Course guide
240EQ014 - 240EQ014 - Transportation Science

Last modified: 14/06/2023

Unit in charge: Barcelona East School of Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering.

Degree: **Academic year:** 2023 **ECTS Credits:** 6.0
Languages: Catalan, Spanish

LECTURER

Coordinating lecturer: EULALIA PLANAS CUCHI

Others: Planas Cuchi, Eulalia
Pastor Ferrer, Elsa
Àgueda Costafreda, Alba

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
2. Apply knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience, and practice, critical reasoning to establish economically viable solutions to technical problems.

3. Ability to solve problems that are unfamiliar, incompletely defined, and have competing specifications, considering the possible methods of solution, including the most innovative, selecting the most appropriate, and to correct implementation, evaluating the different solutions Design.

Generical:
1. Know how to establish and develop mathematical models using appropriate informatics, scientific and technological basis for the design of new products, processes, systems and services, and for other already developed optimization.

TEACHING METHODOLOGY

Subject in process of extinction. There is no teaching, the students that enroll it do so only with the right to an exam.

LEARNING OBJECTIVES OF THE SUBJECT

The course aims to introduce students in the joint study of the transfer of energy, matter and momentum. Give them to know the basic laws of these three phenomena, closely related, so they can formulate mathematical models that represent the fundamentals of the real problems of chemical processes. At the end of the course the student should be able to:

OE1. Apply the laws governing the transfer of momentum, energy and matter and interrelate the three phenomena.
OE2. Formulate mathematical models that represent complex real systems both steady state and unsteady.
OE3. Propose models for the individual and global transport coefficients necessary for solving real problems.

STUDY LOAD

Type	Hours	Percentage
Hours small group	18,0	12.00
Self study	96,0	64.00
Hours large group	36,0	24.00

Total learning time: 150 h

CONTENTS

VELOCITY EQUATIONS FOR MOLECULAR TRANSPORT

Description:
Introduction: behavior and physical states of matter. Transport of momentum: Newton's Law, viscosity, non-Newtonian fluids. Transport of heat energy: Fourier's Law, thermal conductivity. Transport of mass: Fick's law, diffusivity. General velocity equation.

Specific objectives:
OE1

Related activities:
Theory lessons. Problem solving lessons. Independent learning. Assessment activities A1

Related competencies :
CGMQ5. Know how to establish and develop mathematical models using appropriate informatics, scientific and technological basis for the design of new products, processes, systems and services, and for other already developed optimization.
CEMQ1. Apply knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience, and practice, critical reasoning to establish economically viable solutions to technical problems.

CEMQ4. Ability to solve problems that are unfamiliar, incompletely defined, and have competing specifications, considering the possible methods of solution, including the most innovative, selecting the most appropriate, and to correct implementation, evaluating the different solutions Design.

Full-or-part-time: 20h
Assessment sessions: 1h
Theory classes: 3h 30m
Practical classes: 1h 30m
Self study : 14h

THE BALANCE EQUATIONS

Description:
The mass balance: the continuity equation, the combination of balance and rate equation. The momentum balance: equation of motion. The energy balance: energy equation. No dimensional conservation equations

Specific objectives:
OE1

Related activities:
Theory lessons. Problem solving lessons. Independent learning. Assessment activities A1

Related competencies :
CGMQ5. Know how to establish and develop mathematical models using appropriate informatics, scientific and technological basis for the design of new products, processes, systems and services, and for other already developed optimization.
CEMQ1. Apply knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience, and practice, critical reasoning to establish economically viable solutions to technical problems.

CEMQ4. Ability to solve problems that are unfamiliar, incompletely defined, and have competing specifications, considering the possible methods of solution, including the most innovative, selecting the most appropriate, and to correct implementation, evaluating the different solutions Design.

Full-or-part-time: 20h 30m
Theory classes: 5h
Practical classes: 3h
Self study : 12h 30m

STEADY STATE MOLECULAR TRANSPORT

Description:
Momentum transfer: speed profiles. Heat transport: temperature profiles. Mass transport: concentration profiles. Simultaneous transport of properties. Using non-dimensional conservation equations. Study of diffusion with chemical reaction

Specific objectives:
OE1, OE2

Related activities:
Theory lessons. Lessons of resolution of exercises. Independent learning. Assessment activities A1

Related competencies :
CGMQ5. Know how to establish and develop mathematical models using appropriate informatics, scientific and technological basis for the design of new products, processes, systems and services, and for other already developed optimization.
CEMQ1. Apply knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience, and practice, critical reasoning to establish economically viable solutions to technical problems.

CEMQ4. Ability to solve problems that are unfamiliar, incompletely defined, and have competing specifications, considering the possible methods of solution, including the most innovative, selecting the most appropriate, and to correct implementation, evaluating the different solutions Design.

Full-or-part-time: 36h
Assessment sessions: 1h
Theory classes: 9h
Practical classes: 3h
Self study : 23h

UNSTEADY-STATE MOLECULAR TRANSPORT

Description:
Balance equations. Solving the balance equations: application to finite and semi-infinite media

Specific objectives:
OE1, OE2

Related activities:
Theory lessons. Lessons of resolution of exercises. Independent learning. Assessment activities A1, A2

Related competencies :
CGMQ5. Know how to establish and develop mathematical models using appropriate informatics, scientific and technological basis for the design of new products, processes, systems and services, and for other already developed optimization.
CEMQ1. Apply knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience, and practice, critical reasoning to establish economically viable solutions to technical problems.

CEMQ4. Ability to solve problems that are unfamiliar, incompletely defined, and have competing specifications, considering the possible methods of solution, including the most innovative, selecting the most appropriate, and to correct implementation, evaluating the different solutions Design.

Full-or-part-time: 15h
Assessment sessions: 1h
Theory classes: 4h
Practical classes: 1h
Self study : 9h

FLOW TURBULENCE

Description:
Description and approaches to the study of turbulence. Mean values technique. Equations of transport under turbulent conditions. Universal velocity distribution

Specific objectives:
OE1, OE2

Related activities:
Theory lessons. Lessons of resolution of exercises. Independent learning. Assessment activities A1

Related competencies :
CGMQ5. Know how to establish and develop mathematical models using appropriate informatics, scientific and technological basis for the design of new products, processes, systems and services, and for other already developed optimization.
CEMQ1. Apply knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience, and practice, critical reasoning to establish economically viable solutions to technical problems.

CEMQ4. Ability to solve problems that are unfamiliar, incompletely defined, and have competing specifications, considering the possible methods of solution, including the most innovative, selecting the most appropriate, and to correct implementation, evaluating the different solutions Design.

Full-or-part-time: 17h
Theory classes: 4h
Practical classes: 2h
Self study : 11h

BOUNDARY LAYER THEORY

Description:
Introduction. The Prandtl theory: fundamental equations. Boundary layer on flat surfaces: laminar and turbulent regimes.

Specific objectives:
OE1,OE2

Related activities:
Theory lessons. Lessons of resolution of exercises. Independent learning. Assessment activities A1

Related competencies :
CGMQ5. Know how to establish and develop mathematical models using appropriate informatics, scientific and technological basis for the design of new products, processes, systems and services, and for other already developed optimization.
CEMQ1. Apply knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience, and practice, critical reasoning to establish economically viable solutions to technical problems.

CEMQ4. Ability to solve problems that are unfamiliar, incompletely defined, and have competing specifications, considering the possible methods of solution, including the most innovative, selecting the most appropriate, and to correct implementation, evaluating the different solutions Design.

Full-or-part-time: 8h 30m
Theory classes: 2h
Practical classes: 1h
Self study : 5h 30m

INDIVIDUAL AND GLOBAL TRANSPORT COEFICIENTS

Description:
Individual transport coefficients. Momentum: the friction factor. Individual coefficients of heat and mass transfer. Theories about the transport coefficients: film, penetration, etc.. Global transport coefficients. Transfer units.

Specific objectives:
OE1, OE2, OE3

Related activities:
Theory lessons. Lessons of resolution of exercises. Independent learning. Assessment activities A1

Related competencies :
CGMQ5. Know how to establish and develop mathematical models using appropriate informatics, scientific and technological basis for the design of new products, processes, systems and services, and for other already developed optimization.
CEMQ1. Apply knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience, and practice, critical reasoning to establish economically viable solutions to technical problems.

CEMQ4. Ability to solve problems that are unfamiliar, incompletely defined, and have competing specifications, considering the possible methods of solution, including the most innovative, selecting the most appropriate, and to correct implementation, evaluating the different solutions Design.

Full-or-part-time: 22h
Assessment sessions: 1h
Theory classes: 4h 30m
Practical classes: 2h 30m
Self study : 14h

ANALOGY BETWEEN THE TRANSPORT PHENOMENA

Description:
Basic relationships. Description of different analogies: Reynolds and Sherwood-Karman, Prandtl-Taylor and Colburn, Karman and Sherwood.

Specific objectives:
OE1, OE2, OE3

Related activities:
Theory lessons. Problem solving lessons. Independent learning. Assessment activities A1

Related competencies :
CGMQ5. Know how to establish and develop mathematical models using appropriate informatics, scientific and technological basis for the design of new products, processes, systems and services, and for other already developed optimization.
CEMQ1. Apply knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience, and practice, critical reasoning to establish economically viable solutions to technical problems.

CEMQ4. Ability to solve problems that are unfamiliar, incompletely defined, and have competing specifications, considering the possible methods of solution, including the most innovative, selecting the most appropriate, and to correct implementation, evaluating the different solutions Design.

Full-or-part-time: 11h
Assessment sessions: 1h
Theory classes: 2h
Practical classes: 1h
Self study : 7h

ACTIVITIES

A1-QUESTIONNAIRES

Description:
Test questionnaires. Continuous evaluation which will be carried out along the semester

Specific objectives:
OE1, OE2, OE3

Material:
Notes from class.Slides. Reading. Exercises solved in class

Delivery:
Answers to the questions of the questionnaire which will be handed in by the end of the activity

Related competencies :
CGMQ5. Know how to establish and develop mathematical models using appropriate informatics, scientific and technological basis for the design of new products, processes, systems and services, and for other already developed optimization.
CEMQ4. Ability to solve problems that are unfamiliar, incompletely defined, and have competing specifications, considering the possible methods of solution, including the most innovative, selecting the most appropriate, and to correct implementation, evaluating the different solutions Design.
CEMQ1. Apply knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience, and practice, critical reasoning to establish economically viable solutions to technical problems.

Full-or-part-time: 1h
Theory classes: 1h

A2-RESOLUTION WITH MATLAB OF A NON-STEADY STATE CASE

Description:
Resolution of a case in a non-steady state by the MATLAB program

Specific objectives:
OE1, OE2

Material:
The description of the problem to be solved will be uploaded on Atenea. Notes of the class. Slides. MATLAB program

Delivery:
Solution to the exercise, which will have to be introduced into Atenea

Related competencies :
CGMQ5. Know how to establish and develop mathematical models using appropriate informatics, scientific and technological basis for the design of new products, processes, systems and services, and for other already developed optimization.
CEMQ4. Ability to solve problems that are unfamiliar, incompletely defined, and have competing specifications, considering the possible methods of solution, including the most innovative, selecting the most appropriate, and to correct implementation, evaluating the different solutions Design.
CEMQ1. Apply knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience, and practice, critical reasoning to establish economically viable solutions to technical problems.

Full-or-part-time: 10h
Self study: 10h

A3-PARTIAL EXAM

Description:
Exam consisting in the resolution of a problem

Specific objectives:
OE1, OE2

Material:
Notes from class. Slides. Exercises solved in class

Delivery:
Answer to the questions of the exam

Related competencies :
CGMQ5. Know how to establish and develop mathematical models using appropriate informatics, scientific and technological basis for the design of new products, processes, systems and services, and for other already developed optimization.
CEMQ4. Ability to solve problems that are unfamiliar, incompletely defined, and have competing specifications, considering the possible methods of solution, including the most innovative, selecting the most appropriate, and to correct implementation, evaluating the different solutions Design.
CEMQ1. Apply knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience, and practice, critical reasoning to establish economically viable solutions to technical problems.

Full-or-part-time: 1h 15m
Theory classes: 1h 15m

A4-FINAL EXAM

Description:
Final exam of the course based on the resolution of exercises

Specific objectives:
OE1, OE2, OE3

Material:
Notes of the class. Slides. Solved exercises. Bibliographic material of support

Delivery:
Answers to the questions of the exam

Full-or-part-time: 3h
Theory classes: 3h

GRADING SYSTEM

Subject in process of extinction. There is only one final test that corresponds to 100% of the final grade of the subject.