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295504 - FETRA - Transport Phenomena

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering
Academic year: 2017
Degree: BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
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BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Teaching unit Optional)
ECTS credits: 6 Teaching languages: Catalan

Teaching staff

Coordinator: Planas Cuchi, Eulalia

Others: Pastor Ferrer, Elsa
Marti Gregorio, Vicenç

Opening hours

Timetable: Ask for your attention time directly to the Professor by email

Prior skills

Fundamentals of Chemistry, thermodynamics, differential equations, numerical computation

Requirements

To have attended the courses that provide the required skills

Degree competences to which the subject contributes

Specific:
CEQUI-19. Understand mass and energy balances, biotechnology, mass transfer, separation operations, chemical reaction engineering, the design of reactors, and the recovery and processing of raw materials and energy resources.
CEB-01. Solve mathematical problems that may arise in engineering. Apply knowledge of linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and partial differential equations; numerical methods; numerical algorithms; statistics and optimisation.
CEQUI-27. Understand spatial vision and graphic representation techniques, whether using traditional metric and descriptive geometry methods or computer assisted design applications.

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Teaching methodology

Lectures of theory and problems, participatory problem seminars, work on a case study

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

Total learning time: 150h	Hours large group:	60h	40.00%
	Hours medium group:	0h	0.00%
	Hours small group:	0h	0.00%
	Guided activities:	0h	0.00%
	Self study:	90h	60.00%

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Content

INTRODUCTION TO TRANSPORT PHENOMENA

Learning time: 5h

Theory classes: 2h
Self study : 3h

Description:
What is chemical engineering?. Historical evolution of the chemical engineering discipline. Onset of transport phenomena as a discipline within chemical engineering. Fundamentals of property balances, integral and differential forms.

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

Specific objectives:
OE1

VELOCITY EQUATIONS FOR MOLECULAR TRANSPORT

Learning time: 20h

Theory classes: 6h
Laboratory classes: 2h
Self study : 12h

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.

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

Specific objectives:
OE1

THE BALANCE EQUATIONS

Learning time: 19h 10m

Theory classes: 4h
Laboratory classes: 9h 45m
Self study : 5h 25m

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

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

Specific objectives:
OE1

STEADY STATE MOLECULAR TRANSPORT	Learning time: 27h 45m Theory classes: 7h 30m Laboratory classes: 3h Self study : 17h 15m

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

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

Specific objectives:
OE1, OE2

UNSTEADY-STATE MOLECULAR TRANSPORT	Learning time: 18h 45m Theory classes: 4h 30m Laboratory classes: 2h Self study : 12h 15m

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

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

Specific objectives:
OE1, OE2

FLOW TURBULENCE	Learning time: 11h 28m Theory classes: 4h 30m Laboratory classes: 1h Self study : 5h 58m

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

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

Specific objectives:
OE1, OE2

BOUNDARY LAYER THEORY	Learning time: 6h 15m Theory classes: 1h 30m Laboratory classes: 1h Self study : 3h 45m

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

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

Specific objectives:
OE1,OE2

INDIVIDUAL AND GLOBAL TRANSPORT COEFICIENTS	Learning time: 18h Theory classes: 4h Laboratory classes: 2h Self study : 12h

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.

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

Specific objectives:
OE1, OE2, OE3

ANALOGY BETWEEN THE TRANSPORT PHENOMENA	Learning time: 6h Theory classes: 1h 30m Laboratory classes: 0h Self study : 4h 30m

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

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

Specific objectives:
OE1, OE2, OE3

Planning of activities

A1-QUESTIONNAIRES

Hours: 4h 10m
Theory classes: 2h
Self study: 2h 10m

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

Support materials:
Notes from class.Slides. Reading. Exercises solved in class

Descriptions of the assignments due and their relation to the assessment:
Answers to the questions of the questionnaire which will be handed in by the end of the activity

Specific objectives:
OE1, OE2, OE3

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

Hours: 7h
Laboratory classes: 2h
Self study: 5h

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

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

Descriptions of the assignments due and their relation to the assessment:
Solution to the exercise, which will have to be introduced into Atenea

Specific objectives:
OE1, OE2

A3-PARTIAL EXAM

Hours: 4h 10m
Theory classes: 2h
Self study: 2h 10m

Description:
Exam consisting in the resolution of a problem

Support materials:
Notes from class. Slides. Exercises solved in class

Descriptions of the assignments due and their relation to the assessment:
Answer to the questions of the exam

Specific objectives:
OE1, OE2

A4-FINAL EXAM	Hours: 9h Theory classes: 3h Self study: 6h
Description: Final exam of the course based on the resolution of exercises **Support materials:** Notes of the class. Slides. Solved exercises. Bibliographic material of support **Descriptions of the assignments due and their relation to the assessment:** Answers to the questions of the exam **Specific objectives:** OE1, OE2, OE3	

Qualification system

FINAL RATE:

NF = 0.5·NEF + 0.25 NEP + 0.15·NEP + 0,15·NAC + 0,1·NT
Where,

NEF: Rate of the final exam
NEP: Rate of the partial exam
NAC: Average rate of the continuous assessment questionnaires
NT: Rate of the task of solving a problem using Matlab

The course will have a reevaluation exam according to the calendar and rules of the EEBE

Regulations for carrying out activities

The partial and final exams can be made using all available bibliographic material: lecture notes, reference books, collection of problems, etc. continuous assessment tests (questionnaires) can only be done using class notes, readings and book problems.

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Bibliography

Basic:

Bird, R. Byron; Stewart, Warren E; Lightfoot, Edwin N; Mato Vázquez, Fidel. Fenómenos de transporte : un estudio sistemático de los fundamentos de transporte de materia, energía y cantidad de movimiento. Barcelona: Reverté, 1982. ISBN 8429170502.

Brodkey, Robert S; Hershey, Harry C. Transport phenomena : a unified approach. New York: McGraw-Hill, cop. 1988. ISBN 0070079633.

Thomson, William J. Introduction to transport phenomena. Upper Saddle River: Prentice Hall, 2000. ISBN 0134548280.

Beek, W. J; Muttzall, Klaus Max Karl; Heuven, J. W. van. Transport phenomena / W.J. Beek, K.M.K. Muttzall, J.W. van Heuven. 2nd ed. Chichester ; New York: Wiley, c1999. ISBN 0471999903.

Deen, William M. Analysis of transport phenomena. New York [etc.]: Oxford University Press, 1998. ISBN 0195084942.

Complementary:

Poling, Bruce E.; Praunitz, John M.; O'Connell, John P. The Properties of gases and liquids. 5th ed. New York [etc.]: McGraw-Hill, cop. 2001. ISBN 0070116822.

Schlichting, Hermann; Gersten, Klaus. Boundary-layer theory. 8th ed. rev. and enlg. Berlin [etc.]: Springer-Verlag, cop. 2000. ISBN 3540662707.