GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2024-2025

Control of Drug-Delivery Systems (E027790)

Course size *(nominal values; actual values may depend on programme)*

Credits 4.0 **Study time 120 h**

Course offerings and teaching methods in academic year 2024-2025

A (semester 2)	English	Gent	lecture
			independent work

Lecturers in academic year 2024-2025

Ionescu, Clara-Mihaela	TW08	lecturer-in-charge
Copot, Dana	TW08	co-lecturer

Offered in the following programmes in 2024-2025	**crdts**	**offering**
Master of Science in Biomedical Engineering	4	A
Master of Science in Biomedical Engineering	4	A

Teaching languages

English

Keywords

first order – second order- higher-order compartmental models, pharmacokinetic model, pharmacodynamic model, transfer function models, drug effect, synergy, population dynamics, diffusion rate, clearance rate, bolus, infusion rate, saturation, patient safety, monitoring for control, closed loop regulation, linear control, multivariable control, stability, frequency response, time response

Position of the course

The particular focus of the course is drug delivery systems, as they are ubiquitous, as in general anesthesia, diabetes, cancer and chronic pain therapies (to mention a few examples). The following aspects are emphasized:

- To learn - and to apply - the techniques for modelling and identification of physical systems, starting from measured process signals.
- To learn and to apply control techniques for intravenous, oral or aerosol delivery of drugs in therapy
- To understand the communication between a computer or decision-making system and a biological process

Contents

- The role of process dynamics and control in drug delivery systems
- Modelling and identification: pulse transfer function, pharmacokinetics (PK), pharmacodynamics (PD), linearization, transfer function (TF), Mittal Leffler function for drug absorption and clearance
- Analysis of dynamic behaviour, synergy effects, antagonist effect of medication and interaction modelling
- What implies inter-patient and intra-patient variability in terms of models for control
- Drug trapping and risk for over-dosing – non-homogeneous diffusion in compartments
- Control design based on graphical tools, control design based on specifications (patient safety, tolerance interval, time to target settling time, nadir limitations etc)
- Multivariable system analysis and control techniques to simplify loop interactions
- Optimal control of drug delivery rates for positive systems (only input of drug can be manipulated, one cannot take out drug from the body with a controlled signal)

Examples in the course originating from:

- Compartmental models' analysis for control
- Constant/variable-rate intravenous infusion

- Control of infusion of vasoactive drugs
- Depth of anesthesia regulation

Initial competences

- Biomedical signals and systems
- Modelling Physiological Systems

Final competences

1 To understand the communication between a computer and a physical process for data acquiring and data sending
2 To be able to develop a mathematical model from available (limited) signals (PK, PD, TF)
3 To be able to design a (basic) control strategies for required performance specifications
4 To be able to critically evaluate trade-off between safety/performance and positive systems (one can only put drug into the patient, not take out)
5 To understand the difference between basic control (PID control) and optimal control (constrained based)
6 To understand interactions of various drugs and their effect in the body
7 To be able to simplify interactions and complexity for purpose of control
8 To be able to communicate results in an efficient manner and work in group to achieve goals

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Group work, Lecture, Independent work

Extra information on the teaching methods

blended learning, video material available in Ufora for support

Study material

Type: Syllabus

Name: Control of drug delivery systems
Indicative price: Free or paid by faculty
Optional: no
Language : English
Number of Pages : 150
Available on Ufora : Yes
Online Available : Yes
Available in the Library : No
Available through Student Association : No

Type: Slides

Name: Slides DDS
Indicative price: Free or paid by faculty
Optional: no
Language : English
Number of Slides : 500
Available on Ufora : Yes
Online Available : Yes
Available in the Library : No
Available through Student Association : No

References

Laurent Simon, Wiley press, Control of biological and drug-delivery systems (for chemical, biomedical and pharmaceutical engineering), 2013

Course content-related study coaching

The lecturer is available during and after the lectures for further explanation; individual explanation and feedback is available on appointment; feedback sessions are within course agenda

Assessment moments

end-of-term assessment

Examination methods in case of periodic assessment during the first examination period

Written assessment open-book

Examination methods in case of periodic assessment during the second examination period

Written assessment open-book

Examination methods in case of permanent assessment

Possibilities of retake in case of permanent assessment

examination during the second examination period is possible in modified form

Extra information on the examination methods

- Evaluation during exam period: open book written exam

Calculation of the examination mark

multiple-question exam, evaluation /20 per question, final averaged mark