



| Teaching Guide      |                                                                                                                                                                                                                    |        |                                                            |           |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------------------------------------------------------|-----------|
| Identifying Data    |                                                                                                                                                                                                                    |        |                                                            | 2023/24   |
| Subject (*)         | Chemical Engineering                                                                                                                                                                                               |        | Code                                                       | 610G01033 |
| Study programme     | Grao en Química                                                                                                                                                                                                    |        |                                                            |           |
| Descriptors         |                                                                                                                                                                                                                    |        |                                                            |           |
| Cycle               | Period                                                                                                                                                                                                             | Year   | Type                                                       | Credits   |
| Graduate            | 1st four-month period                                                                                                                                                                                              | Third  | Obligatory                                                 | 6         |
| Language            | Spanish                                                                                                                                                                                                            |        |                                                            |           |
| Teaching method     | Face-to-face                                                                                                                                                                                                       |        |                                                            |           |
| Prerequisites       |                                                                                                                                                                                                                    |        |                                                            |           |
| Department          | Química                                                                                                                                                                                                            |        |                                                            |           |
| Coordinador         | Kennes , Christian                                                                                                                                                                                                 | E-mail | c.kennes@udc.es                                            |           |
| Lecturers           | Kennes , Christian<br>Soto Castiñeira, Manuel<br>Vega Martin, Alberto de                                                                                                                                           | E-mail | c.kennes@udc.es<br>m.soto@udc.es<br>alberto.de.vega@udc.es |           |
| Web                 |                                                                                                                                                                                                                    |        |                                                            |           |
| General description | La asignatura describe los conceptos básicos de la Ingeniería Química (operaciones unitarias, balances de materia, energía y cantidad de movimiento, fundamentos de fenómenos de transporte, y reactores químicos) |        |                                                            |           |

| Study programme competences |                                                                                                                                    |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| Code                        | Study programme competences                                                                                                        |
| A11                         | Knowledge and design of unit operations in chemical engineering                                                                    |
| A15                         | Ability to recognise and analyse new problems and develop solution strategies                                                      |
| A19                         | Ability to follow standard procedures and handle scientific equipment                                                              |
| A20                         | Ability to interpret data resulting from laboratory observation and measurement                                                    |
| A25                         | Ability to recognise and analyse link between chemistry and other disciplines, and presence of chemical processes in everyday life |
| B2                          | Effective problem solving                                                                                                          |
| B5                          | Teamwork and collaboration                                                                                                         |
| 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  |

| Learning outcomes                                                                    |  |                             |       |
|--------------------------------------------------------------------------------------|--|-----------------------------|-------|
| Learning outcomes                                                                    |  | Study programme competences |       |
| Know the fundamentals of unit operations in Chemical Engineering and of their design |  | A11                         | B2 C2 |
|                                                                                      |  | A15                         | B5 C3 |
|                                                                                      |  | A19                         |       |
|                                                                                      |  | A20                         |       |
|                                                                                      |  | A25                         |       |
| Apply mass and energy balances to unit operations and (bio)reactors                  |  | A11                         | B2 C2 |
|                                                                                      |  | A15                         | B5 C3 |
|                                                                                      |  | A19                         |       |
|                                                                                      |  | A20                         |       |
|                                                                                      |  | A25                         |       |
| Know the fundamentals of applied kinetics and of the design of (bio)reactors         |  | A15                         | B2 C2 |
|                                                                                      |  | A19                         | B5 C3 |
|                                                                                      |  | A20                         |       |



|                                                          |     |    |    |
|----------------------------------------------------------|-----|----|----|
| Know the fundamentals of mass transfer and heat transfer | A11 | B2 | C2 |
|                                                          | A15 | B5 | C3 |
|                                                          | A19 |    |    |
|                                                          | A20 |    |    |
|                                                          | A25 |    |    |

| Contents                                    |                                                                                                                                                                                                                                  |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Topic                                       | Sub-topic                                                                                                                                                                                                                        |
| 1. Introduction to Chemical Engineering.    | Fundamentals of chemical engineering. Representative examples of processes in the chemical industry. Definitions of common use: (non) continuous operation, (non) steady-state, equilibrium stages, contact between phases, etc. |
| 2. Fundamentals of unit operations.         | Classification of unit operations. Mass transfer-, heat transfer-, simultaneous mass and heat transfer-, and momentum transfer- operations. Representative examples of unit operations. Equipment description.                   |
| 3. Transport phenomena.                     | Mass transport. Heat transfer. Momentum transfer. Fundamentals of rheology. Viscosity. Analogy between different transfer processes and their governing laws. Examples.                                                          |
| 4. Introduction to balance equations.       | General problem-solving strategies. Different types of balances. Dimensions, units, and their conversion.                                                                                                                        |
| 5. Mass balances on non-reactive processes. | General case. Recycle, purge, and by-pass. Steady- and non-steady- state.                                                                                                                                                        |
| 6. Mass balances on reactive processes.     | Simple and multiple reactions. Recycle, purge, and by-pass. Steady- and non-steady-state..                                                                                                                                       |
| 7. Energy balances.                         | Forms of energy. Fundamentals of energy balances. Steady- and non-steady- states.                                                                                                                                                |
| 8. Chemical reactors and bioreactors.       | Ideal batch reactors and continuous reactors. Constant and variable volume/density reactors. Design equations. Non-ideal flow. Multiple reactors. Rate equations. Determination of kinetic data.                                 |

| Planning                                                                                                                        |                            |                      |                               |             |
|---------------------------------------------------------------------------------------------------------------------------------|----------------------------|----------------------|-------------------------------|-------------|
| Methodologies / tests                                                                                                           | Competencies               | Ordinary class hours | Student's personal work hours | Total hours |
| Laboratory practice                                                                                                             | A11 A19 A20 B2 B5<br>C2 C3 | 10                   | 15                            | 25          |
| Guest lecture / keynote speech                                                                                                  | A11 A15 A25 B2 C3          | 26                   | 65                            | 91          |
| Problem solving                                                                                                                 | A11 A15 B2 C3              | 9                    | 20.25                         | 29.25       |
| Mixed objective/subjective test                                                                                                 | A11 A15 A25 B2             | 3                    | 0                             | 3           |
| Personalized attention                                                                                                          |                            | 1.75                 | 0                             | 1.75        |
| (*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students. |                            |                      |                               |             |

| Methodologies                   |                                                                                                                                                                                       |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Methodologies                   | Description                                                                                                                                                                           |
| Laboratory practice             | Experimental work during which the students will use the laboratory set-up in order to check compliance with theoretical models in practice.                                          |
| Guest lecture / keynote speech  | Background and theoretical aspects of each topic will be explained, several examples and problems will be studied and solved and some basic exercises will be solved in large groups. |
| Problem solving                 | Sessions in which the students must solve proposed exercises and problems related to various topics, in small groups.                                                                 |
| Mixed objective/subjective test | Written exam consisting of questions about theory and/or problems.                                                                                                                    |

|                        |
|------------------------|
| Personalized attention |
|------------------------|



| Methodologies                          | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Laboratory practice<br>Problem solving | The students will resolve exercises individually (Small student groups) and with the help and personalised attention of the professor. They will also attend the practical work in the laboratory with the help and personalised attention of the professor of practicals. The guidelines to be followed will be explained before each laboratory session. The students with part time dedication will have to justify their absence in case of not being able to attend classes on the planned schedule. Exercises handed out by the teacher will have to be solved and delivered to the professor, on the planned date, by all students. For students with part-time dedication and exemption from attendance, if necessary they will be attended via Teams. |

| Assessment                            |                            |                                                                                      |               |
|---------------------------------------|----------------------------|--------------------------------------------------------------------------------------|---------------|
| Methodologies                         | Competencies               | Description                                                                          | Qualification |
| Laboratory practice                   | A11 A19 A20 B2 B5<br>C2 C3 | A score will be given based on the work done in the laboratory and the final report. | 20            |
| Guest lecture /<br>keynote speech     | A11 A15 A25 B2 C3          | Participation in the classroom and solving of problems/exercises.                    | 20            |
| Mixed<br>objective/subjective<br>test | A11 A15 A25 B2             | Written exam (theory and problems).                                                  | 60            |

| Assessment comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
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| <p>- The fraudulent completion of tests or evaluation activities, or the detection of plagiarism in any of them, will mean that the student is graded with "fail" (numerical grade 0) in the corresponding call for the academic year, whether the fraudulent performance occurs in the first opportunity as in the second. For this, the qualification in the first opportunity will be modified, if necessary.</p> <p>- The work done in the laboratory will be taken into account as well as the report describing the results, corresponding to the analysis of data, and conclusions. Both aspects will represent 20% of the final mark.</p> <p>- Active assistance to all activities (full time students) as well as exercises to be solved individually and delivered to the professor: 20% of the final mark. For part-time students, the mark will be based on solved exercises to be delivered to the professor.</p> <p>- Final examination: 60% of the final score.</p> <p>- The overall score will be the sum of the above described marks. It will be considered that the student did not present the subject's exam if he/she did not go for the final examination.</p> <p>- In order to pass, the student should obtain a minimum mark of 5/10 in the final exam; otherwise the final grading will be "fail" (4.9). The student will also fail in case the exercises to be solved and delivered to the professor have not been delivered or have not been delivered on time, before the deadline.</p> <p>- The "matrícula de honor" will be rewarded to the students that achieved the maximum score in the first opportunity of evaluation. In the second opportunity, the same marks will be maintained for the lab-course (20% of the final score) as well as assistance (full time students) and delivery of the exercises (20% of the final score) but it will be required to repeat the final written exam that will represent 60% of the final score. For successive academic courses, a new teaching-learning process will start again, and the student will therefore have to repeat all activities and examinations for that new academic course.</p> <p>- The completion and delivery of exercises is mandatory ("grupos reducidos").</p> <p>- Second opportunity: the marks obtained by the students in each of the tests, except the written exam, during the academic year, will be maintained to calculate the score of the next opportunity, applying the same percentages as for the first opportunity. This means that the written exam (Objective test) represents 60% of the final score, both in the first and the second opportunity.</p> <p>The fraudulent performance of tests or evaluation activities will directly imply a failure grade, '0', in the subject at the corresponding opportunity, thus invalidating any grade obtained in all evaluation activities for the extraordinary call.</p> <p>Students exempted from regular attendance to the lessons:</p> <p>Students exempted from regular attendance to the lessons, will be evaluated only according to their scores in the objective tests (60%), problems/exercises solving from seminars (20%) and a theoretical summary of practicals (laboratory) (20%). Handing in solved problems/exercises is compulsory. This holds for both evaluation opportunities.</p> |



## Sources of information

- |                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Basic</b>         | <ul style="list-style-type: none"><li>- COSTA LÓPEZ y col. (). Curso de Química Técnica: Introducción a los procesos, las operaciones unitarias y los fenómenos de transporte en la Ingeniería Química. Editorial Reverté, Barcelona</li><li>- LEVENSPIEL, O., (). Ingeniería de las reacciones químicas. Ed. Reverté, Barcelona</li><li>- COSTA NOVELLA y col. (). Ingeniería Química. Vol. 1. Conceptos generales. Edición Alhambra, Madrid</li><li>- THOMPSON, E.V. &amp; CECKLER, W.H., (). Introducción a la Ingeniería Química. McGraw-Hill</li><li>- FELDER, R.M. &amp; ROUSSEAU, R.W., (). Principios elementales de los procesos químicos. Addison- Wesley Iberoamericana, Wilmington</li><li>- HIMMELBLAU, D.M., (). Principios y cálculos básicos de Ingeniería Química. C.E.C.S.A. México</li></ul> |
| <b>Complementary</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

## 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

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(\*)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.