# Parameter estimation and modeling

**Lecturers**
Philippe BOGAERTS (Coordinator) and Benoît SCHEID

**Course mnemonic**
CHIM-H401

**ECTS credits**
5 credits

**Language(s) of instruction**
English

**Course period**
First term

**Campus**
Solbosch

## Course content

First part (Ph. Bogaerts) : Introduction to parameter estimation; Mathematical model structures (taxinomy and properties); Parameter estimation (least squares, maximum likelihood); Mathematical modeling of biological networks; Case studies.

Second part (B. Scheid) : Scientific modeling is the process of generating abstract, conceptual, graphical and mathematical models. Through several examples of complex systems, the methodology of modeling developed in this course will consist in (i) understanding how these systems work, (ii) identifying the key parameters, (iii) using the appropriate mathematical formalism, (iv) implementing the subsequent model in a numerical solver, (v) performing virtual experiments and (vi) testing and challenging the results whenever possible. Several problems will be considered such as heat diffusion, convection/diffusion of species, predator-prey dynamics, phase separation, two-dimensional thermal convection, and liquid film dynamics.

## Objectives (and/or specific learning outcomes)

Building a mathematical model of a process based on experimental measurements. Helping to concieve mathematical models in order to simulate complex systems and to proceed to virtual experiments. Criticize the quality and validity of the constructed models.

## Pre-requisits and co-requisits

### Required knowledge and skills

**First part** (Ph. Bogaerts) :

Generally, basics of linear algebra; function analysis; statistics and probability theory; linear system dynamics.

More specifically: vectors and matrices (product, inverse, trace, transpose, etc.); function minimization; Taylor series development; integration of first order ordinary differential equations; mathematical expectation, probability density function, mean, variance, stochastic processes, white noise, Gaussian distribution, uniform distribution; state equations and transfer functions for linear time-invariant dynamical systems.

## Teaching method and learning activities

**First part** (Ph. Bogaerts) : Lectures with powerpoint presentation (2ECTS)

**Second part** (B. Scheid) : Lectures (1 ECTS) and practical sessions (1ECTS). Some of the problems treated in the course will be solved "in live" during the course and the others will be solved during the practical sessions in the computer room using a PDE solver (Comsol).

### Contribution to the teaching profile

This teaching unit contributes to the following competences:

- In-depth knowledge and understanding of exact sciences with the specificity of their application to engineering
- In-depth knowledge and understanding of integrated structural design methods in the framework of a global design strategy
- In-depth knowledge and understanding of the advanced methods and theories to schematize and model complex problems or processes
- Reformulate complex engineering problems in order to solve them (simplifying assumptions, reducing complexity)
- The flexibility and adaptability to work in an international and/or intercultural context

### References, bibliography and recommended reading

Papers of the scientific literature.

### Course notes

Université virtuelle and Podcast

## Other information

### Place(s) of teaching

Solbosch

### Contact(s)

Ph. Bogaerts : 3BIO-BioControl (Biosystems Modeling and Control); email: philippe.bogaerts@ulb.be

B. Scheid : TIPs - Transfers, Interfaces and Processes; email: benoit.scheid@ulb.be

## Evaluation method(s)

Other

### Evaluation method(s) (additional information)

**First part** (Ph. Bogaerts) : oral examination without preparation.

**Second part** (B. Scheid) : practical exam on computers.

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

60% first part (Ph. Bogaerts) + 40% second part (B. Scheid)

### Main language(s) of evaluation

English

## Programmes

### Programmes proposing this course at the Brussels School of Engineering

MA-IRMA | Master of Science in Chemical and Materials Engineering | finalité Professional/unit 1