ECTS Information Package: Degree Programme

Master´s degree in

CHEMICAL TECHNOLOGY

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A - General Description

Programme Title - Mestrado em Tecnologia Química

Qualification awarded - Master´s degree in Chemical Technology

Level of qualification - Second-cycle degree, EQF Level 7; ISCED Level 5

Specific admission requirements

General

According to the Portuguese Law, the following candidates are eligible for entry to the course of study leading to the *Mestre* degree:

- Holders of a *licenciado* degree or legally equivalent corresponding to the first cycle of higher education;
- Holders of a foreign higher degree awarded on completion of a first-cycle programme organised in the framework of the Bologna Process;
- Holders of a foreign higher degree which is deemed by the Technical-Scientific Committee of ESTT-IPT to meet the requirements of a *licenciado* degree.
- Holders of an academic, scientific or professional curriculum which is deemed by the Technical/Scientific Committee of ESTT-IPT as appropriate to access the programme.

Specific

The candidates who have, in the preceding year, completed the bachelor´s degree (licenciatura) in Chemical and Biochemical Engineering or the degree in Environmental and Biological Engineering offered by the School of Technology-IPT have direct access to the master´s programme in Chemical Technology.

Without prejudice to the general entry requirements, the following candidates are accepted for entry onto the master´s degree in Chemical Technology subject to admission quotas:

- Holders of a licenciado degree or equivalent in chemical and biological technology related areas such as chemical, biochemical, food, environmental and others;
- Holders of a foreign higher degree in chemical and biological technology areas awarded on completion of a first-cycle programme organised in the framework of the Bologna Process;
- Holders of a foreign higher degree in chemical and biological technology which is deemed by the ESTT/IPT Technical-Scientific Committee to meet the requirements of a licenciado degree.
- Holders of a bacharel degree in chemical and biological areas whose scientific and professional curriculum is deemed by the ESTT-IPT Scientific-Technical Committee as appropriate to access this course of study;
- Holders of an academic, scientific or professional curriculum in chemical and biological areas which is deemed by the ESTT-IPT Scientific-Technical Committee as appropriate to access this course of study.
- Accrual of credits to candidates holding a licenciado degree in chemical engineering or similar programs prior to the Bologna process with a duration equivalent to 300 ECTS credits (5 years of study) is formally analysed on a case-to-case basis.

Specific arrangements for recognition of prior learning (formal, non-formal and informal)

General
Granting of credits from prior learning is regulated by the Portuguese Law taking into account the level of credits and the field of study where they have been earned and is subject to the recognition of ESTT-IPT Technical/Scientific Committee.

- Training undertaken in the context of other higher education programmes of study from national or foreign HE establishments or organised in the framework of the Bologna Process or other prior learning can be credited towards the present programme of study;
- Credits earned from postgraduate studies can also be credited towards this programme of study;
- Professional experience or other training, different from the abovementioned ones, can also be credited towards this programme of study.

Specific

Accrual of credits to candidates holding a licenciado degree in chemical engineering or similar programs prior to the Bologna process with a duration equivalent to 300 ECTS credits (5 years of study) is formally analysed on a case-to-case basis.

Qualification requirements and regulations:

The master´s degrees are governed by the Portuguese Law and applicable program regulations established by the School of Technology-IPT.

In order to complete the master´s degree it is necessary to accumulate 120 ECTS credits distributed throughout 4 curricular semesters as according to the course curriculum.

Profile of the program:

This course of study includes:

- A master´s program organised into modules corresponding to 76 ECTS credits;
- An original project or a professional internship including final report corresponding to 44 ECTS credits.

This master's degree was designed so as to develop skills in the following technical-scientific areas: Chemical Technology (62 compulsory and 12 optional ECTS credits); Industrial Processes (12 compulsory and 16 optional ECTS credits); Environment and Quality (12 compulsory ECTS credits); Physical and Inorganic Chemistry (6 compulsory ECTS credits); Organic Chemistry and Biotechnology (6 compulsory ECTS credits); Mathematics (6 compulsory ECTS credits).

Key learning outcomes:

Graduates from this master´s program are expected to be able to:

- Apply mathematical and engineering concepts and techniques,specially those applied to chemical technology and chemical engineering;
- Define, model and solve problems related with chemical, biological and environmental processes;
- Prepare and implement experiments and tests and be able to interpret and use respective results;
- Use advanced analyses techniques and computer methods in chemical engineering;
- Join project or research teams involved in process development and promote interdisciplinary tasks;
- Promote the development of sustainable processes, clean technologies and rational energy use;
- Design, implement, manage and optimise industries engaged in chemical and biological processes and their key support systems, including waste water management and treatment;
- Evaluate, from the technical, economical and environmental point of view, new products and production technologies;
- Apply the quality control procedures to raw materials and products;
- Plan, draw up, implement and coordinate quality control methodologies as applied to production processes, laboratories and associated industrial services;
- Acquire individual and teamwork methodologies that will allow them to engage in lifelong learning activities;

Occupational profiles of graduates with examples:

Holders of the master´s degree in Chemical Technology are prepared to perform as:

- Production managers or production assistant managers within chemical and biological industries;
- Manager or assistant managers of industrial premises related with chemical technology such as industrial utilities and industrial wastewater treatment plants;
- Members of multidisciplinary teams for the creation, implementation or optimisation of chemical and biological industries;
- Director or middle manager within independent or auxiliary chemical and biological laboratories;

Access to further studies:

The master´s degree in Chemical Technology enables access to third-cycle programmes in chemical, biochemical and biotechnology or related areas according to applicable admission regulations.

Course structure diagram with credits

Course Title	Year	Semester	Credits
Complements of Transport Phenomena	1	S1	6
Heterogeneous Reactors and Catalysis	1	S1	6
Mathematics and Computation	1	S1	6
Polymers and Macromolecular Chemistry	1	S1	6
Surface and Interface Chemistry	1	S1	6
Advanced Chemical Processes	1	S2	6
Advanced Separation Processes	1	S2	6
Industrial Management and Planning	1	S2	6
Option I (Year1/Sem2)	1	S2	6
op: Agri-Food Sciences (*)	1	S2	6
op: Process Optimization (*)	1	S2	6
Option II (Year1/Sem2)	1	S2	6
op: Environment and Energy (*)	1	S2	6
op: Process Dynamics and Control (*)	1	S2	6
Dissertation/Project/Internship	2	A	44
op: Dissertation	2	A	44
op: Internship/Placement	2	A	44
op: Project	2	A	44
Bioprocess Engineering	2	S1	6
Environmental Engineering	2	S1	6
Option III (Year2/Sem1)	2	S1	4
op: Materials Science and Technology (*)	2	S1	4
op: Process Design and Innovation (*)	2	S1	4

(*) This course may not be available in certain academic years. Please confirm availability with the Erasmus coordinator.

Examination regulations, assessment and grading

General
Assessment of course units complies with the Academic Regulations in force at ESTT-IPT, except for the Dissertation, Project and Internship, to which apply the provisions set out in the regulations for the master's degrees offered by the ESTT-IPT.

- Dissertation, Project and Internship have only two assessment seasons and the students are free to choose only one.
- The assessment calendar for the Dissertation, Project and Internship is proposed by the Programme Coordinating Committee to the Technical/Scientific Committee at the beginning of each academic year.
- The general grade improvement scheme does not apply to the Dissertation, Project and Internship.

The overall grade of the master's programme is the arithmetic weighted average rounded off to the ones of the number of ECTS credits and the grades of the course units that form part of the programme of study.
The 10-20 mark expressed on a 0-20 scale is converted into its equivalent in the European grading scale with the awards Satisfactory, Good, Very Good or Excellent.

Specific

The students must develop an original project or undertake professional internship and associated report. Both the project and the internship report must be submitted for appreciation to an examination panel appointed for that purpose.

Graduation requirements:

Completion of the program requires a pass in all its constituent modules including the preparation and public defence of project work or internship report so as to accumulate 120 ECTS credits, of which 104 are compulsory and 16 are selected among optional modules available in the curriculum in compliance with general and specific assessment regulations.

Mode of study:
Full- or part-time.

Program director or equivalente

Director: Dina Maria Ribeiro Mateus
Erasmus coordinator: Valentim Maria Brunheta Nunes
ECTS coordinator: Valentim Maria Brunheta Nunes

B - Description of individual course units

Course unit title	Complements of Transport Phenomena
Course unit code	300102
Type of course unit	Compulsory
Level of Course unit	Second Cycle
Year of Study	First Year
Semester/Trimester when the course unit is delivered	First Semester
Number of ECTS credits allocated	6
Name of Lecturer(s)	Henrique Joaquim de Oliveira Pinho
Learning outcomes of the course unit	The students should acquire in-depth knowledge of transport phenomena and be able to apply the concepts of heat and mass transfer in the design of equipment used in chemical technology.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Be familiar with the concepts of integration and differentiation as well as numerical methods.
Recommended optional programme componentes	Process optimization; Numerical methods; Computer science.
Course contentes	1. Fundamentals of heat transfer; 2. Temperature and heat flow distributions; 3. Turbulent energy flow equations 4. Fundamentals of mass transfer; 5. Concentration and mass flow distributions; 6. Continuity equations for turbulent flows; 7. Analogies and models to predict mass transfer coefficients; 8. Dispersion; 9. Applications.
Recommended or required Reading	- Mateus, D.(2009). *Fundamentos de Transferência de Calor*. Tomar: Instituto Politécnico de Tonar - Lightfoot, E. e Stewart, W. e Bird, R. (2002). *Transport Phenomena*. New York: John Wiley & Sons - Pinho, H.(2019). *Apontamentos de CFT - V. 2019*. Tomar: Disponível através de www.e-learning.ipt.pt
Planned learning activities and teaching methods	Lectures and demonstrations supported by practical cases. Theoretical and practical sessions focused on problem solving, including a lab work (Mass transfer in gas-liquid system).
Assessment Methods and criteria	One or two written tests (70% of final grade; grade greater than 7 points) and one group assignment (30% of final grade; grade greater than 9 points).
Language of Instruction	Portuguese | **Mentoring in** English
Work placement(s)	Not applicable.

B - Description of individual course units

Course unit title	Heterogeneous Reactors and Catalysis
Course unit code	300103
Type of course unit	Compulsory
Level of Course unit	Second Cycle
Year of Study	First Year
Semester/Trimester when the course unit is delivered	First Semester
Number of ECTS credits allocated	6
Name of Lecturer(s)	José Manuel Quelhas Antunes
Learning outcomes of the course unit	Students must acquire abilities of design, simulation and optimization of operating conditions of heterogeneous catalytic reactors and of the catalysis analysis. They must also be able to analyse the relations between transport phenomena and chemical reactions.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Not applicable.
Recommended optional programme componentes	Not applicable.
Course contentes	1- Introduction. 2 - Residence Time Distribution Theory 3 - Catalysis and catalysers; transport phenomena and chemical reaction in catalysers. 4- Catalytic reactors. Characterization and modelling of packed bed reactors. 5 -Fluidised-bed reactors.
Recommended or required Reading	- Fogler, H.(2016). *Elements of Chemical Reaction Engineering*. New Jersey: Prentice-Hall - Levenspiel, O.(1999). *Chemical Reaction Engineering*. New York: John Wiley - Froment, G. e Bischoff, K. (2010). *Chemical Reactor Analysis and Design*. New York: John Wiley & Sons
Planned learning activities and teaching methods	Lectures supported by illustrative case studies. Theoretical-practical classes involving concept application and problem-solving.
Assessment Methods and criteria	Written test - 30%, computational task - 35% and experiemntal tasks - 35%.
Language of Instruction	Portuguese | **Mentoring in** English
Work placement(s)	Not applicable.

B - Description of individual course units

Course unit title	Mathematics and Computation
Course unit code	300101
Type of course unit	Compulsory
Level of Course unit	Second Cycle
Year of Study	First Year
Semester/Trimester when the course unit is delivered	First Semester
Number of ECTS credits allocated	6
Name of Lecturer(s)	Luís Miguel Merca Fernandes José Manuel Quelhas Antunes
Learning outcomes of the course unit	The students should acquire knowledge in the field of Numerical Methods for Ordinary and Partial Differential Equations as well as Unconstrained and Constrained Nonlinear Optimization required for modelling and problem solving in several Chemical Technology domains.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Not applicable.
Recommended optional programme componentes	Not applicable.
Course contentes	1. Ordinary differential equations 2. Systems of linear equations 3. Partial Differential equations 4. Unconstrained nonlinear programming 5. Constrained nonlinear programming
Recommended or required Reading	- Zill, D.(1989). *A First Course in Differential Equations with Applications*. Kent: PWS-Kent Publishing Company - Heath, M.(2001). *Scientific Computing: an Introductory Survey*. New York: McGraw-Hill - Gill, P. e Murray, W. e Wright, M. (1981). *Practical Optimization*. Cambridge: Academic Press - Chapra, S. e Canale, R. (2006). *Numerical Methods For Engineers*. NY: McGraw-Hill
Planned learning activities and teaching methods	Theoretical lectures, with presentation and illustration of the proposed subjects. Theoretical-practical lectures in which exercises are proposed and solved.
Assessment Methods and criteria	Continuous assessment including a computational project. Final written exam.
Language of Instruction	Portuguese | **Mentoring in** English
Work placement(s)	Not applicable.

B - Description of individual course units

Course unit title	Polymers and Macromolecular Chemistry
Course unit code	300104
Type of course unit	Compulsory
Level of Course unit	Second Cycle
Year of Study	First Year
Semester/Trimester when the course unit is delivered	First Semester
Number of ECTS credits allocated	6
Name of Lecturer(s)	Cecília de Melo Correia Baptista
Learning outcomes of the course unit	Study of the morphology, synthesis, classification and daily usage of polymers. Identify the relationships between chemical structure and properties of macromolecular materials. Recognize the most important polymerisation reactions and the processing of plastic materials.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	NA.
Recommended optional programme componentes	NA.
Course contentes	1 ? Basics of macromolecular structure, classification and nomenclature of polymers. 2 ? Chemical structure, morphology, properties and characterization of polymers. 3 ? Polymerization reactions ? stages, characteristics and kinetics. Polymer processing. 4 ? Natural polymers - examples, sources and properties.
Recommended or required Reading	- Stevens, M.(2009). *Polymer Chemistry - An introduction*. New York: Oxford University Press - Carraher Jr., C.(2012). *Introduction to Polymer Chemistry*. New York: CRC Press - Lovell, P. e Young, R. (2011). *Introduction to Polymers*. New York: CRC Press
Planned learning activities and teaching methods	Lectures. Laboratory classes and tutorials including problem-solving. One field trip to a polymer manufacturing/processing facility.
Assessment Methods and criteria	A - Laboratory work assessment. B - Group assignment including oral presentation or written final test. Final grade - (A+B)/2
Language of Instruction	Portuguese | **Mentoring in** English
Work placement(s)	NA.

B - Description of individual course units

Course unit title	Surface and Interface Chemistry
Course unit code	300105
Type of course unit	Compulsory
Level of Course unit	Second Cycle
Year of Study	First Year
Semester/Trimester when the course unit is delivered	First Semester
Number of ECTS credits allocated	6
Name of Lecturer(s)	Valentim Maria Brunheta Nunes
Learning outcomes of the course unit	Students should be able to describe the major models used to describe the physical and chemical behaviour of surfaces and interfaces. They should be able to apply these concepts to important chemical technology systems.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Not applicable.
Recommended optional programme componentes	Not applicable.
Course contentes	1.Colloidal Systems. Industrial importance; 2.Liquid/gas interface. Surface tension. Young-Laplace equation. Kelvin equation. Gibbs isothermal; 3. Liquid/liquid interface. Interfacial tension. Aggregation and tensioactive colloids. Emulsions. Bancroft rule; 4.Solid/gas interface. Chemical and physical adsorption. Adsorption isothermals. Langmuir and BET models.
Recommended or required Reading	- Adamson, A.(1997). *Physical Chemistry of Surfaces*. New York: John Wiley & Sons Inc - Shaw, D.(2013). *Introduction to Colloid and Surface Chemistry*. Oxford: Butterworth Heineman - Rajagopalan, R. e Hiemenz, P. (1997). *Principles of Colloid and Surface*. New York: Marcel Dekker Inc., - Pashley, R. e Karaman, M. (2004). *Applied Colloid and Surface Chemistry*. Chichester: Wiley
Planned learning activities and teaching methods	Theoretical Lectures. Pratical lessons including problem-solving and applied laboratory work.
Assessment Methods and criteria	Short individual written essay on a topic related with surface and interface chemistry and reports (30%). A written mid-term test or final examination (70%).
Language of Instruction	Portuguese | **Mentoring in** English
Work placement(s)	Not applicable.

B - Description of individual course units

Course unit title	Advanced Chemical Processes
Course unit code	300106
Type of course unit	Compulsory
Level of Course unit	Second Cycle
Year of Study	First Year
Semester/Trimester when the course unit is delivered	Second Semester
Number of ECTS credits allocated	6
Name of Lecturer(s)	Henrique Joaquim de Oliveira Pinho
Learning outcomes of the course unit	Students should acquire skills on analysis, design and mass and energy integration of chemical processes and should be able to use computational methods for chemical simulation.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Basic skills on chemical processes design (Mass-energy balances).
Recommended optional programme componentes	Process optimisation; Numerical methods; Computer science.
Course contentes	1.Chemical process industries - generic structure; 2. Chemical processes design principles; 3.Selection and configuration of reactive systems; 4.Design of separation processes; 5.Prediction of properties and operating conditions; 6.Analysis and design of energy networks; 7.Mass integration networks and green chemistry.
Recommended or required Reading	- Westerberg, A. e Biegler, L. e Grossmann, I. (1997). *Systematic Methods of Chemical Process Design*. New York: Prentice-Hall - Smith, R.(2005). *Chemical Process Design and Integration*. New York: John Wiley & Sons - Shaeiwitz, W. e Bailie, R. e Turton, R. (2009). *Analysis, Synthesis and Design of Chemical Processes*. New York: Prentice-Hall - Pinho, H.(0). *Material de apoio*.Acedido em31 de janeiro de 2017 em www.e-learning.ipt.pt
Planned learning activities and teaching methods	Lectures supported by demonstrations and resolution of practical cases. Theoretical and practical sessions focused on the simulation of chemical processes by computational means.
Assessment Methods and criteria	A written test (50% of final grade) and practical component (50% of final grade). The practical part include a group assignment work (30%) and an individual assignment (10%). Participation and presences account for 10%.
Language of Instruction	Portuguese | **Mentoring in** English
Work placement(s)	Not applicable.

B - Description of individual course units

Course unit title	Advanced Separation Processes
Course unit code	300108
Type of course unit	Compulsory
Level of Course unit	Second Cycle
Year of Study	First Year
Semester/Trimester when the course unit is delivered	Second Semester
Number of ECTS credits allocated	6
Name of Lecturer(s)	Paula Alexandra Geraldes Portugal
Learning outcomes of the course unit	Develop skills in design calculus of liquid-liquid extraction, gas-liquid absorption and adsorption equipments. Be able to identify and use advanced separation processes such as membrane and supercritical extraction, ionic permutation and chromatography.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Not applicable.
Recommended optional programme componentes	Not applicable.
Course contentes	1 - Gas-liquid absorption 2 - Liquid-Liquid Extraction 3 - Adsorption, Ionic permutation and chromatography 4 - Membrane separation processes 5 - Supercritical extraction
Recommended or required Reading	- Academic Press, .(2000). *Encyclopedia of Separation Science*. London: Academic Press - Sinha, A. e Parameswar, D. (2012). *Mass Transfer Principles and Operations*. New Delhi: PHI Learning Private Limited - Rousseau, R.(1987). *Handbook of Separation Process Tecnhology*. New York: John Wiley & Sons - Dutta, B.(2007). *Principles of Mass Transfer And Separation Processes*. New Delhi: PHI Learning Private Limited
Planned learning activities and teaching methods	Theoretical sessions where chemical-physical principles and design methods are discussed. Theoretical-practical sessions focused on exercise solving under the lecturer's supervision.
Assessment Methods and criteria	Open-book tests and exams. Minimum pass grade: 9.5 out of 20
Language of Instruction	Portuguese
Work placement(s)	Not applicable.

B - Description of individual course units

Course unit title	Industrial Management and Planning
Course unit code	300110
Type of course unit	Compulsory
Level of Course unit	Second Cycle
Year of Study	First Year
Semester/Trimester when the course unit is delivered	Second Semester
Number of ECTS credits allocated	6
Name of Lecturer(s)	Natércia Maria Ferreira dos Santos
Learning outcomes of the course unit	Students should be able to: - Relate the production function with other functional areas of the company; - Understand and apply the fundamental models and techniques in planning and production management.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Not applicable.
Recommended optional programme componentes	Not applicable.
Course contentes	1. An historical overview of the evolution of production systems and production function. 2. Competition factors: cost, time, quality, innovation, flexibility and environment. 3. Engineering methods and process design. SMED - Single Minute Exchange of Die. Layouts. 4. Production planning. 5. Logistics.
Recommended or required Reading	- Courtois, A. e Pillet, M. e Martin-Bonnefous, C. (2007). *Gestão da Produção*. Lisboa: Lidel - Ribeiro, J. e Roldão, V. (2007). *Gestão das Operações - Uma abordagem integrada*. Lisboa: Monitor - Roldão, V.(2002). *Planeamento e Programação das Operações - na Indústria e nos Serviços*. Lisboa: Monitor - Chase, R. e Aquilano, N. e Jacob, F. (2003). *Operations Management for Competitive Advantage*. .: McGraw -Hill Irwin
Planned learning activities and teaching methods	Explanatory lectures. Theoretical-practical lectures: case studies and practical exercises solving.
Assessment Methods and criteria	Theoretical component: written test. Theorical-practical component: paper of literature review Final mark is the average of the two components. Minimum pass mark is 10 (out of 20) in both components.
Language of Instruction	Portuguese | **Mentoring in** French
Work placement(s)	Not applicable.

B - Description of individual course units

Course unit title	Agri-Food Sciences (*)
Course unit code	300124
Type of course unit	Optional
Level of Course unit	Second Cycle
Year of Study	First Year
Semester/Trimester when the course unit is delivered	Second Semester
Number of ECTS credits allocated	6
Name of Lecturer(s)	
Learning outcomes of the course unit	Students should be able to understand the importance of agriculture, food production and food processing for a sustainable development; apply the HACCP principles; design equipments for unit operations in food industry.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Prior knowledge of microbiology, biochemistry, transport phenomena and separation processes.
Recommended optional programme componentes	Enzyme Engineering, Bioreactors, Separation Processes in Biotechnology.
Course contentes	Agriculture and food production. Food industry. Food quality and safety. Main raw materials. Fundamental principles of the technological processing of foods and food hygiene. Concentration by evaporation. Dehydration - Drying.
Recommended or required Reading	- Brennan, J. e Butters, J. e Cowell, . e Lilly, A. (1990). *Food Engineering Operations*. Barking: Elsevier Science Publishers - Fellows, P.(2017). *Food Processing Technology: principles and practice*. Cambridge: Elsevier - Earle, R. e Earl, M. (2004). *Unit Operations in Food Processing*. New Zealand: Pergamon Press - Freitas, A. e Figueiredo, P. (2000). *Conservacao de alimentos, Livro de apoio a cadeira de conservacao de alimentos*. (Vol. 1). Lisboa: Universidade Lusofona
Planned learning activities and teaching methods	Theoretical lectures on course subjects. Practical lessons including exercises and laboratory activities.
Assessment Methods and criteria	Final written test (80%) and laboratory reports (20%). A minimum pass mark of 10/20 in both assessment components is required to pass.
Language of Instruction	Portuguese | **Mentoring in** English
Work placement(s)	Not applicable.

(*) This course may not be available in certain academic years. Please confirm availability with the Erasmus coordinator.

B - Description of individual course units

Course unit title	Process Optimization (*)
Course unit code	300107
Type of course unit	Optional
Level of Course unit	Second Cycle
Year of Study	First Year
Semester/Trimester when the course unit is delivered	Second Semester
Number of ECTS credits allocated	6
Name of Lecturer(s)	Luís Miguel Merca Fernandes Paula Alexandra Geraldes Portugal
Learning outcomes of the course unit	Students should be able to identify optimization problems in chemical processes, formulate them mathematically, choose appropriate strategies to solve them and use optimization software in integrated environments for problem solving and algorithmic solvers.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Prior knowledge of chemical engineering design, operation and management; Mathematical analysis; Algebra and Numerical Methods.
Recommended optional programme componentes	Not applicable.
Course contentes	PART I ? Introduction and motivation. Linear Programming. Integer Linear Programming. Dynamic programming. PART II ? Formulation and solution of optimization problems in chemical technology. PART III - Computational Optimization Methods.
Recommended or required Reading	- Lasdon, L. e Himmelblau, D. e Edgar, T. (2001). *Optimization of Chemical Processes*. New York: McGraw-Hill. - Hiller, F. e Lieberman, G. (1989). *Introduction to Operations Research*. New York: McGraw-Hill - Magalhães, A. e Guerreiro, J. e Ramalhete, M. (1994). *Programação Linear*. Lisboa: McGraw-Hill
Planned learning activities and teaching methods	Lectures on optimisation methods. Problem-solving applied to chemical technology.
Assessment Methods and criteria	Continuous assessment: mid-term written test (12 grade points)+a computational project (8 grade points). Pass requirement: min. of 3 pts (out of 12) in the test and 4 pts (out of 8)in the project. Test+project at least 9.5 Exam pass mark: 9.5
Language of Instruction	English
Work placement(s)	Not applicable.

(*) This course may not be available in certain academic years. Please confirm availability with the Erasmus coordinator.

B - Description of individual course units

Course unit title	Environment and Energy (*)
Course unit code	300125
Type of course unit	Optional
Level of Course unit	Second Cycle
Year of Study	First Year
Semester/Trimester when the course unit is delivered	Second Semester
Number of ECTS credits allocated	6
Name of Lecturer(s)	Valentim Maria Brunheta Nunes Paulo Manuel Machado Coelho Henrique Joaquim de Oliveira Pinho
Learning outcomes of the course unit	Students should understand the energy-environment relations from the point of view of energy sustainability; be able to analyze the main production systems, energy storage and conversion; develop the ability to make technical assessments of energy systems.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Not applicable.
Recommended optional programme componentes	Not applicable.
Course contentes	1. Energy in modern societies and environmental impact. Global energy statistics and situation in Portugal; 2. Thermodynamic principles of energy conversion. Thermal cycles; 3. Nuclear energy; 4. Storage and transmission of energy; 5. Renewable energy. Wind energy. Hydropower. Solar thermal and photovoltaic systems; 6. Bioenergy. Fuel production from biomass.
Recommended or required Reading	- Golomb, D. e Fay, J. (2004). *Energy and the Environment*. Oxford: Oxford University Press and Open University - Sorensen, B.(2000). *Renewable Energy*. San Diego: Academic Press - Castro, R.(2012). *Uma introducao as Energias Renovaveis: Eolica, Fotovoltaica e Mini-Hidrica*. Lisboa: ISTPRESS
Planned learning activities and teaching methods	Lectures. Tutorials including problem-solving. Field trips. Lab experiments in bioenergy.
Assessment Methods and criteria	3 mini-tests throughout the semester. Final grade is calculated as weighted average: first test-50% and the other two 25%. Final written exam - 100%
Language of Instruction	Portuguese | **Mentoring in** English
Work placement(s)	Not applicable.

(*) This course may not be available in certain academic years. Please confirm availability with the Erasmus coordinator.

B - Description of individual course units

Course unit title	Process Dynamics and Control (*)
Course unit code	300109
Type of course unit	Optional
Level of Course unit	Second Cycle
Year of Study	First Year
Semester/Trimester when the course unit is delivered	Second Semester
Number of ECTS credits allocated	6
Name of Lecturer(s)	Paulo Manuel Machado Coelho José Manuel Quelhas Antunes
Learning outcomes of the course unit	Develop skills on mathematical modelling, dynamic behaviour analysis and automatic control of chemical processes. Skills in designing classical control systems, assuming linear processes or processes that can be linearized. Stability analysis and performance of control loops will be also developed.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Not applicable.
Recommended optional programme componentes	Not applicable.
Course contentes	1-Introduction: revision of Laplace transform, complex algebra and Matlab/Simulink. 2-Modelling and mathematical simulation of chemical processes. 3-Linear systems. Dynamic behaviour of first, second and higher-order systems. Frequency response analysis. 4-Automatic feedback control. Stability analysis. Controller project. 5-Introduction to advanced control systems.
Recommended or required Reading	- Ogata, K.(1997). *Modern Control Engineering*. USA: Prentice-Hall - Mellichamp, D. e Edgar, T. e Seborg, D. (2004). *Process Dynamics and Control*. USA: Wiley - Luyben, W.(1990). *Process Modeling, Simulation and Control for Chemical Engineers*. USA: McGraw-Hill
Planned learning activities and teaching methods	Lectures on which the concepts relating to the course are exposed and practical classes in which are proposed exercises and some laboratorial work.
Assessment Methods and criteria	The assessment consists of three components. In performing a writing test (50%), in performing a computational project on Modeling, Simulation and Control of Chemical Processes (35%) and performing some practical computational work (15%). The final classification will be the weighted average of the classifications obtained in the three components. The student is exempted from examination if he obtains at least 7 values (on a scale of 0 to 20) in each of the three components, and if the final classification after weighting is higher than 9.5 values. Students who do not attend at least two-thirds of the practical classes of the curricular unit or who do not perform the expected project/practical work will be excluded from the final evaluation.
Language of Instruction	Portuguese | **Mentoring in** English
Work placement(s)	Not applicable.

(*) This course may not be available in certain academic years. Please confirm availability with the Erasmus coordinator.

B - Description of individual course units

Course unit title	Dissertation
Course unit code	300129
Type of course unit	Optional
Level of Course unit	Second Cycle
Year of Study	Second Year
Semester/Trimester when the course unit is delivered	Anual
Number of ECTS credits allocated	44
Name of Lecturer(s)	
Learning outcomes of the course unit	Students should be able to apply the skills acquired in the Masters programme in real industrial contexts. In addition to promoting the use and integration of course knowledge, students are encouraged to acquire additional skills needed to perform well in their future professions.
Mode of delivery	----
Prerequisites and co-requisites	Basic concepts provided by chemical technology related courses and in-depth knowledge of the technical content of the training.
Recommended optional programme componentes	Participation in seminars and other relevant events in the area of Chemical Technology is highly recommended.
Course contentes	Practical component: 1. Introduction; 2. Literature review techniques and project structure 3. Market analysis and production planning 4. Chemical technology project - from block chart to the layout. Tutorial monitoring of student internship periods. Case-to-case discussion of issues related with each individual placement/internship.
Recommended or required Reading	- Peters, M. e Timmerhaus, K. e West, R. (2003). *Plant Design and Economics for Chemical Engineers*. New York: McGraw-Hill - Sinnot, R.(1989). *Tecnologia Química: Uma Introdução ao Projecto em Tecnologia Química*. (Vol. VI). Lisboa: Fundação Calouste Gulbenkian - Turton, R. e Bailie, R. e Shaeiwitz, W. (2009). *Analysis, Synthesis and Design of Chemical Processes*. New York: Prentice-Hall - Smith, R.(2005). *Chemical Process Design and Integration*. New York: John Wiley & Sons
Planned learning activities and teaching methods	Theoretical and practical classes to discuss the course topics. Analysis of specific and relevant issues related to each individual placement/internship context.
Assessment Methods and criteria	The students must submit the internship report and present it before peers. A preliminary presentation or introductory work assignments may be required in compliance with the regulatory provisions of the master's programme.
Language of Instruction	Portuguese | **Mentoring in** English
Work placement(s)	Internship or placement is developed in an industry or institution within the chemical technology sector.

B - Description of individual course units

Course unit title	Internship/Placement
Course unit code	300122
Type of course unit	Optional
Level of Course unit	Second Cycle
Year of Study	Second Year
Semester/Trimester when the course unit is delivered	Anual
Number of ECTS credits allocated	44
Name of Lecturer(s)	
Learning outcomes of the course unit	Students should be able to apply the skills acquired in the Masters programme in real industrial contexts. In addition to promoting the use and integration of course knowledge, students are encouraged to acquire additional skills needed to perform well in their future professions.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Basic concepts provided by chemical technology related courses and in-depth knowledge of the technical content of the training.
Recommended optional programme componentes	Participation in seminars and other relevant events in the area of Chemical Technology is highly recommended.
Course contentes	Practical component: 1. Introduction; 2. Literature review techniques and project structure 3. Market analysis and production planning 4. Chemical technology project - from block chart to the layout. Tutorial monitoring of student internship periods. Case-to-case discussion of issues related with each individual placement/internship.
Recommended or required Reading	- Smith, R.(2005). *Chemical Process Design and Integration*. New York: John Wiley & Sons - Shaeiwitz, W. e Bailie, R. e Turton, R. (2009). *Analysis, Synthesis and Design of Chemical Processes*. New York: Prentice-Hall - Sinnot, R.(1989). *Tecnologia Química: Uma Introdução ao Projecto em Tecnologia Química*. (Vol. VI). Lisboa: Fundação Calouste Gulbenkian - West, R. e Timmerhaus, K. e Peters, M. (2003). *Plant Design and Economics for Chemical Engineers*. New York: McGraw-Hill
Planned learning activities and teaching methods	Theoretical and practical classes to discuss the course topics. Analysis of specific and relevant issues related to each individual placement/internship context.
Assessment Methods and criteria	The students must submit the internship report and present it before peers. A preliminary presentation or introductory work assignments may be required in compliance with the regulatory provisions of the master's programme.
Language of Instruction	Portuguese | **Mentoring in** English
Work placement(s)	Internship or placement is developed in an industry or institution within the chemical technology sector.

B - Description of individual course units

Course unit title	Project
Course unit code	300121
Type of course unit	Optional
Level of Course unit	Second Cycle
Year of Study	Second Year
Semester/Trimester when the course unit is delivered	Anual
Number of ECTS credits allocated	44
Name of Lecturer(s)	
Learning outcomes of the course unit	The unit has two main objectives: to assist students in developing the skills necessary for chemical industries design and enable the practical application and integration of knowledge in the field of chemical technology.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Advanced knowledge on chemical technology subjects and identification and development of the specific scientific areas related with the project theme
Recommended optional programme componentes	It is suggested to participate in seminars and other relevant events in the area of Chemical Technology.
Course contentes	Practical component: 1. Introduction; 2. Literature review techniques and project structure 3. Market analysis and production planning 4. Chemical technology project - from block chart to the layout. Tutorial monitoring of student projects. Case-to-case discussion of issues related with the projects in course
Recommended or required Reading	- Smith, R.(2005). *Chemical Process Design and Integration*. New York: John Wiley & Sons - Shaeiwitz, W. e Turton, R. e Bailie, R. (2009). *Analysis, Synthesis and Design of Chemical Processes*. New York: Prentice-Hall - Sinnot, R.(1989). *Tecnologia Química: Uma Introdução ao Projecto em Tecnologia Química*. (Vol. VI). Lisboa: Fundação Calouste Gulbenkian - West, R. e Timmerhaus, K. e Peters, M. (2003). *Plant Design and Economics for Chemical Engineers*. New York: McGraw-Hill
Planned learning activities and teaching methods	Lectures where theoretical contents are explored and project themes are analysed.
Assessment Methods and criteria	The students will develop a project subct to public presentation. An intermediate presentation or practical assignments may be required in compliance with the regulatory provisions of the master's program.
Language of Instruction	Portuguese | **Mentoring in** English
Work placement(s)	It is possible to chose a work placement as an alternative to this course unit (see the "Placement/Internship" course unit).

B - Description of individual course units

Course unit title	Bioprocess Engineering
Course unit code	300111
Type of course unit	Compulsory
Level of Course unit	Second Cycle
Year of Study	Second Year
Semester/Trimester when the course unit is delivered	First Semester
Number of ECTS credits allocated	6
Name of Lecturer(s)	Dina Mateus
Learning outcomes of the course unit	Develop skills in molecular biology techniques within industrial biotechnology. Understand and monitor analytical techniques and unit operations in industrial processes of biocatalysis and fermentation. Implement security rules in biotechnology.
Mode of delivery	----
Prerequisites and co-requisites	Knowledge of biochemistry and cellular biology.
Recommended optional programme componentes	Enzyme Engineering, Bioreactors, Separation Processes in Biotechnology, Genetic Engineering.
Course contentes	Security regulations in biotechnology. Strategies and methodologies used to clone and analyse genes and its products within recombinant DNA technology. Applied biocatalysis. Kinetics of free and immobilised enzymes. Microbial biotechnology. Fermentation technology. Introduction to the design of ideal biological reactors. Practical cases of biological engineering.
Recommended or required Reading	- Lima, N. e Mota, M. e , . (2003). *Biotecnologia - Fundamentos e Aplicações*. Lisboa: Lidel-Edições Técnicas - Videira, A.(2001). *Engenharia Genética - Princípios e Aplicações (Princípios básicos - Cap I a VIII),*. Lisboa: Lidel-Edições Técnicas - Kargi, F. e Shuler, M. (2001). *Bioprocess Engineering - Basic Concepts*. London: Pearson Educatión - Doran, P.(2012). *Bioprocess Engineering Principles*. London: Academic Press - Mateus, D.(0). *Apontamentos das aulas teóricas, enunciados dos exercícios propostos. Protocolos laboratoriais*.Acedido em10 de setembro de 2019 em www.e-learning.ipt.pt
Planned learning activities and teaching methods	Lectures and laboratory sessions. Theoretical-practical classes focused on the resolution of applied exercises and case studies.
Assessment Methods and criteria	Final written test (60%), presentation and discussion of a practical project work (15%) and lab reports (25%). Minimum pass mark in all components: 10/20.
Language of Instruction	Portuguese | **Mentoring in** English
Work placement(s)	Not applicable.

B - Description of individual course units

Course unit title	Environmental Engineering
Course unit code	300112
Type of course unit	Compulsory
Level of Course unit	Second Cycle
Year of Study	Second Year
Semester/Trimester when the course unit is delivered	First Semester
Number of ECTS credits allocated	6
Name of Lecturer(s)	Marco Cartaxo; Rui Sant'Ovaia; Cecília Baptista
Learning outcomes of the course unit	An overview of some environmental issues of great relevance. Provide the knowledge required to debate these issues. Students should be able to identify key monitoring parameters and describe the major treatment technologies available.
Mode of delivery	----
Prerequisites and co-requisites	Not applicable.
Recommended optional programme componentes	Not applicable.
Course contentes	1. Atmospheric pollution. 2. Hydric pollution. 3. Solid Wastes. 4. Unconventional treatment technologies. 5. Bioremediation.
Recommended or required Reading	- Sincero, A. e Sincero, G. (1996). *Environmental engineering : a design approach*. New Jersey: Prentice Hall - Rowe, D. e Peavy, H. e Tchobanoglous, G. (1985). *Environmental engineering*. New York: Mcgraw - Hill - Hendricks, D.(1996). *Water treatment unit process : physical and chemical*. Boca Raton: CRC - Taylor & Francis
Planned learning activities and teaching methods	Lectures where the fundamental principles are described. Theoretical and practical classes where the resolution of application exercises is done and laboratory works about the subjects taught.
Assessment Methods and criteria	Final grade - weighted average of assessment components: 1: Written test (10%). 2, 3 and 4: Written test, thematic work and reports of the experimental works (67%). 5: Written test or thematic work and report of the experimental work (23%).
Language of Instruction	Portuguese | **Mentoring in** English
Work placement(s)	Not applicable.

B - Description of individual course units

Course unit title	Materials Science and Technology (*)
Course unit code	300114
Type of course unit	Optional
Level of Course unit	Second Cycle
Year of Study	Second Year
Semester/Trimester when the course unit is delivered	First Semester
Number of ECTS credits allocated	4
Name of Lecturer(s)	Isabel Nogueira
Learning outcomes of the course unit	Be able to distinguish between different types of materials, the concepts of micro and macro structure, and industrial and technological applications. They should also be familiar with material selection methods and the various deterioration processes: corrosion, fatigue and wear.
Mode of delivery	----
Prerequisites and co-requisites	Not applicable.
Recommended optional programme componentes	Not applicable.
Course contentes	1. Introduction to materials science and engineering. 2. Chemical structure and chemical bond. 3. Types of materials. 4. Material deterioration.
Recommended or required Reading	- Smith, W.(1998). *Princípios de Ciência e Engenharia dos Materiais*. Lisboa: Mc. Graw-Hill - Callister, W.(2010). *Materials Science and Engineering: an Introduction*. New York: John Wiley & Sons - Shackelford, J. e , . (2009). *Introduction to Materials Science for Engineers*. New Jersey: Prentice-Hall - Hummel, R.(2005). *Understanding Materials Science*. New York: Springer-Verlag
Planned learning activities and teaching methods	Lectures designed to introduce the study topics and present theoretical fundamentals. Theoretical-practical sessions intended to further develop theoretical concepts. Field trips.
Assessment Methods and criteria	Short individual essay on a topic related with materials science and technology (30% of final mark). Written mid-term test or final exam with minimum pass grade of 10/20 (70% of final mark).
Language of Instruction	Portuguese | **Mentoring in** French
Work placement(s)	Not applicable.

(*) This course may not be available in certain academic years. Please confirm availability with the Erasmus coordinator.

B - Description of individual course units

Course unit title	Process Design and Innovation (*)
Course unit code	300126
Type of course unit	Optional
Level of Course unit	Second Cycle
Year of Study	Second Year
Semester/Trimester when the course unit is delivered	First Semester
Number of ECTS credits allocated	4
Name of Lecturer(s)	Isabel Maria Duarte Silva Pinheiro Nogueira Henrique Joaquim de Oliveira Pinho
Learning outcomes of the course unit	Students should be able to: identify opportunities for developing new products and new processes; interpret, use and propose patents; participate in the licensing procedures to implement new processes or new industries; propose methods fostering innovation.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Not applicable.
Recommended optional programme componentes	Not applicable.
Course contentes	1. Introduction to the development of new products and new processes; 2. Product development steps; 3. Design and development of new manufacturing processes; 4. Information technology and research networks; 5. Industrial and intellectual property; 6. Implementation of industrial units; 7. Innovation trends.
Recommended or required Reading	- Biegler, L. e Grossmann, I. e Westerberg, A. (1997). *Systematic Methods of Chemical Process Design*. .: Prentice-Hall - Peters, M. e Timmerhaus, K. e West, R. (2003). *Plant Design and Economics for Chemical Engineers*. .: McGraw-Hill - Pires, A.(1999). *Inovação e Desenvolvimento de Novos Produtos*. .: Edições Sílabo - ., ..(2005). *Guia do Empreendedorismo*. .: Edições SEDES
Planned learning activities and teaching methods	Lectures and discussion of sample cases. Practical lessons dedicated to brainstorming and development of new ideas, literature review on patents and innovative projects.
Assessment Methods and criteria	Practical group work(40%); Theoretical component includes a written test (60%) Minimum pass mark: 10 out of 20
Language of Instruction	Portuguese | **Mentoring in** English
Work placement(s)	Not applicable.

(*) This course may not be available in certain academic years. Please confirm availability with the Erasmus coordinator.