

## Modelling and Control of Dynamic Systems (E007120)

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

**Credits 6.0**

**Study time 180 h**

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

A (semester 2)

Dutch

Gent

seminar

practical

lecture

**Lecturers in academic year 2024-2025**

Loccufier, Mia

TW08

lecturer-in-charge

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

**crdts**

**offering**

Bachelor of Science in Engineering(main subject Biomedical Engineering)

6

A

Bachelor of Science in Engineering(main subject Chemical Engineering and Materials Science)

6

A

Bachelor of Science in Engineering(main subject Electrical Engineering)

6

A

Bachelor of Science in Engineering(main subject Electromechanical Engineering)

6

A

Bachelor of Science in Engineering(main subject Engineering Physics)

6

A

Bridging Programme Master of Science in Electrical Engineering(main subject Communication and Information Technology )

6

A

Bridging Programme Master of Science in Electrical Engineering(main subject Electronic Circuits and Systems )

6

A

Bridging Programme Master of Science in Engineering Physics

6

A

Bridging Programme Master of Science in Photonics Engineering

6

A

Master of Science in Industrial Engineering and Operations Research(main subject Manufacturing and Supply Chain Engineering)

6

A

Master of Science in Industrial Engineering and Operations Research(main subject Transport and Mobility Engineering)

6

A

Master of Science in Industrial Engineering and Operations Research

6

A

Preparatory Course Master of Science in Electromechanical Engineering(main subject Control Engineering and Automation )

6

A

Preparatory Course Master of Science in Electromechanical Engineering(main subject Electrical Power Engineering)

6

A

Preparatory Course Master of Science in Electromechanical Engineering(main subject Maritime Engineering)

6

A

Preparatory Course Master of Science in Electromechanical Engineering(main subject Mechanical Construction)

6

A

Preparatory Course Master of Science in Electromechanical Engineering(main subject Mechanical Energy Engineering)

6

A

Preparatory Course Master of Science in Biomedical Engineering

6

A

Preparatory Course Master of Science in Industrial Engineering and Operations Research

6

A

**Teaching languages**

Dutch

**Keywords**

modelling and simulation, linear system dynamics, feedback, dynamic compensators, model based control

**Position of the course**

To learn the basic principles which are necessary for the modelling of the dynamic behaviour of physical systems.

To study and to analyse this dynamic behaviour, using computer simulations, hands on training with small scale experiments and the basic theory of linear system dynamics.

To learn the fundamental methods for the design of dynamic compensators and model based controllers, in order to improve the dynamic behaviour of physical systems.

To apply these analysis and design techniques using computer aided design software and small scale experiments. Python software is used. The use of a personal laptop is required to measure and simulate.

### Contents

- Modelling and simulation of dynamic systems: Dynamic systems, Physical models, Mathematical models, Simulating dynamic systems
- Analysis of dynamic systems: Linear and nonlinear systems, Stability of linear systems, Analysis of first-, second-, and higher-order systems
- Dynamic systems with feedback: Dynamic output feedback, The PID controller, Computer-based implementation of dynamic compensators with Python.
- Design of dynamic compensators in the time domain: Specification of design parameters, Root locus method, Time-domain design
- Design of dynamic compensators in the frequency domain: Frequency analysis, Nyquist stability criterion, Frequency domain design
- Experimental implementation of modeling and control on small scale setups by means of a personal laptop.

### Initial competences

- Students have successfully taken the course 'Basis Mathematics Tools' or 'Basic Mathematics' (i.e. obtained a credit) or have acquired the aspired learning competences in another way (required starting competencies as defined in the Curriculum Rules of the Faculty of Engineering and Architecture, cf. <http://www.ugent.be/ea>)
- Physics, systems and signals

### Final competences

- 1 Combining the knowledge of several engineering disciplines (electronics, electro-mechanical, physics, chemical engineering) in order to obtain mathematical models of physical dynamic systems.
- 2 To derive transfer-function models and state-space models of physical systems and comprehend linear and nonlinear behavior.
- 3 To have insight regarding the static and dynamic behaviour of systems and to apply this insight when designing feedback loops.
- 4 To evaluate in a correct way the results of computer simulations and numerical techniques when designing feedback control systems.
- 5 Being able to analyse feedback control systems using several stability criteria.
- 6 To design of controllers based on the application of root-locus techniques and frequency-response techniques such as Bode, Nyquist.
- 7 To implement modeling and control on small scale setups by using personal laptop

### 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

### Extra information on the teaching methods

The 'modeling and control course' applies iteratively three teaching methods: lectures to learn fundamental concepts, seminars to have a thorough knowledge of problem solving skills for industrial applications, practicals to experimentally model and control small scale setups via personal laptop such that theoretical concepts are translated to practical skills

### Study material

Type: Syllabus

Name: Modelling and Control of Dynamic Systems

Indicative price: € 12

Optional: no

Language : Dutch

Number of Pages : 255

Available on Ufora : Yes

Online Available : Yes

Available through Student Association : Yes

### References

- G.F. Franklin, J. D. Powell and A. Emami-Naeini, Feedback Control of Dynamic Systems, 7th edition, Pearson education limited (2015).
- Dorf and Bishop. 'Modern Control Systems' (13th ed.) Addison-Wesley-Longman Inc. (2016)
- Åström and Hägglund. 'Advanced PID Control'. ISA-The Instrumentation, Systems, and Automation Society (2006)

### Course content-related study coaching

The lecturer is available after lectures. Tutoring during exercises classes and on request.

### Assessment moments

end-of-term and continuous assessment

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

Written assessment

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

Written assessment

### Examination methods in case of permanent assessment

Assignment

### Possibilities of retake in case of permanent assessment

examination during the second examination period is possible

### Extra information on the examination methods

periodic evaluation: The written examination consists of two parts: an exam on concepts and an exam on design of controllers.

The exam on concepts tests the insight and application of the theoretical concepts. The lecture notes and solved problems can be used.

The exam on design of controllers comprises the CAD-design of a controller with Python of an industrial relevant process. All material available via Ufora can be used.

Permanent evaluation: Each student uses a small scale setup, own laptop.

Students execute a number of measurements, process them in Python based on the questions in the assignment and submit the results as a report.

### Calculation of the examination mark

exam 4/5 and reports test 1/5

The exam parts of the periodic evaluation each count for 2/5 of the final mark.

The result of the permanent evaluation can be transferred to the second examination period.