GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2024-2025

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
Master of Science in Bioscience Engineering: Cell and Gene Biotechnology	5	A
Master of Science in Bioscience Engineering: Chemistry and Bioprocess Technology	5	A
Master of Science in Bioscience Engineering: Environmental Technology	5	A
Master of Science in Bioscience Engineering: Food Science and Nutrition	5	A
Master of Science in Pharmaceutical Engineering	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. pp.

464

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%