A - General Description

Course Title – Bio-resources Technology

Qualification Awarded – Bachelor's degree (Licenciatura) (180 credits)

Admission Requirements - General Application for Admission to Higher Education, re-enrolment and mature applications. National examinations in one of the following disciplines: Biology and Geology; Physics and Chemistry; Mathematics.

Educational and Professional Goals – The Bio-resources Technology program is a first-cycle degree (Licenciatura) aiming at providing the students with higher-level education directed towards optimized use and processing of natural resources with a special emphasis on sectors such as forests, mineral, paper and renewable energies (biofuels). It is designed so as to allow a rapid integration in the labour market, both at national and international level. In its design special focus has been given to emerging areas within this particular field of knowledge. The main goals of this degree are, therefore: to deliver higher-level skilled technical staff to perform functions in the industry, services and public administration; deliver high-qualified staff with teaching skills; create competences for activities related with project development and auditing, research, process control and monitoring, among others.

Access to further studies - The first-cycle degree in Bio-resources Technology allows access to second-cycle programmes in such fields as Biotechnology, Chemical Technology, Biochemistry, Energy and Environment and other areas as according to admission requirements set forth for those programmes.

Course structure diagram with credits (60 per year) - Three-year programme (six semesters in total, 30 ECTS credits each):

Course Title	Year	Semester	Number of credits
Mathematical Analysis I	1	1	6.0
Linear Algebra	1	1	5.0
General Chemistry	1	1	5.5
Physics and Technology of Materials	1	1	5.0
Geosciences	1	1	4.0
Forestry Resources	1	1	4.5
Mathematical Analysis II	1	2	6.0
Organic Chemistry	1	2	5.5
Inorganic Chemistry	1	2	5.5
Ecology and Biological Sciences	1	2	4.5

Fluid Mechanics	1	2	4.0
Probability and Statistics	1	2	4.5
Natural Polymers	2	1	5.5
Chemical and Biological Processes	2	1	5.0
Chemical Thermodynamics	2	1	5.0
Biotechnology	2	1	5.0
Physical Chemistry	2	1	4.5
Process Simulation	2	1	5.0
Cellulose and Paper I	2	2	6.0
Renewal Energy and Water Resources	2	2	5.0
Technology and Chemical Reactors	2	2	4.5
Transport Phenomena	2	2	5.0
Process Control	2	2	4.5
Geographic Information Systems (optional)	2	2	5.0
General Microbiology (optional)	2	2	5.0
Statistical Thermodynamics (optional)	2	2	5.0
Biodegradable Polymers (optional)	2	2	5.0
Chemical and Biological Analysis (optional)	2	2	5.0
Biological Reactors	3	1	5.5
Cellulose and Paper II	3	1	6.0
Management and Sustainable Development	3	1	4.5
Biofuels	3	1	4.0
Waste Treatment	3	1	5.0
Chemistry of Solutions (optional)	3	1	5.0
Process Optimization (optional)	3	1	5.0
Hydrology (optional)	3	1	5.0
Economy and Environmental Policies (optional)	3	1	5.0
Enzyme Engineering (optional)	3	1	5.0

Quality Control	3	2	5.0
Recycling, Recovery and Reuse	3	2	5.0
Health and Safety	3	2	3.0
Seminar	3	2	7.0
Natural Resources Management (optional)	3	2	5.0
Paper Coating and Processing (optional)	3	2	5.0
Special Papers (optional)	3	2	5.0
Surfaces and Interfaces (optional)	3	2	5.0
Nanotechnologies (optional)	3	2	5.0
Certification (optional)	3	2	5.0
Cogeneration (optional)	3	2	5.0
Tribology (optional)	3	2	5.0
Process Systems Engineering (optional)	3	2	5.0

Final examination, if any – not applicable

Examination and assessment regulations – final examination no required; examination and assessment defined for each individual course unit

ECTS departmental co-ordinator – Prof. Henrique J.O. Pinho (hpinho@ipt.pt)

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	B - Description of individual course units
Course title	Mathematical Analysis I
Course code	83291
Type of course	One-semester course
Level of Course	I
Year of study	First
Semester/trimester	First
Number of credits	6.0
Name of lecturer	Cristina Costa / Lígia Rodrigues
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Provide the basic concepts and mathematical methods usually used in this engineering degree. Provide the students with skills to work with differential and integral calculus in one real-variable functions.
Prerequisites	NA
Course contents	1 - Preliminaries. 2 - Real functions of a real variable. 3 - Limits and continuity. 4 - Differential calculus 5 - Integral calculus.
Recommended reading	Texts and support material available in the course web page. Jaime Carvalho e Silva; "Princípios de Análise Matemática Aplicada". McGraw-Hill. Swokowski, E. W.; "Cálculo com Geometria Analítica". McGraw-Hill. Piskounov, N.; "Cálculo Diferencial e Integral". Ed. Lopes da Silva. Simmons, G. F.; "Cálculo com Geometria Analítica". McGraw-Hill. Anton, Howard; "Cálculo um novo horizonte. Volume I". Bookman. Stewart, James; "Cálculo. Volume I". Pioneira. Larson, Ron; "Cálculo. Volume I". 8ª Edição. McGraw-Hill.
Teaching methods	Theoretical lectures, with presentation and illustration of the proposed subjects. Theoretical-practical lectures to propose and solve exercises.
Assessment methods	Continuous assessment: two written tests. Exam assessment: one written test.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Linear Algebra
Course code	83292
Type of course	One-semester course
Level of Course	NA
Year of study	First
Semester/trimester	First
Number of credits	5.0
Name of lecturer	Carlos Perquilhas / Pedro Carrasqueira
Objectives of the course (preferably expressed in terms of learning outcomes competences)	The students will be provided with knowledge of Matrix Algebra applied to discussion and resolution of linear equation systems as well as some concepts of vector spaces, determinants, values and eigen values. These are certainly topics of utmost interest in most technology sectors.
Prerequisites	NA
Course contents	Matrices and linear equation systems. Vector spaces. Determinants. Values and eigen values.
Recommended reading	Support material available at IPT e-learning platform. F. Dias Agudo, Introdução à Álgebra Linear e Geometria Analítica, Escolar Editora, Lisboa, 1978. E. Giraldes, P. Smith, Curso de Àlgebra Linear e Geometria Analítica, Mcgraw-Hill, Lisboa, 1995. L. T. Magalhães, Álgebra Linear como Introdução à Matemática Aplicada, Texto Editora, 1989. W. Nicholson, Linear Algebra with Applications, PWS Publishing Company, Boston, 1995.
Teaching methods	Lectures and theoretical/practical classes providing concepts illustrated by case studies.
Assessment methods	Continuous assessment: two written mid-term tests. Final assessment: one written test comprising all matters studied.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	General Chemistry
Course code	83293
Type of course	One-semester course
Level of Course	NA
Year of study	First
Semester/trimester	First
Number of credits	5,5
Name of lecturer	Valentim Maria Brunheta Nunes / Marco António Cartaxo
Objectives of the course (preferably expressed in terms of learning outcomes competences)	To learn and develop basic knowledge of the principles of chemistry, relevant to the other Courses. Stimulate the study of chemistry as a Science and show its importance for Industry and Society, particularly to the activity of future Bio-resources technicians.
Prerequisites	NA
Course contents	Chemical tools. Atoms, molecules and ions. Chemical reactions and stoichiometry. General principles of chemical reactivity. The structure of atoms and molecules. Electron configuration and periodic relationships among the elements. Chemical bonding. Molecular geometry. Physical states of matter. Gases. Intermolecular forces, liquids and solids. Solutions and physical properties of solutions. Chemical equilibrium. Acid-base equilibria. Solubility equilibria.
Recommended reading	Chang, R., Química, 8ª ed., McGraw-Hill, Lisboa, 2005 Atkins & Jones, Chemistry: Molecules, Matter and Change, 4th ed.; Freeman&Co., 1997 Kotz & Treichel, Chemistry & Chemical Reactivity, 5th ed., Thomson Books, 2003
Teaching methods	Lectures and tutorials with resolution of applied exercises and practical execution of laboratorial activities.
Assessment methods	Final written exam and laboratory reports.
Language of instruction	Portuguese.

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	B - Description of individual course units
Course title	Physics and Technology of Materials
Course code	83294
Type of course	One-semester course
Level of Course	NA
Year of study	First
Semester/trimester	First
Number of credits	5.0
Name of lecturer	Isabel Nogueira
Objectives of the course (preferably expressed in terms of learning outcomes competences)	The students will study different types of structural materials at physics level, which explains the behaviour of materials, and at manufacturing and materials properties and wear level.
Prerequisites	General knowledge.
Course contents	**Physics**: Atomic structure of matter; Conservation laws; Electromagnetic fields; Electromagnetic properties of materials. **Materials Technology**: Basic principles; Structural materials and its manufacturing; Materials Tests and Properties; Types of degradation in Materials with industrial applications.
Recommended reading	W. F. Smith, "Princípios de Ciência e Engenharia dos Materiais", McGraw-Hill, Lisboa (1998) ISBN 972-8298-68-4 W. D. Callister, Jr., "Materials Science and Engineering an introduction", J. Wiley & Sons (2003), ISBN 0-471-22471-5 J. P. Davim, A. G. Magalhães, "Ensaios Mecânicos e Tecnológicos", Estante Editora, Aveiro (1992) D. F. MOORE, "Principles and Applications of Tribology", International series in materials science and technology vol. 14, Pergamon Press, Oxford, 1975, ISBN 0 08 019007 3
Teaching methods	Lectures and theoretical-practical sessions including exercise solving.
Assessment methods	Open-book written test during regular or retake examination periods.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Geosciences
Course code	83295
Type of course	One-semester course
Level of Course	NA
Year of study	First
Semester/trimester	First
Number of credits	4.0
Name of lecturer	Stefan Rosendahl
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Develop skills to identify the main types of minerals and rocks, interpret external and internal processes of the earth, read geological maps and apply acquired knowledge to new situations.
Prerequisites	Basics of inorganic chemistry and physics.
Course contents	1 – The structure of the earth, Seismology 2 – Mineralogy 3 – Magmatic, sedimentary and metamorphic rocks 4 – Meteorization 5 – Erosion, transport and deposition processes 6 – Metamorphism 7 – Tectonics and Plate Tectonics 8 – Geohistory 9 – Geological resources: metallic and non-metallic, oil 10 – Prospection and exploration of geological resources
Recommended reading	GALOPIM DE CARVALHO, A.M. (3 livros): Morfogénese e Sedimentogénese (1996), Cristalografia e Mineralogia (1997), Geologia – Petrogénese o Orogénese (1997). – Todos: Univ. Aberta. WYLLIE, P.: A Terra, Nova geologia Global. – Gulbenkian (1982). COSTA, J. BOTELHO: Estudo e classificação das rochas por exame macroscópico. – Gulbenkian (1950).
Teaching methods	Lectures: Topic presentation and discussion. Practical classes: Analysis of rock samples and geological maps.
Assessment methods	Mid-term assessment: two written tests. Final assessment: one written test.
Language of instruction	Portuguese.

	B - Description of individual course units
Course title	Forestry Resources
Course code	83296
Type of course	One-semester course
Level of Course	NA
Year of study	First
Semester/trimester	First
Number of credits	4.5
Name of lecturer	Cecília Baptista / Natércia Santos
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Study of the forest and its main products. Industrial and energetic production. Skills to develop a sustainable forest management.
Prerequisites	NA
Course contents	1. Forest – biodiversity, multiple uses and resources values. 2. Forestry products – characterization and application. 3. Wood, fibre and cork properties. 4. Forest management to sustainable development. 5. Biorefinery concept. 6. Biomass – production of bioenergy and other products.
Recommended reading	Direcção Geral dos Recursos Florestais (2007) Estratégia nacional para as florestas, Ed. I.N.- C.M., Lisboa. Davis, L., Johnson, K.N., Bettinger, P. e Howard, T.E. (2005) Forest management to sustain ecological, economic and social values, 4th ed. McGraw-Hill, New York. Hortal, J.A.G. (2007) Fibras Papeleras, Ed. UPC, Terrassa. Torres, L.O. (2006) La biomasa como fuente de energia renovable, Ed. Gamesal, D.L., U. Vigo, Vigo.
Teaching methods	Theoretical lessons. Theoretical/practical lessons – case studies and exercises resolution. Laboratorial lessons – forestry products characterization.
Assessment methods	Laboratorial and search reports. Theoretical written test.
Language of instruction	Portuguese

	B - Description of individual course units
Course title	Mathematical Analysis II
Course code	83297
Type of course	One-semester
Level of Course	II
Year of study	First
Semester/trimester	Second
Number of credits	6.0
Name of lecturer	Cristina Costa / Carlos Perquilhas
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Provide the basic concepts and the mathematical methods commonly used in this engineering course. Equip the students with skills to work with differential and integral calculus in functions of several real variables.
Prerequisites	NA
Course contents	1- Numerical and Functions Series. 2- Real functions of several real variables. 3- Multiple Integrals.
Recommended reading	Texts and support material available in the course web page. Jaime Carvalho e Silva; "Princípios de Análise Matemática Aplicada". McGraw-Hill. Swokowski, E. W.; "Cálculo com Geometria Analítica". McG-Hill. Piskounov, N.; "Cálculo Diferencial e Integral". Ed. Lopes da Silva. Simmons, G. F.; "Cálculo com Geometria Analítica". Mc Graw-Hill. Anton, Howard; "Cálculo um novo horizonte. Volume II". Bookman. Stewart, James; "Cálculo. Volume II". Pioneira. Larson, Ron; "Cálculo. Volume II". 8ª Edição. McGraw-Hill. Zill D., Cullen M.; "Advanced Engineering Mathematics".PWS Azenha A., Jerónimo M., "Cálculo Diferencial e Integral em R e R^n" McGraw-Hill.
Teaching methods	Lectures with presentation and exemplification of the proposed subjects. Theoretical-practical sessions where exercises are proposed and solved.
Assessment methods	Continuous assessment: two written tests. Final assessment: one written test.
Language of instruction	Portuguese

	B - Description of individual course units
Course title	Organic Chemistry
Course code	83298
Type of course	One-semester course
Level of Course	NA
Year of study	First
Semester/trimester	Second
Number of credits	5.5
Name of lecturer	Cecília Baptista / Marco Cartaxo
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Acquisition of knowledge about the structure, bonding and reactions in organic molecules. Introduction to reaction mechanisms and its representation. Study of the main categories of monofunctional organic compounds.
Prerequisites	Basic foundations of the properties of chemical elements and bonding.
Course contents	Structure and bonding in organic molecules. Reactants and reactions in organic chemistry. Electronic approach of the reactions and intermediates. Hydrocarbons: structure, physical properties, nomenclature reactivity and reactions (alkanes, alkenes, alkynes, aromatic hydrocarbons). Other organic compounds: structure, physical properties, nomenclature reactivity and reactions (alkyl halides, alcohols, thiols, ethers, phenols, amines, aldehydes, ketones, carboxylic acids and its derivatives).
Recommended reading	Vollhardt, K.P.C.; Schore, N.E. - "Organic Chemistry – Structure and Function", 3ª ed., W.H. Freeman & Co., New York, 1999. Carey, F.A., "Organic Chemistry", 6ª ed., Mc-Graw-Hill International Edition, New York, 2006. Campos, L. S.; Mourato, M. – "Nomenclatura dos compostos orgânicos", Escolar Editora, Lisboa, 1999.
Teaching methods	Theoretical classes focusing on the properties and reactions of monofunctional organic compounds. Practical classes to solve applied problems. Laboratorial sessions involving practice of such processes as synthesis, purification and analysis of these compounds.
Assessment methods	Laboratorial assessment and mid-term test or final exam.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Inorganic Chemistry
Course code	83299
Type of course	One-semester course
Level of Course	NA
Year of study	First
Semester/trimester	Second
Number of credits	5.5
Name of lecturer	Valentim Maria Brunheta Nunes / Marco António Cartaxo
Objectives of the course (preferably expressed in terms of learning outcomes competences)	To learn and develop basic knowledge of the principles of chemistry, relevant for the other Courses. Stimulate the study of chemistry as a Science and show their importance for Industry and Society, particularly to the activity of future Bio-resources technicians.
Prerequisites	NA
Course contents	Theories of chemical bonding. Valence Bond Theory and Molecular Orbital Theory. Electrochemistry. Review of redox reactions. Metallurgy and the chemistry of metals. Bonding in metals and semiconductors. Non-metallic elements and their compounds. Transition metal chemistry and coordination compounds. Crystal field theory. Nuclear chemistry. Nuclear stability and radioactivity. Nuclear transformations and energy.
Recommended reading	Chang, R., Química, 8ª ed., McGraw-Hill, Lisboa, 2005 Atkins & Jones, Chemistry: Molecules, Matter and Change, 4th ed.; Freeman&Co., 1997 Kotz & Treichel, Chemistry & Chemical Reactivity, 5th ed., Thomson Books, 2003
Teaching methods	Lectures and tutorials with resolution of applied exercises and practical execution of laboratorial activities.
Assessment methods	Final written exam and laboratory reports.
Language of instruction	Portuguese.

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	B - Description of individual course units
Course title	Ecology and Biological Sciences
Course code	832910
Type of course	One-semester course
Level of Course	NA
Year of study	First
Semester/trimester	Second
Number of credits	4.5
Name of lecturer	Luis Filipe Neves Carreira dos Santos
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Acquisition of skills to: understand ecological concepts; understand the significance of the balance of ecosystems; be able to calculate diversity and environmental quality rates based on the interpretation of natural data and make decisions.
Prerequisites	Biology and English at high school level and basic statistics.
Course contents	1 Ecological Principles; 2 Communities; 3 Ecosystems; 4 Population Dynamics; 5 Feeding Territory and Biological resources; 6 Island Biogeography; 7 Environmental Problems; 8 Water quality bio-indicators
Recommended reading	Campbell - *Biology 3rd Edition*, 1994 Sacarrão, G.F., 1991; *Ecologia e Biologia do ambiente*. Cunningham, W., Saigo, B. 1999, Environmental Science Fifth Edition, WCB/McGraw-Hill Provini, A., Galassi, S., Marchetti, R. 2003, Ecologia applicata, Società Italiana di Ecologia, Città Studi Edizioni. Odum, E.P. 2004, Fundamentos de Ecologia, Gulbenkian
Teaching methods	Lectures, Tutorials and Practice.
Assessment methods	50% written exam and 50% assignments.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Fluid Mechanics
Course code	832911
Type of course	One-semester course
Level of Course	NA
Year of study	First
Semester/trimester	Second
Number of credits	4.0
Name of lecturer	Paula Alexandra Geraldes Portugal
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Provide the physical principles of the fluid mechanics. To develop skills to carry out calculations with Newton's law, basic law of hydrostatics, law of continuity of flows, equation of Bernoulli, continuous loss of energy, and power of pumps and turbines.
Prerequisites	Background knowledge on physics, algebra and mathematical analysis.
Course contents	1 – Physical properties of fluids. 2 – Basic law of the hydrostatics and his application to several systems. 3 – Interpretation and application of the law of continuity of flows. 4 – The general equations of flows, the equations of Navier-Stokes, the equation of Bernoulli and its applications. 5 – Concepts of energy and power of flows. Loss of energy. Pumps and Turbines.
Recommended reading	Giles, R.; "Mecânica dos Fluidos e Hidráulica"; McGraw-Hill Quintela, C.; "Hidráulica"; Fundação Calouste Gulbenkian White, F.; "Fluid mechanics" McGraw-Hill Bird, R. et al; "Transport Phenomena", John Wiley&Sons
Teaching methods	Theoretical sessions in which the concepts and laws of mechanics of fluids are provided and theoretical-practical sessions where exercises are proposed and solved by the students under the lecturer's supervision.
Assessment methods	Written examinations divided into a theoretical component including "true" or "false" questions (5 values) and a practical component including exercise solving (15 values)
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Probability and Statistics
Course code	832912
Type of course	One-semester course
Level of Course	NA
Year of study	First
Semester/trimester	Second
Number of credits	4.5
Name of lecturer	Lígia Rodrigues
Objectives of the course (preferably expressed in terms of learning outcomes competences)	The goal of this course is to provide the students with the basic foundations of some of the main techniques and methodologies of Statistics, so that they develop analysis and reasoning skills that will allow them to design and implement solutions to various problems. By doing this, they will also be provided with tools that facilitate decision-making.
Prerequisites	Knowledge of previous Mathematical Analysis and Linear Algebra modules.
Course contents	1 - Elements of probability. 2 - Random variables. Some probability distributions. 3 - Sampling and sample distributions. 4 - Estimation of parameters. 5 - Tests of hypotheses. 6 - Correlation and simple linear regression.
Recommended reading	Texts and material support available on the course website. Guimarães, Rui C. e Cabral, José A. S. (2007). *Estatística*. 2.ª Edição, McGraw-Hill. Pedrosa, A. C. e Gama, S. M. A. (2004). *Introdução Computacional à Probabilidade e Estatística*. Porto Editora.
Teaching methods	Theoretical classes presenting and illustrating the concepts and methods taught. Theoretical-practical sessions where exercises are solved. Tutorial classes making use of software for the statistical treatment of data.
Assessment methods	Continuous assessment: two mid-term tests; final exam: regular exam periods and recovery exam.
Language of instruction	Portuguese

	B - Description of individual course units
Course title	Natural Polymers
Course code	832913
Type of course	One-semester course
Level of Course	NA
Year of study	Second
Semester/trimester	First
Number of credits	5.5
Name of lecturer	Cecília Baptista / Teresa Silveira
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Structure and properties of macromolecular materials. Physiologically active polymers of vegetable or animal origin. Special focus to polysaccharids and proteins. Brief study of other natural organic polymers and its synthetic derivatives.
Prerequisites	Basics of organic chemistry.
Course contents	1 – Structure and properties of macromolecular compounds. 2 – Physiologically active polymers of a natural origin: polysaccharids, proteins and polynucleotides. 3 – Composition, structure and properties of some natural polymers with emphasis to cellulose. Preparation of synthetic derivatives. 4 – Amino acids and protein synthesis. Natural and regenerated proteins. 5 – Other organic polymers of a natural origin – rubber, lignin, amber. Relevant commercial applications.
Recommended reading	Stevens, M.P. (1999) "Polymer Chemistry – An Introduction", 3rd ed., Oxford University Press, Inc., USA. Quintas, A., Freire, A.P. e Halpern, M.J. (2008) "Bioquímica – Organização Molecular da Vida", 1ª ed., Lidel, Lisboa. Kamide, K. (2005) "Cellulose and Cellulose Derivatives", Polymer Science Library, Elsevier,B.V.
Teaching methods	Lectures. Laboratory sessions involving extraction and analysis of polymers from natural samples.
Assessment methods	Ongoing assessment based on laboratory sessions and a practical test. Final exam.
Language of instruction	Portuguese.

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	B - Description of individual course units
Course title	Chemical and Biological Processes
Course code	832914
Type of course	One-semester course
Level of Course	NA
Year of study	Second
Semester/trimester	First
Number of credits	5.0
Name of lecturer	Henrique Pinho
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Students should be able to understand processes involving the chemical and biological transformations of bio-resources and to perform material and energy balances.
Prerequisites	Basic knowledge of units and process variables, thermodynamics and stoichiometric calculations.
Course contents	1 – Chemical and biological processes design. 2 – Process flowsheet design and analysis. 3 – Unit operations principles. 4 – Mass balances in chemical and biological processes. 5 – Biological transformations stoichiometry 6 – Solving mass and energy balances in chemical and biological processes.
Recommended reading	Texts and support material available on the course website. R. M. Felder and R. W. Rousseau, *Elementary Principles of Chemical Processes*, 3rd ed., Wiley (2000). Michael L. Shuler, Fikret Kargi, *Bioprocess Engineering, Basic Concepts*, 2nd ed., Prentice Hall PTR (2002).
Teaching methods	Lectures: description and demonstration of course contents. Tutorials: resolution of proposed exercises.
Assessment methods	Written examination.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Chemical Thermodynamics
Course code	832915
Type of course	One-semester course
Level of Course	NA
Year of study	Second
Semester/trimester	First
Number of credits	5.0
Name of lecturer	Valentim Maria Brunheta Nunes
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Study of the Principles of Chemical Thermodynamics. Application to systems, either solid, liquid or gaseous, with interest to Chemical Engineering. Introduction of Environmental issues. Development of significant calculus techniques in Engineering.
Prerequisites	NA
Course contents	Ideal and real gases. The zeroth law of thermodynamics. Internal energy and the first law of thermodynamics. Thermochemistry. Entropy and the second law of thermodynamics. Third law of thermodynamics. The Helmoltz and Gibbs functions. Combining the first and second laws. Chemical potential. Chemical equilibrium. Physical transformations in pure substances. Phase rule. Ideal solutions. Raoult's law and Henry's law. Colligative properties. Mixtures of volatile liquids.
Recommended reading	Atkins, P., de Paula, J., *Physical Chemistry*, 7th ed, Oxford University Press, Oxford, 2001 Azevedo, E. G., *Termodinâmica Aplicada*, 2ª ed., Escolar Editora, Lisboa, 2000 Smith, Van Ness e Abbott, *Introduction to Chemical Engineering Thermodynamics*, McGraw-Hill, New York, 1995.
Teaching methods	Lectures and tutorials.
Assessment methods	Final written exam.
Language of instruction	Portuguese

	B - Description of individual course units
Course title	Biotechnology
Course code	832916
Type of course	One-semester course
Level of Course	NA
Year of study	Second
Semester/trimester	First
Number of credits	5.0
Name of lecturer	Cecília Baptista / Dina M. R. Mateus
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Structure, organization, metabolism and reproduction of prokaryotic microorganisms (bacteria) and eucariotic (fungi). Introduction to fundamentals of molecular biology and applications of the recombinant DNA technology.
Prerequisites	Fundamentals of the structure and properties of biological molecules.
Course contents	Prokaryotic microorganisms – bacteria – morphology, structure, characteristics and metabolism. Prokaryotic microorganisms – fungi – organization, nutrition, metabolism and reproduction. DNA - structure, replication, mutation, repair and recombination Transcription. Genetic code and decoding of genetic information. Regulation of gene expression. Genome and its expression. Recombinant DNA technology. Execution of laboratory assignments on sterilization, culture media, growth/identification of microorganisms and extraction/purification/quantification of DNA.
Recommended reading	Wiley, J.M., Sherwood, L.M. e Woolverton, C.J. – "Prescott, Harley, and Klein's Microbiology", 7ª ed., McGraw-Hill, USA, 2008. Copper, G. M. e Hausman, R. E. –" The Cell, a Molecular Approach", 4ª ed., ASM Press-Sinauer-Associates Inc., Washington, D.C., 2007.
Teaching methods	Lectures and theoretical-practical and laboratorial sessions including problem-solving and laboratorial work.
Assessment methods	Practical assessment and final exam.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Physical Chemistry
Course code	832917
Type of course	One-semester course
Level of Course	NA
Year of study	Second
Semester/trimester	First
Number of credits	4.5
Name of lecturer	Marco Cartaxo
Objectives of the course (preferably expressed in terms of learning outcomes competences)	The students are supposed to acquire knowledge and skills that enable them to solve problems related with fundamental aspects of physical chemistry which will serve as a basis to other more advanced disciplines.
Prerequisites	Basics of chemistry, thermodynamics, mathematics and physics.
Course contents	1 – Quantum Mechanics: principles; translational, vibrational and rotational movements. Structure and spectra. 2 – Chemical Kinetics: introduction; chemical reaction kinetics; kinetic theory of gases; molecular dynamics. 3 – Electrochemistry: electron transfer; voltammetry; electrolysis; galvanic cells; corrosion.
Recommended reading	Support material and handouts available from the course webpage. P. W. Atkins, *Physical Chemistry*, Oxford University Press, Oxford, 7th ed., (1998) Formosinho, *Fundamentos de Cinética Química*, Fundação Calouste Gulbenkian, Lisboa (1983)
Teaching methods	Lectures with illustrative cases. Theoretical-practical classes involving concept application and problem-solving.
Assessment methods	Open-book written test.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Process Simulation
Course code	832918
Type of course	One-semester course
Level of Course	NA
Year of study	Second
Semester/trimester	First
Number of credits	5.0
Name of lecturer	José Manuel Quelhas Antunes
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Development of skills in programming languages used to solve mathematical models typical of process engineering.
Prerequisites	Knowledge of computing from user's point of view, basics of mathematical analysis and linear algebra.
Course contents	1- Programming and programming languages 2- Data; data types; simple instructions and subprograms. 3- Applied numeric methods: interpolation, linear equations, ordinary differential equations and partial derivatives. 4- Case studies in process engineering.
Recommended reading	Texts and support material available on the course website. S. Chapra and R.P. Canale. "Numerical methods for engineers: with programming and software applications". 4th ed., McGraw-Hill, Boston (2002). W.Y. Yang, W. Cao, T.S. Chung and J. Morris. "Applied Numerical Methods Using MATLAB". John Wiley, New Jersey (2005).
Teaching methods	Lectures presenting and using illustrative case studies. Theoretical-practical classes involving execution of computer-oriented assignments and problem-solving.
Assessment methods	Weighted average of the theoretical assessment (a written test in regular or exam period) and the practical assessment (reports of practical assignments).
Language of instruction	Portuguese

	B - Description of individual course units
Course title	Cellulose and Paper I
Course code	832919
Type of course	One-semester course
Level of Course	NA
Year of study	Second
Semester/trimester	Second
Number of credits	6.0
Name of lecturer	Cecília Baptista / Manuel Rosa
Objectives of the course (preferably expressed in terms of learning outcomes competences)	The major processes for paper pulp transformation. Detailed study of the kraft process (wood preparation, decoction, chemicals preparation and recovery). Knowledge of bleaching processes from the chemical and technological points of view.
Prerequisites	Basics of organic and inorganic chemistry.
Course contents	1 – Introduction – the Cellulose sector. 2 – Different pulp production processes: mechanic, chemical and mixed. 3 – Kraft process: reagents, chemical reactions involved, kinetics, equipments and technologies, chemical recovery. 4 – Bleaching processes: ECF, TCF and ECF-"light". Reagents and sequences used. 5 – Environmental impacts of decoction and bleaching processes. 6 – Processability of the different pulps.
Recommended reading	Gullichsen, J. e Paulapuro, H. (Eds.), Book 3 (2000) "Forest Products Chemistry"; Book 5 (1999) "Mechanical Pulping"; Books 6A e 6B (2000) "Chemical pulping", Papermaking Science and Technology Series., Fapet Oy, Helsínquia Dence, C.W. e Reeve, D.W. (Eds.) (1996) "Pulp Bleaching - Principles and Practice", Tappi Press, Atlanta
Teaching methods	Lectures. Theoretical-practical sessions – exercises on mass and energy balances. Laboratory sessions – pulp decoction, bleaching and characterization.
Assessment methods	Ongoing assessment based on reports of laboratory assignments. Final exam.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Renewal Energy and Water Resources
Course code	832920
Type of course	One-semester course
Level of Course	NA
Year of study	Second
Semester/trimester	Second
Number of credits	5.0
Name of lecturer	José Luís Carreiras
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Knowledge of the different types of renewable energies and its use. Be able to evaluate Portuguese availability of water resources, both at surface and ground level.
Prerequisites	NA
Course contents	Characterization of renewable energies. Solar power. Wind power. Water power. hydroelectric recovery; wave power; tidal power. Geothermal power. Biomass. Recovery of renewable powers. Technical and economical issues. Evaluation of water resources: surface and ground waters. Portuguese Water resources: Water availability and needs.
Recommended reading	NA
Teaching methods	Lectures and tutorials.
Assessment methods	Written test and teamwork.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Technology and Chemical Reactors
Course code	832921
Type of course	One-semester course
Level of Course	NA
Year of study	Second
Semester/trimester	Second
Number of credits	4.5
Name of lecturer	José M. Quelhas Antunes / Paula Alexandra Geraldes Portugal
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Acquire skills to operate solid waste processing units and analyse and project ideal chemical reactors.
Prerequisites	Basics of chemical kinetics and thermodynamics.
Course contents	1 – Particulate solids processing. 2 - Filtration, centrifugation and sedimentation. 3 – Drying. 4 – Classification, characterization and selection of ideal chemical reactors. 5 – Methods of experimental determination of the kinetics of chemical reactions. 6 – Continuous and discontinuous stir reactors. 7 – Tubular reactors.
Recommended reading	Texts and support material available on the course website. A.S. Foust, L.A. Wenzel, C.W. Clump, L. Maus and L. B. Andersen, "Principles of Unit Operations", John Wiley and Sons, 2nd ed., New York 1980 Fogler, H.S., *Elements of Chemical Reaction Engineering*, Prentice-Hall, New Jersey ,1986.
Teaching methods	Lectures presenting and using illustrative case studies. Theoretical-practical classes involving concept application and problem-solving.
Assessment methods	Weighted average of the theoretical assessment (a written test in regular or exam period) and the practical assessment (reports of practical assignments).
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Transport Phenomena
Course code	832922
Type of course	One-semester course
Level of Course	NA
Year of study	Second
Semester/trimester	Second
Number of credits	5.0
Name of lecturer	Dina M. R. Mateus
Objectives of the course (preferably expressed in terms of learning outcomes competences)	To master fundamental concepts of heat. To know how to interpret the behaviour of thermal systems and solve practical problems. To be able to calculate the transfer area of heat transfer equipment. To master fundamental mass transfer concepts, namely those necessary for the design of mass transfer operations.
Prerequisites	Differential and Integral Calculus
Course contents	Mechanisms of energy transport. Fourier's law of heat conduction, thermal conductivity. Steady-state heat conduction. Thermal insulation, fins. Unsteady-state heat conduction. Convective heat transfer. Interphase transport, heat transfer coefficients. Radiation heat transfer. Heat exchangers. Mechanisms of mass transport. Fick's law, diffusivity. Steady-state molecular diffusion. Unsteady-state molecular diffusion. Convective mass transfer. Interphase mass transport, mass transfer coefficients. Momentum, heat and mass transfer analogies.
Recommended reading	Fundamentos de Transferência de Calor, D.M.R. Mateus, IPT (2009). Transport Phenomena, R.B. Bird, W.E. Stewart, and E.N. Lightfoot, John Wiley, Inc. (2002). Fundamentals of Momentum, Heat and Mass Transfer, J.R. Welty, R.E. Wilson and C.E.Wicks, John Wiley & Sons (2001).
Teaching methods	Lectures and tutorials. Practical work includes design of an equipment.
Assessment methods	Design of a heat transfer equipment in conjunction with two partial tests during the term or one final exam.
Language of instruction	Portuguese

	B - Description of individual course units
Course title	Process Control
Course code	832923
Type of course	One-semester course
Level of Course	NA
Year of study	Second
Semester/trimester	Second
Number of credits	4.5
Name of lecturer	Isabel Nogueira
Objectives of the course (preferably expressed in terms of learning outcomes competences)	To provide students with basic understanding of the processing of automatic control systems; to demonstrate the importance of instrumentation in an automatic control system; to describe the running of the main components of a measurement instrument; to understand the running of the process industry's most common transducers; to measure the main physical quantities present in an industrial process.
Prerequisites	Knowledge of Physics and Mathematics.
Course contents	1. Introduction to Process Control 2. Industrial Process 3. Process Diagrams and Layout 4. Automatic Process Control 5. Control Rings 6. Final Elements of Control
Recommended reading	Gustavo da Silva, "*Instrumentação Industrial*", Escola Superior Tecnologia – IPS (1999) Santos Cruz, "*Curso de Instrumentação Industrial*", CENERTEC, Porto (1990) Sighieri, L.; Nishinari, A; "*Controle Automático de Processos Industriais – Instrumentação*", 2nd ed., Edgard Blücher; São Paulo (1973) Jones, E.; "*Instrument Technology- vol I – Measurement of Pressure, Level, Flow and Temperature*", 3rd ed.; Butterworths, London (1974)
Teaching methods	Lectures and theoretical-practical classes including case studies and problem solving.
Assessment methods	Open-book written test during regular or retake examination periods.
Language of instruction	Portuguese

	B - Description of individual course units
Course title	Geographic Information Systems (option)
Course code	832924
Type of course	One-Semester course
Level of Course	NA
Year of study	Second
Semester/trimester	Second
Number of credits	5.0
Name of lecturer	José Luís Carreiras
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Provide basic theoretical skills on cartography and GIS technologies and functionalities. The students will learn how to use the ArcView software with application to case studies.
Prerequisites	Basic computer skills at user level.
Course contents	1 – Fundamentals. SIG components. Geographic information. GIS types. 2 – Cartography basics. Coordinate systems. Cartographic projections. Scales. Chart reading. 3 – GIS functionalities. Space analysis. 4 – Geographic information gathering techniques 5 – GIS applications in particular to territory planning and the environment. Case study analysis. 6 –Use of ArcView software. Practical application works.
Recommended reading	Aronoff, S. – "*Geographic Information Systems: A management Perspective*". Comas, D. e Ruiz, E. – "*Fundamentos de los Sistemas de Information Geográfica*", Ed. Ariel Geografia. Matos, J. – "*Fundamentos de Informação Geográfica*", Ed. Lidel. "*Using ArcView Gis*", Manual do utilizador, ESRI.
Teaching methods	Lectures and tutorials that will be held in the computer room to enable the use of ArcView.
Assessment methods	Individual assignments executed in the practical sessions, one final group assignment and one theoretical test.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	General Microbiology (option)
Course code	832924
Type of course	One-semester course
Level of Course	NA
Year of study	Second
Semester/trimester	Second
Number of credits	5.0
Name of lecturer	Cecília Baptista
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Study of the microbial diversity and classification, the prokaryotic and eukaryotic cell organization, morphology and growth patterns. Introductory microbial ecology and biogeochemical cycling.
Prerequisites	Knowledge of the structure and properties of the biological molecules.
Course contents	1 – A survey and classification of life at the cellular level. 2 – Morphology, ultrastructure and characteristics of prokaryotic and eukaryotic microbes. 3 – Viruses: structure, morphology and replication. 4 – Microbial nutrition, growth, control, metabolism and reproduction. 5 – Introductory microbial ecology and biogeochemical cycling.
Recommended reading	Wiley, J.M., Sherwood, L.M. e Woolverton, C.J. – "Prescott, Harley, and Klein's Microbiology", 7ª ed., McGraw-Hill, USA, 2008. Ferreira, W.F.C. e Sousa, J.C.F. – "Microbiologia", 1ª ed., Volumes 1, 2 e 3, Lidel, Lisboa, 1998, 2000 e 2002. Waites, M.J., Higton, G., Morgan, N.L. e Rockey, J.S. – "Industrial Microbiology: An Introduction", Blackwell Pub. L., USA, 2001.
Teaching methods	Theoretical classes about the characteristics and applications of eucariotic and procariotic microorganisms. Laboratorial classes about sterilization, culture media, laboratorial growing and identification techniques.
Assessment methods	Laboratorial written test and final theoretical examination.
Language of instruction	Portuguese

	B - Description of individual course units
Course title	Statistical Thermodynamics (option)
Course code	832924
Type of course	One-semester course
Level of Course	NA
Year of study	Second
Semester/trimester	Second
Number of credits	5.0
Name of lecturer	Valentim Maria Brunheta Nunes
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Acquisition of basic knowledge of the principles of Statistical Thermodynamics. Application to solid, liquid and gaseous systems with interest in Engineering.
Prerequisites	NA
Course contents	Statistical thermodynamics. The Maxwell-Boltzmann distribution. Statistical thermodynamics of the perfect monoatomic gas. Diatomic and polyatomic gases. The third law of thermodynamics. Solids. The Einstein model. Heat capacity of solids. Law of Dulong and Petit.
Recommended reading	Azevedo, E. G., *Termodinâmica Aplicada*, 2ª ed., Escolar Editora, Lisboa, 2000 Maczek, A., Statistical Thermodynamics, Oxforf Science Publications, Oxford, 2006
Teaching methods	Lectures and tutorials.
Assessment methods	Final written exam.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Biodegradable Polymers (option)
Course code	832924
Type of course	One-semester course
Level of Course	NA
Year of study	Second
Semester/trimester	Second
Number of credits	5.0
Name of lecturer	Henrique Pinho
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Develop abilities as to the production and use of biodegradable materials with special emphasis to those resulting from the processing of natural renewable materials.
Prerequisites	Basics of organic chemistry.
Course contents	1 – Pollution and biodegradation concept. 2 – Classification, structure and biodegradable polymer properties. 3 – Biodegradable polymers applications. 4 – Biodegradable composites engineering. 5 – Biodegradable materials manufacturing processes.
Recommended reading	Teaching material available at course web page. Chiellini, E., Solaro, R., Biodegradable Polymers and Plastics, Springer, 2003. Yu, L., Biodegradable Polymer Blends and Composites from Renewable Resources, Wiley, 2008.
Teaching methods	Lectures and theoretical-practical sessions involving case study and problem solving.
Assessment methods	Literature search and a written mid-term test or retake exam.
Language of instruction	Portuguese

	B - Description of individual course units
Course title	Chemical and Biological Analysis (option)
Course code	832924
Type of course	One-semester course
Level of Course	NA
Year of study	Second
Semester/trimester	Second
Number of credits	5.0
Name of lecturer	Maria Teresa da Luz Silveira
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Provide skills on matters related to instrumental methods involving power absorption, emission and dispersion and solvent extraction separation techniques.
Prerequisites	Basics of electromagnetic spectrum and magnitude units used in the study of radiation.
Course contents	1 – Vis and UV spectrophotometry 2 – Turbidimetry and nephelometry 3 – Emission flame photometry 4 – Atomic absorption spectrometry 5 – Solvent extraction
Recommended reading	Gonçalves, M.L.S.S., "Métodos Instrumentais para Análise de Soluções, Análise Quantitativa", 4ª ed., Fundação C. Gulbenkian. Skoog, L.,"Principles of Instrumental Analysis", 4th ed., Int. Edition. Willard, Merritt,Dean, Sette, "Instrumental Methods of Analysis", 7th ed. Int. Edition. Pecsok, Shields, Caims, Mcwilliam, "Modern Methods of Chemical Analysis", John Willey & Sons. Ewing, G.W., "Instrumental Methods of Chemical Analysis", McGraw-Hill Book Company.
Teaching methods	Lectures addressing subject content proposed, theoretical-practical classes and laboratorial sessions with application of knowledge acquired.
Assessment methods	Written tests and reports on laboratory work performed.
Language of instruction	Portuguese.

	B - Description of individual course units
Course title	Biological Reactors
Course code	832930
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	First
Number of credits	5.5
Name of lecturer	Dina Maria Ribeiro Mateus
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Be able to select information for research at laboratory level on global kinetics of the microbial process in order to chose the appropriate fermenter or battery of fermenters to be used; operation mode; design the vessel and respective mixing, aeration and cooling devices.
Prerequisites	Microbiology and biochemistry concepts.
Course contents	Stoichiometry and kinetics of microbial growth. Design and analysis of biological reactors: batch reactor, continuous-flow stirred-tank, fed-batch, CSTR with recycle and wall growth, plugflow reactor with recycle, bubble-column, fluidized-bed, trickle-bed, CSTRs in series, association CSTR-PFR. Oxygen transfer, consumption rates and oxygen-limited fermentations. Heat balance, sterilisation. Scale-up criteria. Industrial bioreactor construction. Case studies and Laboratory sessions.
Recommended reading	Basic Biotechnology. Colin Ratledge and Bjorn Kristiansen Eds Cambridge University Press (2001). Bioprocess Engineering Principles, P.M. Doran, Academic Press (1995).
Teaching methods	Theoretical classes consist of an introduction to course foundations and practical/laboratory classes involve resolution of application exercises and laboratory sessions.
Assessment methods	Weighted average of the information on laboratory performance, written reports of the conducted experiments and final exam.
Language of instruction	Portuguese.

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	B - Description of individual course units
Course title	Cellulose and Paper II
Course code	832931
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	First
Number of credits	6.0
Name of lecturer	Natércia Maria Ferreira Dos Santos
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Provide the students with knowledge of the paper production process. Study unit operations involved in the production process. Acquire knowledge of paper chemistry.
Prerequisites	Basics of chemistry, physics, mass balances, enthalpic balances and raw materials.
Course contents	1 - The historical context of papermaking. 2 - Raw materials - Characteristics and processing. 3 - Stock Preparation and wet-end operations. 4 - Refining / beating. 5 - Paper Machine 6 - Paper Chemistry (wet-end chemistry)
Recommended reading	Neimo, L., (2000), Papermaking Chemistry, Tappi Press, Atlanta. Karlsson, M., (2000), Papermaking, Part 2 – Drying, Tappi Press, Atlanta. Jokio, (2000), Papermaking, Part 3 – Papermaking Finishing, Tappi Press, Atlanta. Paulapuro, H., (2000), Papermaking Part1, Stock Preparation and Wet End, Fapet Oy, Helsinquia. Canavarro, J.M., (1985), Tecnologia do Papel e Cartão Canelado, Oditécnica, Lisboa.
Teaching methods	Lessons theoretical. Lessons of laboratory practice.
Assessment methods	Theoretical assessment: one written test in each assessment period. Practical assessment: laboratory assignments and reports.
Language of instruction	Portuguese

	B – Descrição das unidades curriculares
Course title	Management and Sustainable Development
Course code	832932
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	First
Number of credits	4.5
Name of lecturer	Carlos Duarte / Natércia Maria Ferreira Dos Santos
Objectives of the course (preferably expressed in terms of learning outcomes competences)	The objective of this course is to provide an integrated view of sustainable development. The aim is to provide skills for the implementation of a sustainability strategy.
Prerequisites	NA
Course contents	Organizations and management functions. Strategic management and planning models. Concepts of microeconomics and macroeconomics. Sustainable development: delivery of sustainability, policies and methodologies for sustainable development.
Recommended reading	Dias, R., (2006), Gestão Ambiental, Responsabilidade Social e Sustentabilidade, Ed. Atlas, São Paulo. Santos, O., (2003), Gestão Ambiental, Lidel, Lisboa. O'Riordan, T., (1995), Environmental Science for Environmental Management, Longman, Essex.
Teaching methods	Lectures. Theoretical-practical sessions: case studies and exercise resolution.
Assessment methods	Theoretical evaluation - Written test. Theoretical-practical evaluation - Report of literature search.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Biofuels
Course code	832933
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	First
Number of credits	4.0
Name of lecturer	Henrique Pinho
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Develop skills on the manufacturing and use of biofuels.
Prerequisites	Fundamentals of chemical and biological processes.
Course contents	1 – Energy, renewable fuels and environmental policies. 2 – Renewable energy resources. 3 – Renewable fuels. 4 – Feed stocks and natural resources for biofuels manufacturing. 5 – Biofuels production processes. 6 – Energy resources management.
Recommended reading	Mousdale, D., Biofuels: Biotechnology, Chemistry, and Sustainable Development, CRC Press, 2008. Drapcho, C., Nghiem, J., Walker, T., Biofuels Engineering Process Technology, McGraw-Hill, 2008.
Teaching methods	Lectures and theoretical-practical sessions involving case study and problem solving.
Assessment methods	Literature search and a written mid-term test or retake exam.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Waste Treatment
Course code	832934
Type of course	One-Semester course
Level of Course	NA
Year of study	Third
Semester/trimester	First
Number of credits	5.0
Name of lecturer	Rui Marques Sant'Ovaia
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Be able to identify the major pollution sources, define strategies for prevention and remediation and implement treatment processes.
Prerequisites	NA
Course contents	Identification and characterization of gaseous, liquid and solid effluents caused by the different industrial activities, particularly pulp and paper production. Definition of treatment/elimination strategies for each type of effluent. Calculation of liquid, solid and gaseous effluents caused by paper industry and design of selected treatment units. Simulation exercises.
Recommended reading	Woordard & Curran, Inc., Industrial Waste Treatment Handbook, 2nd ed., Butterworth-Heinemann, 2006. Williams, P.T., Waste Treatment and Disposal, 2nd ed., Wiley, 2005.
Teaching methods	Lectures. Theoretical-practical sessions: estudo de casos.
Assessment methods	Theoretical assessment: one written test in each assessment period. Theoretical-practical assessment: reports
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Chemistry of Solutions (option)
Course code	832935
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	First
Number of credits	5.0
Name of lecturer	Maria Teresa da Luz Silveira
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Provide skills of conductometry and provide in-depth study of previous knowledge of redox reactions, precipitation reactions, complexometry and complex reactions.
Prerequisites	NA
Course contents	1 - Conductimetry 2 - Redox reactions 3 – Precipitation reactions 4 – Complexometry and complex reactions
Recommended reading	Material prepared by the lecturer Gonçalves, M.L.S.S., Métodos Instrumentais para Análise de Soluções, Fundação Calouste Gulbenkian, 4ª Ed., Lisboa, 2001. Christian, D.G., “Analytical Chemistry”, 4ª ed., John Wiley & Sons, New York Segal, B.G., “Chemistry Experiment and Theory”, John Wiley & Sons, New York
Teaching methods	Lectures providing description of course contents. Tutorials and laboratory classes for application of the concepts learned.
Assessment methods	Written tests and laboratory reports.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Process Optimization (option)
Course code	832935
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	First
Number of credits	5.0
Name of lecturer	Paula Alexandra Geraldes Portugal
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Provide knowledge of the methodologies to raise and solve problems related with project optimization and operation of units and equipments used to process natural and synthetic materials.
Prerequisites	Master such matters as mathematical calculus, including mathematical analysis, algebra and numeric calculus methods.
Course contents	PART I – Optimization theory and methods: Introduction and motivation. Linear programming. Entire Linear Programming. Dynamic programming. PART I I – Formulation and resolution of optimization problems in chemical technology. Application to industrial management, production management and flowsheeting. Application to heat transfer and energy conservation, fluid transfer, separation processes and chemical and biological reactors.
Recommended reading	-Edgar, T. F., Himmelblau, D. M., Lasdon, L. S. (2001) Optimization of Chemical Processes, 2nd edition, McGraw-Hill. -Hiller, F. S., Lieberman, G. (2005) Introduction to Operations Research, 8th edition McGraw-Hill. -Tavares, L. V., Correia, F. N. (1999) Optimização Linear e não Linear, 2ª edição, Fundação Calouste Gulbenkian.
Teaching methods	Lectures on optimization methods. Problem-solving applied to materials processing technology.
Assessment methods	A written mid-term test or a final examination.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Hydrology (option)
Course code	832935
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	First
Number of credits	5.0
Name of lecturer	José Luís Carreiras
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Get familiar with hydrological processes and hydrological variables.
Prerequisites	NA
Course contents	1 – Fundamentals. Water cyle. Hydrographic basins. Water balances. 2 – Rainfall. Time and space distribution. Analysis of Rainfall Data. 3 – Evaporation and evapotranspiration. 4 – Runoff. Hydrographs. 5 – Relationship between rainfall and runoff. Hydrologic models. 6 – Erosion and deposition.
Recommended reading	Lencastre, A. E Franco, F. – "*Lições de Hidrologia*", ed. Universidade Nova de Lisboa, 1984. "*Curso Internacional de Hidrologia Operativa*", Manual, ed. DGRAH, 1984. Linsley, Kolher e Paulhus – "*Hydrology for Engineers*", 1988. Chow, Maidment e Mays – "*Applied Hydrology*", 1988.
Teaching methods	Lectures and tutorials.
Assessment methods	Written test and assignments executed across the semester.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Economy and Environmental Policies (option)
Course code	832935
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	First
Number of credits	5.0
Name of lecturer	Natércia Maria Ferreira Dos Santos
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Be familiar with the great issues of environment and sustainable development in Portugal and in the world. Acquire skills to understand the environmental policies at global level and at national level and concepts related with Environmental Economy.
Prerequisites	NA
Course contents	1 - Introduction - Population and demography: dynamics of populations worldwide and in Portugal. 2 - Natural resources and sustainable use. Issues of natural resources and their use in Portugal and in the world. 3 - The concept of sustainable development. Forms of environmental degradation. 4 - Environmental policies in the EU - institutions and conventions. 5 - Clean Technologies. Recyclable materials: the new industrial ecology.
Recommended reading	Chiras, D.D., (2001), Environmental Science. Creating a Sustainable Future, 6ª Ed., Jones and Bartlett Publishers, Sudburry. Braga, J., (1999), Guia do Ambiente – As empresas Portuguesas e o desafio ambiental, Monitor, Lisboa. Drou, D., (1998), Ambiente e Escolhas Políticas, Biblioteca Básica de Ciência e Cultura, Instituto Piaget. Kirkwood R.C., Longley A.J., (1995), Clean Technology and the Environment, Blackie Academic & Professional, Glasgow.
Teaching methods	Lectures. Theoretical-practical sessions: case studies.
Assessment methods	Theoretical evaluation: Written test. Theoretical-practical evaluation: Report of literature search. Completion of a course unit requires a minimum grade of 10 on both parts.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Enzyme Engineering (option)
Course code	832935
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	First
Number of credits	5.0
Name of lecturer	Dina Maria Ribeiro Mateus
Objectives of the course (preferably expressed in terms of learning outcomes competences)	The students are expected to acquire integrated training in the enzyme engineering domain by learning fundamental concepts such as enzymology, protein engineering, biocatalyst immobilisation, mass transfer applied to biological systems, and design and operation of enzyme reactors.
Prerequisites	Organic and biochemistry concepts.
Course contents	Structure and function of enzymes. Classification and nomenclature. Large-scale production. Enzyme kinetics, inhibition, stability and deactivation. Protein engineering. Immobilisation of biocatalysts. Kinetics in immobilised enzyme systems. Design and analysis of ideal, and non-ideal, enzyme immobilised reactors. Bio-catalysis in non-conventional media. Medical and industrial utilization of free and immobilised enzymes. Laboratory sessions on: demonstration and comparison of different methods for biocatalyst immobilisation; kinetic characterization; operation of different types of enzymatic reactors.
Recommended reading	*Applied Biocatalysis* , A.J.J. Straathof e P. Adlercreutz, Harwood Academic Publishers, Chur, Switzerland (2000). *Bioprocess Engineering – Basic Concepts*, M.L. Shuler e F. Kargi. Pearson Educatión (2002).
Teaching methods	Theoretical classes consist of an introduction to course basic foundations and practical/laboratory classes involve resolution of application exercises and laboratory sessions.
Assessment methods	Weighted average of laboratory work, written reports of the conducted experiments, and final exam.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Quality Control
Course code	832941
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	Second
Number of credits	5.0
Name of lecturer	Natércia Maria Ferreira Dos Santos
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Skills to develop and implement control or quality assurance systems. Skills to analyze Quality costs and implement statistic control systems.
Prerequisites	Basics of statistics.
Course contents	1 - Introduction - The historical context of Quality 2 - Quality management systems. Standards of quality assurance. 3 - Certification of companies. ISO 9000. Accreditation of entities. ISO 17025 4 - Audits. 5 – Analysis of Quality Cost. 6 – Implementation and analysis of statistical process control.
Recommended reading	PIRES, A.R., *QUALIDADE – SISTEMAS DE GESTÃO DA QUALIDADE*, 2ª Ed., Edições Sílabo, 2000, Lisboa. CAPELAS, L. (Coordenadora), *MANUAL PRÁTICO PARA A CERTIFICAÇÃO E GESTÃO DA QUALIDADE COM BASE NAS NORMAS ISO 9000:2000*, Verlag Dashöfer Ed. Prof., 2001, Lisboa. JURAN, J.M., *JURAN´S QUALITY CONTROL HANDBOOK*, 4ª Ed., McGraw-Hill, 1988, Singapura. GRANT, E., LEAVENWORTH, R., *STATISTICAL QUALITY CONTROL*, 7ª Ed., Mc Graw Hill, 1996, USA.
Teaching methods	Lectures. Theoretical-practical sessions: case studies.
Assessment methods	Theoretical evaluation - Written test. Theoretical-practical evaluation – Report on literature search. Final grade is the average of the two assessment parts. Completion of a course unit requires a minimum grade of 10 on both parts.«
Language of instruction	Portuguese

	B - Description of individual course units
Course title	Recycling, Recovery and Reuse
Course code	832942
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	Second
Number of credits	5.0
Name of lecturer	Rui Marques Sant'Ovaia
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Skills to develop and implement systems for recycling and reuse as well as treatment processes.
Prerequisites	Basics of industrial processes.
Course contents	1 – General aspects. 2 – Legislation for use of recycled products. 3 – Quality control and recyclability. 4 – Unit operations. 5 – Deinking of pulp fibres.
Recommended reading	Papermaking Science and Technology, vol.7, Gottsching, L. and Pakarinen, H. Eds., 2000, Helsinky. Biermann, C., Handbook of Pulping and Papermaking, 2ª Ed., Academic Press, 1996, London.
Teaching methods	Lectures. Theoretical-practical sessions: case studies.
Assessment methods	Theoretical evaluation - Written test. Theoretical-practical evaluation – Report on literature search. Final grade is the average of the two assessment parts. Completion of a course unit requires a minimum grade of 10 on both parts.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Health and Safety
Course code	832943
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	Second
Number of credits	3.0
Name of lecturer	Isabel Nogueira
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Development of fundamental skills on the chemical and biochemical processes in the field of Health and Safety. Emphasis is placed on the hazard and risk analysis and the understanding of the accident prevention methods.
Prerequisites	Basic General Knowledge
Course contents	1. Process Safety Principles 2. Introduction to Industrial Health 3. Hazard Assessment 4. Risk Prevention and Control Strategies 5. Domino Effect 6. Security Signs and Signage and Individual Protection Equipment 7. Atmospheric Dispersion Modelling 8. Gas and Vapour Hazards 9. Dust Explosion Hazards 10. Risk of Static Electricity Build Up,
Recommended reading	Course texts and related materials available through IPT e-Learning. A. S. Miguel, "*Manual de Higiene e Segurança do Trabalho*", Porto Editora (1989) R. Macedo, "Manual *de Higiene do Trabalho na Industria*", McGraw-Hill, Lisboa (1986) A. Laurent, "*Sécurité des procédés chimiques*", Editions TEC & DOC, Paris (2003) ISBN 2-7430-0635-8 Martel, "*Guide du Risque Chimique*", Dunod, Paris (2002)
Teaching methods	The course incorporates theoretical and practical learning.
Assessment methods	Written examination.
Language of instruction	Portuguese

	B - Description of individual course units
Course title	Seminar
Course code	832944
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	Second
Number of credits	7.0
Name of lecturer	Cecília Baptista / Stefan Rosendahl / Rui Sant'Ovaia / Natércia Santos
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Promote the development of individual and teamwork methodologies. Allow application of knowledge and skills acquired within the degree.
Prerequisites	NA
Course contents	All matters included in the different degree courses and matters related with bio-resources technology and sustainable development.
Recommended reading	NA
Teaching methods	Theme sessions on the major domains of the degree conducted by faculty members from the chemical and environmental engineering department and by academic and industrial specialists.
Assessment methods	Execution of a composite report on one or several themes addressed in the sessions with oral presentation and discussion.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Natural Resources Management (option)
Course code	832945 / 832946
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	Second
Number of credits	5.0
Name of lecturer	Stefan Rosendahl
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Develop skills to analyse the different stages of utilization of a natural resource, analyse and minimize the environmental impact of the exploration of natural resources and propose recovery plans of exploration for abandoned areas.
Prerequisites	Basics of Geosciences.
Course contents	Water, forest and geological resources. Prospection and evaluation of geological sites and deposits. Estimate and calculation of nature reserves and renewal rates. Methods for the exploration of resources with a view to their sustainability. Management and treatment of exploration waste. Resource refining, concentration and transformation techniques. Environmental impact of resource exploration and treatment. Rehabilitation of geological sites and deposits after exploration.
Recommended reading	PEARCE, D. &TURNER, K.: Economics of Natural Resources and the Environment. – Prentice Hall (1989). CROSS, N. & STIGSON, B.: Breaking New Ground. Mining, Minerals, and Sustainable Development. - Earthscan Publications Ltd., 2002. HARRIS, J. M.: Environmental and Natural Resource Economics – A Contemporary Approach. - Houghton Mifflin Company, 2002.
Teaching methods	Lectures: Topic presentation and discussion. Practical classes: Search and exercises on selected topics.
Assessment methods	Mid-term assessment: a written test, submission and presentation of an assignment on a selected topic. Final assessment: written test and practical assignment.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Paper Coating and Processing (option)
Course code	832945 / 832946
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	Second
Number of credits	5.0
Name of lecturer	Natércia Maria Ferreira Dos Santos
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Provide knowledge about manufacturing processes of coated papers and packaging.
Prerequisites	Basics of chemistry, physics, material and energy balances and raw materials.
Course contents	Pigmentation and coating. Coatings for printing, decorative and functional papers. Characterization of coating formulations and coated papers. Study of relationship between coating colours properties and final paper properties. Processes and equipment for the production of packaging papers. Characterization and design of packaging.
Recommended reading	Lebtinen, E., (2000), Pigment Coating and Surface Sizing of Paper, Fapet Oy, Jyvaskyla – Finlândia. Savolainen, A., (2000), Paper and Paperboard Converting, Fapet Oy, Jyvaskyla – Finlândia. Velho, J., (2003), Mineral Fillers for Paper – Why, What, How, Tecnicelpa, Tomar. Canavarro, J.M., (1985), Tecnologia do Papel e Cartão Canelado, Oditécnica, Lisboa.
Teaching methods	Lectures and laboratory sessions.
Assessment methods	Theoretical evaluation - Written test. Practical evaluation – Work carried out during laboratory sessions.
Language of instruction	Portuguese

	B - Description of individual course units
Course title	Special Papers (option)
Course code	832945 / 832946
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	Second
Number of credits	5.0
Name of lecturer	Rui Marques Sant'Ovaia
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Skills to evaluate the properties of the special paper. Skills to select appropriate raw materials and papermaking processes.
Prerequisites	Knowledge of papermaking technology.
Course contents	1 – The concept of special paper. Functional characteristics. 2 – Applications in furniture, electric and electronic industry. 3 –Graphic papers. 4 –Packaging: bags and boxes. 5 –Raw materials. Mechanical structure and porosity. 6 –Surface finish and coating.
Recommended reading	Papermaking Science and Technology, vol.18, Hanny Paulapuro Ed., 2000, Helsinky. Biermann, C., Handbook of Pulping and Papermaking, 2ª Ed., Academic Press, 1996, London.
Teaching methods	Lectures. Theoretical-practical sessions: case studies.
Assessment methods	Theoretical evaluation - Written test. Theoretical-practical evaluation – Report on literature search. Final grade is the average of the two assessment parts. Completion of a course unit requires a minimum grade of 10 on both parts.«
Language of instruction	Portuguese

	B - Description of individual course units
Course title	Surfaces and Interfaces (option)
Course code	832945 / 832946
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	Second
Number of credits	5.0
Name of lecturer	Valentim Maria Brunheta Nunes
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Development of the major models that describe the physicochemical behaviour of surfaces and interfaces. Application of those concepts to important systems in the field of Bio-resources Technology.
Prerequisites	NA
Course contents	Colloidal systems. Industrial importance. Liquid/gas Interface. Surface tension. Young-Laplace equation. Kelvin equation. Gibbs isotherm. Liquid/liquid Interface. Interfacial tension. Association colloids and surfactants. Emulsions. Solid/gas interface. Chemical and physical adsorption. Adsorption isotherms. Langmuir and BET models. Solid/liquid interface. Wetting and contact angle. Some applications in detergency, flotation, extraction of petroleum, painting and coating.
Recommended reading	Adamson, A.W., Gast, A.P., *Physical Chemistry of Surfaces*, 6th ed, John Wiley & Sons Inc., New York, 1997 Shaw, D.J., *Introduction to Colloid and Surface Chemistry*, 4th ed., Butterworth Heineman, Oxford, 1999 Hiemenz, P.C., Rajagopalan, R., *Principles of Colloid and Surface Chemistry*, 3rd ed., Marcel Dekker Inc., New York, 1997
Teaching methods	Lectures and tutorials.
Assessment methods	Final written exam and reports of laboratorial activities.
Language of instruction	Portuguese

	B - Description of individual course units
Course title	Nanotechnologies (option)
Course code	832945 / 832946
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	Second
Number of credits	5.0
Name of lecturer	Natércia Maria Ferreira Dos Santos
Objectives of the course (preferably expressed in terms of learning outcomes competences)	The basic aim of this course is to provide an overview of nanomaterials, considered innovative, in the context of the current requirements of industry and environment. Provide an overview of nanotechnology and associated materials, particularly in the paper industry, and discuss prospects for development and implementation.
Prerequisites	Basic knowledge of chemistry and physics.
Course contents	Nanomaterials and nanotechnology. Manufacturing processes. The potential of nanomaterials - Applications of nanoparticles in paper industry. Concept of nanopaper - High Tech paper as the key to printing evolution. Analysis of surface characteristics of paper at nanoscale.
Recommended reading	Poole, C.P. e Owens, F.J., (2003), Introduction to Nanotechnology, Wiley. Kohler, M. e Fritzsche, W., (2004), Nanotechnology, Wiley. Madou, M., (2002), Fundamentals of Microfabrication – The Science of Miniaturization, CRC Press. Niskanen, K., (2000), Paper Physics, Fapet Oy, Helsinquia.
Teaching methods	Lectures. Theoretical-practical sessions: case studies.
Assessment methods	Theoretical evaluation - Written test. Theoretical-practical evaluation - Report on literature search.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Certification (option)
Course code	832945 / 832946
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	Second
Number of credits	5.0
Name of lecturer	Rui Marques Sant'Ovaia
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Become familiar with the methodologies to carry out certification programs. Be able to evaluate fulfilment of outcomes in the certification process.
Prerequisites	NA
Course contents	Certification and accreditation. Reference programs. Certification audits. Certification for products and methods. Certification of workers. Branding. Certification as a management system.
Recommended reading	Peach ,R. Ed., The ISO 9000 Handbook, McGraw-Hill, 1997. Kolarik, W., Creating Quality, McGraw-Hill, 1995.
Teaching methods	Lectures. Theoretical-practical sessions: case studies.
Assessment methods	Theoretical evaluation - Written test. Theoretical-practical evaluation - Report on case studies.
Language of instruction	Portuguese

	B - Description of individual course units
Course title	Cogeneration (option)
Course code	832945 / 832946
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	Second
Number of credits	5.0
Name of lecturer	Rui Marques Sant'Ovaia
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Be able to collaborate in the execution of preliminary viability surveys or projects for cogeneration units. Be able to be part of a technical evaluation team.
Prerequisites	NA
Course contents	Energy conversion processes and thermodynamic cycles. Cogeneration concept. Combined cycle. Cogeneration system design and analysis. Evaluation of cogeneration opportunities: a case study.
Recommended reading	Turner, W., Energy Management Handbook, 3 th. Ed., Faimont Press, 1997. Grainger, J., Power and Energy – Power System Analysis, 2nd ed., McGraw-Hill, 1994.
Teaching methods	Lectures. Theoretical-practical sessions: case studies.
Assessment methods	Theoretical evaluation - Written test.
Language of instruction	Portuguese

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	B - Description of individual course units
Course title	Tribology (option)
Course code	832945 / 832946
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	Second
Number of credits	5.0
Name of lecturer	Isabel Nogueira
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Concepts of tribology as the science and technology of interacting surfaces under relative movement. Acquire skills as to the interactions generated during running-in of solid surfaces which influence materials behaviour towards friction, wear and lubrication.
Prerequisites	Basic knowledge.
Course contents	1. Tribologia: definição, história, análise de sistemas tribologicos. 2. Características gerais das superfícies técnicas. 3. Tensões de contacto. 4. Processos de degradação das superfícies. 5. Condições gerais de atrito entre sólidos. 6. Diferentes regimes de lubrificação.
Recommended reading	F. A. PINA DA SILVA, “Tribologia - Noções Gerais”, Fundação Calouste Gulbenkian, Lisboa, 1985 L. ANDRADE FERREIRA, “Tribologia – Notas de Curso – Lubrificação e Lubrificantes”, Publindústria, Edições Técnicas, Porto, 1998, ISBN 972 95794 5 8 F. P. BOWDEN AND D. TABOR, “The Friction and Lubrication of Solids”, Oxford University Press, 1950, 1954,ISBN 0 19 850777 1 D. F. MOORE, “Principles and Applications of Tribology”, International series in materials science and technology vol. 14, Pergamon Press, Oxford, 1975, ISBN 0 08 019007 3
Teaching methods	Theoretical-practical classes including case studies and problem solving.
Assessment methods	Open-book written test during regular or retake examination periods.
Language of instruction	Portuguese

	B - Description of individual course units
Course title	Process Systems Engineering (option)
Course code	832945 / 832946
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	Second
Number of credits	5.0
Name of lecturer	José Manuel Quelhas Antunes
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Develop skills in the analysis of dynamic behaviour of processes and its control.
Prerequisites	Knowledge of process simulation and industrial instrumentation.
Course contents	5- Process Systems. 6- Transfer functions 7- Dynamic behaviour of type systems. 8- Response to frequency disturbances 9- Feedback control 10- Stability and controller project.
Recommended reading	Texts and support material available on the course website. Seborg, D. E., Edgar, T. F., Mellichamp, D. A., *Process Dynamics and Control*, John Wiley & Sons, New York (2002). Luyben, W. L., *Process Modeling, Simulation and Control for Chemical Engineers*, Second Edition, McGraw – Hill, New York (1990)
Teaching methods	Lectures presenting and using illustrative case studies. Theoretical-practical classes involving execution of computer-oriented assignments and problem-solving.
Assessment methods	Weighted average of the theoretical assessment (a written test in regular or exam period) and the practical assessment (reports of practical assignments).
Language of instruction	Portuguese