

Course Unit: Technical Drawing I					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: João Lopes Teaching Staff:					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
1 st	1 st	45 TP + 15 OT			5
Workload (hours): <div style="text-align: right;"> Classes: 45 Tutorial: 15 Fieldwork: Individual Work and Assessment: 80 </div>					
Objectives: <p>Learning the basic concepts and techniques Technical Drawing as a language definition and transmission characteristics of systems and industrial products, with gradual introduction of the use of computer aided design. At the end of the course, students should be able to represent parts, mechanical assemblies and mechanisms required for different stages of product life cycle (design, implementation, installation and operation) most common in mechanical engineering.</p>					
Prerequisites:					
Curriculum: 1 Methods <ul style="list-style-type: none"> • Sketching • Manual or by instrument • Computer aided design 2 Engineering drawings: common features <ul style="list-style-type: none"> • Line styles and types • Multiple views and projections • Orthographic projection • Auxiliary projection • Isometric projection • Oblique projection • Perspective • Section Views • Scale • Showing dimensions • Sizes of drawings • Technical lettering 3 Systems of dimensioning and tolerancing					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

4 Example of an engineering drawing

- Working drawings
- Assembly drawings

Teaching and Learning Methods:

Classroom theory and practical lessons tutorials drawing up specific designs of mechanical components in AutoCAD environment.

Assessment:

Realization of a minimum set of four practical work (70%) and a theoretical and practical test (30%).

Bibliography:

- *Engineering Drawing*. Basant Agrawal and C M Agrawal (2008). Tata McGraw Hill, New Delhi.
- *Engineering Drawing*. Paige Davis, Karen Renee Juneau (2000).
- *AutoCAD 2002*. Depressa & Bem. José Garcia, Pedro Leão Neto. FCA - Editora de Informática.
- *Desenho Técnico*. Veiga da Cunha. Editora Calouste Gulbenkian
- *Desenho Técnico Moderno*. Editora LIDEL
- *Desenho de construções Mecânicas*. Simões Morais. Porto Editora
- *Desenhista de Máquinas*. Engº Francesco Provenza
- *Traçado da Planificação de Peças em Chapa*. José Manuel S. Echevarria

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: Physics I					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Teaching Staff: José Martins de Oliveira					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
1 ^o	1 ^o	30 T + 15 TP + 15 OT	Mandatory		5
Workload (hours): <div style="text-align: right;"> Classes: 45 Tutorial: 15 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: <p>A solid background in the principles of classical mechanics with special emphasis on Static through an introduction, illustrated by problems with applications, from simple to elaborate concepts. This knowledge will be needed to understand and deepen various subsequent disciplines of course of Mechanical Engineering.</p>					
Prerequisites: <p>Acquired knowledge in Mathematics of Secondary Education</p>					
Curriculum: 1. STATICS Introduction What Is Mechanics? Fundamental Concepts and Principles Systems of Units Conversion from One System of Units to Another Numerical Accuracy 2. STATICS OF PARTICLES Introduction Forces in a Plane Force on a Particle. Resultant of Two Forces Vectors Addition of Vectors Resultant of Several Concurrent Forces Resolution of a Force into Components Rectangular Components of a Force. Unit Vectors Addition of Forces by Summing x and y Components Equilibrium of a Particle Newton's First Law of Motion					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

Problems Involving the Equilibrium of a Particle.

3. RIGID BODIES: EQUIVALENT SYSTEMS OF FORCES

Introduction

External and Internal Forces

Principle of Transmissibility. Equivalent Forces

Moment of a Force about a Point

Varignon's Theorem

Moment of a Couple

Equivalent Couples

Addition of Couples

Couples Can Be Represented by Vectors

Resolution of a Given Force Into a Force at O and a Couple

Reduction of a System of Forces to One Force and One Couple

Equivalent Systems of Forces

Equipollent Systems of Vectors

Further Reduction of a System of Forces

3. EQUILIBRIUM OF RIGID BODIES

Introduction

Free-Body Diagram

Equilibrium in Two Dimensions

Reactions at Supports and Connections for a Two-Dimensional Structure

Equilibrium of a Rigid Body in Two Dimensions

Statically Indeterminate Reactions. Partial Constraints

Equilibrium of a Two-Force Body

Equilibrium of a Three-Force Body

4. DISTRIBUTED FORCES: CENTROIDS AND CENTERS OF GRAVITY

Introduction

Areas and Lines

Center of Gravity of a Two-Dimensional Body

Centroids of Areas and Lines

First Moments of Areas and Lines

Composite Plates and Wires

Determination of Centroids by Integration

Theorems of Pappus-Guldinus

5. ANALYSIS OF STRUCTURES

Introduction

Trusses

Definition of a Truss

Simple Trusses

Analysis of Trusses by the Method of Joints

Analysis of Trusses by the Method of Sections

6. FORCES IN BEAMS AND CABLES

Introduction

Internal Forces in Members

Cables

Cables with Concentrated Loads

Cables with Distributed Loads

Parabolic Cable Cabo parabólico.

6. FRICTION

Introduction

The Laws of Dry Friction. Coefficients of Friction

Angles of Friction

Problems Involving Dry Friction

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

7. DISTRIBUTED FORCES: MOMENTS OF INERTIA

Introduction

Moments of Inertia of Areas

Second Moment, or Moment of Inertia, of an Area

Determination of the Moment of Inertia of an Area by Integration

Polar Moment of Inertia

Radius of Gyration of an Area

Parallel-Axis Theorem

Moments of Inertia of Composite Areas

Moments of Inertia of Masses

Moment of Inertia of a Mass

Teaching and Learning Methods:

Theoretical Classes – theoretical exposition of the contents, using for example acetates or "power point", alternating with practical examples and interacting with students.

Theoretical and Practical Classes – Resolution of exercises by the teacher after discussion with the students of the statement, the methods used and the clarification of doubts.

Tutorials – Clarification of doubts about the theory or problem solving

Assessment:

1. **Continuous Assessment:** 2 partial written tests (P1 e P2) and participation in class (PA) and resolution problems outside the classroom (TA).

Classification = $0.4 \times (P1 + P2) + 0.05 (PA) + 0.15 \times (TA)$, all items are evaluated on a scale of 0 to 20, and with a minimum grade of 8 in any of the tests.

2. **Final Assessment:** Written exam (EX)

Classification = $0.8 \times (EX) + 0.05 (PA) + 0.15 \times (TA)$, all items are evaluated on a scale of 0 to 20.

The student is approved if receives equal or more than 10 on continuous assessment or final assessment.

Bibliography:

BEER, JOHNSTON - Vector Mechanics for Engineers – Statics 6^a Edition - Mc Graw-Hill.

HIBBELER, R.C – Engenharia Mecânica Estática , 8.^a Edição, LTC-Livros Técnicos e Científicos.

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: Informatics and Programming					
<p>Department: Mechanical Engineering Department Programme: 1st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance</p> <p>Teaching language: Portuguese Course Unit Chair: Mauro Figueiredo Teaching Staff: Mauro Figueiredo</p>					
Year	Semester	Contact hours ⁽¹⁾	Type	ECTS code	ECTS
1 ^o	1 ^o	15L+45T	Required		5
<p>Workload (hours): 140</p> <p style="text-align: right;"> Classes: 15 Tutoria: 45 Fieldwork: 0 Individual Work and Assessment: 80 </p>					
<p>Objectives: The objective of this discipline is to supply and optimize knowledge of theoretical/practical level in informatics and in programming. The student will develop competences in the algorithm resolution of problems; use of procedural approaches and objected oriented programming; and write programs using Visual Basic.</p>					
<p>Pre-requisite:</p>					
<p>Curriculum:</p> <ol style="list-style-type: none"> Visual Basic Introduction to the environment of the visual basic.net. Introduction to the object oriented programming. Writing of a first application: the functionality of the application, forms and controls, design the graphic interface, writing of the code. Windows forms and controls Interface of the Windows forms. Analysis of the properties, approaches and events of the forms. Controls and its insertion in forms. Use of controls Study of the controls of the Windows forms: Button; Label, TextBox, ListBox, ComboBox, CheckBox and RadioButton. Menus Create menus and submenus. Execute code in the click of a menu item. Data types, variables, operators and expressions, elementary instructions Data types: pre-defined and defined by the user. Statement of variables and constants. Logical, relational, and arithmetic operators. Elementary instructions: instructions of attribution, input and output data. Control structures Sequence. Structures of repetition: Do While...Loop, Do Until ...Loop, Do ...Loop While, Do...Loop Until, For...Next, While...End While. Structures of decision: If...Then...Else, Select Case. Files 					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

Text files: creation, write and read.

8. Procedures

Procedures and types of procedures: Sub Procedure; Event handling Procedure and Function procedure. Passage of arguments. Optional arguments.

9. Structured data types

Tables: one-dimensional (vectors) and two-dimensional. Basic operations with vectors. Records: manipulation, vectors.

10. Classes and objects

The concepts of class and object. Create classes and objects. Define properties, methods and events.

Teaching and Learning Methods:

Theoretical classes – theoretical exposition of the contents using the power point.

Tutorial Orientation – Explanation of doubts in problems resolution.

Assessment:

1st Hypothesis – Two tests. The classifications should be equals or over 8 (eight) values:

1st test with a weight of 50% in the final classification.

2nd test with a weight of 50% in the final classification.

2nd Hypothesis – Final Exam.

3rd Hypothesis - Last Exam.

Notice:

- a) This approach of evaluation proposed cancels any another presented previously.
- b) The student will be approved if he gets a minimum of 10 values in any one of the three hypotheses of evaluation presented.
- c) The students interested in carry out the two tests need to register in advance.
- d) The tests are individually with exclusive consultation of a sheet A4 written of the 2 sides. The elaboration of that sheet is of student responsibility.
- e) The components realized in the computer are obligatorily saved in a pen disposed by the own student. Any problem related with the loss of the work during the test, forgetfulness of saving or any problem with the pen is of students responsibility and implies a classification of 0 (zero) in that component of the evaluation.

Bibliography:

- António Gameiro Lopes, *Introdução à Programação em Visual Basic 2010*. F C A-Editora Informática, 2010
- Henrique Loureiro, *Visual Basic 2010, Curso Completo*. F C A-Editora Informática, 2010

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: INTRODUCTION TO PROFESSION / PERSONAL DEVELOPMENT

Department: Mechanical Engineering Department
Programme: 1st Cycle in Mechanical Engineering
Scientific Area: Mechanical Engineering
Specialisation in: Thermal; Management and Industrial Maintenance

Teaching language: Portuguese

Course Unit Chair: Rui Penha

Teaching Staff: Rui Penha

Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
1	2	15T+ 15S+ 110TA	TP		

Workload (hours):

Classes: 30

Tutorial: 0

Fieldwork:

Individual Work and Assessment: 110

Objectives: In general, facilitate the acquisition of knowledge and skills in the areas of citizenship, communication techniques, framing the political and legal environment that surrounds the Engineer. Awareness of ethical issues.

Prerequisites: None

Curriculum: Contents:

1 - potential aspects of student success in higher education.

2 - Writing academic essays.

3 - The organization of the state and its administration. An introduction to the fundamental principles of law and its importance in the framework of professional engineering.

4 - The Universal Declaration of Human Rights, the United Nations and the fundamental values of Western civilization and its view of the universe.

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5 - Major survey systems to the world: the natural sciences and social skills, mathematics and philosophy. What is a science and the scientific method.

6 - Ethics.

• Codes of ethics;

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

- Text by philosopher John McMurray.

7 - The fundamentals of communication between people, CV Preparation, Commercial communications in English.

Teaching and Learning Methods:

Assessment: a) written examination

b) Individual assignment: a) Summary of the Portuguese Constitution, organs of state and its core competencies, type and hierarchy of laws; b) Justification for the values of Western Civilization and summary of the Universal Declaration of Human Rights, and the role of the United Nations; c) Executive Summary of the code of ethics of a professional association of engineers, d) Operational planning for the semester the student through a Gantt chart to enhance success.

Bibliography: Armenian Rego and Jorge Braga (2005) Ethics for Engineers - Challenging Syndrome Shuttle Challenger, Lidel, Lisbon.

* Mendes, John Castro (2004) Introduction to the Study of Law, PF, Cacém.

* Constitution of the Republic of Portugal (2007) Almedina, Coimbra.

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: Mathematics I					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Magda Faria Ruivo Teaching Staff: Magda Faria Ruivo					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
1	1	30 T + 15 TP + 15 OT	mandatory		5
Workload (hours): 140 <div style="text-align: right;"> Classes: 45 Tutorial: 15 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: Provide a solid foundation on Mathematical Analysis in R, understanding an array (operations and applications) that allows students to pursue, successful in other subjects of the course. In general terms it is intended that students develop skills in inductive and deductive reasoning, to deepen knowledge with objectivity, exposure and processing of knowledge that are acquired with clarity and precision of language. Specifically the student should master the concepts involved in the contents and use them with dexterity, and also learn to apply them with flexibility and critical sense, to other discipline and other scientific areas.					
Prerequisites: Knowledge acquired in the Mathematics discipline from High school.					
Curriculum: 1 – Real Numbers. 1.1 – Real Numbers; 1.2 – Absolute value; 2 – Complex Numbers. 2.1 – Definitions; 2.2 – Operations on complex numbers; 2.3 – The Argand Plane; 2.4 – Trigonometric representation; 2.5 – Operations on trigonometric representation; 3 – Calculus of One variable. 3.1 – Definitions: function; domain; range; constant function; increasing and decreasing functions; inverse function; composite function and implicit function; 3.2 – Elementary functions: power function, exponential function, logarithmic function, trigonometric functions and inverse trigonometric functions; 3.3 – Limits and Continuity; - Definitions; - Properties of limits; - Intermediate- Value, Bolzano and Weierstrass Theorems;					

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

- 3.4 – The Derivative;
 - Definitions and geometric interpretation;
 - Derivatives rules;
- 3.5 – Rolle's Theorem and L'Hôpital's Rules;
- 3.6 – Extremes, concavity, asymptotes and zeros of a function.
- 4 – Integration.
 - 4.1 – The indefinite Integral;
 - Definitions;
 - Integration formulas;
 - Integration Techniques;
 - Integration of Rational functions;
 - 4.2 – The definite Integral;
 - Definitions;
 - The Riemann Integral;
 - Properties of the integral;
 - The Mean-value theorem;
 - The fundamental Theorem of Calculus;
 - The integration methods;
 - 4.3 – Applications of the Definite Integral;
 - Area between two curves;
 - Volume of solid of revolution;
 - Length of a plane curve;
 - Area of a surface of revolution;
- 5 – Matrices and Determinant;
 - 5.1 – Matrices;
 - Definition;
 - Special Matrices;
 - Operations with matrices and proprieties;
 - Transpose matrix;
 - Adjunct matrix
 - Inverse matrix;
 - 5.2 – Determinant;
 - Definition;
 - Evaluation;
 - Proprieties;
 - 5.3 – System of Linear equations;
 - Solution set;
 - Matrix representation;
 - Cramer's rule;
 - Solving the system using the inverse matrix;

Teaching and Learning Methods:

Lectures (T) – theoretical exposition of the contents, using acetates or “power point”, alternated with practical examples and interacting with students.

Theoretical and Practical (TP) – resolution by the professor of exercise sheets (with at least one exercise for each programmatic point) after discussion with the students of the statement, the methods used and the clarification of doubts.

Tutorials (OT) – Answering questions about the resolution of the exercise sheets.

Assessment:

Continuous assessment: three tests, may not in each of the tests have a lower classification to eight values.

Final assessment: written exam.

The student is approved if it receives a rating equal to or greater than 10 in the continuous assessment or final assessment.

Bibliography:

- Elementos de Cálculo Diferencial e integral em \mathbb{R} e \mathbb{R}^n – Acilina Azenha - McGrawHill

(1) Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

- Cálculo Diferencial e Integral - Vol. I - N. Piskounov
- Cálculo - Vol. 1 e 2 - Tom M. Apostol
- Colecção Matemática
 - Primitivas e Integrais - Manuel Alberto Ferreira, Isabel Amaral
 - Álgebra Linear 1 - Manuel Alberto Ferreira, Isabel Amaral
- Cálculo com Geometria Analítica - Vol. 1 - Earl W. Swokowski
- Álgebra Linear - Seymour Lipschutz
- Calculus – Howard Anton, Wiley

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit:					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Chemistry Teaching Staff: Humberto da Silva Neto hneto@ualg.pt					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
1st	1st	30T + 15 TP + 15 OT			5
Workload (hours): <div style="text-align: right;"> Classes: 45 Tutorial: 15 + 5 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: <p>Getting enough Chemistry knowledge, in order to become capable of solving mechanical engineering problems, mainly those related to materials, products, and their reactions.</p>					
Prerequisites:					
Curriculum: <p>1 - Microscopic structure of matter.</p> <p>Historical approach. Classifications and properties of matter. Dalton theory.</p> <p>Atomic structure.</p> <p>Atomic number and atomic mass.</p> <p>Mole; molar mass.</p> <p>Chemical formulas.</p> <p>Ions. Ionic compounds.</p> <p>2 - The electronic structure of atoms. Periodic Table.</p> <p>Bohr's theory.</p> <p>Hydrogen spectrum and its interpretation.</p> <p>Quantum theory.</p> <p>Electronic configuration.</p> <p>The periodic table.</p>					

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

3 - Chemical reactions.

Chemical equations.

Mass relations.

Energy variations.

4 - Chemical bonding.

Ionic bonding; Lewis notation; Energies; The Born-Haber cycle; Relationships between bond length, bond energy, and macroscopic properties.

Covalent bonding; dipole moment; bond length and bond energy; covalent networks; macroscopic properties.

Metallic bonding; free electrons; metallic crystals; Relationships between microscopic structure of metals and their macroscopic properties.

Intermolecular forces. Van der Waals forces. Ion-dipole forces. Hydrogen bonds. Macroscopic properties forecast.

5 - Solutions.

Types of solutions. The effects of temperature and pressure. Concentration units.

6 - Chemical equilibrium.

Completeness and speed of reactions.

Open, closed, and insulated chemical systems.

Equilibrium constant. Factors that affect it. Le Châtelier's principle.

7 - Acids and bases.

Definitions. Brönsted acids and bases. Conjugated acid - base pairs.

Strengths of acids and bases. Acidity and basicity constants.

The ion product of water. pH. pH calculations.

8 - Electrochemistry.

Redox reactions. Electrochemical cells. Standard electrode potentials. Corrosion. Electrolysis.

9 - Chemical kinetics.

Teaching and Learning Methods:

Lectures, Theoretical and Practical classes, Tutorials, Individual study.

Assessment:

Two tests, each of them about a part of the program.

Or an exam covering the whole program; a later exam is possible.

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Bibliography:

R. Chang, " Química ", McGraw-Hill de Portugal, Lisboa, 1994.

R. Chang, " Chemistry ", McGraw-Hill, 1998.

P.W. Atkins, J. A. Beran, " General Chemistry ", Scientific American Books, New York, 1992.

W. Buenos , " Química Geral ", McGraw-Hill, São Paulo, 1978.

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: Numerical Calculation					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Mauro Figueiredo Teaching Staff: Mauro Figueiredo					
Year	Semester	Contact hours ⁽¹⁾	Type	ECTS code	ECTS
1 ^o	1 ^o	15L+45T	Required		5
Workload (hours): 140 <div style="text-align: right;"> Classes: 15 Tutoria:l 45 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: To acquire and improve the knowledge of numerical methods and their practical application. Explore numerical methods by developing and programming numerical algorithms.					
Pre-requisite recommended: The course unit of Informatics and Programming, from the 1st Semester.					
Curriculum: <ol style="list-style-type: none"> Errors Absolute and Relative Errors. Round-off and truncation errors. Error Propagation. Direct problem and Inverse problem. Nonlinear Equations Bisection Method. False-Position Method. Secant Method. Linear Interactive Method. Newton-Raphson Method. Polynomial Equations: Descartes signal rule; Languerre-Thibault Method; Budan-Fourier Theorem. Linear Equations Sistems Basic concepts. Direct methods: Gauss Method; triangular factorization; ;tri-diagonal systems Interactive Methods: Jacobi; Gauss-Seidel; stopping criteria and convergence in interactive methods. Interpolation Linear interpolation. Lagrange's interpolator. Neville-Aitken method. Newton divided differences method. Inverse Interpolation. Numerical Integration Rectangle rule. Midpoint rule. Trapeze rule. Simpson rule. 					
Teaching and Learning Methods: Theoretical classes – theoretical exposition of the contents using the power point . Tutorial Orientation – Explanation of doubts in problems resolution and about the practical programming activities with Visaul Basic.					
Assessment The assessment will consist of:					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

- 2 assignments and
- 2 Written tests or a Final Exam or Recourse Exam.

- Students that do not obtain the minimum score of 'satisfactory' in the practical assignments, will not qualify for the final or recourse exams and the written test scores will not take any effect.
- In each test is required a minimal score of 8.
- The student will be approved if it obtains sufficient minimum grade average of the work and grade equal to or above 10 on the average frequency or examination.
- Students may be asked to discuss their assignments.
- After delivery of the statement of each job, the student must submit the assignment on time for each job.
- Os trabalhos serão realizados nas aulas teórico-práticas e de orientação tutorial.
- Aos trabalhos será atribuída uma nota qualitativa correspondente a:
- Assignments will be done in practical classes and tutorials.
- Assignments will be marked a qualitative grade corresponding to:

Excellent	19-20
Very Good	16-18
Good	13-15
Satisfactory	10-12
Fail	<10

Consider the average value of each interval to calculate the average of the practical

- The final grade will be a function of frequency of average scores (final examination or examination of appeal) and the assignments as indicated in the following table:

Tests/Exam Assignments	20	19	18	17	16	15	14	13	12	11	10	<10
Excellent	20	20	19	18	18	17	17	16	16	15	15	Rep
Very Good	19	19	18	18	17	16	16	15	14	14	13	Rep
Good	18	17	17	16	16	15	14	14	13	12	12	Rep
Satisfactory	16	16	15	15	14	13	13	12	12	11	10	Rep
Failed	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Rep

Excl – Excluded, students in these conditions can not take any tests.

Rep – Failed, in this condition the student is admitted to any exams.

Bibliography:

- Márcia Ruggiero, Vera Lopes; *Cálculo Numérico, Aspectos Teóricos e Computacionais*; Makron Books.
- Edite Fernandes, *Computação Numérica*, Universidade do Minho, 2ª edição, 1998.

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

- Francis Scheid; *Análise Numérica*; Coleção Schaum, McGraw-Hill.
- Steven Chapra, Raymond Canale; *Numerical Methods for Engineers*, McGraw-Hill.
- Heitor Pina; *Métodos Numéricos*; McGraw Hill.

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: Drawing II					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: César Gonçalves Teaching Staff: César Gonçalves					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
1 ^o	2 ^o	45 TP + 15 OT	Required		5
Workload (hours): <div style="text-align: right;"> Classes: 45 Tutorial: 15 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: Acquisition of knowledge of the program AutoCAD 3D (Computer Aided Design). Learning the techniques needed to design industrial facilities. Ability to prepare survey of industrial plants, to identify manufacturing facility equipment and components.					
Prerequisites: Drawing I					
Curriculum: <ul style="list-style-type: none"> • Orthogonal Projections: The student is able to use the European and American methods, partial and auxiliaries views for the mechanical components and mechanisms representation. • Prospects: The student acquires skills to read and draw different types of prospects via the same methods of construction • 3D Computer Aided Design Architecture of the program AutoCAD - menus Advanced commands design Commands planning, design and working methods Commands to display and print design Basic customization, file management and advanced editing and construction commands • Design of Industrial Facilities Types of piping (piping) drawings: schemes, plans, isometric and auxiliary structures. Identification of equipment, piping, instruments and reservoirs through current symbolism - standards used. Representation of industrial plants in schemes, plans and execution of isometric piping. 					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

Teaching and Learning Methods:

Theoretical-practical and tutorials lessons drawing specific designs of mechanical components in AutoCAD environment.

Assessment:

Realization of two tests of frequency (55%) and a set of practical work (45%)
Final exam (55%)

Bibliography:

- 3D CAD systems manuals
- Desenho Técnico – Veiga da Cunha – Ed. Calouste Gulbenkian
- Desenho Técnico Moderno, 4 ED. Ed. LIDEL
- Desenho de construções Mecânicas 1º-3º Simões Morais – Porto Editora
- Desenhista de Máquinas – Engº Francesco Provenza
- Desenho II – (in the library)
- Tubulações Industriais – Pedro C. Silva Telles – Ed. Interciência
- Tabelas e Gráficos para projecto de tubulações – Pedro Carlos S. Telles. Ed. Interciência.

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: Physics II					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Teaching Staff: José Martins de Oliveira					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
1 ^o	2 ^o	30 T+15 TP+15 OT	Mandatory		5
Workload (hours): <div style="text-align: right;"> Classes: 45 Tutorial: 15 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: <p>In this course we study the kinematics and dynamics of particles and rigid bodies, making use of the constant connection to practical cases, by solving problems. It has been a key objective that the students acquire a solid background in the principles of classical mechanics, which allows it to effectively address the following disciplines of mechanical engineering course.</p>					
Prerequisites: <p>Knowledge in Physics I</p>					
Curriculum: 1 – KINEMATICS OF PARTICLES Rectilinear Motion of Particles <ul style="list-style-type: none"> – Position, Velocity, and Acceleration – Determination of the Motion of a Particle – Uniform Rectilinear Motion – Uniformly Accelerated Rectilinear Motion – Motion of Several Particles Curvilinear Motion of Particles <ul style="list-style-type: none"> – Position Vector, Velocity, and Acceleration – Rectangular Components of Velocity and Acceleration – Motion Relative to a Frame in Translation – Tangential and Normal Components 					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

2 KINETICS OF PARTICLES: NEWTON'S SECOND LAW

- Newton's Second Law of Motion
- Linear Momentum of a Particle. Rate of Change of Linear Momentum
- Systems of Units
 - Equations of Motion
 - Dynamic Equilibrium
- Motion under a Central Force. Conservation of Angular Momentum
- Newton's Law of Gravitation

3 – KINETICS OF PARTICLES: ENERGY AND MOMENTUM METHODS

- Work of a Force
- E Kinetic Energy of a Particle. Principle of Work and Energy
- Applications of the Principle of Work and Energy
- Power and Efficiency
- Potential Energy
- Conservative Forces
- Principle of Impulse and Momentum
- Impulsive Motion
- Impact

4– PLANE MOTION OF RIGID BODIES: ENERGY AND MOMENTUM METHODS.

- Principle of Work and Energy for a Rigid Body
- Work of Forces Acting on a Rigid Body
- Kinetic Energy of a Rigid Body in Plane Motion
- Systems of Rigid Bodies
- Conservation of Energy
- Power

5 – MECHANICAL VIBRATIONS

Vibrations without Damping

- Free Vibrations of Particles. Simple Harmonic Motion
- Simple Pendulum (Approximate Solution)
- Free Vibrations of Rigid Bodies
- Application of the Principle of Conservation of Energy

Teaching and Learning Methods:

Theoretical Classes – theoretical exposition of the contents, using for example acetates or "power point", alternating with practical examples and interacting with students.

Theoretical and Practical Classes – Resolution of exercises by the teacher after discussion with the students of the statement, the methods used and the clarification of doubts.

Tutorials – Clarification of doubts about the theory or problem solving.

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Assessment:

1. **Continuous Assessment:** 2 partial written tests (P1 e P2) and participation in class (PA) and resolution problems outside the classroom (TA).

Classification = $0.4 \times (P1 + P2) + 0.05 (PA) + 0.15 \times (TA)$, all items are evaluated on a scale of 0 to 20, and with a minimum grade of 8 in any of the tests.

2. **Final Assessment:** Written exam (EX)

Classification = $0.8 \times (EX) + 0.05 (PA) + 0.15 \times (TA)$, all items are evaluated on a scale of 0 to 20.

The student is approved if receives equal or more than 10 on continuous assessment or final assessment.

Bibliography:

BEER, JOHNSTON - Dynamics (McGraw-Hill/Editora) 6ª Edition

MERIAM, J.L e KRAIGE, L.G. – Engineering Mechanics, - Statics Volume I , 3.ª Edição, John Willey & Sons, Inc.;

SINGER, Ferdinand, L.- Mecânica para Engenheiros- Dinâmica, HARBRA- Editora Harper & Row do Brasil, Lda.

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: Mathematics II					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Magda Faria Ruivo Teaching Staff: Magda Faria Ruivo					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
1	2	30 T + 15 TP + 15 OT	mandatory		5
Workload (hours): 140 <div style="text-align: right;"> Classes: 45 Tutorial: 15 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: Pursue basic training in mathematical analysis spanning to R^n . Study and solve linear and ordinary differential equations. In general terms it is intended that students develop skills in inductive and deductive reasoning, to deepen knowledge with objectivity, exposure and processing of knowledge that are acquired with clarity and precision of language. Specifically the student should master the concepts involved in the contents and use them with dexterity, and also learn to apply them with flexibility and critical sense, to other discipline and other scientific areas.					
Prerequisites: Knowledge of what is taught in Mathematics I.					
Curriculum: 1 – Calculus of two or more variables <ul style="list-style-type: none"> 1.1 – Definition 1.2 – Limits 1.3 – Continuity 1.4 – Partial Derivatives <ul style="list-style-type: none"> 1.4.1 – First order derivatives 1.4.2 – Geometric interpretation 1.4.3 – Higher-order partial derivatives 1.5 – Increment and differentiable 1.6 – Total differentials 1.7 – Chain rule 1.8 – Implicit partial differentiation 1.9 – Homogeneous function 1.10 – Directional derivatives 1.11 – The Gradient 1.12 – Extremes: Maximum, minimum and saddle point 2 – Ordinary Differential Equations <ul style="list-style-type: none"> 2.1 – Basis 					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

<ul style="list-style-type: none"> 2.2 – Definitions 2.3 – First order differential equation <ul style="list-style-type: none"> 2.3.1 – Definitions 2.3.2 – <ul style="list-style-type: none"> 2.3.2.1 – Separable equation 2.3.2.2 – Exact equation 2.3.2.3 – Integrating factors 2.3.3 – <ul style="list-style-type: none"> 2.3.3.1 – Homogeneous polar differential equation 2.3.3.2 – Almost homogeneous differential equation 2.3.3.3 – First order linear differential equation 2.3.3.4 – Bernoulli equation 2.3.3.5 – Riccati equation 2.4 – Equações diferenciais ordinárias de ordem superior <ul style="list-style-type: none"> 2.4.1 – $f[x, y^{(n)}] = 0$ 2.4.2 – $y^{(n)} = f[y^{(n-1)}]$ 2.4.3 – $y'' = f[y, y']$ 2.4.4 – Homogeneous linear differential equation with constant coefficients 2.4.5 – Inhomogeneous linear differential equation with constant coefficients 3 – Multiple Integrals <ul style="list-style-type: none"> 3.1 – Definition 3.2 – Properties 3.3 – Double integrals 3.4 – Evaluating 3.5 – Converting coordinates 3.6 – Triple integrals 	<p>Teaching and Learning Methods:</p> <p>Lectures (T) – theoretical exposition of the contents, using acetates or “power point”, alternated with practical examples and interacting with students.</p> <p>Theoretical and Practical (TP) – resolution by the professor of exercise sheets (with at least one exercise for each programmatic point) after discussion with the students of the statement, the methods used and the clarification of doubts.</p> <p>Tutorials (OT) – Answering questions about the resolution of the exercise sheets.</p> <p>Assessment:</p> <p>Continuous assessment: three tests, may not in each of the tests have a lower classification to eight values.</p> <p>Final assessment: written exam.</p> <p>The student is approved if it receives a rating equal to or greater than 10 in the continuous assessment or final assessment.</p> <p>Bibliography:</p> <ul style="list-style-type: none"> ✓ Piskounov N. – “Cálculo Diferencial e Integral e Integral”, Vols. I e II – Ed. Lopes Silva ✓ APOSTOL T. M. – “Cálculo”, Vol. 2 – 1991 – Editorial Reverté ✓ SWOKOWSKI E. W. – “Cálculo com Geometria Analítica”, Vol. II – 1983 – Ed. McGraw-Hill do Brasil, Lda ✓ WYLIE C. R., BARRET L. C. – “Advanced Engineering Mathematics”, 5th edition, 1985 – McGraw-Hill International Editions ✓ MARTIN Jr. R. H. – “Ordinary Differential Equations”, 1983 – McGraw-Hill, International Student Edition ✓ ANTON, HOWARD – “Calculus”, 6th edition – Wiley
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(1) Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

Course Unit:					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Materials Teaching Staff: Humberto da Silva Neto hneto@ualg.pt					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
1st	2nd	30 T + 15 TP + 15 OT			5
Workload (hours): <div style="text-align: right;"> Classes: 45 Tutorial: 15 Fieldwork: Individual Work and Assessment: 80 </div>					
Objectives: Getting acquainted with materials that are widely used in mechanical engineering. To become capable of selecting materials, and of adapting mechanical engineering projects to materials properties and limitations.					
Prerequisites: Chemistry.					
Curriculum: 1 - Microscopic characteristics versus macroscopic properties. Microscopic structure of matter. Macroscopic properties - mechanical, physical, chemical, and others. Relationships between them. 2 - Non ferrous metals. Heavy metals and its alloys: Copper; Tin; Lead; Nickel. Light metals and its alloys: Aluminium; Titanium; Beryllium; Magnesium. Refractory metals: Molybdenum, Wolfram, Niobium, and Tantalum. 3 - Introduction to Polymer Materials. Polymer molecules and their structure. Thermoplastics, thermosets, elastomers, natural polymers. Polymerization. Crystallinity. Rheology. Mechanical behavior.					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

4 - Fabrication of Plastics.

Injection molding. Extrusion. Compression. Blow molding. Forming processes.
Processes for foams and fibers. Other processes.

5 - Some relevant Polymers.

6 - Elastomers and Rubbers.

Introduction. Structure and properties. Fabrication. Some relevant elastomers.

7 - Ceramic Materials.

Introduction. Microstructure versus properties. Processing of Ceramics.
Technical ceramics. Refractories. Abrasives. Glasses.

8 - Composites and reinforced Plastics.

Types of Composites. Properties combinations. Fiber composites. Laminates. Other composites.
Fabrication.

9 - Materials selection.

Teaching and Learning Methods:

Lectures, Theoretical and Practical classes, Tutorials, Individual study, Plant visits.
Voluntary individual Monograph is possible.

Assessment:

Two tests, each of them about a part of the program.
Or an exam covering all the program; a later exam is possible.
Voluntary individual Monograph contributes with 20 %.

Bibliography:

- Princípios de Ciência e Eng^a dos Materiais, William F.Smith, McGraw-Hill, 1998.
- Des Matériaux, Jean-Paul Bailon, Éditions de l'École Polytechnique de Montréal, 2000.
- The Principles of Materials Selection for Engineering Design, Pat L. Mangonon, Prentice Hall, 1999.
- Materiais II, Vol. 1 e 2. IST
- Materiais, A. Remy, M. Grey, R. Gonthier. Hemus.
 - Engineering Materials 2, Michael F. Ashby, David R.H. Jones. Pergamon, 1994.

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: Thermodynamics / Termodinâmica					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Fausto J. C. Firmino Teaching Staff: Fausto J. C. Firmino; Nelson Sousa					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
1	2	30 T+ 15TP + 15 OT	Compulsory		5
Workload (hours): 140 <div style="text-align: right;"> Classes: 45 Tutorial: 15 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: <p>To provide students with the basic concepts of thermodynamics, such as energy, perfect and real gas properties, States and processes.</p> <p>Students should also know the first and second law of thermodynamics, the concept of reversibility and irreversibility and perform mass and energy balances.</p> <p>Finally, students should know and calculate the functioning parameters of the main thermodynamics cycles: the Carnot cycle, Joule cycle, Rankine cycle, combined cycle (Joule- Rankine) and refrigeration cycle.</p>					
Prerequisites: <p>Knowledge acquired in the disciplines of mathematics and physics of the Secondary degree</p>					
Curriculum: <p>Fundamental concepts. Thermodynamic properties of pure substances: surface P, v, t. perfect gas properties. Compressibility Factor. Calculation of fluid properties. Distinction between vapours and gases. Diagrams and tables of properties.</p> <p>First law of Thermodynamics – heat, work (various forms of work), internal energy, enthalpy. Specific heats of perfect gases, solids and liquids. Application of first law to closed systems and open systems – difference between stationary and transient regime.</p> <p>Second law of thermodynamics – reversibility and irreversibility. Carnot cycle and thermodynamic efficiency. Entropy. Entropy variation of pure substances, liquids and solids and ideal gases. Reversible work and efficiency of various devices (compressor, turbine).</p> <p>Thermodynamic relations – some general thermodynamic relations for the internal energy, enthalpy, entropy and specific heats.</p>					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

Thermodynamic cycles: gas engines cycles, steam engines cycles and refrigeration cycles

Teaching and Learning Methods:

Theoretical Lessons – exposure of content using acetates or "power point", alternating with practical examples and interacting with students.

Theoretical Practical Lessons – teaching by resolution of practical exercises, after discussion with the students about the methods to be used and clarification of doubts arising.

Laboratory Practice lessons – execution of practical tests in the laboratory and/or use of specific software.

Tutorial lessons – Clarification of doubts about the resolution of the exercises.

Assessment:

The knowledge assessment can be made of a continuous mode or by taking an exam.

In the case to be made of a continuous mode students must provide the following evidence:

- 4 Mini tests whose classification of each, will vary between 0 and 5 values.
- A computation work using the EES software
- 1 final test on all matter.

The final classification will be determined in accordance with the expression:

$$NF = NMT * 0.2 + NT_EES * 0.1 + NT * 0.7$$

NF – final classification

NMT – sum of classification of 4 mini-tests

NT_EES – Computation work classification

NT – classification of final test, which must be greater than or equal to 8 values

if the evaluation is done through an exam, the final classification is the classification of the exam.

The student will be approved if the final classification is equal to or greater than 10 (ten) values.

Tests / Exams

The mini tests shall be done along the semester, have duration of 1 (one) hour and students will have to solve a problem, and can only consult a datasheet form and tables. The classification of each, will vary between 0 and 5 values.

Both the final test, and the exam have a duration of 2 hours, and students must solve a set of problems and there is no restriction in the consult elements.

Computation work

The student should use the program EES to model the operation of a thermodynamic cycle.

The deadline for delivery the work coincides with the end of the academic period.

Bibliography:

Yunus A. Çengel, Michael A. Boles, Termodinâmica, McGraw Hill (3ª ed. em Português);
Michael J. Moran, Howard N. Shapiro, Fundamentals of Engineering Thermodynamics, John Wiley & Sons, Inc (4th edition);
Karlekar B. V. , Thermodynamics for Engineers, Prentice-Hall;
Rogers & Mayhew, Engineering Thermodynamics Work and Heat Transfer, Longman;
G. Van Wylen, R. Sonntag, C Borgnakke, Fundamentos da Termodinâmica Clássica, Ed. Edgard Blucher Ltda

(1) Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: PHYSICS III					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Teaching Staff: Artur Clemente Neto Viegas					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
2 ^o	1 ^o	20T+20TP+10PL+10OT	Mandatory		5
Workload (hours): <div style="text-align: right;"> Classes: 50 Tutorial: 10 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: Provide basic knowledge about the phenomena in electrical circuits. Provide methods of electrical circuit parameters. Demonstrate the laws of electrical circuits. Explain the electromagnetic phenomena and its measurement. Introduction to application technology of electromagnetic phenomena.					
Prerequisites: Mathematics I and II					
DESCRIPTION OF CONTENT 1. CONSTITUTION OF MATTER. Energy bands and the valence band. Conductors, insulators and semiconductors. Electrical charges. Coulomb's law. Electric field. Basic electrical quantities and derivatives. Ohm's Law as local and general. 2. CIRCUITS IN CURRENT (DC). Electrical circuits and components. Direct application of Ohm's Law. Association of resistance. Analysis of DC circuits. Electrical power. Electrical energy. Amount of heat. Diagram of electric charge. Joule's Law. 3. EQUIVALENT CIRCUITS DC. Thevenin's theorem. Norton's Theorem. Superposition Theorem. Wheatstone bridge. 4. CIRCUITS ALTERNATING CURRENT (AC) SINGLE PHASE. AC sine wave. Coils. Capacitors. Resistive circuits (R), inductive (L) and capacitive (C) pure. RL circuit, RC, LC and RLC. Impedances. Power supply in C.A.. Power factor and its importance. Power factor					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

compensation. Circuits predominantly capacitive, inductive and resistive. Resonance.

5. MATRIX METHODS FOR CIRCUIT ANALYSIS.

Current method in the loop and branch. Matrix of impedances. Nodal voltage method. Input impedance. Transfer impedance.

6. EQUIVALENT CIRCUITS AC.

Thevenin's theorem. Norton's Theorem. Superposition Theorem. Wheatstone bridge.

7. WAVES.

Behavior of ferromagnetic materials. Laws of Electromagnetism. Hysteresis.

Teaching and Learning Methods:

Theoretical and Practical - Exhibition of the main theoretical aspects in the classroom (table) using transparencies or power point followed by examples of concrete applications, whenever possible. Exercises by the teacher, interacting with students in each programmatic point.

Lectures and Laboratory Practice - Implementation of DC circuits (voltage divider), AC (resonant) circuit and electromagnetic phenomena. Making reports on practical work, with use of the results of laboratory tests for the discussion and conclusion.

Tutorial - Clarification of doubts about the resolution of the monitoring exercises and practical work.

Assessment:

1. Continuous assessment: two written tests plots (P1 and P2), 3 practical work (T1, T2 and T3) and participation in lectures - practical and tutorials.

Rating = $0,65 \times \left(\frac{P1+P2}{2} \right) + 0,25 \times \left(\frac{T1+T2+T3}{3} \right) + 0,1 \times \left(\frac{TP+OT}{2} \right)$, with a minimum grade of 8 points P1 and P2 on the evidence, all evidence being evaluated on a scale of 0 to 20.

2. Final Rating: Rating = $0,65 \times E + 0,25 \times \left(\frac{T1+T2+T3}{3} \right) + 0,1 \times \left(\frac{TP+OT}{2} \right)$, with a minimum grade

of 8 marks in written examination (E), rated on a scale of 0 to 20.

The student classification is approved if it receives less than 10 continuous assessment or final assessment.

Bibliography:

Brandão, Diogo da Paiva Leite, **General Electrical**, Calouste Gulbenkian

Gussov, Milton, **Basic Electricity**, McGraw-Hill Schaum

Joseph E. Edminister, **Electrical Circuits**, McGraw-Hill

O`Malley, John, **Circuit Analysis**, McGraw-Hill Schaum

Martinez, Nelson, **Introduction to the Theory of Electricity and Magnetism**, Edgard Blucher Publishing, Inc.

(1) Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: Fluid Mechanics I / Mecânica dos Fluidos I					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Fausto J. C. Firmino Teaching Staff: Fausto J. C. Firmino					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
2	1	30T + 12TP + 3PL + 15 OT	Compulsory		5
Workload (hours): 140 <div style="text-align: right;"> Classes: 45 Tutorial: 15 Fieldwork: Individual Work and Assessment: 80 </div>					
Objectives: <p>The discipline of fluid mechanics I is an introductory course in the area of fluid mechanics. Thus the main objective is to provide students with the general concepts governing the static and the flow of fluids, and a correct interpretation of the processes involved. When they finish the course students should be able to:</p> <ul style="list-style-type: none"> a) Know the basic properties of fluids. b) Devise mentally a system model, identifying the relevant phenomena and effects despised. c) Determine hydrostatic forces exerted in flats and curves surfaces. d) Determine the forces exerted by the flow at solid surfaces. e) Use the Bernoulli equation, f) Know basic phenomena in fluid flow like boundary layer separation or drag forces, etc 					
Prerequisites: Differential and integral calculus to solve equations of fluids mechanics.					
Curriculum: 1-properties of fluids (2 weeks) 1.1-Fluid definition. 1.2-Viscosity. 1.3-Density, specific volume, specific weight and pressure. 1.4-Perfect Gas. 1.5-Volumetric elasticity module.					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

1.6-Steam pressure.

1.7-Surface tension.

1.8-Reynolds number

.

2-Fluid static (4 weeks)

2.1-Pressure at a point.

2.2-Fundamental Equation of fluid Statics.

2.3-Absolute pressure and effective pressure. Pressure Gauges.

2.4-Forces on flat surfaces.

2.5-Forces on curved surfaces.

2.6-Buoyancy and stability.

3-Fluid dynamics (4 weeks)

3.1 - System and control Volume.

3.2 - Equation of continuity and flow definitions.

3.3 - The linear momentum equation.

3.4 - Euler equation along a stream line.

3.5 - Steady flow energy equation.

3.6 - Bernoulli equation.

4-Flow in pipelines. (5 weeks)

4.1 - Steady laminar flow of incompressible fluid.

4.2 - Laminar flow in circular pipe.

4.3 - Concept of turbulent flow.

4.4 - Resistance in turbulent flow forced into pipelines.

4.5 - Permanent Flow of incompressible fluids in simple systems of pipelines.

4.6 - Calculation of friction losses.

4.7 - Qualitative notions of boundary layer.

4.8 - The development of boundary layer inside ducts.

4.9 - Separation phenomenon and its dependence of longitudinal gradient of pressure.

Teaching and Learning Methods:

Theoretical Lessons – exposure of content using acetates or "power point", alternating with practical examples and interacting with students.

Theoretical Practical Lessons – teaching by resolution of practical exercises, after discussion with the students about the methods to be used and clarification of doubts arising.

Laboratory Practice lessons – execution of practical tests in the laboratory and/or use of specific software.

Tutorial lessons – Clarification of doubts about the resolution of the exercises.

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Assessment:

The evaluation of knowledge has the components: written tests and laboratory work.

The written test component can be carried out by frequency, consisting of two written tests, with the same weight to the note of the written component, or by an exam.

The minimum score of each written test is 8 values.

The Laboratory component is composed of two laboratory work. For each laboratory work must be performed on the original report, carried out by groups with a maximum of two students, who may be the subject of oral discussion. In the case of teaching staff require oral the classification of the various elements of the group can be different. The minimum score of each laboratory work for approval in the discipline is of 10 values. The student isn't admitted to the exam without this requirement. The final classification is calculated by:

$$NF = 10\% \times (NT1) + 10\% \times (NT2) + 80\% \times (NWT)$$

NT – Final classification

NT1 – Classification of 1º Laboratory work

NT2 – Classification of 2º Laboratory work

NWT – Classification written test

Bibliography:

- 1 - Mecânica dos Fluidos - Frank M. White. McGraw - Hill.
- 2 - Mecânica dos Fluidos – 3ª Ed. Luis Adriano Oliveira e António Gameiro – ETEP, 2006.
- 3 - Mecânica dos Fluidos - Victor L. Streeter. McGraw - Hill.
- 4 - Fundamentals of Fluid Mechanics - 2. Ed. P. Gerhart; R. Gross; J. Hochstein; Addison-Wesley.
- 5 - Fluid Mechanics - W. P. Boyle. McGraw - Hill.
- 6 - Mecânica dos Fluidos e Hidráulica Geral - J. Novais Barbosa. Porto Editora.
- 7 - Fluid Mechanics with Engineering Applications – R. Daugherty, J. Franzini & E. Finnemore, McGraw – Hill, 1989.

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

Course Unit: Mechanics of Materials					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Teaching Staff: José Martins de Oliveira					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
2 ^o	1 ^o	30 T+15 TP+15 OT	Mandatory		5
Workload (hours): <div style="text-align: right;"> Classes: 45 Tutorial: 15 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: The aim is to develop a simple and logical analysis capabilities in the study of Mechanical Engineering of the interconnections between forces, moments, normal stress, shear stress, tensile deformation, bending and twisting through the application of concepts already assimilated static, kinematic and dynamic now supplemented with material properties					
Prerequisites: Acquired knowledge in the courses of Physics I and Physics II.					
Curriculum: 1. Concept of Stress Introduction Axial Loading; Normal Stress Shearing Stress Bearing Stress in Connections Application to the Analysis and Design of Simple Structures Stress on an Oblique Plane under Axial Loading Stress under General Loading Conditions; Components of Stress 24 Design Considerations 2. Stress and Strain – Axial Loading Normal Strain under Axial Loading True Stress and True Strain Stress-Strain Diagram Hooke's Law; Modulus of Elasticity Elastic versus Plastic Behaviour of a Material Repeated Loadings; Fatigue Deformations of Members under Axial Loading					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

Statically Indeterminate Problems
 Problems Involving Temperature Changes
 Poisson's Ratio
 Multiracial Loading; Generalized Hooke's Law
 Further Discussion of Deformations under Axial Loading; Relation among E , ν , and G
 Stress and Strain Distribution under Axial Loading; Saint-Tenant's Principle
 Stress Concentrations

3. Torsion

Introduction
 Preliminary Discussion of the Stresses in a Shaft
 Deformations in a Circular Shaft
 Stresses in the Elastic Range
 Angle of Twist in the Elastic Range
 Statically Indeterminate Shafts
 Design of Transmission Shafts
 Torsion of Noncircular Members
 Thin-Walled Hollow Shafts

4. Pure Bending

Introduction
 Symmetric Member in Pure Bending
 Deformations in a Symmetric Member in Pure Bending
 Stresses and Deformations in the Elastic Range
 Deformations in a Transverse Cross Section

5. Members under Transverse Loading

Introduction
 Basic assumptions for the distributions of normal stresses

6. Analysis and Design of Beams for Bending

Introduction
 Shear and Bending-Moment Diagrams
 Relations among Load, Shear, and Bending Moment

7. Deflection of Beams

Introduction
 Deformation of a Beam under Transverse Loading
 Equation of the Elastic Curve
 Direct Determination of the Elastic Curve from the Load Distribution
 Statically Indeterminate Beams
 Method of Superposition
 Application of Superposition to Statically Indeterminate Beams

Teaching and Learning Methods:

Theoretical Classes – theoretical exposition of the contents, using for example acetates or "power point", alternating with practical examples and interacting with students.
 Theoretical and Practical Classes – Resolution of exercises by the teacher after discussion with the students of the statement, the methods used and the clarification of doubts.
 Tutorials – Clarification of doubts about the theory or problem solving.

Assessment:

- Continuous Assessment:** Two partial written tests ($P1$ e $P2$) and participation in class (PA) and resolution problems outside the classroom (TA).
 Classification = $0.4 \times (P1 + P2) + 0.05 (PA) + 0.15 \times (TA)$, all items are evaluated on a scale of 0 to 20, and with a minimum grade of 8 in any of the tests.
- Final Assessment:** Written exam (EX)
 Classification = $0.8 \times (EX) + 0.05 (PA) + 0.15 \times (TA)$, all items are evaluated on a scale of 0 to 20.

The student is approved if receives equal or more than 10 on continuous assessment or final assessment.

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Bibliography:

Beer, Johnston – Mecânica UHF Materiais

Mimosinho/Gere – Mecânica dos Sólidos

E.P. Popós – Resistência dos Materiais

NASH, WILLIAM, A. – Resistência dos Materiais, 4.^a Edição ; Shunts Migras – hl;

SILVA, V.DIAS – Mecânica e Resistência dos Materiais, 2.^a Edição, ZUARI – Edição de Livros Técnicos, Lda.

BRANCO, CARLOS MOURA – Mecânica dos Materiais, Teoria e Aplicações, McGraw-Hill

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: Statistical Methods					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Teaching Staff: Cláudia Dias Sequeira – cdsequeira@ualg.pt					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
2 ^o	1 ^o	30 T+ 15 TP+ 15 OT	compulsory		5
Workload (hours): <div style="text-align: right;"> Classes: 45 Tutorial: 15 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: Provide students technical exploratory statistical analysis of data and probability analysis. Thus, an exploratory point of view, students should learn methods of description of a sample of one or two variables. On the other hand, it is intended to provide students with the tools necessary for the probabilistic approach, on the population analysis of the results obtained in the same sample. To this end, we study the theory of probability, discrete random variables, and their continuous distributions. Knowing counting techniques; know the process of choosing samples and how the events are related to the statistical reality. Draw conclusions from the data collected and processed, identifying the conditions of applicability of the tests of hypotheses and interpret the data.					
Prerequisites: Knowledge is required on Mathematics learnt at High School level					
Curriculum: Theory of Probability <ul style="list-style-type: none"> Basics notions of results space, event and the probability of an event. Conditional probabilities, independent events, theorem of total probability and Bayes' theorem. Random variables, distribution function, distribution and probability density function. Random Vectors: marginal and conditional. Independence of random variables. Parameters of the random variables: mean, variance, covariance. Generating function of moments: definition, properties of f.g.m. Discrete distributions: uniform, binomial, negative binomial, multinomial, hypergeometric and Poisson. Continuous distributions: uniform, normal, gamma, exponential, chi-square, T-Student and F-Snedecor. Statistical Inference <ul style="list-style-type: none"> Sampling Theory: Understanding the statistical sample. Theory of estimation, point estimation, estimator and estimation properties. 					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

- Estimation intervals: Confidence intervals for the mean, variance, mean difference, variance ratio, proportions and difference between proportions.
- Tests of hypotheses: null hypothesis and alternative, the two types of error and the power function of a test. Level of significance. Test of a mean, variance, comparison of two means and two variances.
- Testing adjustment and Kolmogorov-Smirnov test.

Simple Linear Regression

- Bivariate Data
- Representation of Bivariate Data
- Coefficient of linear correlation or empirical sample
- Straight Regression
- Elemental analysis

Outliers

Teaching and Learning Methods:

Classes theory (T): Explanation of theory, based on slides or 'power points', together with examples.

Calculus in classes (TP): Examples of problem solving with at least one exercise on each point programmatic, clarification of questions and doubts).

Tutorials (OT): Clarification of doubts during problem solving by students.

Assessment:

Assessment is made with two tests (80%), or one final examination and a set of exercises. Grading is based on following weights and formula:

Final grade: Two Tests (80%) + Exercises (20%)

Bibliography:

Bhattacharyya, G. e Johnson, R. (1988), *Statistical Concepts and Methods* , John Wiley.

Freund, J. (1992). *Mathematical Statistics*. Prentice-Hall.

Milton, J. e Arnold, J. (1987). *Probability and Statistics in the Engineering and Computing Sciences*. Mc Graw Hill.

Montgomery, D. C. e Runger, G.C. (2002). *Applied statistics and probability for engineers*. John Wiley.

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (OT); Individual study (**TA**).

Course Unit: Mechanical Technology					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Mechanical Technology Teaching Staff: Carlos Alberto Mascote da Cruz					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
2	1	30T+15TP+15OT	Mandatory		5
Workload (hours): 140 <div style="text-align: right;"> Classes: 45 Tutorial: 15 Fieldwork: Individual Work and Assessment: 80 </div>					
Objectives: Formulation of basic concepts for the understanding of techniques and technologies of processing of metallic materials					
Prerequisites:					
Curriculum: I - Metallic Structure - General characteristics of metals 1- Materials - Exploration, Resources and Reserves 2 - Definition of elasticity modulus 3 - Metallic Materials - their characteristics and properties II - Crystalline Structure of Metals 1 - Crystal Systems – Allotropy 2 - Plans and crystallographic directions. Miller indexes 3 - Types of deformation III - Plasticity of Metals 1 - Elastic Deformation 2 - Plastic Deformation 2.1 - Deformation by Slip 2.2 - Deformation twinned 3 - Deformation of Metals 3.1 - Cold deformation 3.2 - Hot deformation					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

IV - Metallic Alloys

1 - Equilibrium Diagrams

- 1.1 - Binary Alloys
- 1.2 - Preparation of an equilibrium diagram
- 1.3 - Behaviour of binary alloys during their cooling
- 1.4 - Transformation of solid solutions
- 1.5 - Relationship between the shape of the equilibrium diagram and the properties of the alloys.
- 1.6 - Equilibrium diagram of Fe-C alloys
- 1.7 - Rule of Stages

2 - Diagram of Austenite Transformation

- 2.1 - Isothermal Transformation
- 2.2 - Continuous cooling transformation
- 2.3 - Methods of Preparation of TC Curves
- 2.4 - Critical speed
- 2.5 - Practical interest of Diagrams TC

V - Thermal and thermo-chemical treatment Fe-C alloys

- 1 – Annealing
- 2 – Quenching
- 3 – Tempering
- 4 – Carburizing
- 5 – Nitriding

VI - Mechanical Properties

- 1 - Mechanical Properties
- 2 - Safety factors and stress allowable working

VII - Mechanical Testing

- 1 - Traction test
 - 1.1 - Stress-strain graph
 - 1.2 - Stretching and necking – Ductility
 - 1.3 - Diagram Real Stress - Real Strain
 - 1.4 - Stress-strain curves - deformation for different materials
 - 1.5 - Types of fracture by traction
 - 1.6 - Types of Samples
 - 1.7 - Tenacity and resilience
- 2 - Hardness Testing
 - 2.1 - Brinell Hardness Test
 - 2.2 - Rockwell hardness test
 - 2.3 - Vickers hardness test
 - 2.4 - Relationship between hardness and tensile strength
- 3 - Creep Test

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

- 3.1 – Creep phenomenon
- 3.2 – Creep test
- 3.3 - Creep resistance
- 3.4 - Resistance to creep rupture
- 3.5 - Curves representing creep properties
- 3.6 - Recovery and Relaxation
- 4 – Crash Test
- 4.1 – Crash Tests
- 4.2 - Transition temperature
- 5 – Fatigue Test
- 5.1 - Fatigue Test
- 5.2 - Types of Samples
- 5.3 - Factors influencing the fatigue strength
- 5.4 - Relationship between fatigue limit and tensile strength of metals

VIII - Steels

- 1- Classification of steels
- 2 – Chemical Composition
- 3 - Properties of Carbon Steel
- 4 - Effects of alloying
- 5 - Types of steel

IX - Cast Iron

- 1 – Cast Iron
- 2 - White Cast Iron
- 3 - Grey Cast Iron
- 4 - Malleable Cast Iron
- 5 - Ductile cast iron

X - Foundry

- 1 - Casting Molds, types of molds.
- 2 - Sintering

Teaching and Learning Methods: Lectures and theoretical-practical, classroom tutorials study materials related to the program

Assessment: performance of two test frequency

Bibliography: Mechanical Technology - Vicente Chiaverini Vol-I - McGraw-Hill
 Steel's - Pinto Soares
 Engineering Materials – M.F.Ashby
 Teacher's Notes

(1) Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

Course Unit: Heat Transfer / Transmissão de Calor					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Fausto J. C. Firmino Teaching Staff: Fausto J. C. Firmino					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
2	1	15 T+ 29 TP + 16 OT	Compulsory		5
Workload (hours): 140 <div style="text-align: right;"> Classes: 44 Tutorial: 16 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: The first objective of the course is to provide the student with a good understanding of the fundamental physical mechanisms of conductive, convective and radiative heat transfer. The second objective is to introduce the student to the application of heat transfer theory to the solution of basic problems in engineering heat transfer. The third objective is to give the student a good understanding of the application of heat transfer to practical heat transfer problems.					
Prerequisites: Differential calculus to solving equations of heat transfer. Knowledge of thermodynamics for the correct identification of variables involved in the processes of heat transfer.					
Curriculum: CHAPTER 1 – INTRODUCTION Heat transfer processes: Conduction, convection and radiation. Physical origins (mechanisms) and rate equations (Fundamental laws) – <i>Fourier's law</i> (conduction), Newton's law of cooling (convection) and <i>Stefan-Boltzmann law</i> (radiation). The conservation of energy requirement – the law of conservation of energy. Balance of energy for a control volume and for a surface. Units and dimensions. CHAPTER 2 – CONDUCTION The heat diffusion equation. Development of the general equation in Cartesian coordinates. Heat equation in cylindrical coordinates and in spherical coordinates. Boundary and initial conditions. One-dimensional, steady-state conduction. The plane wall – simple and composite wall.					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

Contact resistance. Radial systems – the cylinder and the sphere (simple and composite wall). Critical thickness of insulation. Plane wall and cylinder with thermal energy generation.

Heat transfer from extended surfaces (fins). Fins of uniform cross-sectional area – equations of temperature distribution and heat loss. Fins of nonuniform cross-sectional area. Efficiency of a single fin and of a finned surface (overall surface efficiency).

Transient conduction. Solid without internal temperature gradients – The Lumped Capacitance Method. Graphical representation of one-dimensional transient conduction in the plane wall, long cylinder, and sphere with convection (*Heisler charts*).

CHAPTER 3 – CONVECTION

Introduction to convection. The convection boundary layers: The velocity boundary layer and the thermal boundary layer. Dimensionless parameters.

Forced convection – External flow. The flat plate in parallel flow: laminar and turbulent flow. Flow across cylinders (circular and noncircular), spheres and banks of tubes. Convection correlations.

Forced convection – Internal flow. Hydrodynamic and thermal considerations: Entrance and fully developed regions. Laminar and turbulent flow inside circular and noncircular tubes. Convection correlations.

Free convection. Dimensionless parameters. Vertical, horizontal and inclined plates. Enclosures. Convection correlations.

CHAPTER 4 – HEAT EXCHANGERS

Introduction to Heat Exchangers: Types. The overall heat transfer coefficient. The fouling factor.

Analysis of heat exchangers: The log mean temperature difference method. The Effectiveness-NTU method.

Selection of Heat Exchangers

CHAPTER 5 – RADIATION

Fundamental concepts: spectrum of electromagnetic radiation, blackbody radiation – *Planck's law*, *Stefan-Boltzmann's law*, *Wien's law*. The gray surface – *Kirchhoff's law*. Surface emission, absorption, reflection and transmission.

Radiation exchange between surfaces. The view factor. Blackbody radiation exchange. Radiation exchange between diffuse, gray surfaces in an enclosure: Net radiation exchange at a surface, radiation exchange between surfaces. Radiosity and irradiation.

Teaching and Learning Methods:

Theoretical Lessons – exposure of content using acetates or "power point", alternating with practical examples and interacting with students.

Theoretical Practical Lessons – teaching by resolution of practical exercises, after discussion with the students about the methods to be used and clarification of doubts arising.

Laboratory Practice lessons – execution of practical tests in the laboratory and/or use of specific software.

Tutorial lessons – Clarification of doubts about the resolution of the exercises.

Assessment:

Two tests (Test 1 and Test 2) or one Final Exam. The tests and the exam will be open-book.

The final score will be obtained making the average of the two tests. The minimum score of each of them is 8,0/20 and the minimum average score to get approval is 9,5/20. Otherwise the

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

students will have to get approval in the Final Exam.

Bibliography:

Incropera, DeWitt, Bergman, Lavine, **Fundamentos de Transferência de Calor e de Massa**, 6th edition, Gen LTC, 2008

Y.A. Çengel, **Heat Transfer – A Practical Approach**, 2nd edition, McGraw-Hill, 2003

M.N. Ozisik, **Heat Transfer – A Basic Approach**, McGraw-Hill, 1985

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: Fluid Mechanics II					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Teaching Staff: Frederico Morgado (MSc) - fmorgado@ualg.pt					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
2nd	2nd	30L+12TP+3PL+15T+80IS	Compulsory	14411022 14411043	2nd
Workload (hours): <div style="text-align: right;"> Classes: 50 Tutorial: 10 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: In this course students will learn how to use the generalized Bernoulli equation with application to real pipe systems in order to be able to project real life applications, namely in the field of water distribution. This includes calculation and drawing of installation curves and familiarization with different types of pumps, which include interpretation and use of characteristic curves. Students will also learn how to anticipate and make basic calculations on water hammer. Finally they will become familiar with Hardy-Cross method for the calculation of multiple pipe systems.					
Prerequisites: Knowledge is required on (i) Mathematics and Physics learnt at High School level and (ii) on the introductory course of Fluid Mechanics I.					
Curriculum: <u>1 – Head Loss</u> Generalized Bernoulli equation, empirical formulae for the calculation of head loss, analytical calculations in multiple pipe systems, installation curves, graphic approach for problem solving, economic pipe size. <u>2 – Pumps and hydraulic systems</u> Types of pumps, compressors and fans, characteristic curves, system equilibrium, cavitation, introduction to dimensional analysis, introduction to project of real water distribution systems, selection of pressure reservoirs. <u>3 – Transient flow</u> Water hammer caused by sudden closure of valves or pumps stopping, equipment for protection against water hammer. <u>4 – Multiple pipe systems</u> Solution of multiple pipe systems using the Hardy-Cross method, including systems with reservoirs and interstage pumps.					
Teaching Methods/Procedures: Lectures, seminars and tutorials are used to pass to students a good equilibrium among theory and					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

problem solving. Laboratory practice is also required, so as to have a 'hands on' approach and improved understanding.

Lectures (L): Explanation of theory, based on slides or 'power points', together with examples (aims for student interaction);

Theoretical and Practical (TP): Examples of problem solving by lecturer, with at least one problem per study topic (includes discussion with students of alternative solutions, and clarification of questions and doubts).

Practical and Laboratory (PL): Laboratory work performed by students assisted by lecturer.

Tutorials (T): Clarification of doubts during problem solving by students.

Assessment:

Assessment is made after reports from laboratory work and problem solving by students together with, either two tests, or one final examination. Grading is based on following weights and formulae:

Final grade: 1st Test (35%) + 2nd Test (35%) + 1st Lab (10%) + 2nd Lab (10%) + Problem Solving (10%) or Exam (70%) + 1st Lab (10%) + 2nd Lab (10%) + Problem Solving (TP) (10%)

Bibliography:

- White, F.M., Mecânica dos Fluidos, McGraw-Hill.
- Cengel, Y.A., & Cimbala, J.M., Mecânica dos Fluidos: Fundamentos e Aplicações, McGraw-Hill.
- Munson, B., Young, D., Okiishi, T. & Huebsch, W., Fundamentals of Fluid Mechanics, Wiley.
- Gerhart, P., Gross, R. & Hochstein, J., Fundamentals of Fluid Mechanics, Addison-Wesley.
- Daugherty, R., Franzini, J. & Finnemore, E., Fluid Mechanics with Engineering Applications, McGraw – Hill.
- Macintyre, Archibald Joseph, 1980. "Bombas e Instalações de Bombeamento". L.T.C. Ed.
- Karasik I. J. "Pump Handbook" Mc-Graw Hill 2^a Ed. 1986.
- Martins F. "Folhas de Mecânica dos Fluidos II, 1^a Parte" 1995.

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: ELECTRICAL MACHINES					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Teaching Staff: Artur Clemente Neto Viegas					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
2 ^o	2 ^o	20T+20TP+10PL+10OT	Mandatory		5
Workload (hours): <div style="text-align: right;"> Classes: 50 Tutorial: 10 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: Understanding electrical rotating machines AC, single phase and three phases. Explain the constructive aspects of electrical machines. Selecting electric motors in typical applications of mechanical engineering. Explain the types of practice starts and their selection. U-turn and speed variation. Protection of electric motors and their operators.					
Prerequisites: III Physical and Mechanical Technology					
Curriculum: 1. ALTERNATING CURRENT (AC) MOTORS. Constitution Motors and its classification. Principle of operation. Operating characteristic curves. Losses, Power and Efficiency. 2. ENGINE STARTING SYSTEMS IN (AC). Boot methods and their justification. Boot Apparatus to apply and their characteristics. 3. SYSTEMS PROTECTION AND SECURITY OF ENGINES IN LOW VOLTAGE. Network Dimensioning and Protections. Protective Equipment to be used and its features. 4. THREE- PHASE ELECTRICAL NETWORKS. Getting Acquainted. Load Balancing. Three-phase systems. Balanced and unbalanced systems. Symmetric and asymmetric systems. Circuits star. Circuit's triangle. 5. TRANSFORMERS AND THEIR APPLICATIONS. Constitution of a transformer and its characteristics. Principle of operation of transformers. Measuring transformers.					
Teaching and Learning Methods: Theoretical and Practical - Exhibition of the main theoretical aspects in the classroom (table) using transparencies or power point followed by examples of concrete applications, whenever possible.					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

Exercises by the teacher, interacting with students in each programmatic point.

Lectures and Laboratory Practice - Implementation of DC circuits (voltage divider), AC (resonant) circuit and electromagnetic phenomena. Making reports on practical work, with use of the results of laboratory tests for the discussion and conclusion.

Tutorial - Clarification of doubts about the resolution of the monitoring exercises and practical work.

Assessment:

1. Continuous assessment: two written tests plots (P1 and P2), 3 practical work (T1, T2 and T3) subject to oral argument if the teacher so wishes, with minimum grade in all the work of eight values and participation in lectures - practice and guidance.

Rating = $0,65 \times \left(\frac{P1+P2}{2} \right) + 0,25 \times \left(\frac{T1+T2+T3}{3} \right) + 0,1 \times \left(\frac{TP+OT}{2} \right)$, with a minimum grade of 8 points P1 and P2 on the evidence, all evidence being evaluated on a scale of 0 to 20.

2. Final Rating: Rating = $0,65 \times E + 0,25 \times \left(\frac{T1+T2+T3}{3} \right) + 0,1 \times \left(\frac{TP+OT}{2} \right)$, with a minimum grade

of 8 marks in written examination (E), rated on a scale of 0 to 20.

The student classification is approved if it receives less than 10 continuous assessment or final assessment.

Bibliography:

Dawes, C. L. **Electrical Engineering** McGraw-Hill

Chapman, S. J. **Electric Machinery Fundamentals** McGraw-Hill

Grant, I. S. and Phillips, I. S. **Electromagnetism** John Wiley and Sons

Esquimateca - **Industrial Control Technologies** Editions CITEFA

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: Prevention and Safety					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Teaching Staff: António M. C. Oliveira e Sousa					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
2	2	30T + 30TP + 150T			5
Workload (hours): 140 <div style="text-align: right;"> Classes: 60 Tutorial: 15 Fieldwork: 5 Individual Work and Assessment: 60 </div>					
Objectives: Raising awareness on Occupational Health and Safety, highlighting the social and economic perspectives, in combination with the existing formal requirements. Identify areas of intervention and the resources available to mechanical engineering professionals to prevent and minimize workplace risks.					
Assessment: Practical exercises and search work (30%) + 2 tests (35% each) or Final Exam (100%)					
Bibliography: COLETA, J. (1989); Acidentes de Trabalho, Atlas, S. Paulo, Brasil CABRAL, F. e VEIGA, R. (2001); Higiene, Segurança, Saúde e Prevenção de Acidentes de Trabalho, Verlag Dashöfer, Lisboa CASTRO, A. e TARRINHO, A. (2001); Segurança, Higiene e Saúde no Trabalho – Compilação de Legislação, Ed. Rei dos Livros, Lisboa IDICT (1997); Serviço de Prevenção das Empresas: Livro Verde, IDICT, Lisboa IDICT (1998); Reparação Automóvel - Manual de Prevenção, IDICT, Lisboa INTERNET: Organismos Públicos e privados de interesse na área. Estatísticas disponíveis LEGISLAÇÃO EM VIGOR: Vária MIGUEL, A. (1998); Manual de Higiene e Segurança no Trabalho, Porto Ed. MIGUEL, A. (1997); Higiene e Segurança no Trabalho: Ruído, Incêndios e Iluminação, Porto Ed. Multimédia OLIVEIRA, C. e MACEDO, C. (1996); Segurança Integrada, Comp. Seguros Bonança, Lisboa S. A. (1993); Regulamento Geral de Segurança e Higiene do Trabalho nos Estabelecimentos Industriais, Serviço de Informação Científica e Técnica (SICT), MESS S. A. (1999); Regulamento de Segurança contra Incêndio, Porto Ed.					

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: HEAT TRANSFER II					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal Teaching language: Portuguese Course Unit Chair: António Hugo Lamarão Teaching Staff: António Hugo Lamarão					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
2	2	12,5T+23,5TP+6PL+18OT			5
Workload (hours): 140 <div style="text-align: right;"> Classes: 42 (12,5T+23,5TP+4PL) Tutorial: 18 (18OT) Fieldwork: Individual Work and Assessment: 80 </div>					
Objectives: <p>The main objective of the course is to provide the student with a good understanding and the ability to interpret the fundamental equations governing the physical mechanisms of natural and forced convection, and two phase flows. It is also intended that the students apply the knowledge acquired in the calculation and design of heat exchangers.</p>					
Prerequisites: <ul style="list-style-type: none"> - Calculus and differential equations for solving problems of heat transfer. - Thermodynamics (for a correct identification of all the variable involved in heat transfer processes). - Conduction and radiation heat transfer (Heat Transfer I). 					
Curriculum: Part 1 – Convection Heat Transfer <ul style="list-style-type: none"> • Introduction: flow over a body and flow inside a duct – basic concepts on hydrodynamic and thermal layers. • Forced convection for flow over bodies (external flow): dimensionless parameters; laminar flow over a flat plate; turbulent flow over a flat plate; flow across a single circular cylinder; flow across a noncircular cylinder; flow across a single sphere; flow across tube bundles; summary of correlations. • Forced convection for flow inside ducts (internal flow): hydrodynamically and thermally developed laminar flow; hydrodynamic and thermal entrance regions; turbulent flow inside ducts; flow inside a duct of annular cross section; summary of correlations. • Free convection: Dimensionless parameters; Correlations of free convection on a vertical plate; free convection on a horizontal plate; free convection on an inclined plate, free convection on a log cylinder; free convection on a sphere; free convection in enclosed spaces; summary correlations. <p>Length: 5 weeks / 15 (T+TP) + 5 hours (OT) + 27 hours (TA)</p> Part 2 – Boiling and Condensation <ul style="list-style-type: none"> • Introduction and basic concepts. • Condensation on a vertical flat plate. • Condensation on horizontal tubes and tube bundles. • Pool boiling: regimes and correlations. 					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

Length: 5 Weeks / 13 hours (T+TP) + 7 hours (OT) + 23 hours (TA)

Part 3 – Heat Exchangers

- Classification of heat exchangers.
- General equations of heat transfer in heat exchangers.
- Project and analysis of heat exchangers: Logarithmic Mean Temperature Difference method (LMTD) and Effectiveness method (ϵ -NTU)
- Assemblies of heat exchangers.
- Economic evaluation of heat exchangers.

Length: 5 weeks / 14 hours (T+TP) + 6 hours (OT) + 30 hours (TA)

Teaching and Learning Methods:

Assessment:

Three midterm quizzes (30% + 20% + 30%) + 1 Lab report (20%) or Final Exam (80%) + 1 Lab report (20%)

Bibliography:

1. Frank P. Incropera, David P. DeWitt, Theodore L. Bergman, Adrienne S. Lavine / Fundamentals of Heat and Mass Transfer / John Wiley & Sons, 6th ed., 2007
2. Yunus A. Çengel / Heat and Mass Transfer – A Practical Approach / McGraw-Hill, 3rd ed., 2007
3. M. N. Ozisik / Heat Transfer - A Basic Approach / Mc Graw Hill, 1985

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

Course Unit: / Machine elements or Machine elements I					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Manuel Carlos Mestre Nunes Teaching Staff: Manuel Carlos Mestre Nunes					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
2 ^o	2 ^o	30 T + 15 TP + 15 OT	Compulsory		5
Workload (hours): 140 <div style="text-align: right;"> Classes: 45 Tutorial: 15 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: Acquisition of knowledge in the area of machine elements: Bearings, Belt drives, chain drives and gear drives. Basics of static and fatigue design, selection and design of mechanic elements.					
Prerequisites: Knowledge is required on “Mechanics of Materials”					
Curriculum: <ol style="list-style-type: none"> 1. TRIBOLOGY <ul style="list-style-type: none"> Introduction Analysis of surface roughness Contact between Solid Surfaces <ul style="list-style-type: none"> Adhesion Abrasion Friction Wear <ul style="list-style-type: none"> Adhesive Abrasive Fatigue Impact Lubrication <ul style="list-style-type: none"> Introduction Basic principles of lubrication Lubricating oils (Mineral, Synthetic, Boundary lubrication, viscosity, contamination, compatibility, other additives, ...) Greases 2. MECHANICAL SPRINGS. <ul style="list-style-type: none"> Types of springs; helical compression springs; springs characteristic; stresses and stiffness; buckling; wire materials; fatigue loading; spring design. 3. SCREWS 					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

Thread Standards and Definitions, The Mechanics of Power Screws, Threaded Fasteners, Joints—Fastener Stiffness, Joints—Member Stiffness, Bolt Strength, Tension Joints—The External Load, Relating Bolt Torque to Bolt Tension, Statically Loaded Tension Joint with Preload, Fatigue Loading of Tension Joints, Bolted and Riveted Joints Loaded in Shear

4. WELDED JOINTS

Welded joints; geometric properties welded joints; traditional analysis; throat stresses and joint safety; unified analysis.

Teaching and Learning Methods:

Classes theory (T): Explanation of theory.

classes (TP): Examples of problem solving.

Tutorials (OT): Clarification of doubts during problem solving by students.

Assessment:

2 Tests (70%) or exam (70%)

Individual works with reports (30%)

Minimum pass mark for written tests (or exam) is 8,0 and for reports 8,0.

Final mark (NF) is calculated as follows:

Written test (or exam) 70% (NE) and reports 30% (NP).

$NF = 0,70 \times NE + 0,30 \times NP$

Final mark of 10.0 (ten) or higher in the NF.

Bibliography:

- Principles of tribology – J. Halling – Macmiller Education
- Benlloch, M. (1990); Los Lubrificantes, CEAC, Barcelona
- Benlloch, M. (1984); Lubrificantes y lubricación aplicada, CEAC, Barcelona
- Silva, P. (1985) ; Tribologia, Fund. Calouste Gulbenkian, Lisboa
- S. A. (2000); BP – Lubrificantes: Produtos e características, CD multimédia, BP Portugal
- Elementos de máquinas – Nieman
- Elementos de máquinas – Shigley
- Fadiga – Mecânica dos materiais – C. Moura Branco – Gulbenkian
- Calcul des assemblages par elements filetés – Encyclopedie de l'ingenieur
- Regulamento de estruturas de aço para edificios
- Fadiga de estruturas soldadas – C. Moura Branco – Gulbenkian
- Projecto de Órgãos de Máquinas – C. Moura Branco – Gulbenkian

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

Course Unit: INDUSTRIAL AUTOMATION					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Raul Lana Miguel Teaching Staff: Raul Lana Miguel					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
3rd	1st	30 TP + 7 PL + 23 OOT			5
Workload (hours): 140 <div style="text-align: right;"> Classes: 37 Tutorial: 23 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: Students receiving a credit for this course will have demonstrated their ability to: <ol style="list-style-type: none"> 1. Understand the basic concepts of industrial automation and apply a systematic approach to solve problems. 2. Understand the main applications of hydraulic and pneumatic circuits using hard wired logic and PLC based automation. 3. Automation system modeling using SFC/GRAFCET. 					
Prerequisites: Basic notions of mathematics and electrical machines.					
Curriculum: 1.INTRODUCTION Objectives of automation. Types and levels of automation. Automated systems. Structure of the automated systems. Automation technologies. Areas of use of various technologies. Methodology of choice in automation. Process control. 2. LOGIC ELEMENTS Terminology. Handling units and sensors. Human-machine-interfaces. Relays. Logic gates. Elementary logic functions. Bistables: classification, types and permission modes. 3. BOOLEAN LOGIC Boolean functions and its representation. Definitions. Analytical, numerical, and graphical representation. Karnaugh maps. Incomplete functions. Simplification of logic functions: analytical, graphical and numerical methods. Implementation of logic functions. Hard wired logic. Circuits with logic gates. Use of EPROMs. Data acquisition boards. 4. PNEUMATIC AND HIDRAULIC SYSTEMS Main components in pneumatic and hydraulic systems. Specification and symbolic representation assignments. Cyclical linear motion. Operating diagram. Types of control circuits. 5. SEQUENTIAL FUNCTION CHART (SFC/GRAFCET) SFC levels. SFC main components. Implementing SFC based programs: Sequencers, PLCs, and embedded systems.					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

Teaching and Learning Methods:

Theoretical and Practical Classes - Exhibition of the main theoretical subjects in the classroom board followed by practical examples of applications. Projection of slides, films and simulation software will be carried out whenever possible. Exercises will be solved by the teacher, interacting with students in each programmatic point.

Lectures and Laboratory Practice - Implementation of the control circuits with logic gates and relays. Design and implementation of pneumatic systems with cyclical linear motion. PLC/PAC programming and HMI configuration. Reports on practical work, with use of laboratory tests and simulation results.

Assessment:

1. **Continuous Assessment:** 2 partial written exams (P1 e P2) and 3 lab reports (T1, T2 e T3).

Final grade = $0,7 \left(\frac{P1 + P2}{2} \right) + 0,3 \left(\frac{T1 + T2 + T3}{3} \right)$, with minimum grade of 8 on P1 and P2 exams, all testes are evaluated on a 0 to 20 scale.

2. **Final Exam Assessment:** Final grade = $0,7 E + 0,3 \left(\frac{T1 + T2 + T3}{3} \right)$, with minimum grade of 8 on final exam (E), on a 0 to 20 scale.

Bibliography:

Pinto, J.R.C., Técnicas de Automação, 2004, ETEP

Francisco A., Autómatos Programáveis, 2003, ETEP

Pires, J. N., Automação Industrial, 2002, ETEP

Padilla, A.J.G., Sistemas Digitais, 1993, McGraw-Hill

Jacob, J.M., Industrial Control Electronics – Applications and Design, Prentice-Hall International Editions

Novais, J.M.A., Método Sequencial para Automatização Electropneumática, 1995, Fundação Calouste Gulbenkian

Novais, J.M.A., Ar Comprimido Industrial, 1995, Fundação Calouste Gulbenkian

Götz, W., Hidráulica. Teoria e aplicações., 1991, Robert Bosch GmbH

Novais, J.M.A., Autómatos Programáveis, 1995, Fundação Calouste Gulbenkian

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: Renewable Energies					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: António Mortal Teaching Staff: António Mortal					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
3 ^o	1 ^o	30TP+6PL+24OT	Obrigatória		5
Workload (hours): 140 <div style="text-align: right;"> Classes: 36 Tutorial: 24 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: Skill to evaluate the potential for the use of different renewable resources to produce energy in order to make the selection and set the dimension of the conversion equipment. Thermal solar system and wind park projects. Viability Studies: financial and environmental impact studies.					
Prerequisites:					
Curriculum: 1. INTRODUCTION (12 hours) 1.1. Conventional and renewable energies 2. WIND ENERGY (24 hours) 2.1. Characterization of wind resource. 2.2. Functional principle of aero generators. 2.3. Wind park project. 2.4. Economical and legal aspects. 2.5. Environmental impact evaluation. 3. SOLAR ENERGY (24 hours) 3.1. Solar geometry. 3.2. Solar radiation. 3.3. Passive systems. 3.4. Active systems. 3.4.1. Thermal conversion. 3.4.1.1. Flat-plate collectors. 3.4.1.2. Concentrative collectors. 3.4.2. Heat systems for specific areas and for washing water. 3.4.3. Solar furnaces 3.4.4. Solar Power Stations 3.4.5. Photovoltaic conversion 3.5. Technical applications					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

4. OTHER FORMS OF RENEWABLE ENERGY (18 hours)

- 4.1. Hydro energy
- 4.2. Ocean energy
- 4.3. Geothermal energy
- 4.4. Biomass
- 4.5. Hydrogen

Teaching and Learning Methods:

Assessment:

One test

One practical assignment

Final score = 8,0 (test score) + 0,3 (practical assignment score) or

Final score = Practical Assignment (includes presentation and debate)

Bibliography:

1 – Renewable Energies; Generalities

1.1 - BOYLE, G: *Renewable Energy -Power for a Sustainable Future* -Oxford University Press

1.2 - Varios Autores: *Guide des Energies Renouvelables* -Ministere de la Region Wallone

1.3 - CASSEDY, E.S.: *Introduction to Energy* -2nd edition, 1998, Cambridge University Press

2 – Solar Energy

2.1 - DUFFIE J. A.; BECKMANN W.A.: *Solar Engineering of Thermal processes* -2nd edition, 1980, John Wiley & Sons

2.2 - RABL A.: *Active Solar Collectors and their Applications*

2.3 - KREITH F.; KREIDER J. F.: *Principles of Solar Engineering* -Hemisphere publishing Corp.

3 – Active Solar Systems

3.1 - CABIROL T.; PELISSON A.; ROUX D.: *O Aquecedor a Água* -Edições CETOP

4 – Photovoltaic Systems

4.1 – IMAMURA M. S.; HELM P.; PALZ W.: *Photovoltaic System Technology* -Ed. Commission of the European Communities

5 – Passive Solar Systems

5.1 - MOIT A F.: *Energia Solar Passiva* -Vols. 1 e 2 -Instituto Nacional Casa da Moeda

5.2 - CANHA DA PIEDADE A.: *Termica dos Edificios*, 1982, LNEC

5.3 - SZOKOLA Y S. V.: *Energia Solar y Edification*, 1978, Editorial Blume

5.4 - CHOUARD P.; MICHEL H.; SIMON M. F.: *Bilan Thermique d'une Maison Solaire*, 1979, Editions Eyrolles

5.5 - s/autor: *Regulamento das Caracteristicas de Comportamento Termico dos Edificios* - Dec. Lei n° 40/90 de 6/2/90 (D.R. -I Serie)

6 – Wind Energy

6.1 - GOURIERES D.: *Energie Eolienne* -2^{erne} edition, 1982 -Eyrolles

6.2 - WALKER J. F.; JENKINS N.: *Wind Energy Technology* -1997, John Wiley & Sons

6.3 - FRERIS L. L.: *Wind Energy Conversion Systems* -1990, Prentice Hall

6.4 - SARAIVA, J. A. G.: *Bombagem de Agua com Moinhos de Vento* -1985, LNEC

7 – Wave Energy

7.1 - ROSS D.: *Power from Waves* -1995, Oxford University Press

8 – Biomass

8.1 - OLIVEIRA M. E.: *Biomassa -Um Recurso Energetico Renovável*-1986, LNETI

8.2 - OLIVEIRA M. E.: *Produção de Biogás a partir de Resíduos de industrias Agro-Alimentares* -1984, LNETI

(1) Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

Course Unit: Pollution and Environment					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Nelson Sousa Teaching Staff: Nelson Sousa					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
3rd	1st	15L+30TP+15T	Compulsory		5
Workload (hours): <div style="text-align: right;"> Classes: 45 Tutorial: 15 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: <p>This course unit aims to alert students to the major environmental problems, identifying the causes and consequences of human action on the environment. Known the environmental problems are taught techniques in order to mitigate their environmental impact. This involves the study and analysis of water and wastewater treatment plants, use of air pollution dispersion models, solid waste management and implementation of products life-cycle assessment.</p>					
Prerequisites:					
Curriculum: <ol style="list-style-type: none"> 1. Environmental Problems <ol style="list-style-type: none"> 1.1. Main causes of environmental problems 1.2. Brief history of the use and conservation of resources 1.3. Ecosystem functioning 1.4. Major environmental problems 1.5. Economy, energy and environment 2. Pollution in the Aquatic Environment <ol style="list-style-type: none"> 2.1. Water treatment 2.2. Wastewater treatment 3. Air pollution <ol style="list-style-type: none"> 3.1. Pollutants and polluters 3.2. Air Quality 					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

- 3.3. Treatment and control of air pollutants
- 3.4. Dispersion and transport of pollutants

- 4. Solid Waste Management
 - 4.1. Municipal solid waste management
 - 4.2. Industrial waste management
 - 4.3. Recycling

- 5. Life-Cycle Assessment
 - 5.1. Introduction
 - 5.2. Life-Cycle Assessment
 - 5.3. Applied methodology

Teaching and Learning Methods:

Lectures - Theoretical analysis of contents, interacting with students.

Theoretical and Practical - Discussion and debate of the content. Resolution of exercises by the teacher.

Tutorial - Clarification of doubts about the resolution of the exercises. Orientation of the students.

Assessment:

1. Five activities to be carried out during term time, with a weighting of 40% of final grade (A1. .. A5), evaluated on a scale of 0 to 20
2. Attendance at practical classes and tutorials, with a weighting of 20% of final grade (PA), assessed on a scale of 0 to 20.
3. A test or final exam with a minimum score of 8 points and a weighting of 40% of final grade (TF), rated on a scale of 0 to 20.

Classification =

The student is approved if its classification is superior or equal to 10.

Bibliography:

- **Davis, Mackenzie; Cornwell David; Introduction to environmental engineering; McGraw-Hill.**
- **Miller, G. Tyler; Living in the environment: principles, connections, and solutions; Wadsworth Publishing Company.**
- **Ferrão, Paulo Cadete; Introdução à gestão ambiental; IST Press.**
- **Forstner, Ulrich; Integrated pollution control; Springer**

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: Pipe Networks					
Branch(es): Thermal; Management and Industrial Maintenance					
Teaching language: Portuguese					
Course chair and teaching staff: Daniel N.Cabrita					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
3	1	15L + 30TP + 15T + 80IS	Mandatory		5
Total working hours: <div style="text-align: right;"> Classes: 45 Tutorial: 15 Field assignments: Individual study and assessment: 80 </div>					
Objectives: <ul style="list-style-type: none"> - Complementary theoretical knowledge in the field of Fluid Mechanics - Provide a means of calculation that allows the design of networks - Characterization of equipment, materials and solutions that enable the implementation of systems - Provide students with a means that will allow for easy insertion and adaptation to future professional roles 					
Prerequisites: Knowledge in the disciplines of Fluid Mechanics I and Thermodynamics I					
Curriculum: 1 - Building Pipe Networks: 1.1 – Water supply 1.2 – Domestic waste water 1.3 – Water fire fighting systems 2 – Natural gas networks 3 - Hydraulic Networks in HVAC systems 4 - Aerolic Networks in HVAC systems 5 – Compressed air networks 6 – Steam networks					
Teaching Methods/Procedures: Lectures and practical classes Tutorial classes – individual and group support for practical examples resolution					
Assessment:					

⁽¹⁾ Lectures (L); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (FA); Workshops (W); Tutorials (T); Individual study (IS).

Written tests (2), each worth 50%, with minimal individual mark of 8 in 20 (10 as minimum average, in 20)
or
Written final global examination (10 as minimum in 20)

Bibliography:

- Pedroso, Vitor M.R. – “ Manual dos Sistemas Prediais de Distribuição e Drenagem de Águas”
- Azevedo Neto, G.º Alvarez - “Manual de Hidráulica” I vol., Ed. Edgar Blutcher Lta.,1982
- White - “Fluid Mechanics”, Mc-Graw Hill. 2ª Ed., 1986
- Streeter V. L., Wylie E. B. – “Mecânica dos Fluidos”, Mc-Graw Hill, 7ª Ed., 1982
- Karasik I. J. – “Pump Handbook”, Mc-Graw Hill, 2ª Ed., 1986
- Brigaux-Garrigou – “Fontaneria e instalaciones sanitarias” – Guy Brigaux Y Maurice Garrigou, 3ª Ed., Editorial Gustavo Gill, S.A., Barcelona, 1976
- □ Regulamento Geral dos Sistemas Públicos e Prediais de Distribuição de Água e de Drenagem de Águas Residuais, Decreto Regulamentar - Diário da República – I Série – B N.º 194 – 23.08.1995
- Manual Técnico de Instalações de Gás - Lisboagás
- Associação Portuguesa dos Gases Combustíveis
Instituto Tecnológico do Gás. Dimensionamento I. Dimensionamento II
- Air conditioning manual – Carrier
- Compressed air manual – Atlas Copco
- Technical documents Spirax-Sarco

⁽¹⁾ Lectures (**L**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**FA**); Workshops (**W**); Tutorials (**T**); Individual study (**IS**).

Course Unit: Applied Thermodynamics					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Celestino Rodrigues Ruivo Teaching Staff: Celestino Rodrigues Ruivo					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
3rd	1nd	15T+25 TP+5PL+15OT+80TA	Obligatory		5
Workload (hours): <div style="text-align: right;"> Classes: 45 Tutorial: 15 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: <p>The students should understand the concepts related to:</p> <ul style="list-style-type: none"> -the characterization of the composition of gas mixtures and gas-vapour mixtures. Calculation of mixtures properties and analysis of thermodynamic processes involving two mixtures. -psychrometrics applied to the moist air. Analysis of basic air conditioning processes in HVAC&R installations. -outdoor and indoor conditions for sizing purposes of HVAC&R installations, taking into account the thermal comfort, air quality and the rational use of the energy. -thermal loads calculation based on simplified methodology to take into account in sizing and selecting HVAC&R equipment. 					
Prerequisites: <p>Thermodynamics, Heat Transfer, Fluid Mechanics.</p>					
Curriculum: <p>1- Mixtures. Introduction. Composition of a gas mixture, mass and mole fractions. Ideal mixtures. Dalton's law of additive pressures. Amagat's law of additive volumes. Gas mixtures and gas-vapour mixtures. Properties of mixtures. Processes involving mixtures.</p> <p>2- Psychrometrics applied to the moist air. Composition of the moist air. Parameters of the moist air: specific humidity or moisture content, relative humidity, dew point, enthalpy, saturation temperature and wet bulb temperature. Psychrometric charts. Condition line for the space and sensible heat factor. Air conditioning processes: mixtures of airflows, simple heating, simple cooling, humidifying and dehumidifying.</p> <p>3- Thermal loads. Outdoor and indoor design conditions for thermal load calculation, sizing and selecting HVAC&R equipment.</p> <p>Heat transfer in building structures. Properties of common building materials. Thermal resistances. Overall heat-transfer coefficients and mass of walls, floors, ceilings and roofs.</p>					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

Heating load calculations. Simplified methodology neglecting thermal inertia in the heat transmission through external envelope in contact with outdoor air, the soil and internal spaces.

Cooling load calculations. Heat transfer through external walls and roofs predicted by the method CLTD (ASHRAE), the method sol-air temperature and method of Mackey & Wright. Heat transfer through windows predicted by the method CLTD and CLF/SHGF (ASHRAE) with and without shading devices. Heat gain from people, lights and appliances predicted by the method CLF (ASHRAE). Heat transfer through internal walls, ceilings and floors predicted by assuming negligible thermal inertia.

Ventilation thermal loads. Heat transfer in pipes and ducts. Heat gains from fans.

Teaching and Learning Methods:

Theoretical sessions – content presentation using "power point", alternated with some practical examples..

Theoretical -practical sessions – Exercises and lab experiments

Tutorial – Explanation of doubts and support in the development of specific calculation sheets for the thermal load evaluation. Support in the elaboration of lab works and case studies.

Assessment:

1º written test (30 %) + 2º Test (30 %) + case study (30%)+Session participation TA (10 %)

or

exam (60%) + case studies (30%)+ Session participation TA (10 %)

Bibliography:

Yunus A. Çengel, Michael A. Boles, Termodinâmica, McGraw Hill (3rd ed. in Portuguese);

-Jones W. P. - Engenharia de Ar Condicionado - Campus Ltda

-ASHRAE Handbook, Fundamentals Volume, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. Atlanta, GA,1989

-Cooling and Heating Load Calculation Manual, American Society of Heating, - Refrigerating and Air Conditioning Engineers, Atlanta, GA.

-Manual de Ar Condicionado, Carrier Air Conditioning Company.

-W. P. Jones, Air Conditioning Engineering, Edward Arnold, Third Edition 1985

-Faye C. McQuiston and Jerald D. Parker, Heating, Ventilating, and Air Conditioning Analysis and Design, John Wiley & Sons, Inc Fourth Edition, 1994

-Stoecker, W. F. e Jones, J. W. - Refrigeração e Ar Condicionado, McGraw-Hill, 1985

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: Air Conditioning					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Celestino Rodrigues Ruivo Teaching Staff: Celestino Rodrigues Ruivo					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
3rd	2nd	15T+25 TP+5PL+15OT+80TA	Obligatory		5
Workload (hours): <div style="text-align: right;"> Classes: 45 Tutorial: 15 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: <p>The students should understand the concepts related to:</p> <p>Air conditioning systems and simplified methodologies for selecting and sizing purposes of most common HVAC equipment.</p> <p>Psychrometric analysis of the behaviour of air conditioning system operating at full and partial load scenarios.</p>					
Prerequisites: <p>Thermodynamics, Heat Transfer, Fluid mechanics, Thermal machines, and Applied Thermodynamics.</p>					
Curriculum: <ol style="list-style-type: none"> 1 – Air conditioning systems. Systems all-air, systems all-water, systems all refrigerant, hybrid systems. Systems description and operating schemas. 2- Applied psychrometrics to HVAC installations with a single zone with simultaneous control of temperature and relative humidity and with only temperature control. Psychrometric evolutions at partial load scenarios. 3- Performance and selection of HVAC equipment. Systems all-water: fancoils, radiators, radiant floor, cooled ceiling. Unitary systems: evaporative coolers, SPLIT systems, Rooftops. Systems all-refrigerant serving several zones: system MULTISPLIT and system with variable refrigerant flow. System all-air: heating coil, cooling coils, dehumidifying, heat and mass recovery, humidifiers, desiccant wheels, air handling units. Grills and diffusers. Chillers and heat pumps. Cooling towers. 4- Fluid distribution systems 					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

Air systems: duct sizing and fan selection

Water systems: piping sizing and pump selection.

Teaching and Learning Methods:

Theoretical sessions – content presentation using "power point", alternated with some practical examples..

Theoretical -practical sessions – Exercises and lab experiments

Tutorial – Explanation of doubts and support in the development of specific calculation sheets for the thermal load evaluation. Support in the elaboration of lab works.

Assessment:

11º Test (30 %) + 2º Test (30 %) + Works (30%)+Session participation TA (10 %)

or

exam (60%) + works (30%)+ Session participation TA (10 %)

Bibliography:

- Yunus A. Çengal, Michael A. Boles, Termodinâmica, McGraw Hill (3ª ed. in Portuguese);

Jones, W. P., Air Conditioning Engineering 3th Edition, 1985 - Ed. Edward Arnold

ASHRAE Handbook (1989) - Fundamentals, American Society of Heating - Refrigerating and Air Conditioning Engineers, Atlanta, GA, 1989

Cooling and Heating Load Calculation Manual, American Society of Heating, - Refrigerating and Air Conditioning Engineers, Atlanta, GA.

Manual de Ar Condicionado, Carrier Air Conditioning Company.

Stoecker, W. F. e Jones, J. W. - Refrigeração e Ar Condicionado, McGraw-Hill, 1985

McQuiston, Faye C. e Parker, Jerold D; Heating, Ventilating and Air Conditioning Analysis and Design; John Wiley & Sons, Inc. 4th Ed. 1994

Manufacturers catalogues of HVAC equipment.

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: Refrigerating Installations					
Branch(es): Thermal					
Teaching language: Portuguese					
Course chair and teaching staff: Daniel N.Cabrita					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
3	2	15L+ 30TP + 15T + 80IS	Mandatory		5
Total working hours: <div style="text-align: right;"> Classes: 45 Tutorial: 15 Field assignments: Individual study and assessment: 80 </div>					
Objectives: <ul style="list-style-type: none"> - Complementary theoretical knowledge in the field of refrigeration cycles - Provide a means of calculation that allows the design of refrigeration systems - Characterization of equipment, materials and solutions that enable the implementation of systems - Provide students with the means that will allow easy insertion and adaptation to future professional roles 					
Prerequisites: Knowledge acquired in the disciplines of Thermodynamics I, Thermodynamics II and Fluid Mechanics I					
Curriculum: Chapter 1 – The refrigeration and its applications <ul style="list-style-type: none"> 1.1 - Historical notes 1.2 - The role of refrigeration in the conservation of raw materials (food and non-food) 1.3 - Refrigeration applications on non-food field 1.4 - Basic conditions for the use of refrigeration –Monvoisin rules Chapter 2 – Application of refrigeration to food <ul style="list-style-type: none"> 2.1 - Types of microorganisms and their action in cooling chambers 2.2 - Food Basic composition 2.3 - Effect of freezing on food 2.4 - Factors that promote the development of microorganisms in food 2.5 - HACCP Chapter 3 – Thermal loads in refrigeration plants <ul style="list-style-type: none"> 3.1 - Characterization of refrigeration plants thermal loads 3.2 - Thermal loads due to infiltration and air renewal 3.3 - Calculation of thermal loads for low temperature preservation, quick cooling tunnels and freezers Chapter 4 – Insulation / Dimensioning/ Materials / Steam barriers Chapter 5 – Refrigeration Cycles <ul style="list-style-type: none"> 5.1 - Study of the theoretical refrigeration cycle. Practical refrigeration cycle 5.2 - Parametric analysis of the cycle 5.3 - Refrigeration systems with two or more stages of compression 					

⁽¹⁾ Lectures (L); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (FA); Workshops (W); Tutorials (T); Individual study (IS).

5.4 - Refrigeration fluids (refrigerants) – classification and characteristics.

Chapter 6 – Main equipment of refrigeration plants

- 6.1 - Compressors: types, characteristics and performance. Study of alternative and screw compressors
- 6.2 - Evaporators: types, characteristics and performance. Study of main evaporators with air and liquid coolers
- 6.3 - Condensers: types, characteristics and performance. Study of water, air and evaporative condensers
- 6.4 - Expansion devices: types and characteristics
- 6.5 - Refrigeration systems balance

Chapter 7 – System components selection and sizing

- 7.1 – Calculation of nominal power. Selection of main equipment
- 7.2 - Selection of control equipment and safety devices
- 7.3 - Resolution of practical cases

Teaching Methods/Procedures:

Lectures and practical classes

Tutorial classes – individual and group support for practical examples resolution

Assessment:

Written tests (2), each worth 50%, with minimal individual mark of 8 in 20 (10 as minimum average, in 20)

or

Written final global examination (10 as minimum in 20)

Bibliography:

W.B. Gosney / Principles of Refrigeration / Cambridge University Press, 1982

W.F. Stoecker, J.W. Jones / Refrigeration and Air Conditioning / Mc Graw Hill, Int. Stud. Ed., 1982

ASHRAE, Handbook of Fundamentals

ASHRAE, Handbook of Refrigeration

ASHRAE, Handbook of Equipment

P.J. Rapin / Installations Frigorifiques, Tome 2 / Pyc Edition, 1981

D.Collin / Applications Frigorifiques, vol I e vol II

Roy Dossat / Principles of Refrigeration

G.Ballot e M.Duminil / Isolation Frigorifique

⁽¹⁾ Lectures (L); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (FA); Workshops (W); Tutorials (T); Individual study (IS).

Course Unit: Maintenance Management					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Francisco Manuel Vicente Sena Teaching Staff: Francisco Manuel Vicente Sena					
Year	Semester	Working hours ⁽¹⁾	Type	Code ECTS	ECTS
3 ^o	1 ^o	15T+30TP+15OT	Obrigatória		5
Workload (hours): 140 <div style="text-align: right;"> Classes: 45 Tutorial: 20 Fieldwork: 10 Individual student assessment: 65 </div>					
Goals Know historical development of the maintenance function and its importance as an firm function; To involve and keep up to date the students with concepts and technical applied terms on maintenance and particular with its management; Know the technical terms according to European standards of maintenance; Know the fundamental principles to make a preventive maintenance plan; To understanding the structure of maintenance costs; To understanding the procedures of maintenance planning and programming; To understanding the importance of the maintenance management indicators.					
Former learning requirements:					
Course learning subjects					
<ol style="list-style-type: none"> 1. Introduction Historical development of the maintenance function; Concepts and technical terms applied in maintenance; Goals of the maintenance function and its integration in the firm goals; Maintenance strategies and its applications. 2. Preparation process of the preventive maintenance plan Definition and functional evaluation of the critical equipment to integrate in maintenance plan; Criteria to select the equipment for maintenance; How to choose the maintenance jobs. 3. Planning and programming of maintenance works Preparation of maintenance works; Programming and control of maintenance works; Application of PERT / CPM in maintenance works. 4. Maintenance costs Direct and indirect costs; Assessment of maintenance costs. 5. Maintenance management indicators Definition; Kinds of indicators (KPI); 					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

Use of indicators.

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Assessment process

1. Continuous process

1 written test on all course program meaning 35% of total evaluation;
1 written work formed by two modules delivered to students along the semester. This work amounts to 60% of the course evaluation;
1 report on field trips amounts to 5% of the course evaluation;
All students must to achieve at least 8 points either the written test and the written work to avoid the final examination;
To be exempt of the final term examination all students must achieve at least 10 points;
The continuous evaluation will be quoted from 0 to 20 points.

2. Final term examination

Final term examination which will be quoted from 0 to 20 points.

Bibliography

- Cabral, A. S. – Organização e Gestão da Manutenção, Lidel
- EN NP13306 – Terminologia de Manutenção
- EN 13460 – Documentos para a Manutenção
- Fernández, F. – Teoría y Práctica del Mantenimiento Industrial Avanzado, FC Editorial, 2003
- Ferreira, L.A. – Uma introdução à Manutenção, Publindústria, 1998
- Gaither, N. e Frazier, G. – Operations Management, Thomson Learning, 2002
- Garrido, S.G. – Organización y Gestión Integral de Mantenimiento, Diaz de Santos, 2003
- Monchy, F. – Maintenance, Dunod, 2003

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: Computer Aided Manufacturing					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: César Gonçalves Teaching Staff: César Gonçalves					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
3 ^o	1 ^o	30 TP + 15 P + 15 OT	Required		5
Workload (hours): 140 <div style="text-align: right;"> Classes: 45 Tutorial: 15 Fieldwork: Individual Work and Assessment: 80 </div>					
Objectives: <p>The discipline aims of Computer Aided Manufacturing, is to convey a set of basic knowledge in advanced technologies for work preparation, production and manufacturing. It is intended to develop students skills in preparation, programming and use of CNC machine tools for optimizing the performance of manufacturing processes.</p>					
Prerequisites: Mechanical Technology II					
Curriculum: 1 – INTRODUCTION - Numerical control machine tools - Preparation of work With a module 1, the student acquires knowledge about general characteristics of numerical control machine tools and preparation work for this type of machines. 2 – CNC MACHINE TOOLS - CNC machine tools - CNC control systems - Controllable systems of CNC machines (shafts, fixing, tool change, cooling, lubrication, ...) - Axis system - Origin of coordinates - Number of axes					

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

- Coordinate systems

With the second module, the student acquires knowledge about specific CNC machine tools.

3 – PREPARATION OF WORK FOR CNC MACHINES

- Determination of the tool trajectory
- Tool movement

With the third module, the student acquires knowledge and skills to develop the required preparation work to manufacture parts on CNC machines (lathe and milling machine).

4 – NUMERICAL CONTROL (Manual programming)

- Code G
- Program construction (lathe and milling machine)

With the fourth module, the student acquires knowledge and skills to develop G-code programs resulting from the preparation of work previously done.

5 – NUMERICAL CONTROL (Computer Aided Programming)

- Use of software for building programs.

With the module 5, the student acquires knowledge and skills to develop programming using specific software for CNC machines.

Teaching and Learning Methods:

Theoretical-practical and practical lessons, tutorials lessons for developing work preparation, G-code programs and use of appropriate software.

Assessment:

Conducting a test of frequency (40%) and a set of practical work preparation, G-code programs and use of suitable software for the manufacture of mechanical parts on CNC lathes and milling machines (60%).

Bibliography:

(I) - Lecture notes.

(ii) - Machine manuals.

(iii) - Comando Numérico Aplicado às Máquinas – Ferramenta. Eng. A. Machado. Ed. Icone, Brasil 1986.

(iv) - CIM. Principles of Computer Integrated Manufacturing. J. Waldner. Ed. Wiley, England 1992.

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: / Machine elements II					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Manuel Carlos Mestre Nunes Teaching Staff: Manuel Carlos Mestre Nunes					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
3 ^o	1 ^o	30 T + 15 TP + 15 OT	Compulsory		5
Workload (hours): 140 <div style="text-align: right;"> Classes: 45 Tutorial: 15 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: Acquisition of knowledge in the area of machine elements: Bearings, Belt drives, chain drives and gear drives. Basics of static and fatigue design, selection and design of mechanic elements.					
Prerequisites: Knowledge is required on “Mechanics of Materials”					
Curriculum: 1. Bearings: Different types of bearings; Bearing selection. 2. Belt drives, chain drives, and gear drives. Design, selection principles 3. Clutches, brakes, Couplings: Classification, selection and design.					
Teaching and Learning Methods: Classes theory (T): Explanation of theory. classes (TP): Examples of problem solving. Tutorials (OT): Clarification of doubts during problem solving by students.					
Assessment: Test (80%) or exam (80%) Individual works with reports (20%) Minimum pass mark for written test (or exam) is 8,0 and for reports 8,0. Final mark (NF) is calculated as follows: Written test (or exam) 80% (NE) and reports 20% (NP). $NF = 0,80 NE + 0,20 NP$ Final mark of 10.0 (ten) or higher in the NF.					
Bibliography: Mechanical Engineering Design. Shigley, Joseph E., Mischke, Charles R., McGraw-Hill , 6ª Edição, 2001. - Fundamentals of Machine Elements. Hamrock, Bernard J., Jacobson, Bo, Schmid, Steven R., McGraw-Hill, 1999. - Mechanical Design of Machine Elements and Machines. Jack A., Wiley, 2003 - Mecânica dos Materiais. Branco, C. M., Fundação Calouste Gulbenkian, 1985					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

- Catálogo Geral, SKF Portugal, Lisboa.
 - Calcul des assemblages par elements filetés – Encyclopedie de l'ingenieur
 - Regulamento de estruturas de aço para edifícios
 - Fadiga de estruturas soldadas – C. Moura Branco – Gulbenkian
- Projecto de Órgãos de Máquinas – C. Moura Branco – Gulbenkian

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: Structural Analysis					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Manuel Carlos Mestre Nunes Teaching Staff: Manuel Carlos Mestre Nunes					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
3 ^o	2 ^o	15 T + 30 TP + 15 OT	Compulsory		5
Workload (hours): 140 <div style="text-align: right;"> Classes: 45 Tutorial: 15 Fieldwork: 0 Individual Work and Assessment: 80 </div>					
Objectives: <p>Acquisition of knowledge in the area of structural analysis methods and to further develop the students' ability to reason, think and to apply them to solve statically indeterminate structures. Besides the practical aspects on structural analysis, advanced theoretical knowledge shall be transmitted.</p>					
Prerequisites: <p>Knowledge is required on “Mechanics of Materials” and “Fisics”</p>					
Curriculum: <ol style="list-style-type: none"> 1. Introduction to the analysis of structures. 2. Stability of columns and frames, Curved Beams Engineering. 3. Castigliano's Theorem and Reciprocity on Curved Beams Engineering. 4. Elastic stability: Euler's elastic stability. Concepts and models of stability. Stability of columns and frames. 5. Plate Theory: Classical formulation. Plates bending. Resultant loads. Normal and shear stress distribution. Deflections and displacements. Equilibrium equations. Analytical methods: rectangular plates. Analytical methods: circular plates. Variational formulation: Rayleigh-Ritz direct technique. 6. Introduction to Mohr's circle and its derivation for the state of plane stress, Stresses on Thin-walled Pressure Tanks. 7. Finite Element Method: Finite element method for static analysis of beams and portal frames. Internal forces. (optional) 					
Teaching and Learning Methods: <p>Classes theory (T): Explanation of theory. classes (TP): Examples of problem solving. Tutorials (OT): Clarification of doubts during problem solving by students.</p>					
Assessment:					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

1 Test (75%) or exam (75%)
Individual works with reports (30%)
Minimum pass mark for written tests (or exam) is 8,0 and for reports 8,0.
Final mark (NF) is calculated as follows:
Written test (or exam) 75% (NE) and reports 25% (NP).
 $NF = 0,75 \times NE + 0,25 \times NP$
Final mark of 10.0 (ten) or higher in the NF.

Bibliography:

- Principles of tribology – J. Halling – Macmiller Education
- Benlloch, M. (1990); Los Lubrificantes, CEAC, Barcelona
- Benlloch, M. (1984); Lubrificantes y lubricación aplicada, CEAC, Barcelona
- Silva, P. (1985) ; Tribologia, Fund. Calouste Gulbenkian, Lisboa
- S. A. (2000); BP – Lubrificantes: Produtos e características, CD multimédia, BP Portugal
- Elementos de máquinas – Nieman
- Elementos de máquinas – Shigley
- Fadiga – Mecânica dos materiais – C. Moura Branco – Gulbenkian
- Calcul des assemblages par elements filetés – Encyclopedie de l'ingenieur
- Regulamento de estruturas de aço para edifícios
- Fadiga de estruturas soldadas – C. Moura Branco – Gulbenkian

Projecto de Órgãos de Máquinas – C. Moura Branco – Gulbenkian

⁽¹⁾ Lectures (**T**); Theoretical and Practical (**TP**); Practical and Laboratory (**PL**); Field Assignments (**TC**); Workshops (**S**); Tutorials (**OT**); Individual study (**TA**).

Course Unit: Mechanical Technology II					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: César Gonçalves Teaching Staff: César Gonçalves					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
2º	2º	30 TP + 15 P + 15 OT	Required		5
Workload (hours): 140 <div style="text-align: right;"> Classes: 45 Tutorial: 15 Fieldwork: Individual Work and Assessment: 80 </div>					
Objectives: <p>This course unit has as general objectives:</p> <p>1 - Provide a theoretical and theoretical-practical knowledge of welding processes. With practical classes, intended to raise awareness of the practical concepts of welding procedures through the implementation of practical works using the existing equipment in the workshops.</p> <p>2 - Provide a theoretical and theoretical-practical knowledge of metallic materials mechanical processing, present the theoretical foundations of the cutting chipping theory and stamping. It is intended to inform practical concepts of cutting processes, bending and folding using the existing tools-machines in the workshops of the Department.</p>					
Prerequisites:					
Curriculum: <p>1 – CHIPPING CUT Cutting parameters Cutting operations/ cutting tools Optimization criteria for cutting Tooling-Machines</p> <p>2 - STAMPING Matrices and punches Folding Burglary cut Embeding</p>					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

Selection of presses

3 - WELDING

Electrodes, techniques, and Arc Welding manual procedures of steels with low carbon.

Materials and equipment for cutting and gas welding.

Equipments and technology of the oxygen lance cutting, with and without strippers.

Electric arc welding and its application.

Basic notions about the metallurgical process arc welding.

Gas arc welding of carbon steels and with alloy.

Gas arc welding of non-ferrous metals.

Welding equipment and technology of semi-automatic electric arc welding and TIG.

Defects in welded joints.

Quality control of welded joints.

Teaching and Learning Methods:

Theoretical, theoretical-practical and tutorials lessons with the completion of:

- 2 works of chipping cut (lathe + mill + filers + mill drill)
- 1 work of sheet
- 1 work of welding

Assessment:

- Two test of frequency (1º and 3º chapters).
- Four (4) practical work.
- 50% works note + 50% tests notes.
- Minimum tests notes, 8.0 values in each test.
- The works are required and are conducted in the practical classes.
- The student must obtain a minimum note of 10 values on average of 4 practical works to obtain frequency and be admitted to exam.
- The final note: 50% works note + 50% exam note

Bibliography:

- Estampas a frio de la chapa - MARIO ROSSI
- Tecnologia mecânica - 3 VOL. - V. CHIAVERINI
- Soldadura eléctrica e a gás - RYBACOV
- Procedes de jonction - TRIIOULEYRE
- Guia do utilizador de soldadura manual - SAF
- Arco eléctrico e apontamentos de soldadura - IST
- Tecnologia de los procesos de soldadura - P. T. HOULDCROFT WELDING HANDBOOK
- Lectures notes – CÉSAR GONÇALVES
- Sebenta processos de soldadura – EST – CÉSAR GONÇALVES

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).

Course: Condition-based maintenance					
Branch: Management and Industrial Maintenance					
Learning language: Portuguese					
Year	Semester	Contact classes ⁽¹⁾	Compulsory / Not compulsory	ECTS code	ECTS
3 ^o	2 ^o	15T+15TP+ 15PL+15OT	Compulsory		5
Total contact hours: 140 <div style="text-align: right;"> Classes: 45 Tutorial: 20 Field trip report: 10 Individual homework assignments and evaluation: 65 </div>					
Course learning objectives Understand the importance of condition-based maintenance in maintenance strategies framework; To know and understand the most relevant techniques in condition-based maintenance; To transfer the fundamental theoretical and practical knowledge required to implement the vibration and thermography techniques in condition-based maintenance; Understand the root cause failures of equipment by vibration analysis.					
Prerequisites: Physics I, Mathematics I and Mathematics II					
Course major topics:					
<ol style="list-style-type: none"> 1. Introduction Fundamental concepts and definitions of condition-based maintenance. Advantages and justification of condition based-maintenance in preventive maintenance programs. 2. Measurement, analysis and control of equipment vibrations Basics of vibration analysis; Signal processing; Root causes of vibration in equipment; Dynamic response of equipment; Methodology of vibrations analysis. 3. Vibrations associated to failures in machinery Type of failures in machinery; Effects resulting of looseness, unbalance and misalignment. Selection of the measurement locations and applications. 4. Thermography Theoretical basics; Applications in real cases. 					

⁽¹⁾ Ensino teórico (T); Teórico-prático (TP); Prático e laboratorial (PL); Trabalho de campo (TC); Seminário (S); Orientação tutorial (OT); Trabalho individual do aluno (TA).

Grading

1. Continuous grades

Two written tests: 45% of total;

Two practical assignments on vibrations and thermography: 50% of total;

One field trip report: 5% of total;

Final grade will be based on an absolute scale from 0 to 20.

2. Final grade

Final exam grade will be based on an absolute scale from 0 to 20.

References

- Girdhar, P. – **Practical Machinery Vibration Analysis and Predictive Maintenance**, Elsevier/Newnes, 2004.
- León, F.C.G. – **Tecnología del Mantenimiento Industrial**, Universidad de Murcia, 1998.
- Hunt, T.M. – **Condition Monitoring of Mechanical and Hydraulic Plant**, Chapman & Hall, 1996.
- Mobley, K. – **An introduction to Predictive Maintenance**, Butterworth-Heineman, 2002.
- Mobley, K. – **Root Cause Failure Analysis**, Newnes, 1999.
- Morel, J. – **Surveillance Vibratoire et Maintenance Prédictive**, Techniques d'Ingénieur.
- Nepomuceno, L.X. – **Manutenção Preditiva em Instalações Industriais**, Editora Edgard Blucher LTDA.
- **Standard ISO 10860-1 and 2.**
- Rao, S. – **Mechanical Vibrations**, Addison-Wesley.

⁽¹⁾ Ensino teórico (T); Teórico-prático (TP); Prático e laboratorial (PL); Trabalho de campo (TC); Seminário (S); Orientação tutorial (OT); Trabalho individual do aluno (TA).

Course Unit: Project					
Department: Mechanical Engineering Department Programme: 1 st Cycle in Mechanical Engineering Scientific Area: Mechanical Engineering Specialisation in: Thermal; Management and Industrial Maintenance Teaching language: Portuguese Course Unit Chair: Celestino Rodrigues Ruivo ? Teaching Staff: Celestino Rodrigues Ruivo					
Year	Semester	Contact hours ⁽¹⁾	Type	Code ECTS	ECTS
3rd	2nd	15TP+30OT	Obligatory		10
Workload (hours): <div style="text-align: right;"> Classes: 15 Tutorial: 30 Fieldwork: 0 Individual Work and Assessment: 235 </div>					
Objectives: The student should apply the acquired knowledge in previous course units in the conception and sizing of mechanical systems related to the structures area and conception of programs related to management and industrial maintenance					
Prerequisites:					
Curriculum: Module 1: structures in mechanical engineering Module 2: management and industrial maintenance in mechanical engineering					
Teaching and Learning Methods: Resolution of two case studies, each one related to each module.					
Assessment: 1st case study (50%) + 2nd case study (50%) The presence in classes must be higher than 75%					
Bibliography: Indicated by the professors affected to each module.					

⁽¹⁾ Lectures (T); Theoretical and Practical (TP); Practical and Laboratory (PL); Field Assignments (TC); Workshops (S); Tutorials (OT); Individual study (TA).