GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2019-2020

Process Modelling and Control (O000141)

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

Credits 5.0	Study time 150 h	Contact hrs	60.0 h

Course offerings and teaching methods in academic year 2019-2020

A (semester 1)	English	seminar: practical PC room classes	20.0 h
		seminar: coached exercises	10.0 h
		lecture	30.0 h

Lecturers in academic year 2019-2020

Rao, Shodhan	KR01	lecturer-in-charge

Offered in the following programmes in 2019-2020	crdts	offering
Bachelor of Science in Environmental Technology	5	A
Bachelor of Science in Food Technology	5	A
Bachelor of Science in Molecular Biotechnology	5	A

Teaching languages

English

Keywords

Modelling, state-space and input/output models, process control, simulation, stability analysis.

Position of the course

The aim of the course is to introduce on the one hand modelling of biosystems and on the other hand automatic control of processes using feedback controllers. Students need to be convinced of the necessity of modelling and control of systems in modern process operation and gain insight in the way these control systems are built. The student learns how to analyse a biosystem in a mathematical way. This entails building of a mathematical model and analyzing the properties of the model by simulating it. The course also introduces the concept of feedback control in order to obtain the desired output from a given plant and the concept of stability which is very important in designing a controller.

Contents

1. Introduction to modelling of biosystems, modelling using balance laws, simulations using MATLAB Simulink.
2. State space and input-output modelling approaches, transfer function, linearity and linearization of models, conversion from state space to input-output form.
3. Dynamics of linear systems in the time domain: first order, second order, response to impulse, step and ramp inputs, important parameters, higher order systems.
4. Analysis of frequency response: general, low order systems, higher order systems, Nyquist and Bode plots, important parameters, resonance.
5. Feedback control: block scheme, types of control problems, closed loop response, introduction to P, PI, PD and PID controllers, steady state offsets, servo and regulatory problems.
6. Signal flow graphs, Mason’s gain rule.
7. System stability: definition, characteristic equation, Routh-Hurwitz, root locus analysis, Bode stability, Nyquist stability, gain and phase margin.
8. Control of systems with time delay: destabilizing character, lead-compensation.

Initial competences

0000083 - Mathematics 2: Multivariable Calculus and Geometry

0000088 - Mathematics 3: Differential Equations.

Final competences

1 Identify the balance laws of a given biosystem.
2 Translate a given biosystem into a mathematical model.
3 Simulate a given mathematical model in a software environment.
4 Analyse key properties of a mathematical model using MATLAB software.
5 Transform a state space model into an input-output model.
6 Analyse the stability of a given closed-loop system.
7 Design parameters for P, PI and PID controllers of linear systems in such a way as to ensure stability and minimize steady state offsets in the closed loop system.

Conditions for credit contract

This course unit cannot be taken via a credit contract

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Lecture, seminar: coached exercises, seminar: practical PC room classes

Learning materials and price

A combination of notes provided in the class and power point slides.

References

Oggunaike B.A. and Ray W.H. (1994). Process Dynamics, Modeling and Control. Oxford University Press.
Gopal M. (2002). Control Systems – Principles and Design. Tata McGraw-Hill Education.
Ogata K. (2009). Modern Control Engineering (5th Edition), Pearson.

Course content-related study coaching

Evaluation methods

end-of-term evaluation and continuous assessment

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

Written examination with open questions, skills test

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

Written examination with open questions, skills test

Examination methods in case of permanent evaluation

Assignment

Possibilities of retake in case of permanent evaluation

examination during the second examination period is not possible

Calculation of the examination mark

Non-periodic Evaluation - Assignment: 20%
Periodic Evaluation - Final Exam: 80%