UNIVERSIDAD DE CASTILLA - LA MANCHA

GUÍA DOCENTE

1. General information

Course: TRANSPORT PHENOMENA
Code: 310740
Type: CORE COURSE
ECTS credits: 6
Degree: 2336 - MASTER DEGREE PROGRAM IN CHEMICAL ENGINEERING
Academic year: 2023-24
Center: 1 - FACULTY OF SCIENCE AND CHEMICAL TECHNOLOGY
Group(s): 20
Year: 1
Duration: First semester
Main language: Spanish
Second language: English
Use of additional languages:
English Friendly: Y
Web site:
Bilingual: N

Lecturer: **MANUEL SALVADOR CARMONA FRANCO** - Group(s): **20**

Building/Office	Department	Phone number	Email	Office hours
ITQUIMA/Dirección	INGENIERÍA QUÍMICA	6709	manuel.cfranco@uclm.es	M-Th 13:00-14:00

Lecturer: **IGNACIO GRACIA FERNANDEZ** - Group(s): **20**

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Enrique Costa Novella	INGENIERÍA QUÍMICA	3419	ignacio.gracia@uclm.es	M-Th 13:00-14:00

2. Pre-Requisites

Not established

3. Justification in the curriculum, relation to other subjects and to the profession

Transport phenomena constitute, together with thermodynamics and chemical reaction engineering, one of the three pillars of chemical engineering to describe industrial processes. This subject describes the phenomenological processes of transport of: quantity of movement, heat and matter that, combined with the other two aforementioned pillars, will allow modeling and operating industrial processes.

The implementation of this subject in the Master of Chemical Engineering, means that the previous knowledge required in it has been developed in the subjects of Initiation to Chemical Engineering, Balances of Matter and Mechanical Energy of Fluids, Separation Operations, Projects, Basic Operations of the Food and Pharmaceutical Industry and Advanced Simulation of Chemical Processes. Some of the previous theoretical knowledge required has been completed through laboratory practices in subjects such as the Integrated Laboratory of Basic Operations and Chemical Reaction Engineering

4. Degree competences achieved in this course

Course competences

Code	Description
CB06	To possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context
E01	To 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.
E03	To conceptualize engineering models, apply innovative methods in problem solving and appropriate software applications, for the design, simulation, optimization and control of processes and systems.
E04	To have the ability to solve problems that are unknown, 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.
G01	To have adequate knowledge to apply the scientific method and the principles of engineering and economics, to formulate and solve complex problems in processes, equipment, facilities and services, in which matter undergoes changes in its composition, state or energy content, characteristic of the chemical industry and other related sectors including the pharmaceutical, biotechnological, materials, energy, food or environmental sectors.
G02	To 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 environmental conservation.
G05	To know how to establish mathematical models and develop them by means of appropriate computing, as a scientific and technological basis for the design of new products, processes, systems and services, and for the optimization of others already developed.
G06	To have the capacity of analysis and synthesis for the continuous progress of products, processes, systems and services using criteria of safety, economic viability, quality and environmental management.
G07	To integrate knowledge and deal with the complexity of making judgments and decisions, based on incomplete or limited information, including reflections on the social and ethical responsibilities of professional practice
G09	To communicate and discuss proposals and conclusions in multilingual forums, specialized and non-specialized, in a clear and unambiguous way
G11	To possess the skills of autonomous learning in order to maintain and improve the competences of chemical engineering that allow the continuous development of the profession
MC1	To have acquired advanced knowledge and demonstrated an understanding of the theoretical and practical aspects and of the working methodology in the field of Chemical Engineering with a depth that reaches the forefront of knowledge
MC2	To be able, through arguments or procedures developed and supported by themselves, to apply their knowledge, understanding and problem-solving skills in complex or professional and specialized work environments that require the use of creative or innovative ideas

MC3	To have the ability to collect and interpret data and information on which to base their conclusions including, where necessary and relevant, reflection on social, scientific or ethical issues in the field of chemical engineering
MC4	To be able to deal with complex situations or those that require the development of new solutions in the academic, work or professional field of study of Chemical Engineering
MC5	To know how to communicate to all types of audiences (specialized or not) in a clear and precise way, knowledge, methodologies, ideas, problems and solutions in the field of the study of Chemical Engineering
MC6	To be able to identify their own training needs in the field of study of Chemical Engineering and work or professional environment and to organize their own learning with a high degree of autonomy in all kinds of contexts (structured or unstructured).

5. Objectives or Learning Outcomes

Course learning outcomes

Description

To have the ability to calculate property flows and concentration profiles in different systems situations.

To have the ability to design a pipe network incorporating the elements of regulation and measurement of flow rates.

To have the ability to pose and solve conservation equations for molecular transport in situations of different complexity (including dynamic state or two-dimensional transport). Be aware that the lack of knowledge and complexity of turbulent transport force to the use of approximate calculation methods, with the introduction of transport coefficients.

To acquire skill in determining the rheological behavior of a fluid. To understand the concept of boundary layer

To acquire skills in estimating transport properties.

To know the meaning of the different terms of the expressions of the general microscopic equations of conservation of any extensive property and particularized to the transports of mass, energy and momentum

To know the importance of transport phenomena in Chemical Engineering.

6. Units / Contents

Unit 1: General knowledges
- **Unit 1.1** General knowledges
- **Unit 1.2** Kinematic of fluids
- **Unit 1.3** Dynamic of fluids
- **Unit 1.4** Fluid behaviour

Unit 2: Molecular Transport
- **Unit 2.1** Mechanims and Fluids
- **Unit 2.2** Transport of property
- **Unit 2.3** Conservation Equation

Unit 3: Application of the Conservation Equations
- **Unit 3.1** Internal flow of fluids in laminar regime
- **Unit 3.2** Heat transmision by conduction in solids
- **Unit 3.3** Mass transfer by diffusion

Unit 4: Turbulent Transport
- **Unit 4.1** Average Conservation equation
- **Unit 4.2** Theory about turbulence
- **Unit 4.3** Boundary layer theory
- **Unit 4.4** Individual transport coefficients
- **Unit 4.5** Global Transport coefficients

7. Activities, Units/Modules and Methodology

Training Activity	Methodology	Related Competences (only degrees before RD 822/2021)	ECTS	Hours	As	Com	Description
Class Attendance (theory) [ON-SITE]	Lectures	E01 E03 G06 G09	1.12	28	N	-	
Problem solving and/or case studies [ON-SITE]	Problem solving and exercises	E01 E03 E04 G06 G07 MC1 MC2 MC3	0.88	22	Y	Y	
Group tutoring sessions [ON-SITE]	Group tutoring sessions	E04 G07 G09 MC2 MC3 MC4 MC5 MC6	0.08	2	Y	N	
Progress test [ON-SITE]	Assessment tests	CB06 E01 E03 E04 G01 G02 G06 MC2 MC3 MC4	0.32	8	Y	Y	
Study and Exam Preparation [OFF-SITE]	Self-study	E01 E03 G01 G02 G05 G06 G07 G11 MC1 MC2 MC3 MC4 MC5 MC6	3.6	90	N	-	
		Total:	**6**	**150**			
		Total credits of in-class work: 2.4					**Total class time hours: 60**
		Total credits of out of class work: 3.6					**Total hours of out of class work: 90**

As: Assessable training activity

Com: Training activity of compulsory overcoming (It will be essential to overcome both continuous and non-continuous assessment).

8. Evaluation criteria and Grading System

Evaluation System	Continuous assessment	Non-continuous evaluation*	Description
Assessment of problem solving and/or case studies	50.00%	0.00%	It includes problems solved and delivered individually and in groups and cases raised about what was presented in the

			group tutorials.
Test	50.00%	100.00%	They will be tests of progress in the case of continuous evaluation and final test in the case of non-continuous evaluation
Total:	**100.00%**	**100.00%**	

According to art. 4 of the UCLM Student Evaluation Regulations, it must be provided to students who cannot regularly attend face-to-face training activities the passing of the subject, having the right (art. 12.2) to be globally graded, in 2 annual calls per subject , an ordinary and an extraordinary one (evaluating 100% of the competences).

Evaluation criteria for the final exam:

Continuous assessment:

To pass the subject, a minimum average rating of 5 points (out of 10) will be necessary. In each of the evaluable parts it will be necessary to obtain a minimum rating of 4 (out of 10).

Non-continuous evaluation:

To pass the subject, the average is required to be equal to or greater than 5.0.

Specifications for the resit/retake exam:

The evaluation system will be by examination, without the part of delivery of problems or solved cases

9. Assignments, course calendar and important dates

Not related to the syllabus/contents

Hours	**hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	28
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	22
Group tutoring sessions [PRESENCIAL][Group tutoring sessions]	2
Progress test [PRESENCIAL][Assessment tests]	8
Study and Exam Preparation [AUTÓNOMA][Self-study]	90

Global activity

Activities	**hours**
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	22
Class Attendance (theory) [PRESENCIAL][Lectures]	28
Group tutoring sessions [PRESENCIAL][Group tutoring sessions]	2
Progress test [PRESENCIAL][Assessment tests]	8
Study and Exam Preparation [AUTÓNOMA][Self-study]	90
Total horas:	150

10. Bibliography and Sources

Author(s)	Title/Link	Publishing house	Citv	ISBN	Year	Description
Costa, E.; Calleja, G.; Ovejero, G.; De Lucas, A.; Aguado, J. y Uguina, M.A	Ingeniería Química 2. Fenómenos de Transporte	Alhambra	Madrid	84-205-1021-1	1984	
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Bennett, C.D. Y Myers, J.E.	Momentum, Heat and Mass Transfer	McGraw-Hill	New York	978-84-291-7047-4	1984	
Costa, E.; Calleja, G.; Ovejero, G.; De Lucas, A.; Aguado, J. y Uguina, M.A	Ingeniería Química 3. Flujo de Fluidos	Alhambra	Madrid	84-205- 1119-6	1984	
Costa, E.; Calleja, G.; Ovejero, G.; De Lucas, A.; Aguado, J. y Uguina, M.A.	Ingeniería Química 4. Transmisión de Calor	Alhambra	Madrid	84-205-1408-6	1986	
Schilichting, H. and Gersten, K.	Boundary Layer Theory	Springer		978-3-662-52919-5	2017	
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Bird, R.B.; Steward, W.E. y Lighfoot, E.N.	Fenómenos de transporte	Reverté	Barcelona	84-291-7050-2	1982	
Chapman A.J.	Fundamentals of heat transfer	McMillan	New York	0-02-321600-X	1984	
Fahien, R.W.	Fundamentals of Transport Phenomena	McGraw-Hill	New York	978-0070198913	1983	
Duderstadt, J.J. y Martin W.R	Transport Theory	Wiley-Interscience Publication	New York	0-471-04492-X	1979	
Frederickson, A.G	Principles and Applications of Rheology	Prentice Hall		978-0137009633	1964	
Geankopolis, C.J.	Transport Processes and Unit Operations	Prentice Hall	New Jersey	0-13-045253-X	1993	
Kern, D.Q	Procesos de Transferencia de Calor	CECSA	Mexico	968-26-1040-0	1999	
Reid, C,R.; Prausnitz, J.M. y Poling, E.B	The Properties of Gases and Liquids	McGraw-Hill	New York	0-07-149999-7	2001	
Brodkey, R. S. Y Hersahey, H. C	Transport Phenomena. A Unified	McGraw-Hill	New York	0-07-100152-2	1998	

Crank	Approach The mathematics of Diffusion	Oxford University Press	Oxford	0-19-853344-6	1975
Themelis, N.J	Transport and Chemical Rate Phenomena	Gordon and Breach Publishers	Basilea	978-2884491273	1995
Welty, J.R.; Wicks, C.E.; Wilson, R.E. and Rorrer G.L	Fundamentals of Momentum, Heat and Mass Transfer.	Wiley		978-0470128688	2008