



| Teaching Guide      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |                                |         |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|--------------------------------|---------|
| Identifying Data    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |                                | 2022/23 |
| 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     | Face-to-face                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |                                |         |
| 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                 | <a href="https://moodle.udc.es/">https://moodle.udc.es/</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |                                |         |
| General description | <p>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.</p> <p>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.</p> |        |                                |         |

| 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 | B4 | C2                          |
|                                                                                               | A16 | B7 | C3                          |
|                                                                                               | A19 |    | C8                          |



|                                                                                                                                                                             |                                        |                |          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|----------------|----------|
| To know the basic programming elements within the LabVIEW program environment.                                                                                              | A20<br>A22<br>A23<br>A25               | B3             | C3<br>C6 |
| To develop procedures for data acquisition and analysis from the instrumentation available in the laboratory.                                                               | A19<br>A20<br>A21<br>A22<br>A23<br>A25 | B2<br>B3<br>B5 | C3<br>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<br>A22                             | B3             | C3<br>C6 |

| Contents                                             |                                                                                                                                                                                  |
|------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Topic                                                | Sub-topic                                                                                                                                                                        |
| -General concepts in system control.                 | -Basic principles. Types of control design. Discrete systems. 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. Variable and data types.                                                                                    |
| -Basic operations with data.                         | -Logic operators. Mathematical operators. Array and clusters' build-up.                                                                                                          |
| -The use of structures.                              | -For and While loops. Making decisions with conditional structures. 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<br>A25 B3 B5 C2                    | 7                    | 14                            | 21          |
| ICT practicals                  | A15 A16 A20 B2 B3<br>B4 C2 C3 C6                   | 2.5                  | 10                            | 12.5        |
| Laboratory practice             | A15 A16 A19 A20<br>A22 A23 B2 B3 B5 B7<br>C3 C6 C8 | 22                   | 44                            | 66          |
| Mixed objective/subjective test | A15 A20 A21 A22<br>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 introduction to the use of graphical programming is given. |



|                                 |                                                                                                                                                                                                                                                                     |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ICT practicals                  | Sessions where simple exercises are solved in order to become familiar with programming design, 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<br>ICT practicals | <p>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.</p> <p>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).</p> |

### Assessment

| Methodologies                   | Competencies                                       | Description                                                                                                               | Qualification |
|---------------------------------|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|---------------|
| Laboratory practice             | A15 A16 A19 A20<br>A22 A23 B2 B3 B5 B7<br>C3 C6 C8 | The usefulness and functionality of the designed computerized control application of research equipment will be assessed. | 45            |
| ICT practicals                  | A15 A16 A20 B2 B3<br>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<br>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 assessments, 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 assessment.
- Marks from the first opportunity with a minimum of 5 out of 10 can be maintained.
- 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.

**FINAL NOTE:** The fraudulent realization of the evaluation tests or activities, once proven, will directly imply a "0" (zero) mark in the subject for the corresponding call, thus invalidating any mark obtained in the evaluation activities for that call.

## Sources of information

|                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Basic</b>         | <ul style="list-style-type: none"><li>- Travis, J. and Kring, J. (2008). LabVIEW for Everyone Graphical Programming Made Easy and Fun. Prentice Hall</li><li>- del Río Fernández, J; Shariat-Panahi, S.; Sarriá Gandul, D. y Lázaro, A.M. (2011). LabVIEW Programación para sistemas de instrumentación. Garceta</li><li>- Various (2000-2014). Reports and collaboration papers from National Instruments, in PDF and PPS format (restricted sharing in the asignature web cloud).</li><li>- Hernández Gaviño, Ricardo (2010). Introducción a los sistemas de control: Conceptos, aplicaciones y simulación con MATLAB. Prentice Hall</li><li>- Seborg, D.E.; Edgar, T.F.; Mellichamp, D.A. (2004). Process Dynamics and Control. John Wiley &amp; Sons</li><li>- 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.</li></ul> |
| <b>Complementary</b> | <ul style="list-style-type: none"><li>- Artículos de investigación relacionados coa temática, procedentes de distintas fontes, como por exemplo o Journal of Chemical Education ou Journal of Automated Methods &amp; Management in Chemistry</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

## 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.&nbsp;- The information sources are written in English, therefore non English-speaking students should have at least an average level of understanding of this language.-&nbsp;In order to reduce paper consumption, following the Green Campus objectives of the Faculty of Science, all the material to be evaluated (except the mixed test) will be presented in PDF digital format.

**(\*)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.**