Teaching Guide				
Identifying Data				2022/23
Subject (*)	Physico-chemistry and quality of water		Code	632844203
Study programme	Mestrado Universitario en Enxeñaría da Auga (plan 2012)			
Descriptors				
Cycle	Period	Year	Type	Credits
Official Master's Degree	1st four-month period	First	Obligatory	6
Language	English			
Teaching method	Face-to-face			
Prerequisites				
Department	Enxeñaría Civil			
Coordinador	Delgado Martin, Jordi	E-mail	jorge.delgado@udc.es	
Lecturers	Barrientos Rodríguez, Victor Delgado Martin, Jordi Vázquez González, Ana María	E-mail	victor.barrientos@udc.es jorge.delgado@udc.es ana.maria.vazquez@udc.es	
Web	caminos.udc.es/hosting/masteragua/			
General description	This subject is aimed at presenting some basic concepts about the physics and chemistry of natural waters as well as some key ideas about water quality. Elemental water chemistry concepts are combined with other practical topics like natural water sampling, data analysis and graphical representation. More advanced contents include the description of processes governing the variability of the chemical composition of natural waters in its different reservoirs (precipitation, continental lotic and lentic systems, ground water, sea water).			

Study programme competences / results	
Code	Study programme competences / results
A1	Knowledge, understanding and capacity to apply legislation related with water engineering during professional development. Capacity to analyse the working mechanism of the economy and public and private management of water
A2	Capacity to resolve basic physical problems of water engineering and theoretic and practical Knowledge of the chemistry, physics, mechanics and technologic properties of the water
A5	Knowledge of the basic concepts about ecology applied to water engineering. Capacity to act in the respectful way and enriching way about the environment contribution to the sustainable development. Capacity to analyse the ecological quality of water. Knowledge of the basic principles of the ecology and basic understanding of the working continental water systems
A16	Knowledge of the chemical basis of water which totally condition its behaviour in nature and its uses. Understanding and knowledge of the different water regulations for quality at local, national and European level
A19	Knowledge of advanced water treatment with different conclusions: depuration, re-use, purification, elimination of nutrients and regeneration treatments
A20	Use and management of measuring equipment in the field and in the laboratory. Knowledge of the methodology of control process and the determination of design parameters for water treatment processes
A21	Knowledge of water quality control models. Capacity to analyse and propose solutions to problems in water quality control
A25	Knowledge and understanding of water in different situations: the working of ecosystems, environmental factors with the purpose of to make an inventory of medium, applying the methodology to value the impact and its use in studies and evaluations of the environmental impact.
B1	To resolve problems effectively
B2	To apply critical thinking, logic and creativity
B3	To work individually with initiative
B4	To communicate effectively in work surroundings
B5	Continuous recycling of knowledge in a general perspective in a global situation of water engineering
B6	Understanding of the need to analyse history to understand the present
B7	Facility to integrate in multidiscipline teams
B8	Capacity to organize and plan
B9	Capacity for analysis, synthesis and structure of information and ideas

C1	To understand the importance of the enterprising culture and to know the means at the reach of the enterprising people
C2	To value knowledge critically, technology and available information to resolve problems that they will face
C3	To assume as a professional and citizen the importance of learning throughout life
C4	To value the importance of the investigation, innovation and technology development in the social ?economic advance and cultural in society
C5	To posses and understand knowledge that gives a base or oportunity to be original in the development and for applications of ideas, often in the context of investigation
C6	The students must be able to apply the acquired knowledge and their capacity to resolve problems in new surrandings or not well known within wider contexts (or multidiscipline) related with the study area
C7	The students must be able to integrate knowledge and to affront the complexity to formulate judgements from information that, been incomplete or limited, include reflexions about social responsabilities and ethics related to the application of the knowledge and judments
C8	The students must be able to comunicate their conclusions, knowledge and the last reasons that support them, to spezialated publics and not spezialated in a clear and unambiguous way.
C9	The student must possess the learning ability with permits them to continues to study in a manner wich will be in a great measure self directed and individual

Learning outcomes			
Learning outcomes	Study programme competences / results		
Learning the basic principles of water chemistry.	AC1 AC2 AC5 AC16 AC19 AC20 AC21 AC25	BC1 BC4 BC5 BC6 BC9	CC1 CC2 CC3 CC4 CC5 CC6 CC7 CC8 CC9
Learning the basic principles of the analytical techniques aimed at quantifying the concentrations of water contaminants and their constituents.	AC2 AC16	BC1 BC2 BC4 BC5 BC7 BC9	CC2 CC3 CC4
Ability to plan and execute sampling surveys for water chemistry	AC1 AC2 AC20 AC21 AC25	BC1 BC2 BC3 BC5 BC7 BC8 BC9	CC4
Ability to establish relationships between physico-chemical data and the chemical state of a water body or the prescribed legal environmental quality objectives.	AC1 AC25	BC2 BC5 BC7	CC2 CC3 CC4

Ability to perform statistical descriptions relative to the chemical quality of water.	AC2 AC16 AC20 AC21	BC1 BC2 BC4 BC7 BC8 BC9	CC2 CC3 CC4
Ability to perform graphical representations of water chemistry	AC2 AC25	BC1 BC2 BC3 BC8 BC9	CC2 CC3 CC4
Learning basic hydrochemical processes	AC16 AC19	BC1 BC2 BC7 BC9	CC3 CC4
Learning the basic principles of hydrochemical modelling	AC21	BC1 BC2 BC7 BC9	CC4

Contents	
Topic	**Sub-topic**
Basics of water chemistry	Structure and properties of water - Phase diagram of water - Density, salinity, heat capacity, viscosity - Oceanic stratification and thermohaline circulation - Phase transformations of water - Stereochemistry of the wáter molecule Basic chemistry concepts - Ponderal laws - Mass conservation - Mol and stoichiometry - Concentration units - Intensity and capacity properties Colligative properties - Adhesión, cohesion and capillarity Chemical bonding and aqueous interactions - Types of chemical bonding - Aqueous interactions - Emulsions and solutions Chemical equilibrium and solubility - Thermodynamic systems and laws - Components, phases and species - Collision theory and chemical reactions - Mass action law and the equilibrium constant - Le Chatelier's Principle - Chemical kinetics and reaction rates

Sampling and monitoring	Planning a water quality survey Routine and special analyses Water sampling: Tools and methodology Sample pre-treatment and preservation In situ versus laboratory parameter determination Sampling water systems - Ground water sampling and special equipment - Precipitation - Surface water (streams and rivers) - Lakes and reservoir sampling
Basic analitical techniques and quality assessment of water analysis	Experimental measurements Basic statistics - Statistical moments - Distribution functions and non-parametric statistics - Quantiles - Outliers Basic analytical chemistry: - Precision - Accuracy - Error and bias - Calibration and analytical limits Quality assessment: - Recommendations and rules-of-thumb Quantitative and qualitative analyses Selection of instrumental analytical techniques: - Titrimetry - Spectrometric methods - Chromatographic methods
Graphical analyses of water quality data	Basic graphical assessment - Single water samples - Multiple water samples Advanced plotting and analysis techniques - Correlations and false correlations - Complex relationships - Time- and flow-adjusted concentrations - Time trend analyses - Time series analyses Analyses tools: - Time trends - PAST

Interpretation of the quality of natural waters (Part I)	The water cycle and the global enegy budget Precipitation - Components of precipitation (dry, bulk, wet, hail, fog, etc.) - Precipitation sampling - Rain/forest/soil interactions - Smog and photochemical smog - Meteorological drivers and rain shadows - Chemical composition of precipitation - Sea spray - Acid rain - Global effects on precipitation - Critical loads - Local effects in precipitation
Interpretation of the quality of natural waters (Part II)	Rivers and Streams - Basins and watersheds - River processes - Hyporrheic and riparian zones - Diel cycles - Major constituent origin and processes - Space and time dependencies in riverine systems
Interpretation of the quality of natural waters (Part III)	Lakes and Reservoirs - Fresh water environments and ecological zoning - Lake types - The Aral Sea disaster - Special cases: Reservoirs, pit lakes and subglacial lakes - Residence time - Morphometrical studies: Methodology and descriptors - Energy budgets in lakes and reservoirs - Thermal classification of lakes and reservoirs - Light, attenuation and transparency - Oxygen - The cycles of C, N and P and their coupled systems

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Guest lecture / keynote speech	A1 A2 A5 A16 A19 A21 A25 B5	30	30	60
Seminar	A1 A2 A5 A16 A19 A20 A21 A25 B1 B2 B3 B4 B5 B6 B7 B8 B9 C1 C2 C3 C4 C5 C6 C7 C8 C9	30	30	60
Personalized attention		30	0	30
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Guest lecture / keynote speech	Regular lectures where the main theoretical contents of the subjects are regarded

Seminar	Field trips and laboratory practice Field trips will be organized so that the student can put into practice a part of the knowledge acquired in the subject The students will go to the laboratory where they will put into practice the knowledge acquired to: -Make the design of a field survey -To carry out the necessary analysis to obtain the value of the different physical-chemical parameters of the water samples collected in the organized field campaigns Prior to the implementation of the work in the laboratory, the student will perform a basic theoretical preparation for each proposed practice, which will consist of reading the script to know the objective of the practice, know what he will do and why, know perfectly the management of the equipment that will be used and perform the necessary calculations for its experimental development. Before starting the practical session, the student will be called to assess if he is ready to start the practice

Personalized attention	
Methodologies	**Description**
Seminar Guest lecture / keynote speech	Pernonalized attention to be provided for the seminars and tutorings. These will require an adequate planning in order to make compatible the availability of teachers and students. These sesions may be telematic (e.g. Teams) in case that presentiality becomes limited

Assessment			
Methodologies	**Competencies / Results**	**Description**	**Qualification**
Seminar	A1 A2 A5 A16 A19 A20 A21 A25 B1 B2 B3 B4 B5 B6 B7 B8 B9 C1 C2 C3 C4 C5 C6 C7 C8 C9	The attendance to the semminars and the work being developed at the semminars will be considered for the final mark	50
Guest lecture / keynote speech	A1 A2 A5 A16 A19 A21 A25 B5	The knowledge of the concepts developed at the magistral lectures will be assesed and considered for the final mark	50

Assessment comments
-Tests: Short answer and exercises. The evaluation of the theoretical part of the units of the subject will be done through a test-type examination at the end of the semester. The development of the teaching material will led to the resolution of practical problems that will be assessed at the end of each topic through a focus-control. The weighting over the final mark of this partial assessment will be 50%.-Field trips and visits. Field trips will be organized so that the student can put into practice part of the knowledge acquired in the subject -Laboratory practices. The students will develope in the laboratory some of the knowledges acquired in order to: - Plan a water sampling survey - To carry out the necessary analyses to obtain the value of the different physical-chemical parameters of the water samples collected in their planned field survays Prior to the implementation of the work in the laboratory, the student will receive a basic or contextual theoretical background for each proposed practice, which will consist of: a) reading the script to know the objective of the practice; b) know what to do and why; c) understand best laboratory management procedures in order to make good and safe use of the equipment. Before starting the practical session, the student will be called to assess if he is ready to start the practice. At the end of the course, students will present a personal work related to field work and laboratory work whose partial weight over the total mark of the subject will be 50%

Sources of information	
Basic	- James I. Drever (1997). The Geochemistry of Natural Waters: Surface and Groundwater Environments (3rd Edition). Prentice Hall - Werner Stumm and James J. Morgan (1996). Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters (3rd Ed.). Wiley Interscience - C.A.J. Appelo and D. Postma (2005). Geochemistry, Groundwater And Pollution (2nd Ed.). Balkema - John D. Hem (1985). Study And Interpretation of the Chemical Characteristics of Natural Water. U.S. Geological Survey - Arthur Hounslow (1995). Water Quality Data: . Lewis Publishers
Complementary	

Recommendations
Subjects that it is recommended to have taken before
Subjects that are recommended to be taken simultaneously
Subjects that continue the syllabus
Other comments

(*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.