UNIVERSIDAD DE CASTILLA - LA MANCHA

GUÍA DOCENTE

1. General information

Course: HEAT TRANSFER
Code: 57716
Type: CORE COURSE
ECTS credits: 6
Degree: 344 - CHEMICAL ENGINEERING
Academic year: 2023-24
Center: 1 - FACULTY OF SCIENCE AND CHEMICAL TECHNOLOGY
Group(s): 21 22
Year: 2
Duration: C2
Main language: Spanish
Second language: English
Use of additional languages:
English Friendly: Y
Web site:
Bilingual: N

Lecturer: **IGNACIO GRACIA FERNANDEZ** - Group(s): **21 22**

Building/Office	Department	Phone number	Email	Office hours
Enrique Costa Novella	INGENIERÍA QUÍMICA	3419	ignacio.gracia@uclm.es	M-Th 13:00 to 14:00

Lecturer: **PAULA SANCHEZ PAREDES** - Group(s): **21 22**

Building/Office	Department	Phone number	Email	Office hours
Enrique Costa Novella. Ingeniería Química.Despacho 8.	INGENIERÍA QUÍMICA	3418	paula.sanchez@uclm.es	Monday-Wednesday from 12:00 to 14:00 h

2. Pre-Requisites

Not established

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

Heat transfer is of great importance not only in chemical engineering, but in all branches of engineering. Its study is fundamental to understand and predict the thermal behaviour of a system, especially when heat must be supplied or removed from it. This study is of transcendental importance for the Chemical Industry, since most of the industrial processes as well as the associated basic operations involve heat transfer. Thus, a Chemical Engineer, as a professional in the Chemical Industry, must know perfectly the different mechanisms of heat transfer and calculate different coefficients in different situations that allow the design of heat exchangers, as well as know all the typical instrumentation related to heat transfer and its related basic operations.

4. Degree competences achieved in this course

Course competences

Code	Description
CB03	Be able to gather and process relevant information (usually within their subject area) to give opinions, including reflections on relevant social, scientific or ethical issues.
CB04	Transmit information, ideas, problems and solutions for both specialist and non-specialist audiences.
E03	Basic knowledge about the use and programming of computers, operating systems, databases and computer programs with application in engineering.
E07	Knowledge of applied thermodynamics and heat transmission. Basic principles and their application to solving engineering problems.
E31	Basic knowledge of the principles of transport phenomena and the kinetic and thermodynamic aspects of chemical processes
E32	Ability to manage information sources in chemical engineering. Properly handle the terminology of the profession in Spanish and English in the oral and written records
G01	Ability to write, sign and develop projects in the field of chemical engineering that are intended, according to the knowledge acquired as established in section 5 of order CIN / 351/2009 of February 9, construction, reform, repair, conservation, demolition, manufacture, installation, assembly or operation of: structures, mechanical equipment, energy installations, electrical and electronic installations, industrial facilities and processes and manufacturing and automation processes.
G02	Capacity for the direction, of the activities object of the engineering projects described in the competence G1.
G03	Knowledge in basic and technological subjects, which enables them to learn new methods and theories, and give them versatility to adapt to new situations.
G04	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.
G05	Knowledge for the realization of measurements, calculations, valuations, appraisals, surveys, studies, reports, work plans and other analogous works.
G06	Ability to handle specifications, regulations and mandatory standards.
G10	Ability to work in a multilingual and multidisciplinary environment.
G12	Proficiency in a second foreign language at level B1 of the Common European Framework of Reference for Languages
G14	Proper oral and written communication
G17	Capacity for critical thinking and decision making
G18	Synthesis capacity
G19	Capacity for teamwork
G20	Ability to analyze and solve problems
G21	Ability to learn and work autonomously
G22	Ability to apply theoretical knowledge to practice

5. Objectives or Learning Outcomes

Course learning outcomes

Description

To have the skill to carry out the design of evaporators and condensers.

To have the skill to design and select a heat exchanger.

To know the different types of flow and circulation regimes and their involvement in the calculation of individual heat transmission coefficients.

To have knowledge about the formation of supply and demand curves in the market.

To have the ability to calculate the overall coefficient of heat transmission.

6. Units / Contents

Unit 1: Topic 1: General. Importance of heat transfer. Mechanisms of heat transfer: conduction, convection and radiation. Temperature: definitions and measurement.

Unit 2: Topic 2: Heat transfer by conduction in solids. Rigorous analytical method. Stationary regime: simple conduction and with generation. Non-stationary regime: simple conduction and with generation. Approximate methods: finite difference method.

Unit 3: Topic 3: Heat exchangers. Individual and global heat transfer coefficients. Integration of the fundamental heat transfer equation. heat transfer equation.

Unit 4: Topic 4: Heat transfer in internal flow. Laminar regime in circular cross-section pipes: velocity and temperature profiles. fully developed and developing. Influence of natural convection. Turbulent regime in circular cross-section pipes: fully developed velocity and temperature profiles. velocity and temperature profiles. Transition regime. Non-circular section pipes.

Unit 5: Topic 5: Heat transfer coefficients in external flow. Fluid flow over flat plates and bodies of other geometries. Fluid flow over blocks of tubes. Fluid flow over finned surfaces. Gravity flow of liquids in the form of a layer. Natural convection.

Unit 6: Topic 6: Heat transfer coefficients with phase change. Boiling of liquids Condensation of vapours.

Unit 7: Topic 7: Design of heat exchangers. Design equations: concentric and multi-tube heat exchangers. Design of condensers. Types of heat exchangers.

Unit 8: Topic 8: Basic laws. General laws. Radiant energy conservation equation. Absorbing and emitting characteristics of solid surfaces. solid surfaces. Black bodies: laws of radiation and radiant properties. Non-black bodies.

Unit 9: Topic 9: Radiation exchange between surfaces separated by non-absorbing and non-emitting media. Closed systems of black surfaces: Viewing factors. Closed systems of black and refractory surfaces: refractory factors. Closed systems of grey and refractory refractory surfaces.

Unit 10: Topic 10: Radiation exchange between surfaces and gases. Emissivities and absorptances of gases. Radiation in flames. Calculation of the true temperature of a gas. of a gas. Radiation and natural convection losses.

Unit 11: Topic 11: Evaporation. Fundamental principles. Evaporator design: capacity and basic data. Vacuum evaporation. Exploitation of vapour energy: multiple effects and thermocompression. of vapour energy: multiple effects and thermocompression. Equipment and accessories

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	CB04 E07 G01 G02 G03 G05 G06	1.2	30	N	-	
Workshops or seminars [ON-SITE]	Project/Problem Based Learning (PBL)	CB03 E07 E31 E32 G01 G02 G03 G04 G05 G06 G10 G12 G14 G17 G18 G19 G20 G21 G22	0.95	23.75	Y	N	
Group tutoring sessions [ON-SITE]	Project/Problem Based Learning (PBL)	E07 E31 E32 G01 G02 G03 G04 G05 G06 G10 G12 G14 G17 G18 G19 G20 G21 G22	0.1	2.5	Y	N	
Mid-term test [ON-SITE]	Assessment tests	E07 E31 E32 G01 G02 G03 G04 G05 G06 G10 G12 G14 G17 G18 G19 G20 G21 G22	0.07	1.75	Y	N	
Study and Exam Preparation [OFF-SITE]	Self-study	E07 E31 E32 G01 G02 G03 G04 G05 G06 G10 G12 G14 G17 G18 G19 G20 G21 G22	3.6	90	N	-	
Final test [ON-SITE]	Assessment tests		0.08	2	Y	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
Mid-term tests	75.00%	0.00%	
Assessment of problem solving and/or case studies	25.00%	0.00%	
Final test	0.00%	100.00%	
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:

75% test and 25% assesment of problem solving and/or case studies.

Non-continuous evaluation:

The calification will be assested by the test (100%).

Specifications for the resit/retake exam:

The calification will be assested by the test (100%).

Specifications for the second resit / retake exam:

The calification will be assested by the test (100%).

9. Assignments, course calendar and important dates

Not related to the syllabus/contents

Hours	**hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	30
Workshops or seminars [PRESENCIAL][Project/Problem Based Learning (PBL)]	20
Group tutoring sessions [PRESENCIAL][Project/Problem Based Learning (PBL)]	2.5
Mid-term test [PRESENCIAL][Assessment tests]	3.75
Study and Exam Preparation [AUTÓNOMA][Self-study]	90

Global activity

Activities	**hours**
Study and Exam Preparation [AUTÓNOMA][Self-study]	90
Class Attendance (theory) [PRESENCIAL][Lectures]	30
Workshops or seminars [PRESENCIAL][Project/Problem Based Learning (PBL)]	20
Group tutoring sessions [PRESENCIAL][Project/Problem Based Learning (PBL)]	2.5
Mid-term test [PRESENCIAL][Assessment tests]	3.75
Total horas:	146.25

10. Bibliography and Sources

Author(s)	**Title/Link**	**Publishing house**	**Citv**	**ISBN**	**Year**	**Description**
Chapman, A.J. R.H. Perry, D.W. Green y J.O. Maloney	Fundamentals of heat transfer	McGraw-Hill	New York		1987	
Costa, E. y col	Ingeniería Química IV. Transmisión de calor	Ed. Alhambra	Madrid		1986	
Coulson, J.M. y col	Ingenieía Química. Tomos I y II	Reverté,	Barcelona		1988	
Levenspiel, O	Flujo de Fluidos e Intercambio de Calor	Reverte	Barcelona		1993	
Sparrow, E.M	Radiation Heat Transfer	McGraw-Hill	New York		1978	