Chemical and biological reactor design

Lecturers
Frédéric DEBASTE (Coordinator) and David CANNELLA

Course mnemonic
CHIM-H413

ECTS credits
5 credits

Language(s) of instruction
English

Course period
First term

Campuses
Solbosch and Plaine

Course content

After an introduction (chapter 1), the course is divided in 3 parts, each dealing with a specific scale relevent to the reactor. A forth part, on bioreactor, ends the course

Part 1: chemical or biological reaction scale

Chapter 2: reminder on ideal reactors

Chapter 3: composed reaction scheme (serie, parrallel reaction, selectivity), enzymatic reactions (Michaelis-Menten, inhibitions)

Part 2: flow scale

Chapter 4: Residence time distribution and transfer function

Chapter 5: Application to reactors (compartment models, dispersive plug flow, short-circuits, dead volumen, tanks in serie)

Chapter 6: Impact on reactor efficiency (parrallel flow model)

Part 3: mass transfer scale

Chapter 7: reminder about mass transfer

Chapter 8: general strategy on coupling reaction and mass transfer

Chapter 9: reaction catalysed by solid (Thiele modulus, catalyst efficiency)

Chapter 10: reaction between a fluid and a solid (shrinking core model)

Chapter 11: reaction in non-miscible fluid (2 films models, Hatta number, acceleration factor, kLa)

Part 4 : bioreactors

Objectives (and/or specific learning outcomes)

The **objective** of this course is to lead the student to aprehend the tools to design non ideal chemical and biological reactors using a strategy based on the identification and the analysis, including mathematical modelling, of physico-chemical phenomena taking place in the reactor.

Pre-requisits and co-requisits

Required knowledge and skills

- Transport phenomena (mostly mass transport)
- Equilibrium thermodynamics
- Ideal reaction design
- Differential equation solving
- Numerical methods for equation resolutions
- (Bio) chemical kinetics

Teaching method and learning activities

For each part, the basic principles and framework are given at courses. Classical theoretical calculations are realized in groups in seminar. The principles are then applied in exercices sessions of growing difficulty and nearing practical applications. Practical on computer (applying numericl methos in MS Excel) allow to tackle a practical application from biotechnology, food industry or environment engineering.

References, bibliography and recommended reading

Main references : (available at the Bibliothèque des sciences et techniques of ULB and/or at TIPs department)

- O. Levenspiel, *Chemical Reaction Engineering*, 1998
- H. Fogler, *Elements of Chemical Reaction Engineering*, 2005
- R. Bird, W. Steward, E. *Lightfoot Transport phenomena*, 2006

Course notes

Université virtuelle

Other information

Place(s) of teaching

Solbosch and Plaine

Contact(s)

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Evaluation method(s)

written examination, Oral examination, Oral presentation and Group work

written examination

Open question with developed answer

Open book examination

Oral examination

Open question with long development

Examination with preparation

Evaluation method(s) (additional information)

The evaluation combines continuous evaluation and a final oral exam.

The continuous evaluation is realized trough 3 contributions (one short oral presentation by 2, and two written report, also by 2 students) related to exercises on the course topic.

In january, the final exam is written. For this exam, a general problem dealing with the 3 first parts of the course is given. Theory questions for part 4 are also given.

In the second session, a similar exam, but oral, is organized

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

The final mark is composed at 7/20 by the year mark coming from the continuous evaluation and at 13/20 by the exam mark (9 points for parts 1 to 3, 4 points for part 4).

The year mark is automatically transfered to the second session. The year mark is not transfered from one year to another.

Main language(s) of evaluation

English

Other language(s) of evaluation, if applicable

French

Programmes

Programmes proposing this course at the Brussels School of Engineering

MA-IRBC | Master in Chemistry and Bio-industries Bioengineering | finalité Professional/unit 1 and MA-IRBE | Master in Environmental Bioengineering | finalité Professional/unit 1

Programmes proposing this course at the faculty of Sciences

MA-IRBC | Master in Chemistry and Bio-industries Bioengineering | finalité Professional/unit 1 and MA-IRBE | Master in Environmental Bioengineering | finalité Professional/unit 1