

# 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 relevant to the reactor. A fourth 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 apprehend 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-requisites and co-requisites

### 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 through 3 contributions (one short oral presentation by 2, and two written reports, 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 transferred to the second session. The year mark is not transferred 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

