	PROCESO PARA EL DESARROLLO DE LAS ENSEÑANZAS DE LA FACULTAD DE CIENCIAS DE LA UEx	
	Curso académico: 2024-25	Código: P/CL009_FC_D002

PLAN DOCENTE DE LA ASIGNATURA

Identificación y características de la asignatura				
Código	502469		Créditos ECTS	6
Denominación (español)	Diseño de plantas de proceso			
Denominación (inglés)	*Process plant design*			
Titulaciones	Industrial chemical engineering			
Centro	Faculty of sciences			
Semestre	8	Carácter	Optativa	
Módulo	Chemical engineering			
Materia	Products and process engineering			
Profesor/es				
Nombre	Despacho		Correo-e	Página web
Fco. Javier Rivas Toledo	Edificio José Luis Sotelo, 1ª Planta		fjrivas@unex.es	
Área de conocimiento	Chemical engineering			
Departamento	Chemical engineering and physical chemistry			
Profesor coordinador (si hay más de uno)				

Competencias

1.Basics

CB1:Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.

CB2: Students know how to apply their knowledge to their work or vocation in a professional manner and possess the skills that are usually demonstrated through the development and defense of arguments and problem solving within their area of study.

CB3: Students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include reflection on relevant social, scientific or ethical issues..

CB4: Students are able to convey information, ideas, problems and solutions to both specialized and non-specialized audiences.

CB5: Students have developed those learning skills necessary to undertake further studies with a high degree of autonomy

2.Generals

CG1: Ability to draft, sign and develop projects in the field of Chemical Engineering, in accordance with the knowledge acquired as established in section 5 of Order CIN/351/2009 of February 9, 2009, the construction, reform, repair, conservation, demolition, manufacture, installation, assembly or operation of structures, mechanical equipment, energy installations, electrical and electronic installations, industrial installations and plants, and manufacturing and automation processes.

GC2: Ability to manage the activities involved in the engineering projects described in the previous section.

GC3: Knowledge in basic and technological subjects, which enable them to learn new methods

and theories, and provide them with versatility to adapt to new situations.
GC4: Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and abilities in the field of Chemical Engineering.
GC5: Knowledge to carry out measurements, calculations, valuations, appraisals, appraisals, studies, reports, work plans and other similar works.
GC6: Ability to handle specifications, regulations and mandatory standards.
GC7: Ability to analyze and assess the social and environmental impact of technical solutions.
GC8: Ability to apply quality principles and methods.
GC9: Ability to organize and plan within the company and other institutions and organizations.
GC10: Ability to work in a multilingual and multidisciplinary environment.
CG11: Knowledge, understanding and ability to apply the necessary legislation in the exercise of the profession of Industrial Technical Engineer.

3.Transversal

CT1: To develop values of a culture of peace and democratic values.
CT2: Demonstrate the ability to organize, plan, analyze and synthesize.
CT3: Demonstrate skills in the use of computer applications and use of new technologies for learning, dissemination of knowledge and collection of relevant information to make judgments.
CT4: Know how to transmit information, ideas, problems and solutions in a professional environment.
CT5: Possess skills in interpersonal relationships.
CT6: Collect and interpret relevant data to make judgments.
CT7: Recognize diversity and multiculturalism.
CT8: Develop study skills in continuing education and to undertake further studies with a high degree of autonomy.
CT9: To respect the fundamental rights of equality between men and women.
CT10: To respect and promote fundamental rights and the principles of equal opportunities, non-discrimination and universal accessibility for people with disabilities.

4. Especific

CEO4: Design plants, processes and industrial equipment in which chemical, physical and biological processes are developed.

Contenidos

Breve descripción del contenido

- Introduction to plant design: general aspects, location and siting, environmental impact, design codes.
- Conception and definition of the industrial plant project. Analysis and selection of alternatives.
- Preliminary process design: flow diagrams; material and energy balances; material selection; preliminary equipment design; preliminary cost estimation; evaluation and decision.
- Detailed process design: equipment design; plant layout; piping network design; specification sheets; auxiliary services; piping and instrumentation diagram; plant control and operation; risk analysis; detailed cost estimation; budget.

Temario de la asignatura

Theme 1: Matlab basic programming. Arrays. Mathematical operations with arrays. Plots. Functions. Loops and Boolean codes.

Theme 2: Basics in plant design I

1. INTRODUCTION
1.1. Design objective. The need
1.2. Basis of design
1.3. Generation of design concepts
1.4. Suitability testing
1.5. Economic evaluation, optimization, selection.
1.6. Detailed design and equipment selection.
1.7. Procurement, construction, operation.
2. STAGES IN PLANT DESIGN
2.1. Conceptual design
2.2. Basic engineering. Front End Engineering Design (FEED)
2.3. Detailed design
3. PROJECT DOCUMENTATION
4. DESIGN CODES OR STANDARDS
5. DESIGN FACTORS
6. DIAGRAMS. TYPES
6.1. Block Diagrams
6.2. Process Flow Diagrams
6.3. P&ID Diagrams
7. SIMULATION SOFTWARE. MATERIAL AND ENERGY BALANCES
8. CAD SOFTWARE. AUTODESK PLANT 3D

Theme 3: Basics in plant design II

1. PLANT LAYOUT.
1.1. Location
1.2. Site layout
1.3. Plant layout
1.4. Equipment layout
2. ECONOMIC EVALUATION
2.1. Estimation of capital costs 7
2.1.1. Purchased equipment costs
2.1.2. Installed equipment costs
3. CONSTRUCTION MATERIALS
3.1. Mechanical properties
3.2. Corrosion
3.2.1.1. Uniform corrosion
3.3. The selection process
4. SAFETY AND LOSS PREVENTION
4.1. Hazardous materials
4.2. Process hazards
4.3. Product and process safety analysis
4.4. Failure Modal Effects Analysis (FMEA)
4.5. Safety indexes

4.6. HAZOP reports

Theme 4: Fluid flow system design

1. INTRODUCTION TO FLUID FLOW SYSTEM DESIGN
1.1.Standards and diagrams.
1.2. Selection of materials.
1.3. Pipe Thickness Calculation
1.4 Pipe diameter calculation
1.5. Fittings and unions.
1.6. Valves
1.6.1. Definition. Types.
1.6.2. Selection
1.6.3. Cavitation
1.6.4. Design
1.6.4.1. Valve design for liquids.
1.6.4.2. Design of valves for gases.
1.7. Pressure losses in fluid transport systems.
1.7.1. Pressure losses in straight piping.
1.7.2. Pressure losses in accidents and fittings.
1.8. Design of equipment for the transport of fluids. Pumps.
1.8.1. Types of pumps and selection criteria.
1.8.2. Centrifugal pumps.
1.8.2.1. Advantages and disadvantages of centrifugal pumps.
1.8.2.2. Characterization. Dimensional analysis 33
1.8.2.3. Characteristic curves. Concept of NPSH.
1.8.2.4. Impeller design
1.9. Design of fluid handling equipment. Compressors
1.9.1. Types of Compressors
1.9.2.Compression work
1.10. Stress analysis. Span

Theme 5: Diseño de equipos para el transporte de calor. Cambiadores de calor tubo carcasa.

1. DEFINITION AND TYPES
2. SHELL & TUBE EXCHANGERS
2.1. Components
2.2. Heat transfer in T&S heat exchangers
2.2.1. Estimation of U
2.2.2. Study in the tubes
2.2.2.1. Heat transfer. Heat transfer coefficient
2.2.2.2. Pressure drop
2.2.3. Study on the shell

Theme 6: Diseño de columnas. Columnas de destilación de platos. Columnas de relleno.

1. DEFINITION AND TYPES
2. PRELIMINARY DESIGN OF PLATE COLUMNS. MULTICOMPONENT SYSTEMS
2.1. Empirical correlations
2.1.1. Minimum number of stages (Fenske Equation)
2.1.2.Minimum reflux ratio
2.1.3. Feed stage

2.1.4. Distribution of undistributed components. Hengstebeck method.
2.1.5. Plate Efficiency
2.1.5.1. O' Connell correlation
2.1.5.2.Van Winkle correlation
2.1.5.3. AIChE method
2.1.5.4. Carry-over
2.1.6. Column Size
2.1.6.1. Spacing between plates
2.1.6.2. Column diameter
2.1.7. Contact plates. Design.
2.1.7.1. Plate Diameter
2.1.7.2. Liquid flow rate
2.1.7.3. Drag
2.1.7.4.Weep point
2.1.7.5. Liquid height above weir/retention (Francos weir formula)
2.1.7.6. Weir dimensions
2.1.7.7. Perforated area dimensions and perforations
2.1.7.8. Plate pressure drop
2.1.7.9. Downcomer downcomer design
3. PACKED COLUMNS
3.1. Types of packing
3.2. Height of packing columns
3.2.1. Distillation
3.2.2. Absorption
3.3. HTU prediction
3.3.1. Cornell method
3.3.2. Onda Method
3.4. Column Diameter

Actividades formativas

Horas de trabajo del alumno/a por tema		Horas Gran grupo	Actividades prácticas				Actividad de seguimiento	No presencial
Tema	Total	GG	CH	L	O	S	TP	EP
1	7	3						4
2	45	11			5	2		27
3	15	5				1		9
4	30	9			3	1		17
5	22	6			2	1		13
6	17	4			2	1		10
Evaluación	14	4						10
Total	150	42			12	6		90

GG: Grupo Grande (85 estudiantes).
CH: prácticas clínicas hospitalarias (7 estudiantes)
L: prácticas laboratorio o campo (15 estudiantes)

O: prácticas sala ordenador o laboratorio de idiomas (20 estudiantes)
S: clases problemas o seminarios o casos prácticos (40 estudiantes).
TP: Tutorías Programadas (seguimiento docente, tipo tutorías ECTS).
EP: Estudio personal, trabajos individuales o en grupo, y lectura de bibliografía.

Metodologías docentes

1.Expository classes of theory and problems (Description: expository method consisting of the presentation by the professor of the contents of the subject matter. It also includes the resolution of example problems by the professor).
2. Exercise and problem solving (Description: method based on the teacher's presentation of problems and their resolution in the classroom. Students develop and interpret appropriate solutions from the application of problem-solving procedures).
3. Case study (Description: intensive and complete analysis of a real case with the purpose of knowing it, interpreting it, solving it, generating hypotheses, contrasting data, reflecting, completing knowledge, diagnosing it and, sometimes, training in possible alternative solution procedures).
4. Problem-based learning (PBL) (Description: teaching/learning method that has as its starting point a problem designed by the teacher and that the student solves autonomously or guided to develop certain previously defined competencies).
5. Project-based learning (Description: Teaching/learning method in which students carry out a project in a given time to solve a problem or address a task through the planning, design and implementation of a series of activities based on the development and application of acquired learning and the effective use of resources).
7. Cooperative learning (Description: Teaching-learning method based on an interactive approach to work organization. The aim is to achieve an effective exchange of information among students, who must be motivated to achieve their own learning as well as that of others).
8. Learning through the virtual classroom (Description: A teaching/learning situation in which a computer with a network connection is used as a communication system between teacher and student and even between students among themselves and a plan of training activities is developed.)
10. Autonomous learning (Description: Learning situation in which the student autonomously deepens in the study of a subject in order to acquire competences).
11. Evaluation (Description: Learning/evaluation situation in which the student performs a test that serves to reinforce his/her learning and as an evaluation tool).

Resultados de aprendizaje

- To know and correctly interpret a design project of a chemical-industrial plant.
- To know the main design codes.
- To know how to elaborate standardized flow diagrams and piping and instrument diagrams.
- To know how to select construction materials for the main chemical process equipment.
- To know how to make a preliminary cost estimate for a chemical plant.
- To know the main auxiliary services of process plants.
- To know how to interpret process control schemes and interpret risks.

Sistemas de evaluación

The evaluation of the acquired knowledge and competences will be carried out as follows:

- **Ordinary call, continuous evaluation** mode: from the grade obtained in the resolution/delivery of problems posed in class, the completion of reports/assignments and a final written exam, according to the following considerations:
  a) The delivery of proposed problems. Activity not recoverable. Valuation of 15 points out of 100.
  b) The final exam will have a grade of 85 points out of 100. At the request of the students this exam can be divided into two midterms.

The student will need to achieve a minimum grade of 50 points out of 100 to pass the course. To sum up the contributions of the different sections, it is necessary to obtain in each of them, at least, a score of 3 out of 10.

- **Ordinary convocation, global evaluation** mode: based on the grade obtained in the final exam. In order to pass the course by this modality, a minimum grade of 50 out of 100 must be obtained.

- **Extraordinary call, continuous evaluation** modality: the grades obtained in the non-recoverable activities will be maintained. The student will take a written exam that will contribute to the overall grade with 85 points out of 100.

- **Extraordinary call, global evaluation** modality: the evaluation system is the same as the one described in the ordinary call for this evaluation modality.

The exam corresponding to any call of the subject will consist of theoretical-practical questions. These questions will be developed detailing in the exam the steps followed to reach the results that are reflected. Failure to include such information may lead, at the teacher's discretion, to invalidate the question/problem evaluated.

The course will be graded according to the following numerical scale from 0 to 10, with one decimal place, to which the corresponding qualitative grade may be added: 0-4.9: Failed (SS), 5.0-6.9: Passed (AP), 7.0-8.9: Notable (NT), 9.0-10: Outstanding (SB). The honorable mention may be awarded to students who have obtained a grade equal to or higher than 9.0. Their number may not exceed 5% of the students enrolled in the subject in the corresponding academic year, unless the number of students enrolled is less than 20, in which case only one Honorable Mention may be awarded.

Bibliografía (básica y complementaria)

1. “Chemical Engineering Design”. G. Towler, R. Sinnot. Ed. Elsevier. 2013.
2. “Plant Design and Economics for Chemical Engineers” Peters and Timmerhaus. 5ª Ed. McGraw-Hill. 2004.
3. “Chemical Process Equipment. Selection and Design” S.M Walas. Ed. Butterworth-Heinemann. 1990.
4. “Manual del Ingeniero Químico” J.M. Perry. Ed. McGraw-Hill 1999.

5. “Process Design Principles. Synthesis, Analysis, and Evaluation” W.D. Seider, J.D.Seader, D.R. Lewin Ed. John Wiley and Sons Inc. 1999.
6. “Materials Selection in Mechanical Design” M. Ashby. Ed Buttherworth Heinneman, 1999.
7. “The principles of materials selection for engineering design” P.L. Mangonon. Ed. Prentice Hall. 1999.
8. “Manual de recipientes a presión. Diseño y cálculo” E.F. Megyesy. Ed. Limusa. 2001.
9. “Handbook of Chemical Processing Equipment” N.O. Cheremisinoff. Ed. Butterworth Heinemann. 2000.
10. “An Introduction to Chemical Engineering Design” Chemical Engineering Vol. 6. Coulson and Richardson. Ed. Pergamon Press. 1983.
11. “Seguridad Industrial en Plantas Químicas y Energéticas”. J. Mª. Storch de Gracia y T. García Martín. 2ªEdición. Ediciones Díaz de Santos, 2008.

Otros recursos y materiales docentes complementarios

Virtual Classroom of the UEx and Computer Classroom of the Faculty of Sciences of the UEx.
Telematic services of the University of Extremadura.
Computational databases. Process simulation and equipment design software.
Matlab
Plant 3D Autodesk
Unisim Design