Transport Phenomena

Code: 102398
ECTS Credits: 6

2024/2025

Degree	Type	Year
2500897 Chemical Engineering	OT	4

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Teachers

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Teaching groups languages

You can view this information at the end of this document.

Prerequisites

Have completed and passed the subjects of the degree in the areas of mathematics, physics, chemistry, as well as macroscopic balances and computer applications.

Objectives and Contextualisation

Stablish the mathematical model that describes a system from the equations of change of momentum, mass and energy.

Solve the system model by analytical or numerical means, and analyze and discuss the solution.

Competences

- Apply relevant knowledge of the basic sciences, such as mathematics, chemistry, physics and biology, and the principles of economics, biochemistry, statistics and material science, to comprehend, describe and resolve typical chemical engineering problems.
- Communication
- Develop personal work habits.
- Develop thinking habits.

- Understand and apply the basic principles on which chemical engineering is founded, and more precisely: balances of matter, energy and thermodynamic momentum, phase equilibrium and kinetic chemical equilibrium of the physical processes of matter, energy and momentum transfer, and kinetics of chemical reactions

Learning Outcomes

1. Apply relevant knowledge of mathematics, physics and chemistry to the preparation and resolution of transport models.
2. Apply the basic principles of chemical engineering to the preparation and resolution of transport models.
3. Communicate efficiently, orally and in writing, knowledge, results and skills, both professionally and to non-expert audiences.
4. Develop critical thinking and reasoning
5. Manage available time and resources. Work in an organised manner.
6. Practice the fundamental laws of thermodynamics in chemical process engineering problems.
7. Prevent and solve problems.
8. Work autonomously.

Content

1.- Introduction to transport phenomena

History and context in Chemical Engineering, Transport Phenomena and Unit Operations. Systems analysis. Balances of matter, energy and amount of movement. EDP's, Computer Fluidodynamics: CFD. Transport mechanisms

2.- Mathematical expressions in the equations of change

Vectorial equations of balance sheets. Coordinate systems: Cartesian, cylindrical and spherical. Vector operations (algebraic and differential). Expansion of balance equations: Total mass; momentum, heat energy and balance by components. Boundary conditions for resolution.

3.- Mass balance:continuity equation

Deduction of the balance sheet equation.

4.- Balance of linear momentum

Balance and Newton's second law. Expansion of equations of momentum balances. Newton's law of viscosity: 3D transport equation. Other expressions of the balance: Navier-Stokes, Euler. Non-Newtonian fluids. Example of application: Fluid flow velocity profile in a tube: Eq. Hagen-Poiseuille. Incompressible fluids and pressure: Other variables: Vorticity, current lines, pressure equation.

5.- Energy balance

Expressions of the equations of total, mechanical and calorific energy. Fourier's law of heat conduction. 3D transport. Expansion of heat equation equations. Example of application in analytical resolution: ENE 1D conduction (semi-infinite, error-function and concrete geometries: Gurney-Lurie. Example of application in numerical resolution ENE 2D / 3D conduction: Integration software.

6.- Mass balance for components.

Balance in mass and molar units: Expansion of balance equations. Fick's law of diffusion: 3D transport equation. Examples of analytical resolution in systems in EE without chemical reaction: Diffusion of one component through stacionay film and equimolecular contradiffusion. Examples of analytical resolution in systems in ENE without chemical reaction: semiinfinite error-function and concretegeometries-Gurney-Lurie. Examplesof analytical resolution in systems with generation (chemical reaction): homogeneous RQ, heterogeneous catalysis

7.- Transport of property to the interfaces: transport coefficients

General definitions of transport coefficients. Calculation by analogies between FT. Boundary layer theory: solving equations on the boundary layer. Film theory.

8.- Turbulence

Concept of turbulence, turbulence scales. Characteristics of turbulent flow: Fluctuations. Mathematical Solving of Turbulence: Navier Stokes Equation. Numerical methods: Discretization of EDPs. RANS resolution (Reynolds Average Navier Stokes): turbulent flow densities and turbulent properties. Application example: Numerical resolution of the velocity profile in a pipe.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lectures	30	1.2	1, 2, 4
Problems solving	15	0.6	1, 2, 4, 6, 8
seminars	5	0.2	2, 3, 4, 5, 6, 7
Type: Supervised			
Homework	40	1.6	1, 2, 3, 4, 5, 6, 8
exam	4	0.16	1, 2, 3, 5, 6
Type: Autonomous			
Study, problems solving	56	2.24	1, 2, 4, 5, 6, 7, 8

This subject has been deprogrammed from the teaching calendar when the new Chemical Engineering degree came into operation. Tutoring sessions at the request of students will replace unscheduled teaching

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Writing exams	70	0	0	1, 2, 3, 4, 5, 6, 7

homework	30	0	0	2, 3, 4, 5, 6, 7, 8

Check the Catalan version

Bibliography

Christie J. Geankoplis, "Transport Processes and Separation Process Principles", 5th ed. Prentice-Hall, 2018

R.B. Bird, W.E. Steward, E.N. Lighfoot, "Transport Phenomena", revised 2nd ed. Wiley, 2007

Joel Plawsky, "Transport Phenomena Fundamentals", 3rd ed., CRC Press, 2014

Ismail Tosun, "Modeling in Transport Phenomena. A conceptual Approach", 2nd ed., Elsevier, 2007

Software

Free access partial differential equation integration software is used.

Language list

Information on the teaching languages can be checked on the CONTENTS section of the guide.