Study Plan

School: School of Sciences and Technology
Degree: Master
Course: Environmental Chemical Analysis (cód. 606)

1st Year - 1st Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
QUI7866M	Sampling and Processing of Environmental Samples	Chemistry	6	Semester	156
MAT10240M	Numerical Optimization	Mathematics	3	Semester	78
QUI10241M	Chemistry of Soil and Sediments	Chemistry	6	Semester	156
QUI7870M	Chemistry of Aquatic Systems	Chemistry	6	Semester	156
QUI10242M	Toxicology of most Relevant Pollutants	Biochemistry	3	Semester	78
QUI10107M	Laboratorial management and safety	Chemistry	6	Semester	156

1st Year - 2nd Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
QUI7876M	Advanced Analytical Techniques I	Chemistry	6	Semester	156
QUI10243M	Advanced Analytical Techniques II	Chemistry	6	Semester	156
QUI10244M	Pollution and Gas Emissions	Physics and Chemistry	6	Semester	156
QUI10245M	Quality, Standards and Certification of Laboratories	Chemistry	3	Semester	78
QUI10246M	Analysis, Treatment and Valuation of Solid Waste	Chemistry	3	Semester	78
QUI7872M	Analysis, Treatment and Valuation of Liquid Waste	Chemistry	6	Semester	156

2nd Year - 3rd Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
QUI10247M	Research Methodologies	Chemistry	3	Semester	78
QUI8171M	Seminars	Chemistry	3	Year	24
Dissertation					

2nd Year - 4th Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
Dissertation					

Conditions for obtaining the Degree:

*** TRANSLATE ME: Para aprovação na componente curricular deste Mestrado, é necessário a aprovação (através de avaliação ou creditação), das seguintes unidades curriculares:

1º Ano

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1.º Semestre

- 6 UC Obrigatórias num total de 30 ECTS

2.º Semestre

- 6 UC Obrigatórias num total de 30 ECTS

2º Ano

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3.º Semestre

- 1 UC Obrigatória num total de 3 ECTS

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3º e 4.º Semestre

- 1 UC Obrigatória num total de 3 ECTS{\}newline

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Para obtenção do grau, é necessário também a aprovação na Dissertação ou Relatório de Estágio, com um total de 54ECTS, no 3.º e 4.º Semestre. ***

Program Contents

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Sampling and Processing of Environmental Samples (QUI7866M)

1. Sampling Methodology. And statistics applied to environmental sampling
2. Pre-treatment and storage of samples. Pre-concentration of analytes. Classical methods and recent methods for the treatment of organic inorganic and biological samples, including isolation, and concentration and fractioning of the analytes.
3. Sample preparation methods for inorganic analytes
4. Techniques of extraction of organic compounds of various types of matrix

Solid matrices: the classical methods of extraction (leaching with organic solvents or soxhlet). New methods of extraction: Ultrasonic extraction (UE), assisted by microwave (MASE), accelerated solvent (ASE), supercritical fluid (SFE).

Matrix liquid and / or gas: liquid-liquid extraction, techniques of solid phase extraction (SPE); sorptive extraction techniques: micro-solid phase extraction (SPME) and stir bar extraction (SBSE).

5. Processing and analysis of biological samples.

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Numerical Optimization (MAT10240M)

1. Scientific method and experimental design.
2. Analysis of variance models: fixed effects (single and multiple factor), random effects (single and multiple factor) and mixed effects.
3. Multiple comparisons.
4. Complete and incomplete block designs. Latin square designs.
5. Non-parametric approaches.
6. Simple linear regression model and multiple regression model (estimation, inference, prediction, model adequacy and validation). Diagnostics for influence points, outliers,
multicollinearity and autocorrelation. Model selection.
7. Nonlinear Regression.

Back

Chemistry of Soil and Sediments (QUI10241M)

1. Surface geochemistry
1.1 Constituents of soil and sediments
1.2. Weathering Processes
2. Composition of soils and sediments
2.1 Solid Phase
2.2 Liquid Phase
2.3 Gaseous Phase
2.4 Complex Colloidal Soil and ion exchange processes
3. Soil reaction
3.1 Acid soils
3.2 Alkaline soils
4. Growth of plants and plant elements
5. Soil pollution
5.1 Fertilizers
5.2 Pesticides
5.3 Organic wastes
5.4 Case studies (eg. Abandoned mines)
6. Remediation process
6.1 Main processes involved in Phytoremediation:
6.1.1 Phytostabilization
6.1.2 Phytovolatilization
6.1.3 Phytoextraction
6.1.4 Bioremediation of waters (case study).

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Chemistry of Aquatic Systems (QUI7870M)

1. Chemical equilibriums in natural waters: acid-base equilibrium; solubility equilibriums; redox equilibriums.
2. Natural cycle and regulation of trace metals in aquatic environments: Global cycling of metals; solid - water interface; complexation by humic substances; hydrophobic systems; regulation of heavy metals in rivers, lakes and oceans.
3. Introduction to aquatic microbial biochemistry: microbial transformations.
4. Photochemical processes in natural waters.
5. Regulation of the chemical composition of natural waters: biogeochemical cycles of carbon, nitrogen and sulfur; Interdependence of biogeochemical cycles.
6. Nature and types of aquatic pollutants: Eutrophication.
7. Modelling applied to environmental systems: A historical perspective (the main systems and problems modeled, classification of models, the modelling process); models of BOD/COD; stratification models; models of eutrophication; structural dynamic models; new modelling techniques.

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Toxicology of most Relevant Pollutants (QUI10242M)

1. Origin, distribution and persistence of pollutants with toxicological relevance.
2. Toxicity of pollutants on individuals, populations and communities.
3. Methods for assessing the toxicity of pollutants.
4. Routes, methods of exposure and toxicity factors supporting cast.
5. Principles for assessment of toxic hazards. Markers of exposure and toxicity.
6. Biological mechanisms of response and adaptation.
7. Integration of knowledge from the molecular to the global level, the individual to the ecosystem.

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Laboratorial management and safety (QUI10107M)

Safety rules. Safety equipment and hygiene laboratory. Prevention of laboratory accidents. Emergency and evacuation plans. Laboratory waste
disposal. Development of databases and laboratory management. The laboratory design considering functionality, security and economy.
Acquisition of goods and services

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Advanced Analytical Techniques I (QUI7876M)

1. Overview of the chromatographic techniques of HPLC, GC and CE.
2. Coupling the different chromatographic techniques with the mass detector. Advantages of the mass detector when compared with other detectors. Different types of mass detectors and ionization modes. Different types of interfaces and their applications.
3. Recent advances in HPLC and GC: LC-MS, monolithic columns and UHPLC(ultrahigh pressure liquid chromatography), different modes of injection in GC, GC-MS and GCxGC-MS. Different modes of CE and its applications.
4. Case studies from the recent scientific literature will be used to illustrate different applications of the hyphenated techniques in the enviromental analysis field.

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Advanced Analytical Techniques II (QUI10243M)

1. Atomic Absorption and Emission; New techniques based on the use of electrothermal atomizers, hydride generator and plasma;
2. Electrochemical methods; Square wave voltammetry and differential pulse;
3. Advantages and disadvantages of implementing the new methods.

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Pollution and Gas Emissions (QUI10244M)

Air pollutants and its action. Strotospheric ozone. Photochemical smog. Acid rain. Air particles in suspension. Volatile organic compounds. Greenhouse effect gases. Metals and metalic compounds. Air pollutants monitoring. Environmental laws. Standard methods for monitoring the main air pollutants. Methods for gaseous emission treatment. Gravity settlers. Cyclones. Electrostatic precipitators. Filtration. Washers.
Dispersion of pollutants in the atmosphere. Elements of atmospheric physics and dynamics. Atmospheric circulations and the transport of pollutants. Atmospheric Boundary Layer and Turbulence. Air pollution dispersion models.

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Quality, Standards and Certification of Laboratories (QUI10245M)

1. Metrology and Qualimetry
1.1. Quantifying Analytical Uncertainty in Analysis.
1.2. Principles of Metrology and Chemical Metrology.
1.3. Proficiency tests and interlaboratory Tests.
2. Accreditation and certification of laboratories.
2.1. Accreditation advantages.
2.2. Accreditation vs. Certification.
2.3. Accreditation of laboratories in Portugal.
3. Good laboratory practice (GLP).
3.1. History and evolution of GLP.
3.2. GLP: The OECD principles.
3.3. GLP: Portuguese context.
4. Quality management systems (QMS)
4.1. General concepts and definitions.
4.2. The 8 principles of QMS.
4.3. NP EN ISO 9001: 2008.
4.4. Implementation phases of QMS.
4.5. Content of QMS documentation.
4.6. Process development.
5. Environmental management systems (EMS) and occupational health and safety management systems (OHSMS).
5.1. General concepts and definitions.
5.2. NP EN ISO 14001: 2004 and OHSAS 18001:2007.
5.3. Implementation phases of EMS.
5.4. Content of EMS documentation.
5.5. Process development.

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Analysis, Treatment and Valuation of Solid Waste (QUI10246M)

1. National production of solid wastes – A consequence of life
2. Major legislation
3. Sources, composition and properties of solid waste
4. Physical, chemical and biological properties of municipal solid wastes
5. Sources, type and characteristics of hazardous solid wastes
6. Collection, separation, processing and transformation of solid wastes
7. Disposal of solid wastes and residual matter
8. Recycling of waste materials.

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Analysis, Treatment and Valuation of Liquid Waste (QUI7872M)

1. Wastewater characterization
Water pollutants
Sources, fate and effects of pollutants in the aquatic environment
Wastewater constituents (physical, chemical and biological characteristics)
Wastewater sources, flow rates and constituent loadings
Wastewater legislation
2. Main wastewater treatment processes and operations
Objectives and definitions. Physical, chemical and biological unit processes Main equipment: application and design considerations
3. Treatment stages of municipal and some industrial wastewaters
Main goals and processes in each treatment stage
4. Wastewater reclamation and reuse
Reuse applications
Public health and environmental issues
Water reclamation technologies
5. Sludge treatment, disposal and reuse
Sludge characteristics and quantities
Main stages of sludge treatment
6. Natural treatment systems
Land-treatment systems
Constructed wetlands
Abiotic and biotic processes of pollutant removal

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Research Methodologies (QUI10247M)

1. Bibliographic research - evaluate the credibility of the bibliographical sources, utilize technologies of information to conduct literature
research, building information databases;
2. Schedule laboratory work - experimental design with a view to obtain statistically relevant data. The ethical aspects of conducting scientific
research;
3. Preparation of scientific papers based on the results obtained. Ethical issues related to the preparation of the dissertation and scientific
papers in peer review journals.
4. Statistical analysis of data.

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Seminars (QUI8171M)

The discipline contemplates two distinct but complementary components. On the one hand, the students should attend research talks and subsequently elaborate, individually, a written summary. The themes are not fixed but depend, amongst other factors, on the Masters course the students are following.
The other component of the discipline involves the elaboration of an individual monograph on a theme established during the first classes of the semester and proposed by the lecturer or the students, and which may be related with the theme of the student's dissertation. Each student must also make a Powerpoint presentation of the monograph, which will be followed by a discussion period.