Proyecto/Guía docente de la asignatura

Se debe indicar de forma fiel como va a ser desarrollada la docencia en la Nueva Normalidad. Esta guía debe ser elaborada teniendo en cuenta todos los profesores de la asignatura. Conocidos los espacios y profesorado disponible, se debe buscar la máxima presencialidad posible del estudiante siempre respetando las capacidades de los espacios asignados por el centro y justificando todas las adaptaciones que se realicen respecto a la memoria de verificación Si la docencia de alguna asignatura fuese en parte online, deben respetarse los horarios tanto de clase como de tutorías).

Subject	DESIGN OF REACTION PROCESSES		
General subject	PROCESS DESIGN		
Module	1. PROCESS AND PRODUCT ENGINEERING		
Degree	MASTER IN CHEMICAL ENGINEERING		
Plan	542	Code	53747
Time period	2º SEMESTRE	Type/Character	MANDATORY
Level/Cycle	MASTER	Course	1º
Credits ECTS	6		
Language	ENGLISH		
Professor/s in charge	JUAN GARCÍA SERNA SERGIO BORDEL VELASCO		
Department(s)	INGENIERÍA QUÍMICA Y TECNOLOGÍA DEL MEDIO AMBIENTE		
Contact (E-mail, pone)	juan.garcia.serna@uva.es 983 42 31 72 sergio.bordel@uva.es 983 423 166		
Fecha de revisión por el Comité de Título	xx/07/2024		

1. Situation / Concept of the subject

1.1 Context

The design of processes with Chemical Reaction is one of the basic subjects in the curriculum of a Chemical Engineer.

1.2 Relation with other subjects

The subject of "Design of Reaction Processes" is related to the subject of simulation processes of "Process Analysis with Simulators".

1.3 Prerequisites

It is highly recommended that the students have followed a course in reaction engineering or similar during the bachelor's degree.

2. Competences

2.1 General

CG02. Conceive, project, calculate, and design processes, equipment, industrial facilities and services, in the field of chemical engineering and related industrial sectors, in terms of quality, safety, economy, rational and efficient use of natural resources and conservation of the environment ambient.

CG03. Direct and technically and economically manage projects, facilities, plants, companies and technology centres in the field of chemical engineering and related industrial sectors.

CG04. Carry out the appropriate research, undertake the design and direct the development of engineering solutions, in new or unfamiliar environments, relating creativity, originality, innovation and technology transfer.

CG06. Be able to analyse and synthesize the continuous progress of products, processes, systems and services using criteria of safety, economic viability, quality and environmental management.

CG07. Integrate knowledge and face the complexity of making judgments and decision making, based on incomplete or limited information, including reflections on the social and ethical responsibilities of professional practice.

CG10. Adapt to changes, being able to apply new and advanced technologies and other relevant developments, with initiative and entrepreneurial spirit.

CG11. Possess the skills of autonomous learning to maintain and improve the skills of chemical engineering that allow the continuous development of the profession.

2.2 Specific

CEP01. Apply knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience, and practice, with critical reasoning to establish economically viable solutions to technical problems.

CEP02. Design products, processes, systems and services of the chemical industry, as well as the optimization of others already developed, taking as a technological base the various areas of chemical engineering, comprehensive processes and transport phenomena, separation operations and engineering reactions chemical, nuclear, electrochemical and biochemical.

CEP04. Have the ability to solve problems that are unfamiliar, incompletely defined, and have competing specifications, considering the possible solution methods, including the most innovative ones, selecting the most appropriate one, and being able to correct the implementation, evaluating the different design solutions .

CEP05. Direct and supervise all types of facilities, processes, systems and services of the different industrial areas related to chemical engineering.

3. Objectives

The general objectives are:

- Select the type of reactor and the most appropriate operating conditions based on the chemical transformation process.
- Apply calculation models to quantify conversions and equipment sizing in homogeneous and heterogeneous reactors.
- Analyze the influence of deviations of flow ideality on the behavior of reaction systems.

Specific objectives are:

- Analysis of processes with chemical reaction. Fundamental calculus equations. Reaction systems and flow models.
- Complex reactions. Types. Differential and global selectivity. Optimization of reactor configurations.
- Heterogeneous Reactors. Fixed Bed Catalytic Reactor: simple and complex calculation models. Fluidized Bed Catalytic Reactor. Three-phase reactors: trickle-bed reactor and slurry reactor. Calculation methods.
- Applications of non-ideal flow in Chemical Reaction. Macromixing approximation. Simple and combined models. Micromixing.

4. Contents and/or thematic blocks

Block 1: DESIGN OF CHEMICAL REACTION

Carga de trabajo en créditos ECTS: 6

a. Context and justification

See 1.

b. Learning objectives

See 3.

c. Contents

The subject is developed in English language mainly.

The contents are divided into 5 topics:

Topic 1. Introduction to Chemical Reaction Engineering

Reaction overview. Radiography of the chemical sector. Conversion, extent, selectivity and yield. Thermodynamics and equilibrium.

Topic 2. Kinetics of homogeneous reactions

Rate of reaction. Reaction matrix. Multiple chemical reactions. Kinetic fit: derivative, integral and general simulation methodology. Objective function. Computer-aided solutions. Examples.

Topic 3. Kinetics of heterogeneous reactions

Definitions. Catalyst composition. Adsorption and isotherms. Formal kinetic models. Catalyst deactivation. Effectiveness factor.

Topic 4. Ideal reactors

Batch reactor. Plug Flow. Continuous stirred tank. Main equations.

Topic 5. Non-ideal flow

Age functions. RTD. Moment analysis. RTD from tracers. Basic models. Convolution. Macromixing. Micromixing.

Topic 6. Heterogeneous reactions & reactors

Packed bed. Fluidised bed. Gas-solid non-catalytic. Gas-liquid reactors. Multiphase reactors. Trickle Bed Reactors. Case studies.

Topic 7. Ammonia synthesis case study

History. Role of a Chemical Engineer. Process. Catalysts. Poisoning and deactivation. Reactor design and internals. Reactor assembly.

Topic 8. Novel reactors and intensification

Catalytic lab reactors. Monolith reactors. Bubble column reactors. Milli and microreactors. Acoustic reactors. Microwave reactors.

d. Teaching methods

See 5.

e. Working plan

Week 6:	Assignment 1 (Task #1) – Kinetic determination
Week 9:	Assignment 2 (Task #2) – Multiphase Reactor case study
Week 12:	Assignment 3 (Task #3) – Lab example analysis
Week 15:	Assignment 4 (Task #4) – Modelling of a reactor

f. Evaluation

See 7.

g Material docente

Esta sección será utilizada por la Biblioteca para etiquetar la bibliografía recomendada de la asignatura (curso) en la plataforma Leganto, integrada en el catálogo Almena y a la que tendrán acceso todos los profesores y estudiantes. Es fundamental que las referencias suministradas este curso estén actualizadas y sean completas. Los profesores tendrán acceso, en breve, a la plataforma Leganto para actualizar su bibliografía recomienda ("Listas de Lecturas") de forma que en futuras guías solamente tendrán que poner el enlace permanente a Leganto, el cual también se puede poner en el Campus Virtual.

g.1 Bibliografía básica

The reference book available in the electronic library of UVa will be:

- Coulson and Richardson's chemical engineering. Volume 3A, Chemical and biochemical reactors and reaction engineering e-book UVa
- Engineering of Chemical Reactions, O. Levenspiel.
- Elements of Chemical Reaction Engineering, Scott Fogler.
- Heterogeneous Catalysis in practice. Charles N. Satterfield

- Chemical Engineering Kinetics, J.M. Smith
- Chemical Reaction Engineering Handbook of Solved Problems, Stanley M. Walas.

g.2 Bibliografía complementaria

g.3 Otros recursos telemáticos (píldoras de conocimiento, blogs, videos, revistas digitales, cursos masivos (MOOC), …)

Included in Campus Virtual.

h. Recursos necesarios

Python and Excel

MATLAB

Microsoft Teams.

i. Temporalización

Topic 1. Introduction to Chemical Reaction Engineering (4 h)

Topic 2. Kinetics of homogeneous reactions (10 h)

Topic 3. Kinetics of heterogeneous reactions (4 h)

Topic 4. Ideal reactors (10 h)

Topic 5. Non-ideal flow (6 h)

Topic 6. Heterogeneous reactions & reactors (10 h)

Topic 7. Ammonia synthesis case study (10 h)

Topic 8. Novel reactors and intensification (6 h)

5. Teaching methods and methodological principles

The subject is eminently practical oriented to help the students in solving reaction problems using computer aided solutions.

Part of the subject will be complemented with a FLIPPED CLASSROOM in few cases, where the students will receive material and can interact with different questionaries. Professors will analyse this material to focus the class in the most difficult parts identified.

a. Face-To-Face Activities (in class)

j1. Master Classes

Throughout the theoretical classes the contents are developed taking into account the skills and abilities that the student should acquire.

The classes are presented using PowerPoint or Keynote presentations that the students have previously available to download from the subject's website in the Campus Virtual.

Student participation is encouraged at all times during the class.

j2. Practical classes

The practical classes in the computer target the student to learn and acquire capabilities with different tools important to solve reaction engineering problems.

A number of real laboratory and industrial case studies will be analysed.

j3. Face-to-face tutorials on-line assignment

The students can raise the doubts in the preparation of the tasks or any other question they might have.

To encourage the use of the tutorials an on-line Excel file is used, shared by all students and teachers. Each week the teacher indicates the free tutoring "slots" and the students sign up.

j4. Final exam

Students will take a final exam in the computer.

j5. Partial evaluations

Some partial evaluation may be carried out to check the degree of learning by favouring continuous assessment.

b. Non Face-to-Face Activities (at home or somewhere else)

k1. Tasks

The students will develop the kinetic or reaction tasks in the computer.

k2. Virtual contact with the teacher

Using the Campus Virtual, e-mail, LinkedIn or any other means.

k3. Virtual aula

All the content of the course is available in the Campus Virtual UVa:

http://campusvirtual.uva.es

k4. Flipped material classroom

All the flipped material and questionaries will be available on the Campus Virtual UVa:

http://campusvirtual.uva.es

Microsoft Forms may also be used.

6. Dedicational time of the student to the subject

PRESENTIAL ACTIVITIES	HORAS	NON PRESENTIAL ACTIVITIES	HOURS
Theory	30	Tasks 1+2+3+4	60
Practice in the aula	30	Study and autonomous work individual (and flipped material if any)	30
Seminars	0		
Laboratories	0		
Tutorial service			
Evaluation (out of the official examination period)	0		
Total face-to-face activities	60	Total non face-to-face activities	90

7. System and characteristics of the evaluation

INSTRUMENT/ PROCEDURE	VALUE IN FINAL MARK (%)	REMARKS
TEST	30%	WRITTEN
TASKS	15%	Task #1
	15%	Task #2
	5%	Task #3
	20%	Task #4
ATTITUDE IN CLASS	10%	PARTICIPATION It will be considered: participation in class, generation of ideas, attitude and relation with the other classmates and use of the class main/optional materials.
	5%	FLIPPED CLASSROOM It will also be specifically considered the work and responses on the flipped material if any (if not this will be included in the participation)

MARK CRITERIA

- Ordinary call:
  - As per specification in the table.
- Extraordinary call:
  - A minimum mark of 4.0 is required in the written test (exam) to pass.
  - The available assignments marks and attitude in class marks will be preserved to calculate the final mark. The final mark will consider:
    - Task 1-4 *(39.3%)*
    - Attitude in class *(10.7%)*
    - Extraordinary written test (examination) *(50%)*

8. Final remarks

No extra remarks.