

## GUÍA DOCENTE ABREVIADA DE LA ASIGNATURA

### G784 - Dynamics and Control of Chemical Processes

Grado en Ingeniería Química

Grado en Ingeniería Química

Curso Académico 2024-2025

| 1. DATOS IDENTIFICATIVOS |  |                      |  |
|--------------------------|--|----------------------|--|
| Título/s                 | Grado en Ingeniería Química<br>Grado en Ingeniería Química   |                      | Tipología<br>y Curso                         |
|                          |  |                      | Obligatoria. Curso 3<br>Obligatoria. Curso 3 |
| Centro                   | Escuela Técnica Superior de Ingenieros Industriales y de Telecomunicación  |                      |  |
| Módulo / materia         | MATERIA DISEÑO, GESTIÓN Y OPERACIÓN DE PROCESOS. SIMULACIÓN, DINÁMICA, CONTROL E INSTRUMENTACIÓN DE PROCESOS QUÍMICOS. ANÁLISIS, DISEÑO Y OPTIMIZACIÓN DE PROCESOS Y PRODUCTOS<br>MÓDULO FORMACIÓN OBLIGATORIA. QUÍMICA INDUSTRIAL |                      |  |
| Código y denominación    | G784 - Dynamics and Control of Chemical Processes  |                      |  |
| Créditos ECTS            | 6  | Cuatrimestre         | Cuatrimestral (2)                            |
| Web                      |  |                      |  |
| Idioma de impartición    | Inglés   | Forma de impartición | Presencial                                   |

|                      |  |  |  |
|----------------------|--|--|--|
| Departamento         | DPTO. INGENIERIAS QUIMICA Y BIOMOLECULAR   |  |  |
| Profesor responsable | ANA MARIA URTIAGA MENDIA   |  |  |
| E-mail               | ana.urtiaga@unican.es  |  |  |
| Número despacho      | E.T.S. de Ingenieros Industriales y de Telecomunicación. Planta: - 2. DESPACHO (S2065) |  |  |
| Otros profesores     | NAZELY DIBAN-IBRAHIM GOMEZ<br>GABRIEL ZARCA LAGO                                       |  |  |

### 3.1 RESULTADOS DE APRENDIZAJE

- 1. To be able to apply chemical engineering fundamentals to preliminary desing problems .
- 2. To be able to analyze the dynamic response of chemical processes using mathematical modelling methodologies .
- 3. To be able to analyze and compare process control diagramas ..
- 4. To be able to compare and choose process instrumentation , according to the needs of chemical and biotechnological processes.
- 5. To design automatic control systems according to the needs of chemical processes .

#### 4. OBJETIVOS

Process control has become increasingly important in the process industries, since it is critical in the development of more flexible and more complex processes for manufacturing high added value products. Consequently, chemical engineers need to master this subject in order to be able to design and operate modern plants. The concepts of dynamics, feedback and stability are also important for understanding many complex systems of interest to chemical engineers, such as in bioengineering and in general processes in which transformation of matter occurs, emphasizing dynamic behavior, physical and empirical modeling, measurement and control technology, basic control concepts and advanced control strategies. The course provides an appropriate balance of dynamics and control theory and practice, the latter is developed through case studies and one individual project.

Part I provides an introduction to process control and in-depth discussion of dynamic process modeling, based on basic principles of mass and energy conservation. Part II is concerned with the analysis of the dynamic (unsteady-state) behavior of processes. In addition, the important topics of empirical models and their development from plant data are presented. Finally, Part III addresses the fundamental concepts of feedback and feedforward control. The topics include an overview of the process instrumentation that is necessary to implement process control: chemical composition, pressure, temperature, flowrates, final control elements.

#### 6. ORGANIZACIÓN DOCENTE

##### CONTENIDOS

|   |   |
|---|---|
| 1 | <p><b>PART I. INTRODUCTION TO PROCESS CONTROL</b></p> <p>1. Introduction to process control. Illustrative example - A blending process. Classification of Process Control Strategies</p> <p>2. Theoretical models of Chemical processes. General modeling principles for dynamic process models. Representative examples</p>  |
| 2 | <p><b>PART II. DYNAMIC BEHAVIOR OF CHEMICAL PROCESSES</b></p> <p>3. Linearization of non-linear models. Transfer function models. An illustrative example: a continuous blending system</p> <p>4. Dynamic behavior of first-order and second-order processes</p> <p>5. Dynamic response characteristics of more complicated processes: time delays, higher order systems, interacting and non-interacting processes, multiple input-multiple output processes</p> <p>6. Development of empirical models from process data</p>   |
| 3 | <p><b>PART III. FEEDBACK AND FEEDFORWARD CONTROL</b></p> <p>7. Feedback control. Feedback controllers. Control system instrumentation. Sensors and transducers. Final control elements</p> <p>8. Close loop transfer functions. Dynamic behavior and stability of the closed loop response</p> <p>9. PID controller design. Model - based design methods. Tuning relations based on integral error criterion. Empirical tuning. Strategies for the enhancement of PID control.</p> <p>10. Feedforward and ratio control. Feedforward controller design based on dynamic models. Configurations for feedforward-feedback control</p> |

| 7. MÉTODOS DE LA EVALUACIÓN   |                |             |          |        |
|---|----------------|-------------|----------|--------|
| Descripción   | Tipología      | Eval. Final | Recuper. | %      |
| Exam 1  | Examen escrito | No          | Sí       | 35,00  |
| Exam 2  | Examen escrito | Sí          | Sí       | 35,00  |
| Portafolio  | Trabajo        | No          | Sí       | 30,00  |
| TOTAL   |                |             |          | 100,00 |
| Observaciones   |                |             |          |        |
| <p>The evaluation of the course is based in two partial exams and the portafolio. For continuous evaluation, it is compulsory to attend at least 80% of the practical computer sessions, and deliver the reports as defined in the time schedule. Those students having failed any part of the continuous evaluation process can resit in the ordinary and/or extraordinary final evaluation periods. Attendance in class may raise the grade up to one point, provided that the above requirements are met, and based on the results of questionnaires conducted in the classroom.</p> <p>Should a health alert make impossible to do the exams in person, the evaluation methodologies will be adapted to the available telematic channels.</p> |                |             |          |        |
| Criterios de evaluación para estudiantes a tiempo parcial   |                |             |          |        |
| <p>In accordance with article 24 of the REGULATION OF THE EVALUATION PROCESSES OF THE UNIVERSITY OF CANTABRIA the specific procedures that guarantee in each case the evaluation of the same knowledge and competences to be acquired by students full-time will be established, in coordination with the student and the coordinator of the study program.</p>   |                |             |          |        |

| 8. BIBLIOGRAFÍA Y MATERIALES DIDÁCTICOS  |
|--|
| BÁSICA   |
| <ol style="list-style-type: none"> <li>1. Process Dynamics and Control. 4th Edition. D.E. Seborg, T.F. Edgar, D.A. Mellicham, F.J. Doyle. John Wiley &amp; Sons, 2017.</li> <li>2. Chemical Process Control: An introduction to Theory and Practice. G. Stephanopoulos. Prentice Hall, 1984</li> <li>3. Instrumentación y Control de Plantas Químicas. P. Ollero de Castro, E. Fernandez Camacho. Síntesis, 2012.</li> </ol> |

Esta es la Guía Docente abreviada de la asignatura. Tienes también publicada en la Web la información más detallada de la asignatura en la Guía Docente Completa.