

## Process Control (I002672)

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

**Credits 5.0**                      **Study time 150 h**

**Course offerings and teaching methods in academic year 2024-2025**

A (semester 2)	English	Gent	practical
			lecture
			independent work
			seminar

**Lecturers in academic year 2024-2025**

Vanhaelewyn, Gauthier	LA26	staff member
Van Liedekerke, Paul	LA26	lecturer-in-charge

**Offered in the following programmes in 2024-2025**

	crdts	offering
<a href="#">Master of Science in Bioscience Engineering: Cell and Gene Biotechnology</a>	5	A
<a href="#">Master of Science in Bioscience Engineering: Chemistry and Bioprocess Technology</a>	5	A
<a href="#">Master of Science in Bioscience Engineering: Environmental Technology</a>	5	A
<a href="#">Master of Science in Bioscience Engineering: Food Science and Nutrition</a>	5	A
<a href="#">Master of Science in Pharmaceutical Engineering</a>	5	A

**Teaching languages**

English

**Keywords**

Process control, control architecture, monitoring, automation, stability analysis, classic control, modern control

**Position of the course**

Aim of the course is to introduce optimal, automated operation of processes by using controllers. Students gain insight in the necessity of process control systems in modern process operation and the way these control systems are built. In this course the synthesis of a control loop is introduced from both a conceptual and practical angle.

Classic feedback control based on PID-controllers are introduced including their tuning and stability analysis. As basis, the behaviour in the frequency domain of linear systems is thoroughly introduced. Extensions such as cascade and feedforward control are touched on as well as practical problems such as kick and integral windup.

Modern controllers such as state feedback, LQ-control and model-based control are introduced.

**Contents**

Introduction: scope, terminology, role of engineer, overview of controllers  
 System dynamics in time and frequency domain  
 Classic control  
 - Feedback control: block scheme, types of control problems, closed loop response  
 - System stability: definition, stability analysis, gain and phase margin  
 - Dead time: concept, destabilization, smith-predictor  
 - PID tuning: performance criteria, semi-empirical tuning techniques  
 - Practical implementation of PID controllers: proportional/derivative kick, dead-time treatment, integral windup, measurement noise  
 - ON/OFF control, cascade control, feedforward control, feedforward/feedback

- Modern control
- Controllability of linear systems
- State feedback, LQ-control
- State estimation
- Model-based predictive control (MBPC)
- Industrial control systems
- P&IDs, SCADA, PLC, DAQ

### Initial competences

Process Control builds on certain learning outcomes of course unit Modelling and Simulation of Biosystems ; or the learning outcomes have been achieved differently.

### Final competences

- 1 Analysing system behavior with transferfunctions.
- 2 Basic system identification
- 3 Investigation of stability criteria
- 4 Dead time response of a system
- 5 Choosing a control strategy and parameters
- 6 Tuning of controllers
- 7 Practical problems in classical control theory
- 8 Practical implementation of controllers
- 9 Understanding controllability and observability in state space models
- 10 Advanced control: defining objective functions for minimization.  
Principles of Model Predictive Control

### 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

Seminar, Lecture, Practical, Independent work

### Extra information on the teaching methods

Theory: oral lectures and digital learning paths on Ufora  
Exercises: practicum in PC-rooms with supervision as well as a hands-on practicum where students will have to implement and tune their own controller

### Study material

Type: Syllabus

- Name: electronic version available (no cost)
- Indicative price: Free or paid by faculty
- Optional: no
- Number of Pages : 200
- Available on Ufora : Yes
- Online Available : Yes
- Available in the Library : No
- Available through Student Association : Yes
- Additional information: printed version may be charged

### References

- Dutton K. Thompson S. & Barraclough B. (1997) The Art of Control Engineering. Addison Wesley, Harlow, Engeland. ISBN 0-201-17545-2
- Levine W.S. (1995) The Control Handbook. CRC Press, Boca Raton, Florida. pp. 1548
- Marlin T.E. (1995) Process Control – Designing Processes and Control Systems for Dynamic Performance. McGraw-Hill, Singapore. ISBN 0-07-040491-7
- Oggunaike B.A. and Ray W.H. (1994) Process Dynamics, Modeling, and Control. Oxford University Press, New York. ISBN 0-19-509119-1. pp. 1260
- Stephanopoulos G. (1984) Chemical Process Control, an Introduction to Theory and Practice. Prentice-Hall Englewood Cliffs, USA, ISBN 0-13-128629-3
- Van Impe J.F., Vanrolleghem P.A. and Iserentant D. (1998) Advanced Instrumentation, Data Interpretation and Control of Biotechnological Processes. Kluwer Academic Publishers, Dordrecht, The Netherlands. ISBN 0-7923-4860-5.

**Course content-related study coaching**

Study coaching is offered before and after each of the oral lectures and practicum or after appointment. There is also a forum on Ufora.

**Assessment moments**

end-of-term and continuous assessment

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

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

**Examination methods in case of permanent assessment**

Assignment

**Possibilities of retake in case of permanent assessment**

not applicable

**Extra information on the examination methods**

Students who eschew period aligned and/or non-period aligned evaluations for this course unit may be failed by the examiner.

Periodic evaluation (open book):

- Theory: written oral exam (insight questions)
- Exercises: computer exercises

Non-periodic evaluation: results of the hands-on practicum (data, code and models) will have to be reported through Ufora

**Calculation of the examination mark**

Periodic evaluation

- Theory: 25%
- Exercises: 60%

Non periodic evaluation

- Hands-on practicum: 15%