Universitat Autònoma de Barcelona

**2019/2020**

# Heat Transfer

Code: 102440
ECTS Credits: 4

| Degree | Type | Year | Semester |
|---|---|---|---|
| 2500897 Chemical Engineering | OB | 3 | 1 |

## Contact

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## Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

## Prerequisites

It is recommended to have passed the following subjects:

- Basic Operations of Chemical Engineering

- Applied thermodynamics

## Objectives and Contextualisation

The objective of the subject is the study of the principles of heat transmission and its application to the calculation and design of heat exchangers and evaporators.

## Competences

- Demonstrate knowledge of the different reaction, separation and processing operations for materials, and transport and circulation of fluids involved in the industrial processes of chemical engineering.
- Develop thinking habits.
- Objectively compare and select different technical options for chemical processes.
- Work in a team.

## Learning Outcomes

1. Develop scientific thinking.
2. Identify the fluid circulation operations involved in the design of heat transmission systems.
3. Objectively compare and select the different technical options for heat transmission systems.
4. Work cooperatively.

## Content

THEME 1: Introduction to Heat Transfer

Energy of a system: total energy, heat energy and mechanical energy.

Transmission mechanisms: conduction, convection and radiation

Heat energy transmission and Chemical Engineering

THEME 2: Heat transfer by conduction in solids

Steady state conduction

Estimation of properties: thermal conductivity and diffusivity

Resistances in series

Radial conduction

THEME 3: Convection heat transfer

Individual heat transfer coefficient and dimensionless modules

Determination of individual coefficients

Heat transfer in a fluid without phase change

Heat transfer in a fluid with phase change: condensation of vapors, boiling of liquids.

THEME 4: Fundamentals of heat exchangers

Fluid-fluid heat transfer through a wall

Overall heat transfer coefficient

Fouling factors

Design equations of concentric tube hat exchangers

THEME 5: Description and design of heat exchangers

Classification and description of heat exchanger configurations

General methods of heat exchanger calculations

Design by the Kern method

THEME 6: Description and design of evaporators

Classification, description and operation of evaporators

Single effect evaporators

Multiple effect evaporators

## Methodology

THEORETICAL LECTURES:
There will be lectures in which the basic concepts of the syllabus will be introduced. Whenever possible, audiovisual and interactive material to help understand concepts will be used. This material will be available in Moodle before the theoretical sessions are held

PROBLEM SEMINARS:
The teacher and the students will solve problems related to the subject exposed in the theory classes. The

problems will be proposed by the teacher either from "adhoc" or from the proposed problems available in a collection of exercises available in Moodle. The latter will also allow autonomous student learning through the autonomous resolution of exercises out of the seminar sessions.

TUTORIES:
Individual sessions or small groups for the resolution of doubts related to the subject.

HOMEWORK:
Knowledge will be achieved through autonomous learning by students based on literature searches and the realization of a homework in group that will consist of the design of a Shell & Tubes heat exchanger. The teacher will provide a guided document with the specific considerations of the work (index, objectives, extension, bibliography, number of students per group etc ...).
The works must be submitted (in text format) following the period that will be indicated during the course and according to the teacher's instructions. Evaluation criteria and assessment will be provided by the teacher as well.

LECTURES PROGRAMMING:
The programming of all the sessions of the subject will be uploaded to Moodle at the beginning of the semester. Any modification of the sessions will be communicated to the students well in advance through the tool
of "News" of Moodle.

## Activities

| Title | Hours | ECTS | Learning Outcomes |
|---|---|---|---|
| Type: Directed | | | |
| Practical exercises seminars | 13 | 0.52 | 3, 1, 2, 4 |
| Theoretical lectures | 20 | 0.8 | 3, 1, 2 |
| Type: Supervised | | | |
| Tutories | 4 | 0.16 | 3, 1, 4 |
| Type: Autonomous | | | |
| Homeworks | 20 | 0.8 | 3, 1, 2 |
| Literature search | 4 | 0.16 | 3, 1, 2 |
| Solving practical exercises | 24 | 0.96 | 3, 1, 2, 4 |
| Study | 10 | 0.4 | 3, 1, 4 |

## Assessment

Please refer to the Catalan or Spanish version of the Heat Trasnfer syllabus for further details

## Assessment Activities

| Title | Weighting | Hours | ECTS | Learning Outcomes |
|---|---|---|---|---|
| Heat Exchanger design Homework | 15 | 0 | 0 | 3, 2, 4 |
| Theoretical exam 3 | 15 | 1 | 0.04 | 3, 1, 2 |

| | | | | |
|---|---|---|---|---|
| Theoretical-practical exam 1 | 35 | 2 | 0.08 | 3, 1, 2 |
| Theoretical-practical exam 2 | 35 | 2 | 0.08 | 3, 1, 2 |

## Bibliography


Procesos de transferencia de calor

D. Q. Kern, Compañía Editorial Continental.

Flujo de fluidos. Intercambio de calor.

O. Levenspiel. Editorial Reverté.

A Heat Transfer textbook

John H. Lienhard IV; John H. Lienhard V. Editorial PHLogiston Press.

The properties of gases and liquids

R.C. Reid, J.M. Prausnitz, B.C. Polling, 4th Edition. McGraw-Hill.

Modelling in Transport Phenomena

I.Tosun, Editorial Elsevier, 2002

Transport Processes and Separation Process Principles

C.J. Geankoplis, Editorial Prentice Hall.

The Chemical Engineering Guide to Heat Transfer

Volume I: Plant Principles.

Volume 2: Equipment.

Editorial McGraw-Hill.

Chemical Engineering. Volume 6. Design.

J. M. Coulson. J.F. Richardson. Editorial Pergamon Press.

Perry's Chemical Engineering Handbook

Perry, R. H. Editorial McGraw-Hill.