives, guide for laboratory experiments, specific bibliography. Laboratory work in groups helps interaction between students and teachers and between students and each other. Elaboration of how a case study report should be produced, this activity also helps to improve written communication. The case study report serves as self-study material. All topics are tested in the laboratory. One visit to an industrial plant per year is scheduled, in order to visualise a working factory and a personal contact with professional working elements.
Hourly load:	64 hours
Distribution of activities:	Theoretical-practical classes: 64 hours
Bibliography basic:	Lecture notes - E-laminates - IRAM - ISO - ASTM - Standards
Other recommended reading:	Creus Industrial Instrumentation The Doolitle Mechanical Engineer's Laboratory Experimental Methods for Colman Engineers
Evaluation system:	In order to pass the course, the seven subjects and the laboratory practicals will be evaluated in a final oral exam with a free topic. The topics may be theory, problems solved or laboratory tests carried out. Prior to registering for the final exam, the course requires the student to take a pre-examination to consult and evaluate it beforehand with the teaching assistants. There is no promotion system. The conditions for free examination are those established by the faculty regulations.

Ing. Adolfo C.J. Torres Bugeau
Associate Professor

ANALYTICAL PROGRAMME "OLEOHYDRAULICS AND PNEUMATICS"

Contents:

OLEOHYDRAULICS

Track 1: Introduction:
Concepts, principles and fundamental physical laws applied to the oil-hydraulic technique.
Module 2: The hydraulic fluid:
Characteristic properties. Viscosity. Special qualities. Additives. Contaminants.
Pin 3: Basic circuit:
Symbols and methods of representation of components. Power and control circuits Identification of actuating, control, regulation, control and accessory elements. Characteristic aspects of oil-hydraulic circuits.
Socket 4: Hydraulic cylinders:
Single and double acting, plungers, telescopic, double rod, force or motion converters. Balanced cylinders, approach cylinders, rapid advance cylinders. Cushioning.
Ball 5: Bombs:
Classification according to design, function and pressure level. Fixed or variable flow. Characteristic curves. Multiple pumps.
Slot 6: Hydraulic motors:
Classification according to design. Fixed or variable flow. Characteristic curves. Speed variation and reversing.
Pin 7: Drives:
Characteristic components. Valves, filters, tanks, accumulators. Particularities arising from heating and contamination of the hydraulic fluid. Suction, pressure and return lines. Seals and seals
Track 8: Circuit analysis:
Operability, productivity, efficiency and service safety. Readiness, start-up, unplanned shutdowns, restart.

PNEUMATICS

Track 1: Introduction:
Concepts, principles and fundamental physical laws applied to pneumatics.
Ball 2: Air:
Atmospheric air. Compressed air and its pollutants. Compressed air production, accumulation, distribution and conditioning.
Pin 3: Basic circuit:
Symbols and methods of representation of components and circuits. Control, actuation, regulation and control elements...
Pin 4: Pneumatic Actuators:
Single-acting and double-acting cylinders. Cushioning. Multi-position, tandem, impact and special cylinders.
Pin 5: Directional Valves:
Classification according to design, function, actuation. Slide and poppet valves Manually, mechanically, pneumatically and electrically operated.
Socket 6: Control and Auxiliary Valves:
Filing, regulating, unidirectional, quick exhaust, timed. Valve group.
Pin 7: Pneumatic Drives:
Single, multiple, simultaneous, sequential, conditional, repetitive. Introduction to automatic and semi-automatic cycles. Pneumatic memories.
Track 8: Circuit design:
Analysis of operability, productivity, efficiency and operational safety. Readiness, emergency, restart.

Objectives	To indicate the objectives expressed in terms of competences to be achieved by the students and/or activities for which the training imparted qualifies. Know and interpret the technique of the use of compressed fluids, applied to the generation, transmission and transmission of electricity, transformation and control of movements of machines and mechanical devices.
Analytical description of theoretical and practical activities	As the syllabus of the subject is very extensive in relation to the time allotted for it, students must resort to the recommended bibliography in order to broaden and/or deepen the topics of interest. Problem solving is done entirely in class, but with the active participation of the students. For the proposed problems, each student receives specific numerical data; the results and their interpretation are personal work, which, when reviewed, allows the level of understanding and learning of each topic to be evaluated.
Hourly load:	64 hours
Distribution of activated	Theoretical-practical classes: 60 hours Evaluations: 4 hours
Basic bibliography:	Class notes, technical manuals. Koehle, Jorge Francisco
Other bibliography	- Technical manuals. Mannesmann Rexroth. -Technical manuals. Parker Pneumatic - Technical manuals. Festo Neumatic - Technical manuals. Vickers Hydraulic.
Evaluation system:	The evaluation of each regular student is carried out by means of an oral and public examination on theoretical and practical subjects. The examination topic is chosen without taking into account the order of the balls in the syllabus of the subject. In the case of free students, they must pass a previous written exam consisting of the resolution of a series of problems of similar complexity to those developed during the regular course. The results and grade are communicated immediately to the student, informing him, at the same time, of his successes and failures.

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Ing. Jorge Francisco Koehle

Associate Professor

ANALYTICAL PROGRAMME "REFRIGERATION TECHNOLOGY"

Contents:	**TOPIC 1.** Moist air - Water content, relative humidity. Degree of saturation Specific volume. Molar weight. Mollier (i, x) diagram. Enthalpy of moist vapour Saturation curve. Fog zone. American Psychometric diagram. Processes in humid air. Heat and moisture aggregation. Direction of transformation. Moist air cooling. Mixtures of moist air. Evaporation of water in air, boundary cooling. The psychrometer Drying **TOPIC 2.** Heat and moisture exchange between water and humid air - Cooling towers and air washers. Balances of matter and energy. Dalton's law and Lewis' law. Markel's law. Calculation of a cooling tower or scrubber. Operation with conditions different from the calculation conditions (variable load, variable water concentration). **TOPIC 3.** Air conditioning - Indoor design conditions. Air conditioning for human comfort and health. Human body temperature regulation. Comfort. Climate components influencing thermal comfort, pairwise influence and joint influence. Comfort scales. The katathermometer. Other factors on the feeling of thermal comfort. Room air impurities. Air renewal. Air conditioning for industrial use. Climate components. Impurities. **TOPIC 4.** Outdoor design conditions: Weather and climate. Temperature, humidity, wind and solar radiation. Local energy gains and losses. Actual or effective load. Estimation of conditioning or cooling load. Outdoor and indoor loads. Sensible and latent load Total load **TOPIC 5.** Compensation of sensible and latent air-conditioning loads - Supply air. Transformation line of the room. The sensible heat factor. Preparation of supply air. Summer and winter air conditioning. Air-conditioning systems: all-air systems, water-air systems, water systems and direct expansion systems. **TOPIC 6.** The distribution of the supply air - Insufflation or impulsion nozzles. The behaviour of the insufflated current. Induction. Dispersion. Fall or rise. Guide vanes. Location of the impulsion nozzles. Types of discharge nozzles. Return grilles. Air ducts. Classification. Laws of conduction. Duct elements. Layout and calculation. Condensation in ducts **TOPIC 7.** Cold technology - Purpose. Production of the cold source, by: Refrigerating mixtures. Expansion. Evaporation. Absorbers - Absorbers. Expulsion of gas in a liquid. Dry ice Evaporation of a liquid in the atmosphere. Electrical and magnetic processes Cyclic refrigeration processes Efficiency coefficient Refrigeration cycles with vapours. Wet and dry regime.

Contents	Compression in stages with intermediate cooling. Cooling of chambers with different temperatures with two valve compressors and intermediate separator. Refrigeration at very low temperatures. Real refrigeration production process. **TOPIC 8.** Refrigerating fluids - Conditions of the ideal refrigerating fluid. Most commonly used refrigerant fluids. Thermal properties. Chemical and physiological properties. Action on lubricating oils and metals. Handling and transfer of refrigerating fluids. Loading bench. **TOPIC 9.** Elements of compression refrigeration systems - Compressors. Summary of the different types. Calculation. Evaporators. Different types and calculations. Liquid and gas ducts. Calculation. **TOPIC 10.** Operation and regulation of compression refrigeration systems - Manual operation and regulation - Manual operation and regulation Devices for service safety and automatic regulation. Safety valve. Filters. Oil separator. Observation windows. Discharge and start-up valve. Check valve. Magnetic valve. Thermostats. Bimetal. Pressure switches. Pressure valves, etc. Thermostatic expansion valve. Testing. Liquid distributor. Low and high pressure float valve. Capillary tube and orifice plates. Overflow valve. Water valves. Example of automatic operation and regulation. **List of Practical Assignments** Nº 1: Resolution of a refrigeration plant with two cold rooms of different temperatures. Calculation of evaporator and condenser. Nº 2: Psychrometry. Example of psychrometric measurements and typical problem solving. Dryers No. 3: Verification of the design parameters of a cooling tower. No. 4: Verification of the design parameters of an air scrubber. No. 5: Calculation of heat balance and thermal power required for the summer air-conditioning of a room. No. 6: Calculation of cross-sections and pressure drops in distribution and return air recirculation ducts corresponding to the installation of P.T. No. 5. Nº 7: Synthetic monograph in which the student summarises the activity he/she carried out in the workshop practice during the year.
Objectives	To provide the basic technical knowledge related to the production of cold in industrial processes and human comfort.

Analytical description of theoretical and practical activities	The subject is developed through theoretical and practical classes. **Theoretical classes;** consist of the exposition of the topics of the programme in which the students take summary notes of what has been covered, which they will use as a basis for the final exam of the subject. **Practical classes;** application problems are solved and two projects are carried out. One of the projects concerns a refrigeration system and the other involves the various steps recommended for the design of a year-round air-conditioning system. As an example, important rooms of the faculty such as laboratories, amphitheatres, etc. are used and the physical survey, the calculation of the heat balance, the air flow rate of the air conditioning system and the calculation of the air flow rate of the air conditioning system are carried out. supply, choice of conditioning equipment and design of ducting and control.
Hourly load:	80 hours
Distribution of activity	Theoretical and practical classes: 80 hours
Basic Bibliography:	Handbooks Fundamental - **ASHRAE** HandbooksRefrigeration - **ASHRAE** Refrigeration and Air Conditioning - **W.F.Stoecker** Air Conditioning and Heating Manual - **Néstor Quadri**
Other bibliography	-
Evaluation system:	They are of a personal nature and are based on a written exam consisting of three (partial) parts: *Refrigeration, Humid Air, Air Conditioning.* Each part must be passed. In order to sit for the evaluation you must be a regular student. The condition of regular student considers 80% of attendance to the practical work, completion of the two projects and approval of the problems and calculations. The method of assessment is known to the students beforehand.

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Ing. Roberto Lauro Andina
Associate Professor
Chair of Refrigeration
Technology

ANALYTICAL PROGRAMME "HYDRAULIC MACHINES"

Contents :

Thematic unit 1: Introduction.
Classification of rotary and water turbine pumps - Determination of head for pumps.

Thematic unit 2: Hydrodynamic theory of radial pumps.
Deduction of Euler's law.- One-dimensional streamline theory.- Euler's law transformed to two-dimensional theory.- Degree of reaction.- The rotating eddy and Pfleiderer's formula.- Influence of vane thickness.- Losses and yields.- The rotating eddy and Pfleiderer's formula.- The influence of vane thickness.- The rotating eddy and Pfleiderer's formula.- The rotating eddy and Pfleiderer's formula.- The rotating eddy.

Thematic unit 3: Rotor Design.
Calculation of the main dimensions - Design of the pallets by arc of circle and calculated by points - Optimum number of pallets - Optimal number of pallets

Thematic unit 4: The body of the pump.
calculation and design of the volute casing - calculation and design of the guide vanes - calculation and design of the guide vanes - reversing channels and reversing vanes in multistage pumps

Thematic unit 5: High flow pumps.
special paddle design (Francis type paddles) - special paddle design (Francis type paddles)

Thematic unit 6: Axial pumps.
The two-dimensional theory and airfoils as vanes - Calculation and design of rotors and guide vanes - The influence of the grating and its calculation according to the methods of A. Betz and E. Eckert - The influence of the grating and its calculation according to the methods of A. Betz and E. Eckert - The design and design of rotors and guide vanes

Thematic unit 7: The theory of similarity.
Deduction of the similarity formulae. The unitary number of revolutions. Classification of pumps on the basis of their similarity - Model laws

Thematic unit 8: Pump Service.
Characteristic lines and fields - The installation and pump assembly - Pumps in parallel and in series - Cavitation and suction lift - The pumping of the pumping system and the suction head

Thematic unit 9: Water turbines.
Their characteristics and classification - Fields of application - Gross and net head - The deduction of Euler's law for turbines The deduction of Euler's law for turbines.- Efficiencies and losses.- Exhaust losses.- The output losses.- The turbine's efficiency.- The turbine's efficiency.- The turbine's efficiency.- The turbine's efficiency.

Thematic unit 10: The Francis Turbine.
Classification and determination of main dimensions - Design of rotor blades - Guiding blades - Power regulation - Characteristic field

Thematic unit 11: The Kaplan Turbine.
Determination of their main dimensions - Design of the vanes - Calculation of cavitation limits - Characteristic field - Calculation of cavitation limits

Thematic 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 - The design of the buckets and determination of the number of buckets

Thematic unit 13: The service of Turbines.
Suction height and cavitation.

Objectives	Analyse fluids in motion. Use appropriate physical laws and mathematical tools for the calculation, design and recalculation or verification of industrial application equipment. such as pumps, fans and hydraulic turbines
Analytical description of the theoretical and practical activities	The development of the course is organised into the following activities: Theoretical classes. Practical classes including projects. **Theoretical classes:** During these classes, teachers develop the content of the subject's syllabus, take the students to the lecture hall, and then give them a lecture on the subject. The teachers together with the head of practical work. The course uses a blackboard and, in special cases, projectors. **Practical classes:** During these classes, application problems and 3 projects are presented, consisting of the design of a radial pump, an axial pump and finally a hydraulic turbine, giving each student different initial data that will lead them to investigate the different types of machines that will meet the requirements. In order to improve the interpretation of plans and better knowledge of standards, plans and drawings are required by hand without being able to present them using design programmes.
Hourly load:	96 hours
Distribution of activated	Theoretical and practical classes: 96 hours
Basic bibliography:	Rotary PumpsRolf . J. Focke Centrifugal Pumps and Turbochargers Carl Pfleiderer
Other bibliography	Pumps Manuel ViejoZubicaray Machine Project Pablo Tedeschi Industrial Ventilation Committee on Industrial Ventilation Pumps. Selection, use and maintenance Kenneth Mc
Evaluation system:	**REGULAR STUDENTS**, who have an attendance equal or higher than 75% of the classes and who have presented all the practical exercises in due time and form in order to be evaluated orally on the development of the same, thus, being able to have the portfolio approved at the end of the course. **PROMOTION:** Currently the chair does not use this type of system. **"FREE" STUDENTS:** They take a comprehensive theoretical-practical written exam with a previously completed portfolio. If they are successful in this stage, they will be able to sit the comprehensive oral exam. **FINAL EXAMINATION:** the **final** examination is oral and public by a jury.

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Ing. Eduardo Coronel
Assistant Professor
Chair of Hydraulic Machines

ANALYTICAL SYLLABUS "ELECTRICAL INSTALLATIONS "

Contents:

Topic 1- RULES AND REGULATIONS

--The standards and regulations in force in the Argentine Republic - with the application in projects and execution of electrical installations of lighting and motive force in residential and/or industrial buildings. a)- IRAM - VDE standards. b)- Regulation for the design and execution of electrical installations in buildings - Argentine Electrotechnical Association - AEA .

Topic 2 - CALCULATIONS OF LOW VOLTAGE ELECTRICAL COUNDUITS

a)-Calculations of single-phase and three-phase low voltage alternating current lines for buildings. Power supply line-main line-sectional line-circuit line.
b)-Calculations of low-voltage alternating current lines for industrial plants. Feeder line - main line - sectional line - circuit line.
With application to lighting circuits and electrical machines.
c)-Calculations of single-phase - three-phase alternating current distribution networks intended to supply a group of dwellings or neighbourhoods.

Topic 3 - THREE-PHASE MEDIUM VOLTAGE LINES

a)-General concepts of three-phase medium voltage installations - components: columns - insulators - conductors - fittings - accessories .
b)- Public three-phase medium voltage distribution system in the Argentine Republic - overhead and/or underground - general guidelines - radial supply from transformer stations.
c)-Brief review of calculation guidelines for three-phase medium voltage lines.

Topic 4- PROTECTION OF ELECTRICAL NETWORKS

a)-General concepts and calculations of single-phase and three-phase short-circuit currents in overhead and/or underground electrical networks.
b)- Protection of electrical networks and single-phase and three-phase circuits - selectivity - coordination of protections, tripping curves.
c)-Protection elements: fuses-switches. Characteristics of the different types of protection.
d)-Protection of buildings and/or industries against atmospheric discharges.

Topic 5 - VERY LOW VOLTAGE ELECTRICAL SYSTEMS

Brief overview of the most common very low voltage installations.

Topic 6 - GENERAL SERVICES IN PROPERTIES

1. Electro water pumps.
2. Electro pump for sewage liquids.
3. Waste compactors.
4. Air-conditioning equipment: individual-central.
5. Lifts.

Topic 7- EMERGENCY SYSTEM FOR BUILDINGS

--Basic knowledge for the selection and commissioning of generating sets for:

1. Buildings intended for residential dwellings.
2. Office buildings.
3. Public service buildings: sanatoriums-hospitals-etc.
4. Industrial plants.

	Topic 8- INTEGRATING KNOWLEDGE WORK. --Application of the general knowledge acquired during the course of the subject in a practical development: 1. Project for a complete installation of a 1 or 2-storey house (with swimming pool - barbecue area - green space). 2. Design of an electrical installation for lighting and motive power for a workshop or small industrial plant.
Objectives *(in terms of of competences)*:	That the student acquires a broad and clear concept of: -- Low Voltage Electrical Installations, calculations of their conduits according to the requirements of the new AEA regulations in force in the Argentine Republic. --Clearly understand the calculation guidelines for conductors, their installation factors, customer requirements from the point of view of voltage drop, the components involved, always maintaining coordination and selectivity between them to obtain the conditions of safe operation that any installation must meet. -- As for the other installations that exist in a building: very low voltage and general services - the future professional must have a general knowledge of their existence and their use, in pipes independent of the low voltage networks, which will allow him/her to participate in the design, to know how they are executed according to the regulations in force and their relations with the other services.
Analytical description of theoretical and practical activities:	**TEACHING METHODOLOGY**: --Theoretical classes are developed on the blackboard, with the help of slides and with theoretical and practical examples. --Practical work is carried out on application problems with emphasis on the use of tables, manuals, brochures, etc. for the choice of components. **PRACTICAL WORK :** During the course of the subject, various practical tasks are carried out with problems involving the application of the topics presented in the theoretical classes.
Hourly load:	96 hours.
Distribution of activities:	4 hours of theoretical classes per week on two days: Tuesdays and Thursdays of 2 hours each, and practical classes: 2 hours per week per group. Taking into account the large number of students, and for a better understanding of the subject, groups of 20/25 students are formed (total number of committees for the year 2011: 3), with the practical classes taking place at different time schedules. Total duration: 16 weeks.
Basic bibliography:	1. Regulation of electrical installations in buildings - AEA. 2. General and specific information on IRAM standards, 3. Electrical installations - Ing. Marcelo Sobrevila.
Other recommended reading:	4. AEG Manual - AEG TELEFUNKEN. 5. Practical manual and applications - SCHNEIDER ELECTRIC 6. Electrical Installations - Volumes I and II - SPITTA. 7. SIEMENS Low Voltage Manuals. 8. General and Applied Electrical Engineering - Volume I - MOELLER WERR. 9. Technical brochures from various manufacturers.

Evaluation system:	Regularisation is obtained with : 1. Passing two (2) mid-term exams which will be made up - Passing is with a mark of four (4) or more and a final oral or written exam. 2. To have 100% of the practical work APPROVED. 3. Have at least 80% attendance in theory classes.

Ing. Venancio Mauro Carlorosi
Associate Professor

ANALYTICAL PROGRAMME "STABILITY III"

Contents:	**Topic 1: Axially symmetric stresses and strains. General differential equations** **a) Thick-walled cylinders.** Differential equation. Calculation formulae for the different cases applying the different breakage formulae. Applications. b) **Rotating cylinders.** Differential equation. Formulas for dimensioning. Variable thickness disc. Disc of equal resistance. Influence of corana and vanes. **Topic 2: Bending of bent axis bars** Deformation hypotheses. Determination of stresses. Determination of the Z constant. Hyperstatic curved bars. Introduction to plastic calculation. Collapse load. **Topic 3: Twist** Deformation hypotheses. Acting stresses. General approach to the problem. Torsion function conditions at the free edges of the cross-section. Solving circular, elliptical and rectangular cross-sections. Tables for other cross-sections. Analogy with Prandtl's function. Torsion in thin-walled hollow sections. **Topic 4: Plates and membranes** **a) Membranes.** Differential equation of stresses in a membrane. Membrane forces. Membranes of translation and revolution. Resolution of some typical cases. **b) Plates. Plate** bending theory. Deformation hypotheses. Obtaining the differential equation of shifts in the direction perpendicular to the median plane of the plate. Germain-Lagrange equation. Boundary conditions. Calculation of some typical cases. Calculation of moments. Determination of thickness Verification of maximum deflection. Use of tables and graphs for complicated cases. **Topic 5: Contact stresses** Hypotheses for determining stresses and strains. Method for their calculation for point and linear loads in bodies of different curvature. Safety coefficients. Hypotheses of breakage. Surface heat treatments. Importance of the same.
Objectives	To introduce students to the analysis of stresses and deformations in elements frequently used in machine construction. To analyse qualitatively and quantitatively, design and optimise designs.
Analytical description of theoretical and practical activities	The development of the course is organised into the following activities: Theoretical classes and Practical classes. **Theoretical classes:** during these classes the lecturers develop the content of the subject syllabus. These classes are given by the teacher. They use a projector with a PC and support notes including: tables, figures, graphs, formulas and concepts. The classes are participative, with students taking part by asking questions which are answered and commented on by the teacher. **Practical classes:** during these classes, application problems are posed, with individual data, which are solved by the teachers. In addition, other exercises are presented which must be solved by the students. The presentation of the practical work is compulsory since the regularity is obtained by submitting them.
Charge hourly:	64 hours
Distribution of activated	Theoretical lessons: 32 hours Practical lessons: 32 hours
Basic bibliography:	- Strength of materials. Volumes I and II. Timoshenko. - Theory of elasticity. Timoshenko. - Advanced mechanics of materials. Seely-Smith. - Advanced strength of materials. Den Hartog, J.P. - Elasticity and plasticity. Guzmán-Luisoni.
Other bibliography	- Introduction to the theory of plasticity for engineers. Hoffman-Sachs - Berechung der maschinenelemate. Ten Bosch. - Elastizitatslehre fur ingenieure. Euslin, Max.

Evaluation system:	For the regularisation of the subject, they are required to prepare a portfolio containing all the assigned practical work solved. At the end of the course, the students are examined by means of an oral test which consists of the full development of one of the chapters of the programme.

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Ing. Manuel Eduardo Budeguer
Full Professor
Chair of Stability III and
Machine Foundation

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Ing.Guillermo Miguel Díaz Romero
Associate Professor
of Stability III and Vibrations and
Vibrations and Machine Foundation

Analytical Programme "Control Systems"

Contents:	TOPIC 1: INTRODUCTION. General overview. General description of control systems. Feedback. Closed-loop and open-loop control systems. Concepts. Examples. TOPIC 2: MATHEMATICAL MODELS. Representation in linear differential equations. Transfer function: definition. Mechanical and electrical examples. Transfer function of cascade elements. Block diagrams Closed-loop representation in block diagrams Closed-loop systems subjected to a disturbance Block algebra Procedures. Operation. TOPIC 3: CONTROL ACTIONS. Algorithms. Concepts. Control actions: a) Two-position or else; 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 system behaviour. Effects of feedback. TOPIC 4: TRANSIENT RESPONSE ANALYSIS. Typical test signals. Transient and stationary response. Absolute stability. Relative stability and stationary error. First and second order systems: responses to various inputs. Transient response specifications. Stability analysis in the complex plane Routh stability criterion. TOPIC 5: FREQUENCY RESPONSE. Response to a sinusoidal input. Bode, polar and modulus diagrams as a function of phase. Stability analysis. Nyquist stability criterion. Other criteria. TOPIC 6: ELEMENTS OF INDUSTRIAL AUTOMATIC CONTROLS. Classification. Self-acting controls. Component elements of automatic controllers Pneumatic elements: nozzle-vane mechanism, pneumatic relays. Hydraulic elements: hydraulic servomotor, dampers. Mechanical elements: centrifugal or Watt's governor Combinations. The centrifugal governor as an automatic speed controller. Component elements of control systems Pneumatic control valve. Positioners Auxiliary elements in control systems Relays. TOPIC 7: CONTROL SYSTEMS. Symbology. IRAM standard. Cascade control systems: concept; advantages; application conditions; block diagram; examples. Feedforward control: concepts; conditions; block diagrams; examples. Relational control: concepts; conditions; block diagrams; examples. Constraint control: concepts; conditions; block diagrams; examples Other types of control. TOPIC 8: COMMON CONTROL SYSTEM SCHEMES. Automatic controls on steam boilers. Automatic dome level control: one, two and three element control systems. Energy balance control. Hearth control. Air-fuel ratio. Steam pressure and temperature control. Other controls. **LIST OF PRACTICAL ASSIGNMENTS** Nº1: Models. Transfer function. Nº2: Response of First Order systems. Nº3: Response of Second Order systems. Nº4: Control actions. Nº5: Basic elements of a control system. Nº6: Control valves. Nº7: Advanced control systems.
Objectives *(in terms of of competences)*:	To provide students with the basic concepts, terminology and techniques for process control. The young engineer must have within his reach the tools that will allow him to understand and develop control techniques in his professional career.

Analytical description of theoretical and practical activities:	The course is developed through theoretical and practical classes (classical theory and problem solving), laboratory practice and partial evaluations. Course website: http://www1.herrera.unt.edu.ar/faceyt/sistemasdecontrol/ **Theoretical and practical classes:** It is carried out in 2 (two) weekly classes of 5 hours total to develop theoretical aspects and solve problems of practical application linked to the productive activities of the region. Multimedia equipment, specific bibliography, lecture notes, technical manuals and product catalogues are used. This modality allows theory to be brought closer to its application. **Laboratory practice:** Theoretical-practical classes are complemented by work in the laboratory of "Automation and process control", where the student applies the techniques learnt in the lectures with modern equipment and simulation facilities. **Evaluation:** Students must take two partial evaluations, the first one at the end of Topic 5 and the second one at the end of the course.
Hourly load:	80 hours
Distribution of activities:	Theoretical-practical classes: 64 hours Laboratory practice: 12 hours Evaluations: 4 hours
Basic bibliography:	- Modern Control Engineering, K. Ogata, Ed. P. Hall, 1994. - Process Control Systems, F. Shinskey, Mc Graw Hill, 1996. - Automatic Control Engineering, F. Raven, Ed. H.A.S.A., 1980. - Automatic Controls, H. L. Harrison and J. G. Bollinger. Trillas, 1974. - Instrumentación industria, A. Creus Solé, Ed. Marcombo 1999.
Other recommended reading:	Automatic Control Systems, Smith and Corripio, Ed. LIMUSA. - Análisis de sistemas dinámicos y control automático, Canales y Barrera, Ed. LIMUSA. - Industrial process control. Criterios de implementación, A. Creus Solé, Ed. Alfaomega, 1999. - III Seminar on Industrial Technology, Copersucar Technology Centre, 1st ed, 1987. - Instrumentación aplicada a control de calderas, E. A. Bega, 3rd ed, Editora Interciencia, 2003. - Fundamentals of control with MATLAB, E. Pinto Bermúdez and F. M. Espada, Pearson, 2010. - Material prepared by the Chair.
Evaluation system:	In order to regularise the subject, the student must: • Attend 80% of the classes given during the term. • Pass the two mid-term exams with 60%, which will take place on the dates indicated during the first week of classes. • Submit the corresponding practical work before the mid-term exams. • At the end of the course the student must have presented all the practical exercises. A final oral exam must be passed in order to pass the course.

Eng. Marcos A.
Golato
Associate Professor

ANALYTICAL PROGRAMME "VIBRATIONS AND MACHINE FOUNDATIONS"

Contents:	**Thematic unit I: Systems with one degree of freedom.** Undamped free oscillation. Rotation vector. Complex representation. Free damped oscillation. Critical damping Mass suspended from a spring animated by a harmonic motion. Forced oscillations with and without damping Graphical resolution Resolution using complexes Work produced in harmonic motion Electrical analogy **Thematic unit II: Systems with two degrees of freedom.** General equation. Discussion. Vibration absorber without damping. Frahm absorber. Natural frequencies Maximum amplitude for equal frequencies of the absorber and the main mass. Centrifugal absorber. vibration absorber with damping Resolution using complexes Determination of the most favourable calibre and damping. Lanchester absorber. Charts for the calculation of the different types. **Thematic unit III: Systems with several degrees of freedom.** Equation of motion for a system with links. Coordinates and generalised forces. Free vibrations. Various discs. Determinant of frequencies Free vibrations with bending. Shaft with several supports and masses Determination of frequencies. **Thematic unit IV: Shaft bending oscillations.** A mass. Critical angular velocity. Several masses and two supports. Dunkerley and Kull formulae. Stodola procedure. Axes with three supports. Application of Castigliano's principle. Torsional vibrations. Shaft with several masses. Determination of frequencies and modes of vibration according to Holzer. The reduced axis. Mass reduction Inertial moments and equivalent elasticity. **Thematic unit V.** Vibration isolation of machines. Vertical vibration. Maximum amplitude and stress transmitted to the foundation. Rigid and floating foundations. Determination of the desired isolation. The concept of mechanical impedance. Its intervention in the design of the foundation. Calculation of the impedance at a foundation point. Insulation of: buildings, railways, test benches and testing machines, sensitive machines and equipment, piston and screw compressors, shipbuilding equipment, gas and diesel generator sets, rotary printers, metal forming machines, textile machines, piping, fans and air conditioners. **Thematic unit VI: Machine foundations** Block type. Cell type. Walls. Porticoed. With piles. On elastic supports. Elastomer type insulators. With springs. Springs with viscous damping. General concepts for the foundations of a diesel engine, gantries for turbines. Machines subject to irregular shocks. Free-falling, air- or steam-powered or air- or steam-driven screw jacks.
Objectives	To introduce students to the analysis of movement and the determination of oscillation amplitudes in free and forced vibrating systems. Analyse the transmission of forces to the foundation.

Description **analytics of the theoretical activities and practices**	The development of the course is organised in the following activities: Classes Theoretical and Practical Classes. **Theoretical classes:** during these classes, the teachers develop the contents of the subject syllabus. These classes are conducted by the teacher. In their development a computerised flipchart and supporting notes including tables, figures, graphs, etc. are used, formulas and concepts. The classes are participative, with students taking part asking questions that are answered and commented on by the teacher. **Practical classes:** during these classes, application problems are posed with individual data, which are solved by the teachers. In addition, there are other exercises to be solved by the students. The presentation of the practical work is compulsory since regularity is obtained with the presentation of them.
Hourly load:	64 hours
Distribution of activated	Theoretical lessons: 32 hours Practical lessons: 32 hours
Basic bibliography:	- Vibration Problems in Engineering. Timoshenko. - Mechanical Vibrations. Den Hartog, J.P.
Other bibliography	- Practical Solution of Torsional Vibration Problems. Wilson, W.Ker - Vibration and Schock Isolation. Crede, C.E. -Shock and Vibration Handbook. Harris, C.M. and Crede, C.E.
Evaluation system:	For the regularisation of the subject, they are required to prepare a portfolio containing all the assigned practical work solved. At the end of the course, the students are examined by means of an oral test that consists of the complete development of one of the chapters of the programme.

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Ing. Manuel Eduardo Budeguer
Full Professor
Chair of Stability III and
Machine Foundation

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Ing.Guillermo Miguel Díaz Romero
Associate Professor
of Stability III and Vibrations and
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Faculty of Exact Sciences and Technology

MECHANICS DEPARTMENT

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PROGRAMME

LIFTING AND CONVEYING MACHINES

Career Mechanical Engineering

THEMATIC UNIT 1

Generalities.- 1.- Introduction. 2.- Classification: a) According to the way of working: discontinuous and continuous. b) According to the material to be moved: Transport of bulk material, loose pieces, people. c) According to the direction. d) According to the mobility. e) According to its drive. 3.- General technical and economic criteria for the choice of the most suitable equipment. 4.- Economic importance of the transport in the industry and in the country 5. Design of the transportation system. Previous definitions. Design engineering. Morphology of the design.

THEMATIC UNIT 2

Driving machines. 1.- Types of drives: hand-operated, hydraulic - pneumatic - steam - internal combustion engine - electric. Types of engines - control devices. Regulation. Safety, braking. 2.- Determination of the power of the lifting motor taking into account static and dynamic forces. 3.- Characteristics of the load under load. Relative working time.

THEMATIC UNIT 3

Typical elements and parts. a) Elements for the transmission of force and movement: 1. 2.- Steel wire ropes: movement and load-bearing ropes, types - calculation of ropes. 3.- Cable ties and splices. 4.- Chains; cable pulleys. 5.- Chain wheels. 6.- Drums for cables and chains. b) Elements for load suspension: 1.- Hooks; single, double, closed. 2.- Electromagnets. 3.- Pincers. 4.- Common and self-pressing grabs. 5.- Polyps. 6.- Digging buckets. 7.- Buckets.

THEMATIC UNIT 4

Safety devices. a) Ratchets: 1.- General. 2.- Performance 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, friction controlled. b) brakes: 1. 2.- Subdivision according to their construction and function. 3. 3.- Brake moment taking into account static and dynamic forces. 4. 4.- Types of brakes: a) Shoe brakes: single and double; counterweight and spring actuation. Brake lifting by electromagnet and by electro-hydraulic device. b) Band brake. c) Miscellaneous: combined with ratchets. Push brakes. Blade brakes. Centrifugal force brakes. 5.- Brake verification by equivalent thermal power.

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THEMATIC UNIT 5

Various lifting devices. 1.- Jacks: rack and pinion, hydraulic screw jacks. 2.- Simple and double hoists. 3.- Hook armatures. 4.- Rigging with fixed and mobile pulleys. Hand-operated hoists with worm gear and planetary wheels. Electric rigging. 5.- Hand winches for wire rope. Mechanical winches. Electric winches for independent use. Winches for single and double gear for slewing cranes. Winches for sliding crane trolleys. Winches with clutches. Winches for self-priming, single and twin-engine grabs. Winches for lifts and hoists. 6.- Winches.

THEMATIC UNIT 6

Cranes - Types of cranes - jib cranes: wall-mounted, mast-mounted, slewing column, fixed column, monorail, turntable, fixed and mobile. Folding mechanisms for the davit. 2.- Sliding cranes: Arrangement, trolley shapes. Mechanisms with various lifting speeds. Bridge shapes.3.- Gantry cranes: Common. 4.- Funicular cranes: Classical applications in workshops and shunting yards. 5.- Travelling mechanisms: Rails, wheels, resistance to the movement of the motor; moment of the brake.

THEMATIC UNIT 7

Steel structures of cranes: 1.- Standard DIN 120: Compensation and shock factors. Load cases. Intervening forces. Materials and admissible stresses. 2.- Full, simple and reinforced web beams: calculation by tension and deformation. Usual constructive organisations. 3.- Lattice girders: determination of the forces in the members coming from the permanent loads and the moving load. Typical constructive forms.

THEMATIC UNIT 8

Continuous conveyors. 1.- Generalities. Classification and enumeration of the types of conveyors. 3.- Continuous conveyors for bulk materials: General principles - Classification of materials. 3.1. Screw or worm conveyors.
3.2. Oscillating and vibrating conveyors. 3.3. Bucket elevators. 3.4. Conveyor belts. 3.5. Pneumatic conveying. 4.- Continuous conveying for packages and parts. Description of the most common types.

Ing. Manuel Eduardo Budeguer
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BIBLIOGRAPHY

1. Class notes
2. Notes by Ing. E. Conrad.
3. Manuals: Hotte-Dubbel (Volumes I and II)
4. STANDARDS : IRAM - DIN - ASME - ISO
5. Plates: E. T.
6. Williamson and Williamson : "Industrial Transports".
7. H. Ernst: "Lifting and conveying equipment" (3 volumes)
8. V. Zignoli : Transporti Mecanici (2 volumes).
9. W.G. Hudson; Conveyors.
10. Magazine "Fordem und Heben".
11. M. Alexandrov: Lifting and conveying equipment and machines.
12. Steel in construction.

Ing. Manuel Eduardo Budeguer
Associate Professor

ANALYTICAL PROGRAMME "INDUSTRIAL ORGANISATION"

Contents:	UNIT 1: Industrial Organisation. Current importance. Evolution of Business Organisation. Main precursors of Industrial Organisation. Organisation: Authority - Responsibility - Duty. Types of Organisation: Taylor, Fayol, Line and Staff. Committees. Organisational Chart. Types. Matrix structure. The company as a system. Importance of the coordination of subsystems. Business skills. UNIT 2: Planning Department. Production planning and control. Relationship between Production - Sales - Stock. Necessary documentation for manufacturing: technical drawing, routing, operation sheets. Engineering Department of the Production. Productivity. Types of Productivity. UNIT 3: Fixed costs, variable costs. Representation of unit costs. Costs and revenues. Break-even point. P. G. Diagram. Selection and renewal of production equipment. Relation to the production process. Points to consider. Representation of total costs as a decision-making tool. UNIT 4: Depreciation. Causes. Depreciation. Different depreciation systems. Maintenance of production assets; types: corrective, preventive, predictive, detective. Characteristics. RCM methodology, 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 programme. Just-in-time manufacturing. Elements. Kanban. Poka yoke. SMED. UNIT 6: Production control systems. Gantt charts. Characteristics. Types of charts. Critical Path Method. Stages. Application. Control panel. Types of indicators. Balanced Scorecard (BSC). If-then analysis. Dashboard Matrix. KPIs. Drivers. UNIT 7: Study of working methods. Objectives. Spreadsheets. Preparation of spreadsheets for the current and the proposed method. Man - Machine Diagram. Study of movements. Purpose. Bi-manual diagram. Economy of movements. Arrangement of the work area. Gilbreth and the therbligs. Micro-movements. Symogram. UNIT 8: Measurement of work. Purpose. Time studies by timekeeping, by calculation and by pre-determined times. Supplements. Determination of the number of cycles to control. UNIT 9: Statistical Quality Control. Necessity and fundamentals. Design quality and product quality. Assignable and non-assignable causes. Relationship between quality and costs. Control by variables and by attributes. Critical control points. Quantity of parts to control. Fate of defective parts. Graphic 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: Location of industries. Classification of industries: continuous - repetitive - intermittent. Distribution of equipment by process and by product. Factors involved. Practical way of carrying out a layout study. Thread diagram. Basic concepts of automated factories. Economic and social effects of automation. Concepts of lean manufacturing and agile manufacturing. Clusters. **List of Practical Works** 1- Precursors of Industrial Organisation 2- Gantt charts 3- Economic Batch Model 4- Critical Path Method 5- Just in time 6- Statistical Quality Control 7- Point of equilibrium

Objectives *(in terms of of competences)*:	At the end of the course, the student will be able to apply the basic tools to efficiently manage a company dedicated to the production of products and/or the provision of services.
Analytical description of theoretical and practical activities:	The course is developed through theoretical and practical classes (theory and problem solving) and evaluations. Course website: www1.herrera.und.edu.ar/organizacionindustrial. THEORETICAL AND PRACTICAL CLASSES: 2 weekly classes of 2 hours to develop theoretical aspects and solve some application problems. Multimedia equipment is used. This modality allows to bring theory closer to its application. Based on an annual practical work guide, problems are discussed and developed, complementing the theory of the different subjects. EVALUATION: students must take an evaluation halfway through the course.
Charge hourly:	64 hours
Distribution of activities:	Theoretical-practical classes: 60 hours Evaluations: 4 hours
Bibliography basic:	- Operations Management - Roger Schoeder - Mc Graw Hill. 1992 - Handbook of Production Engineering - H. B. Maynard - Reverté S.A. 1976
Other recommended reading:	- Production Management - J. Heizer and B. Render. Render - Prentice Hall 1. 1997 - Introduction to the Study of Labour - International Labour Office - 1963 - Production and Operations Management - Chase, Richard; Aquilano, Nicholas; Jacobs, Robert. Mc Graw Hill - 2001 - Manufacturing Facilities - D. R. Sule - Thomson Learning - 2001 - Industrial Engineering - Niebel, Benjamin; Freivalds, Andris - Alfaomega - 2004 - ISO 9001:2000 Standard - Material prepared by the Chair.
Evaluation system:	In order to regularise the subject, the student must: • Attend 80% of the classes given during the term. • Passing the midterm with 60%: to be taken on a date to be fixed in the first week of classes, or its respective recovery. • Submit practical assignments on TIME AND IN THE RIGHT WAY as they are carried out. • At the end of the course the student must have presented all the practical exercises. A final oral exam must be passed in order to pass the course.

Ing. Nancy Alves
Associate Professor

ANALYTICAL PROGRAMME "LEGAL ENGINEERING"

Contents:	**Theme 1: Engineering in relation to Law. Law and Morality** Engineering in relation to Law: location, scope and importance of the subject in the integral training of the engineer. Rules governing human activity: ethical technical rules. Classification of ethical norms: moral and legal norms. Law: concept, relations with related sciences. Natural law. Law from an objective and subjective point of view. Patrimonial and extra-patrimonial rights. Public law and private law. **Theme 2: Argentine Civil Code. Rules. Customs. The law.** Argentine Civil Code: substantive and formal laws. Incorporation and codification systems. Background and orientation of the Argentine Civil Code. Structure. Sources of Law. The Law: concept, formation, effects, ignorance, waivers. The norm and its hierarchies. Public order. Custom: uses and technical practices. Jurisprudence. Doctrine. Time intervals in law. The federal political system and legislation. Administrative levels. Reserved, delegated and concurrent powers. **Theme 3: Subject of law: natural and legal persons** Subject of law: persons. Classification: persons of visible and ideal existence. Physical persons: birth, existence and purpose. Personality attributes: name, domicile, capacity, civil status and assets. Legal and de facto capacity. Persons under public law and private law. Principles governing them. Birth and extinction. Professional Associations and Councils. Commercial companies. **Theme 4: Object of Legal Relationships: things and goods** Object of legal relations: things and goods. Concept. Classification of things in themselves and in relation to persons. Assets in the public domain of the State: concept and characteristics. Enumeration. Private property of the State. Patrimony: composition. Patrimonial rights: credit rights, rights in rem and intellectual rights. The patrimony as a common pledge of creditors. Different classes of creditors. Privileges. Enforcement and liquidation. **Theme 5: Credit Rights. The Obligations** Obligations: concept. Notions on the sources of obligations. Creditor rights: concept and characteristics. Classifications of obligations. Effects and extinction. Acts and legal acts. Unlawful acts. Vices of the will and unlawful acts. Criminal offence and civil offence. Causes of imputability and unimputability. Strict liability. Damages and prejudices. **Theme 6: Contracts** Contracts: concept and essential characteristics. Classification. Object, form and evidence. Effect of contracts. Commissory agreement. Theory of contractual unforeseeability. Deposit or deposit. Penalty clause. Extinction. Statute of limitation in the matter of professional fees. Administrative contracts. Insurance contracts: general. **Theme 7: Contract for the Lease of Works. Obligations and responsibilities. Privileges. Contract** for the Lease of Works: concept, characters, object, form and proof. Intervening parties. Obligations and responsibilities of the parties before and after the work has been received. Privileges. Right of retention. Documentary pieces that make up the contract: contract and specifications. General specifications: clauses dealing with the object of the contract. Unforeseen and additional works, modifications to the project. acceptance of the work Termination of the contract. Technical specifications, essential requirements. **Theme 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. Consequences of the legal protection of intellectual production. Intervention and control by municipal, provincial and national bodies in intellectual production. Patents. **Topic 9: Real Rights** Rights in rem: Concept, creation, characteristics and enumeration. Rights in rem over the

own thing, another's thing and collateral. Possession and tenancy: concept and differences. Protection of possession. Possessory actions.

Theme 10: Right of Ownership and Condominium Law

Concept, attributes and characters. Inherent powers and extension of the right of ownership. Guarantees. Evolution of the concept of ownership. Ownership as a social function. Ways of acquiring ownership: appropriation; accession; alluvion and ablution, building, sowing and planting: different situations. Tradition. Acquisitive prescription. Extinction of ownership.

Condominium: definition and characteristics. Legal nature. Different types of co-ownership: divisible (ordinary), compulsory indivisible and by confusion of boundaries.

Theme 11: Limitations to the Domain. Restrictions

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

Theme 12: Easements. Enforced easements and administrative easements Easements: concept and characteristics. Classification. Forms of constitution. Compensation. Extinction. Types of civil easements. Types of administrative easements.

Theme 13: Expropriation for reasons of public utility

Expropriation for reasons of public utility: concept, purpose and grounds. Constitutional and civil provisions governing it. Requirements. Expropriation and the social concept of property rights. National and provincial legal regime. Qualification by Law: different types. Legal effects of expropriation. Administrative and judicial procedure. Deferred expropriation. Compensation: its practical valuation.

Perfecting expropriation.

Theme 14: Administrative Law

Administrative Law: concept, characteristics. Administrative and administrative acts. Notions on public services, police power and public domain. Administrative contracts: concept, characteristics, elements, formation, evidence. Forms of contracting.

Theme 15: Public Works Contracts

Public Works Contract: legal nature, definition and characteristics of the contract. Difference with the public works concession. Subjects and object of the contract. Public tender: principles governing this system of selection of the contractor. Work certificates. Provisional and final acceptance. Termination. Professional and business liability. National and provincial legislation on the subject.

Theme 16: Employment Contract. The Duty of Security

Employment contract: concept, modalities, rights and obligations of the parties, social benefits. Termination of the contract. Compensation.

Working conditions and working environment: concept. Risk: definition. Classification of risk factors. Maximum permissible levels. Occupational diseases and accidents at work. Pre-occupational examinations. Health and Safety at Work: Law 19.587.

Theme 17: Environmental Law

Concept, subjects, object. Criteria, principles and institutions of Environmental Law. Background. Constitutional guarantees. Civil Code: Limitations on ownership. Administrative restrictions. Police power. Responsibility of the State. Environmental Damage. Environmental Impact. Environmental Impact Assessment. Liability. Compensation. Comparative legislation.

Theme 18: Procedural Law

Procedural Law: concept. Procedural rules: organic and procedural. Stages of ordinary proceedings. Means of proof. Expert evidence. Arbitration proceedings.

Theme 19: Legal rules governing professional duties. Professional ethics Legal rules regulating the engineer's professional duties: legal nature of professional duties. Legislation regulating professional practice. Professional liability. Professional ethics. Professional fees. Fees, prescription.

Objectives *(in terms of competences)*:	The theoretical-practical concepts taught to students are intended to contribute to their comprehensive training through the analysis and study of the legal institutes that are most applicable in the field of their professional practice, providing them with elements that are fundamental for their better development.
Correlative:	Students must have passed: Assisted Design, Stability II, Materials Testing and Fluid Mechanics; and passed: Electrical Installations and Mechanical and Manufacturing Technology.
Analytical description of theoretical and practical activities:	Two theoretical classes of two hours each per week are given, which include the development of basic concepts supported by examples related to the professional practice of the Mechanical Engineer. The expository method is used for elementary content. The classes are developed in a theoretical-practical way, encouraging the participation of the students through dialogue. In some subjects, students are referred to official bodies and professional associations. The invitation of specialised professionals is foreseen for some points of the programme. Interaction with teachers is encouraged through consultations in class and at other times, which can be individual or group. The teaching-learning process aims to enable the student to cover the subject of professional responsibility and professional ethics with a view to contributing to an awareness of the impact of engineering solutions in the globalised social context.
Hourly load:	64 hours in the first term, two two-hour classes per week.
Distribution of activities:	Theoretical classes: 60 hours Partial Evaluation and Recovery: 4 hours
Bibliography basic:	- Casella José and Miguel Faro. Ingeniería y Derecho. Volumes I and II. Depalma. Bs. As. 1988. - Borda, Guillermo. Manual de Derechos Reales. Perrot. Bs. As. 1994. - Borda, Guillermo. Manual de Obligaciones. Lexis Nexis & Abeledo Perrot. Bs. As. 2006. - Mariani de Vidal, Marina. Curso de Derechos Reales Volume I, II and III. Víctor P. de Zavalía. 1976. - Spota, Alberto G. Tratado de locación de obra. Depalma. Bs. As. 1978. **Regulatory Support:** - National Constitution - Civil Code - Commercial Code - Code of Civil and Commercial Procedure - Laws, decrees, regulations (on topics covered and indicated in due course).

Another recommended bibliography:	Title	Author(s)	Editorial	Year of edition
	Health and Safety in Industry and Commerce Trade	Aguirre Martínez, E.	Trillas	1996
	Theoretical and practical treatise on procedural, civil and commercial law. Volume I, II, II and IV	Alsina, Hugo	Ediar. Buenos Aires	1963, 1957, 1961, 1965
	Rights in rem. Possession	Cura Grassi, Domingo C.	AD-HOC. Buenos Aires	2009
	Administrative Law	Bielsa, Rafael	University National del Litoral. Santa Fe	1949
	Rights in rem: principles, elements and trends	De Reina Tartière, Gabriel. Coordinator	Heliasta. Buenos Aires	2008
	Treatise on Administrative Law. General Part. Volumes I and II	Gordillo, Agustín A.	Machi	1974
	Safety and hygiene at work. for the whole of the Argentine Republic Law 19.587.	Got, Enrique Abel	Editions Antorcha. Buenos Aires	1975
	Code of Civil and Commercial Procedure of the Nation annotated and annotated	Gozaíni, Osvaldo Alfredo	La Ley. Bs. As.	2006
	Annotated Civil Code. doctrine-jurisprudence.	Kiper, Claudio	Rubinzal-Culzoni. Buenos Aires	2004
	Responsibilities of health and safety engineers. Law 19587/72	Mangosio, Jorge E	New Booksh op. Bs.	2003
	Collection of jurisprudential analysis. Rights in rem	Mariani de Vidal, Marina	La Ley. Bs. As.	2002
	Public and Private Water Regime and Legislation	Marienhoff, Miguel	Abeledo Perrot. Bs. As.	1971
	Legal Engineering Handbook	Médica Raúl O.	Depalma. Buenos Aires	1983
	Penal Code (with CD-ROM)	Zamora, Fernando Marcelo	Zavalía. Buenos Aires	2000
	Civil Code (with CD-ROM)	Zavalía, Ricardo de	Zavalía. Buenos Aires	2000
	Código Procesal Penal de la Nación (with CD-ROM)	Zavalía, Ricardo de	Zavalía. Buenos Aires	2000

Evaluation system:	- To achieve regularity, the student must have 70% attendance in theory classes and pass a partial evaluation. The student is entitled to a retake. - The subject is passed by means of a comprehensive final exam, prioritising the oral modality. - The free student takes a written exam that involves the development of theoretical concepts and their application to practical cases. If they pass the first exam, with a minimum of 60%, they move on to the second exam, which is usually oral. The grade is the average of the two exams.

Lawyer Lidia Ester Martorell
Senior Lecturer
Geodesy and Topography Dept.

ANALYTICAL PROGRAMME "STEAM GENERATORS AND THERMAL INSTALLATIONS"

Contents:	**THEMATIC UNIT 1** Introduction. World energy production based on oil, natural gas, coal, hydro and nuclear; reserves and alternative sources. **THEMATIC UNIT 2** Fuels. Classification and valorisation according to their properties (calorific value, volatile substances content, humidity, ash, etc.), linked to their use in the steam generator. Particular characteristics of the main fuels used in the world and in the region. **THEMATIC UNIT 3** Combustion. Analysis of the development of combustion, influence of the physical and chemical phenomena involved in the different stages of combustion (temperature, turbulence, chemical reactions, etc.) and their incidence on the time required. Theoretical and excess air combustion, calculation of minimum air, volume of combustion gases; incomplete reactions, analysis of Ostwald's and Bunte's triangles. i-t diagram for different fuels without and with air preheating. Uses of the diagram. **THEMATIC UNIT 4 H**eat transfer in steam generators. a) Transmission by radiation, concepts and fundamental laws (black and grey bodies, Planck's, Stefan-Boltzmann's and Kirchhoff's laws). Radiation between solids separated by a non-absorbing medium, geometrical factor. Selective radiation of gases and water vapour, flame radiation. Radiative heat transfer in combustion chambers; simplified calculation methods according to Wohlemberg and Broido, cooling figure; temperature of flue gases from the combustion chamber. b) Heat transfer by convection: Formulas for the calculation of the coefficients in the cases: b1) from gases to pipe walls (parallel circulation outside and inside), transverse circulation, b2) to steam in steam superheaters, b3) to boiling water, influence of heat load and pressure, critical flow, Leydenfrost phenomenon. (c) Conduction heat transfer in metals and in scale, ash and soot layers; overall heat transfer coefficient, for flat, cylindrical and extended surfaces (finned tubes); total heat transfer and temperature steps; limit for the application of certain calculation simplifications. **THEMATIC UNIT 5** Firebox characteristics for different fuels. Main dimensions in terms of allowing efficient combustion, adequate heat transfer and minimising the emission of solids into the atmosphere. Equipment for combustion of solid, liquid (fuel oil) and gaseous fuels; alternatives to reduce the emission of polluting gases. **THEMATIC UNIT 6** Draft. Justification, natural draught (chimney) and artificial draught, fans: a) choice of fans (characteristics, specific number of revolutions, absorbed power, regulation); (b) location: balanced draft (forced and induced), pressurised combustion chamber. Formulas for the calculation of draft losses due to friction, deflection, section changes, and upward forces. **THEMATIC UNIT 7** Water circulation in steam generators. Its necessity, classification (recirculation and forced passage). Natural recirculation, approach of the basic equations for a simple system and its analysis, minimum velocity in the downpipes, recirculation in tube bundles, conditions to guarantee a good recirculation. Forced recirculation, La Mont boilers; and forced passage, Benson and Sulzer boilers - monotube. **THEMATIC UNIT 8** Special boilers. Velox boiler and recovery boiler for combined cycles. **THEMATIC UNIT 9** Steam superheaters. Justification and generalities (location, arrangement, division into stages, etc.) Classification (vertical, horizontal, radiation, convection, etc.), calculation, regulation and commissioning.

Contents	**THEMATIC UNIT 10** Air preheaters. Justification and generalities (location, temperature limits, etc.) Classification (recuperative: tube, plate; and regenerative: Ljungstroem, Qpipes) and calculation of the necessary surface for heat transfer. **THEMATIC UNIT 11** Safety relief valves. General (location, characteristic pressures, number of valves, discharge pipework, etc.), types of valves (spring-loaded, weighted, auxiliary power), description, characteristics. **THEMATIC UNIT 12** Materials for steam generators and their hot strength. The creep of hot steel (creep), characteristic values and formulas for the calculation of wall thickness for domes and pipes, fixing of pipes to domes and manifolds, hydraulic test. **THEMATIC UNIT 13** Treatment and chemical control of boiler and feed water. Its necessity and analysis of the elements to be treated, external and internal treatment according to the characteristics of the steam generators and the working pressure; steam purity, separation equipment in the dome and water entrainment. a) Pressure losses. b) Elasticity and strength: cold pretension, compensation of thermal expansion, b1) artificial (bellows), b2) natural (calculation of stresses in flat and spatial systems); verification of the pipe to the combined state of stresses (self-weight, internal pressure, thermal stresses, etc. c) Thermal insulation. d) Desuperheaters, water separators, vapour traps.
Objectives	To provide the student with 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 handling installations in industrial plants.
Analytical description of theoretical and practical activities	The development of the subject comprises the following activities: THEORETICAL CLASSES: The topics are developed through teaching presentations, using available didactic materials: blackboard, transparencies, exhibition of pieces, plates, standards and catalogues. In addition, situations are presented, related to the subject being developed, which correspond to real cases, on which the students give their opinions; articles from specialised magazines in the library are discussed. PRACTICAL WORK: Individual and/or group guided problem solving. Individual attention of students during consultation hours. 9 (nine) practical tasks are solved (5 related to steam generators and 4 to fluid conduction installations). These are problems related to concrete cases of industrial action, in some cases regional, the results of which are analysed. In solving the practical exercises, students apply the knowledge acquired in theory and at the same time become familiar with the values used in industry.
Charge hourly:	128 hours
Distribution of activated	Theoretical and practical classes: 120 hours Evaluations: 8 hours
Basic bibliography:	– **STEAM ITS GENERATION AND USE.** Babcok and Wilcox. 40th Edition. 1992. – **Steam Boilers.** Marcelo Mesny. Editorial Marymar. 1st Edition. 1976. – **POWER BOILERS.** A. Guide to section I of the ASME BOILER AND PRESSURE VESSEL CODE. 1998.

Other bibliography	– **Heat Transfer**. 3rd Edition. J.P. Colman. 1998. – **Industrial Tabulations.** Silva Telles. Editorial Libros Técnicos y Científicos SA. – **HEAT AND MASS TRANSFER.** Baehr, Stephan. Springer 1998. – **Fluid Flow and Heat Exchange.** O. Levenspiel. Reverté S.A. 1996. – **Chemical Engineer's Handbook.** Perry. Mc.Graw.Hill. 1992. – **Manual on Thermal Energy Efficiency in Industry.** Caden. 1984. – **DUBBEL Machine Builder's Manual,** 3rd Ed. Editorial LABOR. 1965 – **Combustion.** Warnatz, Maas, Dibble. Springer 1992
Evaluation system:	In order to pass the course, students must present and pass the practical work portfolio, in this instance the teacher personally accompanies the student in order to corroborate correct learning, increasing the chances of success in the final exam. The subject is passed by means of a final oral exam. This is conceptual and aims to integrate knowledge. Free examinations are held in accordance with the regulations of the academic unit. Students are informed in advance of the forms of assessment, requirements for regularity and other conditions for passing the course.

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Ing. Jorge Ramón Pisa
Associate Professor
Chair in Steam Generators and Thermal Installations

ANALYTICAL PROGRAMME "INTERNAL COMBUSTION ENGINES"

Contents:	**Thematic unit 1 - Introduction:** Thermal machines. Internal combustion and external combustion engines. Differences. Historical overview. Lenoir, Otto-Langen, Nikolaus A. Otto, Daimler, Rudolph Diesel. Otto, Daimler, Rudolph Diesel. Operational characteristics of 2-stroke and 4-stroke engines. **Thematic unit 2 - Theoretical Cycles:** The ideal cycles and their adaptability to different machines. The perfect engine. Carnot, Clausius-Rankine and Otto in i-s and p-v diagrams. Performance. The optimum cycle according to natural limits. The mixed or Sabathé cycle. Comparisons and conclusions. **Thematic unit 3 - Actual reciprocating engine cycles:** The cycles shown. The actual engine. Degree of goodness and average pressures. Indicated power, mechanical efficiency and average friction pressure. Mean effective pressure. Effective power. **Thematic unit 4 - Cycle economics** Fuel energy and mixture energy. Dilution factor Fuel consumption, power and specific consumption. Volumetric and gravimetric efficiency. Determination of the mean effective pressure as a function of the efficiencies. **Thematic unit 5 - Characteristic values:** Overall dimensions of a reciprocating internal combustion engine. Average piston speed. Stroke to bore ratio Speed limits Power per litre and per cylinder. Concepts of the different engines Determination of displacement **Thematic unit 6 - Otto Engines (1st part):** Mixture formation and combustion. Service requirements. Power regulation. Carburettor fuel system The elementary carburettor. Corrections to the elementary carburettor to meet service requirements. Fuel injection fuel supply system Requirements. Direct and indirect injection Modern systems **Thematic unit 7 - Otto Engines (Part 2):** Ignition of the mixture. Regulation. Ignition advance. Necessary energy. Characteristics of the spark. Ignition circuits Battery, magneto and electronic ignition. Static ignition. Spark plugs Abnormal combustion Pitting Fuel requirements Octane number "Engine" and "Research". Their determinations. Different types of fuels used in the Otto engine. Additives and conditions. **Thematic unit 8 - Gas Engines:** Motor combustion from gaseous fuels. Minimum air. Calorific value of the mixture. Comparisons Spontaneous ignition temperature and rate of combustion. Influence on performance Energy equivalences. Schematic diagram of installations. **Thematic unit 9 - Diesel Engines (Part 1):** General. Combustion in the diesel engine. Parameters for macromixing. Penetration and atomisation Ignition delay Fuels; ignition quality Cetane number and its determination Diesel index The total injection process Injection delay and opening delay. Dynamic considerations. **Thematic unit 10 - Diesel Engines (Part 2):** Combustion chambers. Direct and indirect injection. Injection pumps and their regulation Requirements to be met. Different systems. Regulators and advance variator devices. Electronic management Modern high-pressure direct injection systems. **Thematic unit 11 - Air pollution:** Theoretical and actual exhaust emissions. CO, NO_x, C_xH_y, particulate matter, SO_x and their dependencies. Methods to reduce harmful emissions. Anti-contamination devices; EGR system; catalytic converters. Particulate filters **Thematic unit 12 - Distribution in 4-stroke reciprocating engines:** Different arrangements. Valve operation. The cross-section and its dimensioning. Cams and approximate theoretical profile layout. Considerations Spring loading Desmodromic systems.

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Contents:	**Thematic unit 13 - Distribution in 2-stroke reciprocating engines:** Sweeping systems. Theoretical limits of eviction and mixing sweepings. Practical values Calculation of sweeping ports. Sweep pump power Optimisation Pre-exhaust calculation Checks Practical sizing of ports. Conclusions. **Thematic unit 14 - Overfeeding:** Different procedures. Mechanical or turbo-blower system. Thermodynamic basis. Influence on $_{pme}$, density and different efficiencies. Period of load change. The mechanically coupled supercharger. The constant pressure exhaust gas turbocharger and pressure pulse turbocharger. Interference and firing orders Supercharger unit equipment. Considerations for turbocharging on 2 and 4-stroke engines. **Thematic unit 15 - Auxiliary circuits and tests:** Refrigeration. Different types. Heat to be extracted. Cooling fluid pumps. Radiators. Fans. Regulating devices. Engine lubrication Characteristics of lubricating oils Lubrication systems Starting internal combustion engines. Different types and calculation of electric or compressed air starters. Engine testing Characteristic curves Correction of values Standards. **Thematic unit 16 - Dynamics of reciprocating engines:** Accelerations in the connecting rod-crank system. Mass distribution. Shape of crankshafts and firing order. Inertia forces of different orders of the oscillating masses; their compensations. Compensation of the overturning moments of the 1st order. Transverse moments. Their compensation **Thematic unit 17 - Gas Turbines:** Thermodynamic cycles of open systems. Theoretical efficiencies. Compressor, combustor and turbine losses and efficiencies. The effective efficiency. Real cycle optimisation with heat exchangers. Turbine cycles with staged compression and expansion. Terrestrial applications. The compressor. The combustion chamber. The turbine. The materials. Vehicle applications. **Thematic unit 18 - Gas Turbines in Aviation:** Gas turbine applications in aviation. Propeller propulsion considerations. The turbojet. Thermodynamic cycle in the i-s diagram. Thrust. Flight performance. Total efficiency. Gas turbines as twin-flow turbojets. Bypass ratio.
Objectives	Acquire the conceptual bases, methods and criteria for the full knowledge and handling of internal combustion engines, as well as the knowledge to carry out fuel tests and engine tests on test benches, with the ability to interpret the results obtained. The aim of the project is to Encourage research on these issues.
Analytical description of theoretical and practical activities	The development of the course is organised into the following activities: Theoretical classes. Practical classes. Laboratory tests. Consultations. **Theoretical classes**: During these classes, teachers develop the content of the syllabus of the subject, carried out by the teachers with the head of practical work. A blackboard and supporting notes are used for the lectures. **Practical classes**: During these classes, application problems with individual data are posed, the methods for solving which are developed by the lecturers in class. Passing the practical classes is compulsory as this is the way to obtain the regularity of the subject. **Laboratory tests**: Aimed at reinforcing theoretical and practical knowledge. Test benches for reciprocating engines and turbines, engines for fuel tests, gas analysers, etc. are used.
High-loading:	128 hours
Distribution of activated	Theoretical classes: 80 hours Practical classes: 48 hours
Basic bibliography:	- Endothermic engines - Dante Giacosa - Internal combustion engines - Edward F. Obert - Combustion Engine Processes - Lester C. Lichty

Other biblio-graphy	- Internal combustion engines - Hans List - Gas turbines - Pedro Fernández Diéz - Advanced gas turbine cycles - J. H. Horlock
Evaluation system:	**REGULAR STUDENTS**, who have an attendance of 80% or more in the classes and who have passed all the practical work, will obtain the "Subject Certificate" and will have the right to take a final exam of the subject, which may be oral or written. "**FREE" STUDENTS:** They take a comprehensive written theoretical-practical exam. If they are successful in this stage, they will be able to sit the comprehensive oral exam.

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Ing. Ricardo A. Marchese
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ANALYTICAL SYLLABUS "TESTING OF THERMAL MACHINES AND INSTALLATIONS"

Contents:	**THEMATIC UNIT 1.** **Testing of a compressor -** Test methods - Stationary test - Testing of a closed vessel - Testing of a closed vessel Closed vessel loading tests. Theoretical considerations. Ideal and Real compression P-V diagram. Isothermal, adiabatic, volumetric and gravimetric performances. Closed vessel loading test setup and measurements. Test calculations, graphs and reports. **THEMATIC UNIT 2.** **Vacuum pump test -** Definition of vacuum. Differences between a vacuum pump and a piston compressor. The vacuum pump in industry. Test of a vacuum pump evacuating a closed vessel from atmospheric pressure to a given vacuum. Theoretical considerations. Test setup and measurements. Test calculations, graphs and reports. **THEMATIC UNIT 3.** **Dryer test -** Schematic diagram of the installation. Instruments and measurements. Flow rate, humidity, initial and final product temperature. Heating fluid consumption. Flow rate, humidity, initial and final temperature of the drying air. Thermal balance. **THEMATIC UNIT 4.** **Testing of a fan -** Determination of the characteristics of a fan. Diagram of the test installation, with the measurements to be made. Calculation of orifice plates. Reduction of the values obtained to a nominal number of revolutions per minute. Calculations, graphs and test reports. **THEMATIC UNIT 5.** **Testing of a centrifugal pump -** Determination of pump characteristics. Head, flow rate, cavitation through the calculation of NPSHr (Net Positive Suction Head requested). Installation diagram for the test. Power absorbed by the pump and useful power. Efficiency. Reduction of the values to a nominal number of revolutions per minute. Calculations, graphs and test reports. **THEMATIC UNIT 6.** **Testing of a steam generator -** Standards. Test methods: direct or indirect. Diagram of the installation and measurements to be carried out in the direct method. Diagram of the installation and measurements to be carried out in the indirect method. Heat loss. Efficiency. Calculation of the theoretical combustion temperature. Calculation and Test Report. **THEMATIC UNIT 7.** **Testing of a gas turbine -** Schematic diagram of the installation and test measurements. Efficiencies. Specific consumption. Calculations, graphs and final test report. **THEMATIC UNIT 8.** **Testing of a Steam Turbine -** Purpose of the test Installation and measurement scheme for testing a condensing turbine for the purpose of checking the manufacturer's warranty data.
Objectives *(in terms of of competences)*:	64 hours

Analytical description of the theoretical and practical activities practices:	Theoretical basis of the tests to be carried out. Development of the tests, using measuring instruments. Students carry out the tests and produce a report with the results obtained. Didactic elements: Measuring instruments used.
Hourly load:	64 hours
Distribution of activities:	Experimental Training: 32 Problem Solving: 32
Basic bibliography:	• DIN STANDARDS 1942-1943-1944-1945 • CREUS SOLE" INDUSTRIAL INSTRUMENTATION • EXPERIMENTAL METHODS FOR ENGINEERS "HOLMAN".
Other bibliography recommend to:	• LECTURE NOTES AND SHEETS
Evaluation system:	REGULAR STUDENTS: To obtain the regularity of the subject they must have passed the practical work and an attendance of 80% of the classes. Once regularity has been obtained, a comprehensive oral exam of the subject will be taken. "FREE" STUDENTS: They take a comprehensive written theoretical-practical exam. If they are successful in this stage, they will be able to sit the comprehensive oral exam.

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Ing. Benjamin D. Masaguer Aybar
Associate Professor

ANALYTICAL PROGRAMME "INDUSTRIAL ECONOMICS"

Contents:	**Topic 1.** The principles of economics. Economic models. The production possibilities frontier. Positive versus normative analysis. Interdependence and gains from trade: absolute advantage and comparative advantage. **Topic 2.** Model of perfect competition. Demand and the demand curve. Law of diminishing marginal utility. The individual and aggregate demand curve. Relationship between price and quantity demanded. Shifting of the demand curve. Normal good and inferior good. Substitute and complementary goods. **Topic 3.** Supply and the supply curve. The law of supply. Derivation of the supply curve. Marginal cost and profit. Firm supply and aggregate supply. Determinants of supply. Changes in quantity supplied and supply shifts. Price elasticity of supply. Determinants of elasticity. Calculation of elasticity. **Topic 4.** Market and equilibrium. Equilibrium price and quantity. Excess supply and excess demand. Equilibrium shifts. Shifting curves versus movements along curves. Surplus and welfare economics: Consumer surplus and producer surplus. Equilibrium efficiency. **Topic 5.** Market intervention: welfare effects. Regulated prices: effects of a price ceiling and the effect of a price floor. The costs of taxation and subsidies: Tax/subsidy on producers or on consumers and Effects on efficiency and surplus. Determinants of irrecoverable efficiency loss: Elasticities and tax/fiscal distortion and incidence of tax/subsidy. **Topic 6.** Costs of production. Different measures of costs. Short and long-term costs. The firm in a competitive market. Market power: Monopoly. Why they arise, How they behave, Efficiency losses. **Topic 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. **Topic 8.** Macroeconomic data. Income and expenditure of the economy. The measurement and components of GDP. Real and nominal GDP. The Consumer Price Index and the GDP deflator. Correction of economic variables to account for inflationary effects.

Contents	**Topic 9.** The Real Economy in the Long Run. Output and economic growth. Productivity: its role and determinants. Economic growth and economic policy. Savings and investment in national accounting. The loanable funds market. **Topic 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 for money and monetary equilibrium. The inflation tax. The costs of inflation. **Topic 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. NPV and decision criteria. The Internal Rate of Return. The flow of funds.
Objectives	That at the end of the course the students: 1. Understand the basic characteristics of an economic problem by distinguishing problems related to macroeconomics from those related to microeconomics and the relationships between them. 2. Are able to understand the basic concepts of microeconomic analysis. I.e. demand, supply with its determinants and the functioning of both perfect and imperfect markets. 3. Are able to understand the basic concepts of macroeconomic analysis. I.e. are able to conceptually differentiate the relationships between different economic aggregates. 4. Are able to interpret both macroeconomic and sectoral economic reports. 5. Are able to plan and evaluate an investment project correctly.
Analytical description of theoretical and practical activities	At the beginning of the school year, the teacher presents the subjects that will be dealt with during the course, establishing the minimum conditions necessary to pass the subject. The course is organised into theoretical and practical classes. During the classes, the teacher develops the content of the syllabus of the subject using a blackboard and a PC with a projector that includes models, theories, concepts and practical exercises that help to understand the issues raised. The classes are participative, students intervene by asking questions that are answered with the elements learned.
Hourly load	64 hours
Distribution of activities	Theoretical-practical classes: 64 hours
Basic bibliography	• Mankiw, N. Gregory (2007): Principles of Economics, 4th Edition, CENGAGE Learning. • Bresley, Richards and Myers, Stewart (1994). Fundamentals of Corporate Finance, 4th Edition, Mc Graw Hill.

Other bibliography	• Samuelson, Paul A. and Nordhaus, William D. (1999): Economics, 16th Edition, McGraw-Hill. • Mochón, Francisco (2000): Economía. Teoría y Política, 4th Edition, Mc Graw-Hill. • Días Giménez, Javier (1999). Macroeconomía. Primeros Conceptos, Antoni Bosch. • Braun, Miguel and Llach Lucas (2007). Macroeconomía Argentina, 1st Edition, Alfaomega. • Varian, Hal (2007) Microeconomía Intermedia, 7th Edition. Antoni Bosch Editor. • Fontaine, Ernesto (2002). Evaluación Social de Proyectos, 12th Edition, Alfaomega.
Evaluation system	• In order to pass the subject it is essential to pass a partial exam with a mark of 4 or more on a scale of 1 to 10. These students will obtain the "Boleta de regularidad en la materia" and will have the right to take a final exam of the subject, generally written, although it can also be oral or written. In the mid-term examination, emphasis is placed on solving practical problems, multiple-choice questions and true, false or uncertain questions for which justification is required. In the final exams, purely theoretical questions may be included in addition to these. • The exams for Free Students are a comprehensive written theoretical and practical exam.

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Lic. José Javier Bercoff
Assistant Professor
Chair of Industrial Economics

ANALYTICAL PROGRAMME "HYGIENE, SAFETY AND ENVIRONMENTAL CONTROL"

Contents:	**TOPIC 1:** Introduction to Working Conditions and Working Environment (WECW). Evolution from the traditional to the new concept of WECWC. Risk factors. Classification. Accidents. Incidents. Occupational illnesses. Medicine at work. **TOPIC 2:** The physical working environment. Noise and vibrations. Lighting. Thermal load. Ventilation. Ionising and non-ionising radiation. Their determination in working environments. **TOPIC 3:** Chemical and biological contaminants. Classification. Industrial toxicology. Particles, gases and vapours. Toxic, corrosive and explosive substances. Their determination in working environments. **TOPIC 4:** The workload. Physical fatigue. Mental workload. Work organisation. The working day. Circadian cycle. The rhythm of work. Communication. Management style. **TOPIC 5:** Safety conditions. Fire and explosion risk prevention. Electrical risk. Mechanical risk. Machines and tools. Handling, transport and storage of materials. Devices that develop internal pressure. **TOPIC 6:** Personal protective equipment. Criteria for their adoption and selection. Head and eye protection. Hearing protection. Respiratory protection. Hand and foot protection. Protection of the torso and limbs. Collective protection elements. **TOPIC 7:**Laws and regulations in relation to health and safety at work. National law on health and safety at work. National law on labour risks. Functions of the Superintendence of Labour Risks. Functions of the Occupational Risks Insurance Companies. Aspects of the labour contract law related to health and safety at work. Expertise. Occupational health and safety management systems. BS 8800 Standard. IRAM 3800 Standard. **TOPIC 8:** Environment and development. Population growth. Industrialisation. Urbanisation. Energy. Quantification of energy use. Environmental impacts of energy use. Human-induced environmental disturbances. Acid rain. Greenhouse effect. Ozone layer depletion. Environmental Impact Assessment. Methodologies. **TOPIC 9:** Water Resources. Water pollution and contaminants. Pollution indicator parameters. Water potabilisation process. Wastewater purification. **TOPIC 10:** Air Resource. Structure and composition of the atmosphere. Sources of natural and anthropogenic pollution. Types of air pollution. Primary and secondary pollutants. Control of atmospheric pollution. **TOPIC 11:** Waste. Classification. Urban waste. Industrial waste. Hazardous waste. Urban waste treatment. Industrial and/or hazardous waste management. **TOPIC 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. **Practical Work Programme** Practical Work Nº 1: Noise pollution assessment Practical Work Nº 2: Assessment of lighting conditions Practical Work Nº 3: Assessment of heat load Practical Work Nº 4: Determination of gas concentration Practical Work Nº 5: Determination of particles Practical Work Nº 6: Visit to a workshop or industry: survey of risk factors

Objetives	Acquire knowledge to identify, assess and control occupational hazards. To familiarise the student in relation to his/her professional activity with the Law of Hygiene and Safety at Work (Law N°19587), as well as the incidence it has on the environment. Acquire knowledge to identify, assess and control environmental pollution related to industrial activity. Acquire knowledge of the laws, regulations and policies in force in the labour and environmental field and their trends. To develop an integrated vision in the analysis of situations.
Analytical description of theoretical and practical activities	Theoretical and practical classes, with analysis of specific cases, application exercises and field and/or laboratory practice.
Hourly load	60 hours
Distribution of activities	Theoretical classes: 30 hours Practical classes (including evaluations): 30 hours
Basic bibliography:	FUNDAMENTALS OF HYGIENE AND SAFETY. Mangosio J. . Ed. Nueva Librería. Buenos Aires. 1994. HEALTH AND SAFETY AT WORK. Rodellar Lisa R. . Ed. Alfaomega. Bogotá, Colombia. 2002. OCCUPATIONAL HEALTH AND SAFETY. Cortés Díaz J. . Ed. Alfaomega. Bogotá, Colombia. 2002. OCCUPATIONAL HEALTH. Ruiz Frutos. C. et al. Ed. Elsevier-Masson. Barcelona. 2007. INTRODUCTION TO ENVIRONMENTAL SCIENCE. Foster P. . Ed. El Ateneo. Buenos Aires. 1975. NOISE AND ITS CONTROL. Behar A. . Ed. Arbó. Buenos Aires. 1977.
Other bibliography:	RISK ANALYSIS IN INDUSTRIAL INSTALLATIONS. Casal J. et al. Ed. Alfaomega. Bogotá, Colombia. 2001. SAFETY AND PROFESSIONAL HYGIENE. de la Poza J. . Ed. Paraninfo. Madrid. 1996. INDUSTRIAL SAFETY. Grimaldi J. and Simonds R. . Ed. Alfaomega. Mexico. 1996. INDUSTRIAL SAFETY AND HEALTH. Asfahl C. . Ed. Prentice Hall . Mexico. 2000.
System of evaluation:	Teaching regime for regular students: The student must have an attendance percentage of no less than 80% in practical and/or theoretical-practical work.the student must have an attendance percentage of no less than 80% in theoretical classes.the student must present and pass 100% of the practical and theoretical-practical work proposed by the Chair.the student must pass the two evaluation tests. The student who fails any of the evaluation tests will be able to make up for it at the end of the period. Students who fail the two evaluation tests may take a full recovery of the same at the end of the period. Final examination: this will consist of a written or oral test. Promotion regime: those students who pass the assessment tests in the first instance with a grade equal to or higher than 7 (seven) in each of them, will be able to promote the subject, with their final grade being the result of averaging the grades obtained in the two assessment tests. Free examinations: the free examination will consist of an evaluation test of the practical part (exercises, problems and experimental part) and a final examination which will cover the whole programme of the subject. The student must pass the evaluation of the practical part in order to take the final exam.

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Dr. Ing. Ricardo René Ferrari
Associate Professor
Head of Department
Chair of Hygiene, Industrial Safety and Environmental Control

ANALYTICAL PROGRAMME "WORKSHOP PRACTICES I"

Contents	TOPIC 1: Turning tools. Shapes of external tools, internal tools, threading tools and cutting blades: Characteristic angles. Tool sharpening. TOPIC 2: Metal sawing with manual arc and mechanical saw. THEME 3: TOPIC 3: Universal parallel lathe, construction form. Bed; longitudinal, transverse and cone slides and their movements. Speed box, spindle, workpiece clamping chucks, universal, dragging and four-jaw. Tailstock. Drive mechanisms. Shape and height of tool placement. TOPIC 4: Drills for making centres and how to make them. Cylindrical, conical and facing turning. Turning of workpieces with counterpoint and air turning. Knurling. TOPIC 5: Threading on the lathe. Norton box, threading bar and split nut. Types of threads and how to drive the Norton box and replacement gears. How to carry out external and internal threading. Calculation of replacement gears. TOPIC 6: Filing machine, constructive form. Frame, carriage, table, head. Main movements and their drive. Ways of holding workpieces. Tools. Machining work to be carried out on the filing machine. TOPIC7: Drilling machine. How to operate the machines and how to hold the feet. Cylindrical and conical tail twist drills. Drill bit sharpening. TOPIC 8: Threading by hand and with automatic heads. Taps and dies. TOPIC 9: Revolver lathe and copy lathe. Drives and machining operations that can be carried out.
Bibliography	"AROUND MACHINE TOOLS". Gerlig, Heinrich. Editorial Reverté (year 1972) "MILLING, PLANING AND DRILLING". Luchesi, D. Editorial Labor (1975) "MÁQUINAS HERRAMIENTAS MODERNAS", Volumes I and II. Rossi, Mario - Editorial Hoepli (1971). "MECHANICAL TECHNOLOGY", Volumes I and II. Pezzano P. A. - Editorial Alsina (1977) "INGENIERÍA DE MANUFACTURA". Stewart, Black; Vic Chiles; A. J. Lissaman; S. J. Martín. - Editorial Cecsa (1999)
Objectives *(in*	Acquisition of skills in the use of tools and machine tools for the

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terms of competences):	metal working and manufacture of machine parts. Execution of welded joints with electric and autogenous welding.
An ana- lytic description of the theoretical and practical activities of the practices:	- **Practical classes** Practical work is carried out on the manufacture of parts, drilling, threading.
Hourly load	100 hours

Ing. Ricardo Ramón Collado

Associate Professor

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ANALYTICAL PROGRAMME "WORKSHOP PRACTICES II"

Contents	TOPIC 1- Grinding machines and grinding wheels. How to operate the machines. Preparation of the parts to be ground. External and internal grinding. TOPIC 2- Universal milling machine and its accessories. Main movements and their action. Tools. Types of machining to be carried out. TOPIC 3 - Cutting spur and helical gears with the universal gearbox. Gear cutting tools for gear cutting. Calculation of replacement gears. TOPIC 4- Tooth milling machines - screw (creators) machine kinematics. He- r tools. Gear cutting with straight and inclined teeth, Calculation of replacement gears. TOPIC 5- Electric resistance welding. How the equipment works, how to carry out the welding. Types of parts to be welded and their preparation. TOPIC 6- Electric arc welding. Equipment, types of electrodes. Preparation of joints. Welding positions. Regulation of equipment, current to be used and polarity. TOPIC 7- Autogenous welding and cutting, Gases to be used. Torch for cutting, welding and heating. How to carry out the operations. Filler materials and fluxes.
Bibliography	MECHANICAL MILLING MACHINE". Breck, C. E. - Editorial Montesó (1962) "MANUAL DE ENGRANAJES". Duddley D. - Editorial CECSA (1973) "WELDING, APPLICATIONS AND PRACTICE". Horwitz, Henry. - Editorial Alfa Omega (1977) "SOLDAGEM. Brazilian Association of Metals. - Editorial ABM (1975) "MÁQUINAS HERRAMIENTAS MODERNAS", Volumes I and II. Rossi, Mario. - Hoepli Publishing House (1971) "MECHANICAL TECHNOLOGY, Volumes I and II". Pezzano, P. A. - Editorial Alsina (1977) "INGENIERÍA DE MANUFACTURA". Stewart, Black; Vic Chiles; A. J. Lissaman; S. J. Martín. - Editorial Cecsa (year 1999)
Objectives (in terms of competencies):	Acquisition of proficiency in the use of tools and machine tools for metal and metalworking. -Manufacture of machine parts. Execution of welded joints with welding electrical and autogenous
Analytical description of theoretical and practical activities:	- **Practical classes** XX practical work is carried out by manufacturing parts, and learn about the different types of welding.
Hourly load	100 hours

Ing. Ricardo Ramón Collado
Associate Professor

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National University of Tucumán
Faculty of Exact Sciences and Technology
MECHANICS DEPARTMENT
CHAIR OF INTERNAL COMBUSTION ENGINES

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PROGRAMME

INTERNAL COMBUSTION ENGINE WORKSHOP

Mechanical Engineering Degree
2004 Plan

- Otto engines - Diesel engines - Classification - Identification of the different types - Objectification of the cycle - Nomenclature of the different parts or elements.
- Identification and observation of auxiliary oil, fuel, cooling and electrical circuits.
- Tidy disassembly of the engine to see its internal construction.
- Carburettor: Disassembly - Nomenclature - Identification and observation of its different elements - Interpretation of its operation - Fuel pump - Fuel injection system and its components - Operation and possible controls.
- Measurement: Cylinders - Pistons - Crankshaft - Connecting rods - Lights: Ovalisation - Taper - Wear - Tolerances - Alignment.
- Observation of the distribution. Camshaft - Valves, valve seats and guides - Lights - Tolerances - Valve grinding - Leak test.
- Ignition - Elements - Nomenclature - Interpretation of how they function - Different types - Feedrates: Fixed, centrifugal and vacuum - Firing order.
- Diesel injection systems - Nomenclature - Operation - Various types.
- Generating electrical system - Dynamo - Alternator - Voltage regulator - Elements - Nomenclature - Operation - Adjustment method - Starter motor - Relay - Battery - Ammeter - Connections.
- Automotive transmission - Clutch - Gearbox - Differential.
- Engine assembly - Order - Timing of nuts and bolts - Cylinder head tightening order - Ignition timing - Valve light adjustment - Electrical connections - Engine start-up - Bench test.
- Gas turbines - Components - Combustion chambers - Auxiliary circuits - Different types - Turbojets - Testing of a small gas turbine.

Ing. Ricardo A. Marchese
Associate Professor

National University of Tucumán
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MECHANICS DEPARTMENT
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BIBLIOGRAPHY

INTERNAL COMBUSTION ENGINE WORKSHOP

– – "WORKSHOP MANUALS (Thermal Data)" for various engines.
– – "MICROFICHE (CD)". Toyota engines.
– – "SCANIA ENGINES, ENDOTHERMIC ENGINES (Giacosa)".

Ing. Ricardo A. Marchese
Associate Professor

ANALYTICAL PROGRAMME "LANGUAGE PROFICIENCY (ENGLISH)"

Contents:	**Unit I – The English Sentence** Noun Phrase - Verbal Phrase. Its components. Identification and location of these components. Plurals of nouns. Dictionary rule. Different interpretations of the verb "To Be". Verb There + Be. Present tense. Affirmative, negative and interrogative forms. Questions with "Wh words". Practical application: interpreting and translating texts. **Unit II – "Simple Present"** Affirmative form. Do - Does, negation and interrogation. Other forms of negation: prefixes and suffixes. Dictionary rule. Verb form in ing; possible interpretations according to context. Dictionary rule. Defective verbs. Adverbs. Practical application: interpretation and translation of texts. **Unit III – "Simple Past"** Affirmative form. Regular verbs. Irregular verbs. Carriers: Did, negation and interrogative. Adverbs. Dictionary rule. Practical application: interpretation and translation of texts. **Unit IV– "Simple Future"** Tense Carriers: Shall - Will. Negation and interrogation. Adverbs. Practical application: interpreting and translating texts. **Unit V– "To Be·" as auxiliary** Its different forms. 1) "to be" + ing; 2) "to be" + going to; "to be" + infinitive; 4) "to be" + participle; 5) Forms of "to be" + participle with verbs that are difficult to interpret; 6) "To be" (conjugated) + to be + past participle; 7) Defective verbs + "to be" + participle. Practical application: interpretation and translation of texts. **Unit VI – "Comparatives and Superlatives"** Comparative and superlative degrees of adjectives and adverbs. Dictionary rule. Practical application: interpretation and translation of texts. **Unit VII – "Present Perfect" and "Past Perfect"** "Have/ Has + participle. "Present Perfect. Practical application: interpreting and translating texts. "Had + participle. "Past Perfect. Practical application: interpreting and translating texts **Unit VIII – Conditional sentences** Practical application: interpretation and translation of texts. **Unit IX – "Infinitive - Imperative"** Different meanings of the particle "to" depending on the context. Imperative: "Let + noun phrase + verb" - "Let us + verb". Practical application: interpretation and translation of texts.
Objectives *(in terms of competencies)*:	The student will have achieved the final aim when they are able to: 1. Develop a basic communicative competence to read comprehensively. 2. Achieve an adequate reading speed. 3. Be fluent and correct in the elements that make up the new linguistic code (English). 4. Identify differences and similarities between English and Spanish grammar. 5. Infer the semantic value of certain words according to the text in which they are inserted. 6. Translate specific literature correctly.

Analytical description of theoretical and practical activities:	Theoretical classes are given on the different units. In the practical part, an English text from the primer is read and translated into Spanish.
Hourly load	64 hours
Distribution of activities:	Theoretical lessons: 32 hours Practical lessons: 32 hours
Basic bibliography:	Nolasco, R. (1992). Streetwise Intermediate. New York: Oxford University Press. *Maidana, M. [et al] (2006). Lectura Comprensiva y Traducción de Textos II. Tucumán: Faculty of Exact Sciences and Technology.*
Other recommended reading:	Lindholm de Moris, E., [et al] (2002). 1nglés-Ciencias Exactas Selección de Textos. Tucumán: Facultad de Ciencias Exactas y Tecnología. Alexander, L.G. (1967). Fluency in English- An 1ntegrated Course for Advanced Students. London: Longman. Alexander, L.G. (1969). Developing Skills 1ntermediate. London: Longman. Alvarez de Mon, I., Lerchundi, M. and Moreno, P. (1967). English for Electronics Madrid: McGraw - Hill Co. Aronson, S. [et al] (1969). An Approach to Physical Science. New York: John Wiley and Sons, Inc. Baird, R., Cassidy, H. and English, J. (1971). Principles of Organic Chemistry. New York: McGraw-Hill Co. Bates, M. and Dudley Evans, T. (1994). Nucleus General Science. Essex: Longman
Evaluation system:	Assessment will be continuous and will take place every class, so that both students and teachers can immediately recognise progress and difficulties in the implementation of the content taught. In this way it will be possible to make adjustments, reinforce exercises, modify strategies and/or select new texts that best suit the needs and interests of the learners. In order to pass the Language Proficiency course, the student must pass **two Partial Examinations**

Lic. María A. Maidana
Associate Professor - Exclusive Dedication.
Head of Department