A - General description

Programme Title - Chemical and Biochemical Engineering

Qualification awarded – Bachelor's degree - *Licenciatura* (180 ECTS credits)

Admission requirements – General Application for Admission to Higher Education, re-enter and mature applications. Specific examinations in one of the following disciplines: Biology and Geology; Physics and Chemistry; Mathematics. Regional preference is applied in the selection process.

Educational and Professional goals – The Chemical and Biochemical Engineering programme is a first-cycle degree (according to Bologna Declaration) designed to provide high-level training in Engineering on Chemistry-related matters. This degree aims at facilitating access of graduates to the labour market both at national and international level. Special emphasis is placed on emergent areas of knowledge in chemical, biochemical and biotechnology fields. In view to this, the degree delivers technical professionals for top positions in the industry, services and public administration, trainers and instructors, technicians qualified for the development and auditing of industrial projects, researchers, process and quality controllers, etc.

Access to further studies – The Chemical and Biochemical Engineering degree allows access to second-cycle degrees in Chemical, Biochemical and Biotechnology fields and to any Master program requiring a BSc in engineering.

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

Course Title	Year	Semester	Number of credits
Linear Algebra	1	1	5
Mathematical Analysis I	1	1	6
Applied Computing	1	1	4.5
Physics I	1	1	5
Introduction to Chemical and Biochemical Engineering	1	1	4
General Chemistry	1	1	5.5
Mathematical Analysis II	1	2	6
Physics II	1	2	4.5
Fluid Mechanics	1	2	4
Probability and Statistics	1	2	4.5

Inorganic Chemistry	1	2	5.5
Organic Chemistry I	1	2	5.5
Material and Energy Balances	2	1	5
Applied Numerical Methods	2	1	4.5
Chemistry of Solutions	2	1	5.5
Physical Chemistry	2	1	4.5
Organic Chemistry II	2	1	5.5
Chemical Thermodynamics I	2	1	5
Chemical Analysis	2	2	4.5
Biochemistry	2	2	5.5
Transport Phenomena	2	2	5
Microbiology	2	2	5.5
Chemical Reactors I	2	2	4.5
Chemical Thermodynamics II	2	2	5
Economy and Business Administration	3	1	4
Instrumentation and Control	3	1	5
Industrial Processes and Environment	3	1	5
Separation Processes I	3	1	5
Enzyme Engineering (option)	3	1	5.5
Genetic Engineering (option)	3	1	5.5
Raw Materials (option)	3	1	5.5
Chemical Reactors II (option)	3	1	5.5
Industrial Utilities (option)	3	1	5.5
Cellulose Technology (option)	3	1	5.5
Quality Management	3	2	4
Health and Safety	3	2	3
Project	3	2	12
Chemical Processes (option)	3	2	5.5

Separation Processes II (option)	3	2	5.5
Separation Processes on Biotechnology (option)	3	2	5.5
Biological Reactors (optional)	3	2	5.5
Paper Technology (optional)	3	2	5.5
Converting Technology (optional)	3	2	5.5

Final examination, if any – not applicable

Examination and assessment regulations – final examination not 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	Linear Algebra
Course code	91842
Type of course	One-semester course
Level of Course	NA
Year of study	First
Semester/trimester	First
Number of credits	5
Name of lecturer	Carlos Perquilhas; Pedro Carrasqueira
Objectives of the course (preferably expressed in terms of learning outcomes competences)	The students will be equipped 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 engineering 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 covering all matters studied.
Language of instruction	Portuguese

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B - Description of individual course units

Course title	Mathematical Analysis I
Course code	91841
Type of course	One-semester course
Level of Course	I
Year of study	First
Semester/trimester	First
Number of credits	6
Name of lecturer	Cristina Costa, Luís Merca, Manuela Fernandes
Objectives of the course (preferably expressed in terms of learning outcomes competences)	1 - Provide the basic concepts and mathematical methods usually used in this engineering degree. 2 - 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	Applied Computing
Course code	91846
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	Nuno Madeira
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Know basic IT concepts, understand the computer and inside transactions. Know how to develop an IT Project. Develop, use and apply Fortran 77 code. Develop, use and apply Octave environment to perform numerical computations.
Prerequisites	NA
Course contents	Basic IT concepts Algorithms: How to develop a project? 1. Thinking/understanding the problem; 2. Strategy and Planning, 3. Development (Fortran or Octave); 4. Running and use; 5. Maintenance and continuous improvement Develop Fortran 77 Code Use Octave environment to perform numerical computations Link Fortran and Octave
Recommended reading	Chapman, S. J., *Introduction to Fortran 90/95*, Mc-Graw-Hill, New York (1998) Nyhoff, L. R., Leestma, S. C., *Fortran 90 for Engineers & Scientists*, Prentice-Hall, New Jersey (1997) Kerrigan, J. F., *Migrating to Fortran 90*, O' Reilly & Associates, Sebastopol (1994) Handouts prepared by the lecturer.
Teaching methods	Lectures and group work
Assessment methods	Examinations, presentations and project work
Language of instruction	Portuguese

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B - Description of individual course units

Course title	Physics I
Course code	91844
Type of course	One-semester course
Level of Course	I
Year of study	First
Semester/trimester	First
Number of credits	5
Name of lecturer	Rosa Brígida Almeida de Quadros Fernandes
Objectives of the course (preferably expressed in terms of learning outcomes competences)	The basic concepts and principles of material point and systems of particles mechanics are provided. The students should become familiar with the subject matter and be capable of handling the principles and concepts and apply them to concrete situations, solving problems in different areas.
Prerequisites	Elementary trigonometry, elementary algebra and analysis of functions.
Course contents	Introduction: branches of classical physics; measures and units; international system of units; scientific notation; dimensional analysis. Revision of trigonometry and vector analysis. Interactions and forces: fundamental Interactions in nature; effect various forces applied simultaneously; overlapping principle. Statics of point particle and rigid body. Kinematics of material point. Dynamics of particles and particle systems.
Recommended reading	Support material available at www.e-learning.ipt.pt. Alonso & Finn, "*Física um curso universitário*", vol I, Addison Wesley (1972). Halliday & Resnick, *Física*, vols. 1 e 2 Livros Técnicos e Científicos, 4ª Ed. (1978).
Teaching methods	Lectures providing description of course contents. Tutorials and laboratory classes for application of concepts learned.
Assessment methods	Continuous assessment consisting of conceptual mini-tests with formulary and experimental work groups, all during classes. In case of failure, students can take a written exam.
Language of instruction	Portuguese

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B - Description of individual course units

Course title	Introduction to Chemical and Biochemical Engineering
Course code	91845
Type of course	One-semester course
Level of Course	NA
Year of study	First
Semester/trimester	First
Number of credits	4
Name of lecturer	Dina Maria Ribeiro Mateus
Objectives of the course (preferably expressed in terms of learning outcomes competences)	To present, with practical examples, the scope of chemical/biological process engineering, with a special emphasis on its contribution to the economical development, within the framework of a socially and environmentally responsible behaviour. To develop the ability to sketch and read a process flow-chart and perform a degree-of-freedom analysis of simple units.
Prerequisites	Basic knowledge of mathematics and chemistry
Course contents	Integrated vision and strategy in process and bioprocess engineering applied to major sectors of industry. The sustainable and economic development. Introduction to industrial health and safety. Main steps in the development of an industrial project. Unit systems and dimensional analysis. Introduction to engineering calculations. Chemical/biochemical processes and process variables. Flowcharts. Fundamentals of material balances. Typical case studies in chemical and bioprocess engineering.
Recommended reading	R. M. Felder and R. W. Rousseau, Elementary Principles of Chemical Processes, 3rd ed., Wiley (2000).
Teaching methods	Theoretical classes consist of a short introduction to course basic foundations and theoretical/practical classes involve resolution of application exercises. At the end of class work, further exercises are proposed for training. Presentation of a research essay. An on-site visit to an industrial unit.
Assessment methods	A research essay in conjunction with a mandatory final test.
Language of instruction	Portuguese

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B - Description of individual course units

Course title	General Chemistry
Course code	91843
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 other program subjects. Stimulate the study of chemistry as a science and show their significance to Industry and Society, in particular in the activity of future Chemical or Environmental Engineers.
Prerequisites	NA
Course contents	Chemistry 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	Theoretical classes consisting of presentation of course contents. Practical classes with resolution of applied exercises and practical execution of laboratorial activities.
Assessment methods	Final written exam and laboratory reports.
Language of instruction	Portuguese. Possibility of tutorial lectures in English

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B - Description of individual course units

Course title	Mathematical Analysis II
Course code	91847
Type of course	One-semester course
Level of Course	II
Year of study	First
Semester/trimester	Second
Number of credits	6
Name of lecturer	Carlos Perquilhas, Luís Merca, Manuela Fernandes, Pedro Carrasqueira
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

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B - Description of individual course units

Course title	Physics II
Course code	918410
Type of course	One-semester course
Level of Course	II
Year of study	First year
Semester/trimester	Second
Number of credits	4.5
Name of lecturer	Rosa Brígida Almeida de Quadros Fernandes
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Provide the basic concepts and principles of physics of vibrations and waves and of electromagnetism. The students should familiarize themselves with the matter and be capable of handling the principles and concepts and apply them to concrete situations, solving problems in different areas.
Prerequisites	Elementary trigonometry, elementary algebra, function analysis and Physics I.
Course contents	Oscillatory motion. Waves. Doppler effect. Electromagnetism: electric charge and the Coulomb law; Electrical Field and potential; conductors, insulators and dielectrics; Mean power, Ohms law and DC circuits; Capacitors and RC circuits; Magnetic field; Sources of magnetic field; Electric and magnetic induction; Inducers and RLC circuits.
Recommended reading	Texts and other materials on the web site: http://www.e-learning.ipt.pt, on the AIF courses: "Física Computacional 2". Course appointments of Rosa Brígida Fernandes. Alonso & Finn, "*Física um curso universitário*", vol I e II, Addison Wesley (1972).
Teaching methods	Theoretical classes in which the concepts and laws are given and exemplified and theoretical/practical classes where those concepts and laws are applied to a variety of problems.
Assessment methods	Continuous assessment consisting of conceptual mini-tests with formulary and experimental work groups, all during classes. In case of failure, students can take a written exam.
Language of instruction	Portuguese

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B - Description of individual course units

Course title	Fluid Mechanics
Course code	918411
Type of course	One-semester course
Level of Course	NA
Year of study	First
Semester/trimester	Second
Number of credits	4
Name of lecturer	Paula Alexandra Geraldes Portugal
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Provide the physical principles of fluid mechanics. To develop competences 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 of physics, algebra and mathematical analysis.
Course contents	1 – Physical properties of fluids. 2 – Basic law of hydrostatics and its application to several systems. 3 – Interpretation and application of the law of continuity of flows. 4 – From the general equations of flows, passing through the equations of Navier-Stokes to 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 points) and a practical component including exercise solving (15 points).
Language of instruction	Portuguese

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B - Description of individual course units

Course title	Probability and Statistics
Course code	918412
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	Luís Miguel Grilo
Objectives of the course (preferably expressed in terms of learning outcomes competences)	The goal of this course is to equip 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. Some literature: 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

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B - Description of individual course units

Course title	Inorganic Chemistry
Course code	91849
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 chemistry principles relevant to other program subjects. Stimulate the study of chemistry as a science and show its importance for Industry and Society, in particular to engineers in this sector.
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 providing description of course contents. Tutorials involving exercise solving and practical execution of laboratorial activities.
Assessment methods	Final written exam and laboratory reports.
Language of instruction	Portuguese. Possibility of tutorial lectures in English

B - Description of individual course units

Course title	Organic Chemistry I
Course code	91848
Type of course	One-semester course
Level of Course	I
Year of study	First
Semester/trimester	Second
Number of credits	5.5
Name of lecturer	Cecília Baptista and 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, alkines, arenes). Other organic compounds: structure, physical properties, nomenclature reactivity and reactions (alkyl halides, alcohols, thiols, ethers, phenols, amines, aldehydes, ketones, carboxilic 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 this type of 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	Three intermediate theoretical and laboratorial written tests and final theoretical examination.
Language of instruction	Portuguese

B - Description of individual course units

Course title	Material and energy balances
Course code	918416
Type of course	One-semester course
Level of Course	NA
Year of study	Second
Semester/trimester	First
Number of credits	5
Name of lecturer	Henrique Pinho
Objectives of the course (preferably expressed in terms of learning outcomes competences)	The student should be able to perform material and energy balances in single or multi unit processes, with or without chemical transformations, required to further design of chemical and biochemical engineering industrial plants.
Prerequisites	Basic knowledge of units and process variables, chemical thermodynamics and stoichiometry calculations.
Course contents	1 – Introduction: flow sheets and unit operations.. 2 – Mass balances fundamentals. 3 – Process variables gathering, prediction and use. 4 – Mass balances in processes with chemical reaction. 5 – Energy balances fundamentals. 6 – Energy balances in processes with chemical reaction. 7 – Solution of simultaneous mass and energy balances. 8 – Masse and energy balances in stage type processes. 9 – Introduction to computer-aided mass and energy balances.
Recommended reading	Teaching material available at course web page. R. M. Felder and R. W. Rousseau, *Elementary Principles of Chemical Processes*, 3rd ed., Wiley (2000). D. Himmelblau, *Basic Principles and Calculations in Chemical Engineering*, Prentice-Hall, 6th ed. (1996).
Teaching methods	Lectures: description and demonstration of course contents. Tutorials: resolution of proposed calculation exercises.
Assessment methods	Written examination. Students may use all the course and personal study materials.
Language of instruction	Portuguese.

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B - Description of individual course units

Course title	Applied Numerical Methods
Course code	918418
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	João Patrício
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Provide insight on the main concepts of Numerical Methods and Numerical Analysis, namely numerical algorithms for linear systems of equations, nonlinear equations and systems of nonlinear equations, polynomial interpolation, numerical integration and ordinary first order differential equations. Sensitivity for algorithm development and implementation is also developed.
Prerequisites	NA
Course contents	1 – Error and stability 2 – Numerical methods for systems of linear equations 3 – Nonlinear equations and systems of nonlinear equations 4 – Polynomial interpolation 5 – Numerical integration 6 – Numerical methods for ordinary differential equations
Recommended reading	Lecture notes available at the IPT *e-learning* platform. Atkinson, K., ”Elementary Numerical Analysis”, 2nd ed., John Wiley & Sons, N. Y. (1993) Burden R., Faires J., ”Numerical Analysis”. PWS Publishing Company (1993) Pina, H., ”Métodos numéricos”, McGraw-Hill, Lisboa (1995)
Teaching methods	Theoretical and theoretical-practical lectures, with presentation and illustration of the proposed subjects, as well as laboratorial sessions for computer implementation and analysis.
Assessment methods	Continuous assessment: two written tests and computational projects Exam assessment: one written test
Language of instruction	Portuguese

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B - Description of individual course units

Course title	Chemistry of Solutions
Course code	918414
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	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 - Conductometry 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	Physical Chemistry
Course code	918417
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 António Mourão 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 amd physics.
Course contents	1 – Quantic Mechanics: principles; translational, vibrational and rotational movements. Structure and spectra. 2 – Chemical Kinetics: introduction; chemical reactions speed; kinetic theory of gases; molecular dynamics. 3 – Electrochemistry: Electronic transfer; voltimetry; 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	A written mid-term test or a final examination.
Language of instruction	Portuguese

B - Description of individual course units

Course title	Organic Chemistry II
Course code	918413
Type of course	One-semester course
Level of Course	II
Year of study	Second
Semester/trimester	First
Number of credits	5.5
Name of lecturer	Cecília Baptista
Objectives of the course (preferably expressed in terms of learning outcomes competences)	In-depth study of stereochemistry, absolute configurations, structure and properties of hetero-cycles and multifunctional compounds. Introduction to the main groups of organic pollutants and polymer chemistry.
Prerequisites	Basic knowledge of the structure, properties and reactivity of monofunctional organic compounds.
Course contents	1 – Stereochemistry. Quirality, optical activity and configurations. 2 – Structure and properties of multifunctional organic compounds. 3 – Structure and properties of hetero-cycles. 4 – Reactivity of hetero-cycles and multifunctional compounds. 5 – Organic pollutants. 6 – Polymer structure and reactions of polymerization. 7 – Polymer classification and properties. 8 – Structural analysis of organic compounds.
Recommended reading	Carey, F.A. – "Organic Chemistry", 6ª ed., McGraw-Hill International Edition, New York, 2006. Vollhardt, K.P.C.; Schore, N.E. - "Organic Chemistry – Structure and Function", 4ª ed., W.H.Freeman & Company, New York, 2003. Solomons, G.; Fryhle, C. - "Organic Chemistry", 7ª ed., John Wiley & Sons, Inc., New York, 2000.
Teaching methods	Theoretical classes focusing on the properties and reactions of this type of organic compounds. Practical classes to solve applied problems. Laboratorial classes involving practice of such components as synthesis, purification and analysis of these compounds.
Assessment methods	Written laboratory test and final theoretical examination.
Language of instruction	Portuguese

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B - Description of individual course units

Course title	Chemical Thermodynamics I
Course code	918415
Type of course	One semester
Level of Course	I
Year of study	Second
Semester/trimester	First
Number of credits	5
Name of lecturer	Valentim Maria Brunheta Nunes
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Chemical Thermodynamics principles. Application to systems, solid, liquid or gaseous, with interest to Chemical Engineering. Introduction to environmental issues. Development of important techniques of calculus in engineering.
Prerequisites	NA
Course contents	Ideal and real gases. The zero 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 providing description of course contents. Practical sessions involving resolution of applied exercises.
Assessment methods	Final written exam.
Language of instruction	Portuguese. Possibility of tutorial lectures in English

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B - Description of individual course units

Course title	Chemical Analysis
Course code	918419
Type of course	One-semester course
Level of Course	NA
Year of study	Second
Semester/trimester	Second semester
Number of credits	4.5
Name of lecturer	Maria Teresa da Luz Silveira
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Provide skills in instrumental methods covering such topics as energy absorption, emission and dispersion and techniques of separation by solvent extraction.
Prerequisites	Basic principles of electromagnetic spectrum and the magnitudes and 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", 4 ed., Fundação Calouste Gulbenkian, Lisboa, 2001. Skoog, L.,"Principles of Instrumental Analysis", 4 ed.,Internacional edition. Willard, Merritt,Dean, Sette, "Instrumental Methods of Analysis", 7ª Ed. International 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 providing description of course contents. Tutorials and laboratory classes for application of 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	Biochemistry
Course code	918423
Type of course	One-semester course
Level of Course	NA
Year of study	Second
Semester/trimester	Second
Number of credits	5.5
Name of lecturer	Cecília Baptista
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Study of the structure, properties and metabolism of the biological molecules and its functions in living cells. Metabolism of these molecules: carbohydrates, proteins and lipids. Nucleic acids and informational nature of genetic processes.
Prerequisites	Basic knowledge about the structure, properties and reactivity of organic compounds.
Course contents	1 – Molecular origin of life. 2 – Biological molecules: structure, properties, isolation and characterization. 3 – Carbohydrates, proteins and lipids. Enzymes and nucleic acids. 4 – Energy, ATP cycle and biosynthesis. 5 – Metabolism of the main biological molecules. 6 – Connections between the metabolic routes.
Recommended reading	Quintas, A., Freire, A.P. e Halpern, M.J., "Bioquímica – Organização Molecular da Vida", 1ª ed., Lidel, Lisboa, 2008 Halpern, M.J., "Bioquímica", 1ª ed., Lidel, Lisboa, 1997 McKee, T. e McKee, J.R., "Biochemistry - The molecular basis of life", 3ª ed., McGraw-Hill, 2003
Teaching methods	Theoretical classes including description of properties of the main biological molecules, its functions and metabolism. Laboratorial classes involving in-depth study of this kind of molecules and several isolation and characterization procedures.
Assessment methods	Laboratorial written test and final theoretical examination.
Language of instruction	Portuguese

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B - Description of individual course units

Course title	Transport Phenomena
Course code	918421
Type of course	One-semester course
Level of Course	NA
Year of study	Second
Semester/trimester	Second
Number of credits	5
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	Sebentas de Fen. de Transferência I e II , D.M.R. Mateus (2004). 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	Theoretical classes consisting of a short introduction to course foundations and theoretical/practical classes involving resolution of application exercises. At the end of class work, further exercises are proposed for training. Design of heat equipment.
Assessment methods	Design of a heat transfer device 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	Microbiology
Course code	918420
Type of course	One-semester course
Level of Course	NA
Year of study	Second
Semester/trimester	Second
Number of credits	5.5
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. Microbial interactions and role in living systems and biotechnological production.
Prerequisites	Knowledge of the structure and properties of biological molecules.
Course contents	1 – A survey and classification of life at the cellular level. 2 – Morphology, ultrastructure and characteristics of bacteria. 3 – Morphology, ultrastructure and characteristics of fungi, and protists. 4 – Viruses: structure, morphology and replication. 5 – Microbial nutrition, growth, control, metabolism and reproduction. 6 – Characterization of different microbial environments. 7 – Applied and industrial microbiology.
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 eukaryotic and prokaryotic 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

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B - Description of individual course units

Course title	Chemical Reactors I
Course code	918424
Type of course	One-semester course
Level of Course	I
Year of study	Second
Semester/trimester	Second
Number of credits	4.5
Name of lecturer	José Manuel Quelhas Antunes
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Develop abilities in the analysis of chemical reactor projects by carrying out mass and energy balances.
Prerequisites	Basic knowledge of chemical kinetics and thermodynamics.
Course contents	1 – Introduction: classification, characterization and selection of ideal chemical reactors. 2 – Methods of experimental determination of the kinetics of chemical reactions. 3 – Continuous stir reactors. 4 – Discontinuous and semi-discontinuous reactors. 5 – Tubular reactors. 6 – Sequential continuous reactors.
Recommended reading	Teaching material available at course web page. Fogler, H.S., *Elements of Chemical Reaction Engineering*, Prentice-Hall, New Jersey ,1986. Levenspiel, O., *Chemical Reaction Engineering*, Third Edition, John Wiley, New York, 1999.
Teaching methods	Lectures exploring case studies. Theoretical-practical classes involving concept application and problem-solving.
Assessment methods	A written test during the regular examination period.
Language of instruction	Portuguese

B - Description of individual course units

Course title	Chemical Thermodynamics II
Course code	918422
Type of course	One-semester course
Level of Course	II
Year of study	Second
Semester/trimester	Second
Number of credits	5
Name of lecturer	Valentim Maria Brunheta Nunes
Objectives of the course (preferably expressed in terms of learning outcomes competences)	In-depth study of Chemical Thermodynamics. Introduction to Statistical Thermodynamics. Application to solid, liquid and gaseous systems with interest for Chemical Engineering.
Prerequisites	NA
Course contents	Real solutions. Excess functions. Liquid-liquid equilibrium and immiscibility in liquid phase. Theories of solutions. Phase diagrams. Liquid-vapour equilibrium. Ternary systems. Statistical thermodynamics. The Maxwell-Boltzmann distribution. Statistical thermodynamics of the perfect mono-atomic 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	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 providing description of course content. Tutorials involving application of concepts learned.
Assessment methods	Final written exam.
Language of instruction	Portuguese. Possibility of tutorial lectures in English

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B - Description of individual course units

Course title	Economy and Business Administration
Course code	918426
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	First
Number of credits	4
Name of lecturer	Henrique Pinho
Objectives of the course (preferably expressed in terms of learning outcomes competences)	The students are expected to acquire the fundamental concepts of economy and business administration. They should develop abilities to use the principal market analysis tools and to perform planning and economical evaluation of industrial projects.
Prerequisites	NA
Course contents	1 – Introduction: basic principles of economy. 2 – Microeconomics and macroeconomics fundamentals. 3 – Corporate structure and management concepts. 4 – Management functions: sales and marketing; operations; material resources and stocks; human resources; financial planning. 5 –Corporate planning: strategic management and strategic planning models. 6 – Design and economical evaluation of industrial projects. 7–Engineering-management relationship: R&D management; entrepreneurship and business creation.
Recommended reading	Teaching material available at course web page. Neves, J.L.C., *Introdução à Economia*, Ed. Verbo, Lisboa (1997). Sousa, A., *Introdução à Gestão: uma abordagem sistémica*, Ed. Verbo, Lisboa (1990).
Teaching methods	Theoretical-practical classes: presentation of course contents followed by open discussion of proposed case studies; problem solving.
Assessment methods	Written exam (70% of final grade). Group assignments and presentations (30% of final grade).
Language of instruction	Portuguese.

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B - Description of individual course units

Course title	Instrumentation and Control
Course code	918427
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	First
Number of credits	5
Name of lecturer	Isabel Nogueira
Objectives of the course (preferably expressed in terms of learning outcomes competences)	To provide the students with a 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 involved in an industrial process.
Prerequisites	Knowledge of Physics and Mathematics.
Course contents	Introduction to Process Control. Signal Conditioning Circuits. Pneumatic Elements. Pressure Sensors. Level Sensors. Temperature Sensors. Atmospheric Dispersion Modelling. Flow meters. Viscosity Sensors. Final Elements of Control.
Recommended reading	Course texts and related materials available through IPT's e-Learning. Perry, R.; Green, D.; "*Perry's Chemical Engineers' Handbook*"; 6th ed.; Mc Graw-Hill; Singapore (1984). Santos Cruz, "Curso de *Instrumentação Industrial*", CENERTEC, Porto (1990). Gustavo da Silva, *"Instrumentação Industrial"*, Escola Superior Tecnologia – IPS (1999).
Teaching methods	The course incorporates theoretical and practical learning.
Assessment methods	Written examination (first or second session) with a minimum passing score of 9.5
Language of instruction	Portuguese

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B - Description of individual course units

Course title	Industrial Process and Environment
Course code	918428
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	First
Number of credits	5
Name of lecturer	Rui Sant'Ovaia
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Qualification for evaluation, reduction possibilities and control of environment impact from the industrial process.
Prerequisites	Knowledge of statistics, analytical chemistry, mass and energy balances.
Course contents	1 - Introduction. Legislation, Regulation and Ethics. 2 - Hydrology. 3 - Water and Wastewater Treatment. 4 - Air Pollution. Treatment Systems. 5 - Introduction to Noise Pollution. 6 - Solid Waste Management. 7 - Hazardous Wastes. 8 - Incineration.
Recommended reading	M.L.Davis;D.A.Cornwell, *Introduction to Environmental Engineering*, 2nd Ed., McGraw-Hill (1991) 2H.S.Peavy, D.R.Rowe, G.Tchobanoglous, *Environmental Engineering*, McGraw-Hill (1985) Support material made available in class.
Teaching methods	Lectures and laboratory practice for the determination of liquid pollution levels.
Assessment methods	Continuous assessment including problem solving and a final examination test.
Language of instruction	Portuguese

B - Description of individual course units

Course title	Separation Processes I
Course code	918425
Type of course	One-semester course
Level of Course	I
Year of study	Third
Semester/trimester	First
Number of credits	5
Name of lecturer	Paula Alexandra Geraldes Portugal
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Provide skills in the design and calculus of distillation and gas-liquid absorption equipments.
Prerequisites	Basic knowledge of fluids mechanics, thermodynamics, transport phenomena and mass-energy balances.
Course contents	1 - Distillation principles - liquid-vapour equilibrium. 2 - Calculations in batch distillation – Rayleigh's equation. 3 - Calculations in flash distillation. 4 - Columns of fractionating distillation and other equipments. 5 - Calculations of fractionating distillation – reflux ratio – number of stages – operating lines - side stream – multiple feds. 6 - calculations in gas-liquid absorption– operating line – flow rates – number of stages – straight section area and columns height
Recommended reading	Foust, A.; "Principles of Unit Operations"; John Wiley & Sons Rose, L.;"Distillation Design in practice"; Elsevier Perry, J.;"Chemical Engineers Handbook"; McGraw-Hill Coulson, J.; Richardson, R.; "Tecnologia Química", Fundação Calouste Gulbenkian
Teaching methods	Theoretical sessions in which the chemical-physical principles and the design methods are discussed, and theoretical-practical sessions where exercises are solved by the students under the lecturer's supervision.
Assessment methods	Written examinations divided into a theoretical section constituted by multiple-choice questions (5 points) and a practical section consisting of exercise solving (15 points).
Language of instruction	Portuguese

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B - Description of individual course units

Course title	Enzyme Engineering (option)
Course code	918432
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)	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
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	Genetic Engineering (option)
Course code	918431
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)	The students are expected to acquire integrated training in genetic engineering by learning fundamental concepts such as molecular biology, genetics, and the applications of recombinant DNA technology. They will gain skills in the use of relevant molecular techniques.
Prerequisites	Biochemistry and cellular biology
Course contents	DNA structure, replication, restriction and repair. Homologous and heterogeneous recombination of genes. Transcription in eukaryotes and prokaryotes. Protein synthesis. Regulation of genetic expression. Recombinant DNA technology. Restriction enzymes and ligases. Cloning vectors and gene cloning. Methodology to introduce recombinant DNA in clone cells. Instability of r-plasmids. PCR, Southern Blot, Footprinting, Northern Blot, basis and applications. Sequencing of DNA fragments. Genomic banks. Bioinformatics. Laboratory sessions.
Recommended reading	Biotechnology – Genetic Fundamentals and Genetic Engineering, vol 2, H.-J. Rehm, G. Reed, A. Pühler and P. Stadler (Eds) (1993), VCH Publishers INC. Biotechnology – A Laboratory Course, J.M. Becker, G. A. Caldwell and E.A. Zachgo, Academic Press (1996).
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	Raw Materials (option)
Course code	918433
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	Natércia Maria Ferreira Dos Santos
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Be able to characterise fibrous and non-fibrous materials and to become familiar with refining equipment. Be aware of the influence of refining and their operational conditions in the final characteristics of paper.
Prerequisites	Basic knowledge of Chemistry and Physics
Course contents	Introduction to materials science. Structure of materials. Physical and mechanical properties of fibrous materials. Refining and factors influencing. Effects of refining operation on fibres. Influence of refining in the physical and mechanical properties of paper. Properties of non-fibrous materials.
Recommended reading	Biermann, C. J., (1996), Handbook of Pulping and Papermaking, 2ª Ed., Academic Press, S. Diego. Canavarro, J. M., (1985), Tecnologia do Papel e Cartão Canelado, Oditécnica, Lisboa. Levlin, J-E., Soderbjelm, L., (1999), Pulp and Paper Testing, Fapet Oy, Helsinquia. Paulapuro, H., (2000), Papermaking Part1, Stock Preparation and Wet End, Fapet Oy, Helsinquia. Valette, P., Choudens, C., (1989), Le Bois, la Pâte, le Papier, 2ª Ed., CTP, Grenoble.
Teaching methods	Lectures and laboratory practice.
Assessment methods	Theoretical component: written test. Practical component: laboratory work and respective reports. Final grade is the average of the two components. Course unit approval requires a minimum score of 10 points (out of a 0-20 scale) in both components.
Language of instruction	Portuguese

B - Description of individual course units

Course title	Chemical Reactors II (option)
Course code	918429
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	José Manuel Quelhas Antunes
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Develop abilities in the analysis of real reactors through the residential distribution theory and understand the impact of catalysis in transformation processes namely through the study of catalytic reactors.
Prerequisites	Knowledge of ideal chemical reactors, chemical kinetics and thermodynamics.
Course contents	1 – Introduction: revision work on ideal chemical reactors and experimental determination of reaction kinetics. 2 – Distribution of residential times – characteristics, experimental determination and modelling of real reactors. 3 – Catalysers and catalytic reactors. Catalysis; catalyser diffusion, convection and reaction; modelling of fixed-bed catalytic reactors.
Recommended reading	Teaching material available at course web page. Fogler, H.S., *Elements of Chemical Reaction Engineering*, Prentice-Hall, New Jersey ,1986. Levenspiel, O., *Chemical Reaction Engineering*, Third Edition, John Wiley, New York, 1999.
Teaching methods	Lectures presenting and using illustrative case studies. Theoretical-practical classes involving concept application and problem-solving.
Assessment methods	Final mark is the weighted average of an individual assignment (continuous assessment) or a written test (during regular exam period) and the laboratory reports (practical component). Each component represents 50% of total grading.
Language of instruction	Portuguese

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B - Description of individual course units

Course title	Industrial Utilities (option)
Course code	918430
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	Isabel Nogueira, Paula Portugal
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Convey the fundamental knowledge that will enable the student to understand and meet the demands of the heavy industry regarding essential industrial services: electric power, thermal energy, compressed air and refrigeration.
Prerequisites	Fundamentals of Chemistry, Physics and Mathematics.
Course contents	1. Electric Power (alternating current) 2. Thermal Energy 3. Ventilation 5. Compressed Air 6. Refrigeration and Cooling Systems
Recommended reading	Course texts and related materials available through IPT'S e-Learning F. J. Juanico, "*Geradores de Calor*", Ed. Ecemei, *1992.* R. Castro e Silva, "*Curso de Electricidade Prática*". *P. Tippler, "Física-Electricidade e Magnetismo*", *Ed. Ardir.* *L. German, L. Colas, J. Rouquet, "Les Traitements des Eaux", Ed. Dunod.* *J. Novais, "Ar Comprimido Industrial", Ed. Fundação Calouste Gulbenkian.* Atlas Copco, "Manual de Ar Comprimido".
Teaching methods	The course incorporates theoretical and practical learning.
Assessment methods	Written examination (first or second session) with a minimum passing score of 9.5
Language of instruction	Portuguese

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B - Description of individual course units

Course title	Cellulose Technology (option)
Course code	918434
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	Manuel Rosa
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Development of abilities to understand the process variables in the kraft cooking and bleaching stages, the process variables in the sulphite cooking stage, the fundamentals of chemical recovery in the pulp plant and the typical quality control and assurance tests associated with pulp production.
Prerequisites	NA
Course contents	Generalities; Production, reception and preparation of the wood; Types of processes for paper pulp production; Kraft process; Important variables of the Kraft liquor; The Kraft cooking; The sulphite process; Knots separation and washing; Bleaching; Final treatments; Quality control; Recovery boiler.
Recommended reading	Garcia Hortal, J. e Vidal Llucià, T., 1984. Blanqueo de pastas en la industria papelera, Publicaciones Universidad Politécnica de Catalunya, España. Gulliehsen, J. e Fogelholm C., 1999. Chemical Pulping, Fopet Oy, Finland.D, Rydholm, S., 1985. Pulping Processes, 2nd Ed., Robert Krieger Publishing, Malabar, Florida, USA. Reeve, D. e Dence, C., 1996. Pulp Bleaching – Principles and practice, Tappi Press, Atlanta, Geórgia, USA.
Teaching methods	Lectures providing description of theoretical principles. Laboratory kraft cooking and bleaching as well as quality control testes to the final product are executed in the practical and laboratory sessions.
Assessment methods	A grade of 14 (out of a 0-20 scale) or higher in the continuous assessment exempts students from taking final exam.
Language of instruction	Portuguese

B - Description of individual course units

Course title	Quality Management
Course code	918435
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	Second
Number of credits	4
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 quality control and assurance systems, to analyze quality costs and implement statistical control systems.
Prerequisites	Knowledge of basic statistics.
Course contents	Introduction - The historical context of Quality. Quality management systems. Standards of quality assurance. Certification of companies. ISO 9000. Accreditation of entities. ISO 17025. Audits. Quality Cost Analysis. 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 Editores Profissionais, 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 classes: case studies and exercise solving.
Assessment methods	Theoretical component: written test. Practical component: report on literature search. Final grade is the average of the two components. Course unit approval requires a minimum score of 10 points (out of a 0-20 scale) in both components.
Language of instruction	Portuguese

B - Description of individual course units

Course title	Health and Safety
Course code	918436
Type of course	One-Semester course
Level of Course	NA
Year of study	Third
Semester/trimester	Second
Number of credits	3
Name of lecturer	Isabel Nogueira
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Development of fundamental Health and Safety skills in chemical and biochemical processes. Emphasis is placed on the hazard and risk analysis and the understanding of accident prevention methods.
Prerequisites	
Course contents	Process Safety Principles. Introduction to Industrial Health. Hazard Assessment. Risk Prevention and Control Strategies. Domino Effect. Security Signs and Signage and Individual Protection Equipment. Atmospheric Dispersion Modelling. Gas and Vapour Hazards. Dust Explosion Hazards. Risk of Static Electricity Build Up.
Recommended reading	Course texts and related materials available through IPT'S 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 (first or second session) with a minimum passing score of 9.5
Language of instruction	Portuguese

B - Description of individual course units

Course title	Project
Course code	918437
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	Second
Number of credits	12
Name of lecturer	Rui Sant'Ovaia
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Provide ability to draw up and interpret industrial process projects.
Prerequisites	Basics of transfer phenomena, mass and energy balances and unit operations.
Course contents	1 – Project design charts. 2 – Nomenclature. Units (conversion factors). 3 – Fluid mechanics and unit operations (revision). 4 – Building materials. 5 – Mechanical equipment. 6 – Industrial effluent management. 7 – Cost and investment evaluation. 8 – Project control
Recommended reading	*Perry's Chemical Engineers Handbook*, Mc Graw Hill Book Co., 16th Ed. Chopey, Hicks,*Handbook of Chemical Engineering Calculations,* Mc Graw Hill Book Co. J.Coulson, J. Richardson, *Chemical Engineering, Vol.6* ,Pergamon Press
Teaching methods	Lectures and supervised assignments.
Assessment methods	Continuous assessment and final project submitted to a jury for appreciation.
Language of instruction	Portuguese

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B - Description of individual course units

Course title	Chemical processes (option)
Course code	918439
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	Second
Number of credits	5.5
Name of lecturer	Henrique Pinho
Objectives of the course (preferably expressed in terms of learning outcomes competences)	The students should be able to perform advanced material and energy balances in complex processes, solve mass balances in multiphase operations, and use adequate methods of prediction of thermal and physical data.
Prerequisites	Basic knowledge of chemical thermodynamics and stoichiometry calculations, and full use of mass and energy solving procedures.
Course contents	1 – Thermophysical and thermochemical prediction methods. 2 – Mass balances in multiphase operations. 3 – Solid-liquid extraction: solids washing and leaching. 4 – Liquid-liquid extraction: immiscible and partially miscible systems. 5 – Energy balances in processes with mixture and solution. 6 – Simultaneous solving of energy and material balances. 7 – Computer design and solving of energy and material balances.
Recommended reading	Teaching material available at course web page. R. M. Felder and R. W. Rousseau, *Elementary Principles of Chemical Processes*, 3rd ed., Wiley (2000). D. Himmelblau, *Basic Principles and Calculations in Chemical Engineering*, Prentice-Hall, 6th ed. (1996).
Teaching methods	Lectures: description and demonstration of course contents. Practical lessons: resolution of proposed calculation exercises.
Assessment methods	Written examination. Students may bring and use all the course and personal study materials.
Language of instruction	Portuguese.

B - Description of individual course units

Course title	Separation Processes II (option)
Course code	918438
Type of course	One-semester course
Level of Course	II
Year of study	Third
Semester/trimester	Second
Number of credits	5.5
Name of lecturer	Paula Alexandra Geraldes Portugal
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Gain design and calculus skills for solid classification and solid-gas and solid-liquid separation equipments.
Prerequisites	Develop knowledge of fluids mechanics and mass and energy balances.
Course contents	Study of the movement of particles in fluids – drag coefficient and law of Stokes. Description and design of equipment of: Gravitational classification; Sedimentation; Centrifugation; Fixed beds and fluidized beds of particles; Filtration.
Recommended reading	Foust, et. al.; "Princípios das Operações Unitárias; LTC, Rio de Janeiro McCabe, W. ; Smith, J.; Harriott, P.; "Unit Operations of Chemical Engineering"; Mc Graw-Hill Perry, J.;"Chemical Engineers Handbook"; McGraw-Hill Coulson, J.; Richardson, R.; "Tecnologia Química", Fundação Calouste Gulbenkian
Teaching methods	Theoretical sessions in which the chemical-physical principles and the design methods are discussed, and theoretical-practical sessions where exercises are solved by the students under the lecturer's supervision.
Assessment methods	Written examinations divided into a theoretical section consisting of multiple-choice questions (5 points) and a practical section consisting of exercise solving (15 points).
Language of instruction	Portuguese

B - Description of individual course units

Course title	Separation processes in biotechnology (option)
Course code	918440
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	Second
Number of credits	5.5
Name of lecturer	Henrique Pinho
Objectives of the course (preferably expressed in terms of learning outcomes competences)	The students should be able to develop, scale-up and implement unit separation and purification operations to biological products, in the biotechnology industry context.
Prerequisites	Interpretation of process flow sheets and basic knowledge of unit operations.
Course contents	Introduction: fundamentals of recovery and purification of biological products. Recovery of cellular materials: filtration; centrifugation; sedimentation. Cell disintegration: mechanic methods; non mechanic methods. Recovery of soluble products; extraction; precipitation; membrane processes; electrokinetic processes. Purification procedures: adsorption and chromatographic processes; crystallization; drying. Industrial application examples.
Recommended reading	Teaching material available at course web page. Michael L. Shuler, Fikret Kargi, *Bioprocess Engineering, Basic Concepts*, 2nd ed., Prentice Hall PTR (2002). Jean-François Hamel, Subhas K. Sikdar, Jean B. Hunter, Eds, *Downstream Processing and Bioseparation - Recovery and purification of biological products,* Oxford University Press (1989).
Teaching methods	Lectures: description and application examples of biological products recovery and purification methods. Tutorials: resolution of proposed exercises.
Assessment methods	Written exam (70% of final grade), in which students may use all the course and personal study materials. Group assignments and presentations (30% of final grade).
Language of instruction	Portuguese

B - Description of individual course units

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Course title	Biological Reactors (option)
Course code	918441
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)	To become aware of which information to gather or obtain at the laboratory scale, on the global kinetics of the microbial process to get data that will enable selection of the type of fermenter or the battery of fermenters to be used and relevant operation mode; design the vessel and the respective mixing, aeration and cooling devices.
Prerequisites	Microbiology and Biochemistry
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, plug-flow 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 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

B - Description of individual course units

Course title	Paper Technology (option)
Course code	918442
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	Second
Number of credits	5.5
Name of lecturer	Natércia Maria Ferreira Dos Santos
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Provide knowledge of the paper manufacturing process. The operations involved in the production process and paper chemistry.
Prerequisites	Basic knowledge of chemistry, physics, material and energy 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	Lectures. Laboratory practice.
Assessment methods	Theoretical component: written test. Practical component: laboratory work and respective reports. Final grade is the average of the two components. Course unit approval requires a minimum score of 10 points (out of a 0-20 scale) in both components.
Language of instruction	Portuguese

B - Description of individual course units

Course title	Converting Technology (option)

Course code	918443
Type of course	One-semester course
Level of Course	NA
Year of study	Third
Semester/trimester	Second
Number of credits	5.5
Name of lecturer	Rui Sant'Ovaia
Objectives of the course (preferably expressed in terms of learning outcomes competences)	Develop abilities to work in the paper technology sector, to evaluate problems and control the related industrial process.
Prerequisites	Knowledge of paper technology and quality control.
Course contents	1 - Secondary fibres and deinking as raw material. 2 - Wet converting: coating and board (multiply formers). 3 - Dry converting: bag and box making. 4 - Printing: mechanical and electronic system. Relationship ink-paper.
Recommended reading	G.A.Smook, *Handbook for Pulp and Paper Technologists*, TAPPI Ed., 1989. *Paper-making science and technyology*, Fapet Oy, 1998.
Teaching methods	Lectures and laboratory sessions.
Assessment methods	Continuous assessment and a final examination test.
Language of instruction	Portuguese