Fluid mechanics and transfer processes

Lecturers
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Course mnemonic
MECA-H3001

ECTS credits
5 credits

Language(s) of instruction
English

Course period
First term

Campus
Solbosch

Course content

Course philosophy

Several physical processes typical of the everyday life are governed by the transport phenomena. To master their applications, it is necessary to properly describe them, from a physical and mathematical perspective.

The objective of the course "Fluid Mechanics and Transport Processes" is to determine how some physical properties of complex systems, made up of a large number of particles, can be transferred from one point to another. The most important characteristic of this discipline is to offer a unified approach for all the different transport processes, of momentum, energy and mass.

All the transport phenomena can indeed be described in a similar way, in terms of a "cause", namely the driving force, and a "consequence", the flux of the quantity (momentum, energy and mass) under investigation. The objective of this class is to present the main physical principles as well as the approaches for modeling the transfer of three of the four physical quantities in nature, for which the conservation laws apply: momentum, energy and mass. The transport of the electrical charge is not taken up in this class, although it is comparable to the mass transfer.

Several applications will be presented with particular emphasis on the role of transport phenomena in the energy transition, to promote a more efficient production and use of energy. In particular, energy efficiency in buildings will serve as common thread throughout the course.

Thermodynamics and evolution

Fluid statics

Introduction to fluid mechanics:Macroscopic balances, Governing equations, Bernoulli equation. Pressure drops. Boundary layer

Heat transfer: Heat transfer by conduction, Heat conduction with heat generation, Macroscopic energy balance, Transient heat conduction, Thermal convection, Thermal boundary layer. Energy efficiency in buildings.

Mass transfer: Steady mass transfer, Unsteady mass transfer, Convective mass transfer.

Natural convection

Thermal radiation: Basic principles, Radiative heat transfer equations, Radiation coupled with conduction and convection, Earth's radiative balance (greenhouse gas effect and global warming).

Introduction to transport phenomena in turbulent regime

Objectives (and/or specific learning outcomes)

The learning objectives of the course are the following:

- Understanding the theoretical concepts related to the transport of momentum, energy and mass.
- Ability to provide a physical interpretation to the theoretical foundation of transport phenomena.
- Ability to describe and model:
  - Potential and viscous flows, transient and steady.
  - Heat transfer processes by conduction, convention and radiation, in transient and steady state, with and without heat generation.
  - Mass transfer processes by diffusion and convection, in transient and steady state, with and without mass generation.
- Ability to employ dimensionless number to describe and model the transport of momentum, energy and mass.
- Apply the theoretical concepts of transport phenomena to build simplified models for real life applications.
- Knowledge of the basic concepts of turbulent flows, radiation, natural convection and their fundamental formulations.

Pre-requisits and co-requisits

Pre-requisites courses

CHIM-H1001 | Chimie générales et procédés durables | 10 crédits, MATH-H1002 | Analyse I | 5 crédits, MECA-H100 | Mécanique rationnelle I | 5 crédits and PHYS-H101 | Connaissances fondamentales et éléments de physique | 10 crédits

Co-requisites courses

CHIM-H314 | Introduction au génie des procédés | 5 crédits and MECA-H301 | Systèmes énergétiques : principes de bases et technologies durables | 5 crédits

Courses having this one as co-requisit

CHIM-H302 | Pollution du milieu physique | 5 crédits, CHIM-H314 | Introduction au génie des procédés | 5 crédits, CHIM-H316 | Matériaux et chimie inorganique : mise en oeuvre et analyse | 10 crédits, MATH-H304 | Automatique | 5 crédits and MECA-H301 | Systèmes énergétiques : principes de bases et technologies durables | 5 crédits

Teaching method and learning activities

Theory: Lectures with powerpoint support.

Exercises: Exercise sessions under supervision.

Project: Workshops on academic writing.

Contribution to the teaching profile

Acquired competencies with respect to the competence framework:

- Demonstrate expertise and versatility in science and technology
  - Learn how to learn.
  - Gather and organise information.
  - Analyze and summarize information.
  - Grasp new concepts with ease.
- Formulate and analyze complex problems
  - Globalize problems.
  - Use scientific and technical resources.
  - Model problems with the appropriate accuracy.
  - Identify relevant parameters.

References, bibliography and recommended reading

Fluid Mechanics: Fundamentals and Applications, 3/e

Yunus A. Cengel, Univ. of Nevada-Reno

John M. Cimbala, The Pennsylvania State Univ.

ISBN: 0073380326, **Copyright year:** 2014

Heat and Mass Transfer: Fundamentals and Applications, 5/e

Yunus A. Cengel, Adnan Menderes University

Afshin J. Ghajar, Oklahoma State University

ISBN: 0073398187, **Copyright year:** 2015

Course notes

Podcast, Syllabus and Université virtuelle

Other information

Place(s) of teaching

Solbosch

Contact(s)

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Evaluation method(s)

written examination and Written report

Evaluation method(s) (additional information)

Evaluation

- Written exam
  - Theory questions (4 to 5) to assess the student understanding of the main concept related to the transport phenomena (non-dimensional numbers, transport process analogy, determination of limiting steps in transport processes, equation interpretation).
  - Exercises (2 to 3) to assess the student capability to solve practical problems involving transport of momentum heat and mass.
- Written report
  - Group report aimed at assessing the student skills in academic writing.

Determination of the mark (including the weighting of partial marks)

Weighting exam/report: 80/20.

Main language(s) of evaluation

English

Programmes

Programmes proposing this course at the Brussels School of Engineering

BA-IRAR | Bachelor in Engineering : Architecture | unit 3, BA-IRBI | Bachelor in Bioengineering | unit 3 and BA-IRCI | Bachelor in Engineering Sciences | option Bruxelles/unit 3

Programmes proposing this course at the faculty of Sciences

BA-IRBI | Bachelor in Bioengineering | unit 3