Teaching Guide				
Identifying Data				2020/21
Subject (*)	Laboratory Automation		Code	610G01038
Study programme	Grao en Química			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	2nd four-month period	Fourth	Optional	4.5
Language	SpanishGalician			
Teaching method	Hybrid			
Prerequisites				
Department	Química			
Coordinador	Penedo Blanco, Francisco Jose	E-mail	francisco.penedo.blanco@udc.es	
Lecturers	Penedo Blanco, Francisco Jose	E-mail	francisco.penedo.blanco@udc.es	
Web	https://moodle.udc.es/			
General description	Among the different tasks to perform in a laboratory measurement recording, data analysis and modification of experimental conditions depending on those results are some of the most commonly done. These tasks can be often done automatically and unattended using a PC. Most of the existing equipments in laboratories can be controlled and programmed to carry out its operations without human intervention, and these tasks can be automated through software applications. Different strategies to achieve automation of common tasks will be shown in this subject. The everyday work in a laboratory will be easier that way.			
Contingency plan	1. Modifications to the contents - There will be no variations 2. Methodologies *Teaching methodologies that are maintained - ICT practicals (It computes in the final assesment) *Teaching methodologies that are modified - Guest lectures, laboratory practices and mixed test will go to online mode 3. Mechanisms for personalized attention to students - Email: Daily. It will be used to make consultations, request virtual meetings and to solve doubts. - Moodle: According to the needs of the students. - Teams: Weekly sessions in large groups for the advancement of theoretical content, at the time set in the class calendar, and online laboratory practices using laboratory equipment simulators. 4. Modifications in the evaluation - There will be no modifications *Evaluation observations: - The same ones that appear in the teaching guide are kept. 5. Modifications to the bibliography or webgraphy - All work materials will be available digitized in Moodle.			

Study programme competences	
Code	Study programme competences
A15	Ability to recognise and analyse new problems and develop solution strategies
A16	Ability to source, assess and apply technical bibliographical information and data relating to chemistry
A19	Ability to follow standard procedures and handle scientific equipment

A20	Ability to interpret data resulting from laboratory observation and measurement
A21	Understanding of qualitative and quantitative aspects of chemical problems
A22	Ability to plan, design and develop projects and experiments
A23	Critical standards of excellence in experimental technique and analysis
A25	Ability to recognise and analyse link between chemistry and other disciplines, and presence of chemical processes in everyday life
B2	Effective problem solving
B3	Application of logical, critical, creative thinking
B4	Working independently on own initiative
B5	Teamwork and collaboration
B7	Effective workplace communication
C2	Oral and written proficiency in a foreign language
C3	Ability to use basic information and communications technology (ICT) tools for professional purposes and learning throughout life
C6	Ability to assess critically the knowledge, technology and information available for problem solving
C8	Understanding role of research, innovation and technology in socio-economic and cultural development

Learning outcomes			
Learning outcomes	Study programme competences		
To know the basic concepts about equipment control and communication between equipment and PC	A15 A16 A19	B4 B7	C2 C3 C8
To know the basic programming elements within the LabVIEW program environment.	A20 A22 A23 A25	B3	C3 C6
To develop procedures for data acquisition and analysis form the instrumentation available in the laboratory.	A19 A20 A21 A22 A23 A25	B2 B3 B5	C3 C6
To process the numerical data obtained from the acquisition, to create final reports of results with the appropriate format considering the experiment and control process.	A20 A22	B3	C3 C6

Contents	
Topic	Sub-topic
-General concepts in system control.	-Basic principles. Types of control design. Discrete sytems. Control diagrams. General targets and evaluation criteria. Digital and analog data. Programmable logic controller.
-Introduction to graphical programming using LabVIEW	-Front panel, block diagram, tool bars and pop-up menus. Virtual instruments
-Components of a virtual instrument.	-Controls, indicators and constants. Data-flow execution structures. Data categories in LabVIEW.
-Basic operations with data.	-Logic operators. Mathematical operators. Array and clusters' build-up.
-The use of structures.	-For and While loops. Making decisions with Case structure. Sequences. Formulas. Advanced structures.
-Data representation and storage.	-Graphic representations. Input and output files.
-Advance tasks.	-Creation of subVI's. Local variables and "shift registers". Property nodes. Icon edition and terminal connection.
-Instrument control.	-Types of connections. Instrument control through RS232 connection.

Planning				
Methodologies / tests	Competencies	Ordinary class hours	Student?s personal work hours	Total hours
Guest lecture / keynote speech	A15 A16 A21 A23 A25 B3 B5 C2	7	14	21
ICT practicals	A15 A16 A20 B2 B3 B4 C2 C3 C6	2.5	10	12.5
Laboratory practice	A15 A16 A19 A20 A22 A23 B2 B3 B5 B7 C3 C6 C8	22	44	66
Mixed objective/subjective test	A15 A20 A21 A22 A25 B2 B3 C3 C6	2	10	12
Personalized attention		1	0	1
(*)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	Lectures where the theoretical concepts are introduced and basic introduction to the use of LabVIEW program is given.
ICT practicals	Sessions where simple exercises are solved in order to become familiar with the use of the program, as well as the application of logical thinking in programming. They may be carried out in the classroom, but they will be conducted mainly via email or moodle app.
Laboratory practice	Laboratory practices where the knowledge acquired is applied to common situations during the use of laboratory equipments.
Mixed objective/subjective test	Final test where the subject knowledge -both theoretical and practical- is evaluated.

Personalized attention	
Methodologies	Description
Laboratory practice ICT practicals	In the ICT practicals, students will solve suggested exercises where the knowledge acquisition will be checked. Doubts and problems will be also clarified. This methodology will be carried out online. In the laboratory, prior knowledge will be implemented by designing a control application of laboratory equipment, led step by step by the teacher. These practices will be carried out in attendance due to the use of specific analysis equipment (see contingency plan in case of exceptional conditions).

Assessment			
Methodologies	Competencies	Description	Qualification
Laboratory practice	A15 A16 A19 A20 A22 A23 B2 B3 B5 B7 C3 C6 C8	The usefullnes and funcionality of the designed computerized control application of research equipment will be assessed.	45
ICT practicals	A15 A16 A20 B2 B3 B4 C2 C3 C6	Answers to short online practical questions about the theoretical concepts will be assessed	20
Mixed objective/subjective test	A15 A20 A21 A22 A25 B2 B3 C3 C6	Basic theoretical concepts and instrument control and data manipulation skills will be assessed.	35

Assessment comments

Overall:
- Positive final assessment could not be achieved if a mark lower than 5 out of 10 is attained in any of the three methodologies to be evaluated (i.e. ICT practicals, Laboratory practice and Mixed objective/subjective test).
- Minimum mark to successfully pass the subject is 5 out of 10, obtained as a weighted average of the three qualifications achieved.
- Related to the previous two items, in case of an average mark equal or higher than 5 out of 10, but without achieving the minimum mark required in any of the three assessed methodologies, the final mark will appear as FAIL (4.0).
-"Not attended" assessment mark will be applied in case of the student's participation in the assessed activities account for less than 25% of the total score.

For the second assessment opportunity:
- Any part failed on the first one must be repeated. To bear in mind: Due to the limited time between assesments, the first two parts will be concentrated in a few days, before the Mixed O/S test. Their specific schedule depends on the number of students who have to attend this opportunity, and will be published at the end of the first assesment.
- Marks from the first opportunity with a minimum of 5 out of 10 can be maintained.
- No mark will be retained for subsequent courses, i.e. the teaching-learning process including assessment, will start over, which means that the students must complete all scheduled activities for the new course.
- Students assessed in the retake can only obtain an Honors mark if all the Honors available have not been allocated after the first opportunity assessment.

For any assessment opportunity:
- The part-time students do not have a different treatment from those of normal enrollment. In the specific case of students with exemption from attendance the mixed test may be carried out online, but for the laboratory practices (see section 6, "Personalized attention") this is not feasible. Given that guessing in advance the reasons underlying the unattendance is not possible, the teacher will study each case in order to adapt the assessment of said part.

Sources of information	
Basic	- Travis, J. and Kring, J. (2008). LabVIEW for Everyone Graphical Programming Made Easy and Fun. Prentice Hall - del Río Fernández, J; Shariat-Panahi, S.; Sarriá Gandul, D. y Lázaro, A.M. (2011). LabVIEW Programación para sistemas de instrumentación. Garceta - Various (2000-2014). Reports and colaboration papers from National Instruments, in PDF and PPS format (restricted sharing in the asignature web cloud). - Hernández Gaviño, Ricardo (2010). Introducción a los sistemas de control: Conceptos, aplicaciones y simulación con MATLAB. Prentice Hall - Seborg, D.E.; Edgar, T.F.; Mellichamp, D.A. (2004). Process Dynamics and Control. John Wiley & Sons - Outras fontes bibliográficas moi específicas e variables que só se atopan online, aparecerán como arquivos PDF na web da asignatura (dentro da web moodle.udc.es) e estarán accesibles ao longo do curso.
Complementary	-Artículos de investigación relacionados coa temática, procedentes de distintas fontes, como por exemplo o Journal of Chemical Education ou Journal of Automated Methods & Management in Chemistry

Recommendations
Subjects that it is recommended to have taken before

Physical Chemistry 1/610G01016 Physical Chemistry 2/610G01017 Physical Chemistry 3/610G01018
Subjects that are recommended to be taken simultaneously
Advanced Physical Chemistry/610G01020
Subjects that continue the syllabus
Other comments
- Previous knowledge: Basic analysis and statistic mathematics, i.e. numeric integration, statistics related to linear least squares regression analysis, iterative numerical methods for solving equations. - The information sources are written in English, therefore non English-speaking students should have at least an average level of understanding of this language.