GHENT UNIVERSITY

# Course Specifications

Valid as from the academic year 2023-2024

## Sensors, Actuators and Electronic Microsystems (E008446)

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

**Credits 6.0** **Study time 180 h**

**Course offerings in academic year 2023-2024**

| | | |
|---|---|---|
| A (semester 2) | English | Gent |
| B (semester 2) | Dutch | Gent |
| O (semester 2) | English | Gent |

Distance teaching for all teaching activities: yes
Distance assessment for all end-of-term assessments: no
Distance assessment for all continuous assessments: no

**Lecturers in academic year 2023-2024**

| | | |
|---|---|---|
| De Smet, Herbert | TW06 | lecturer-in-charge |
| Vasquez Quintero, Andrés Felipe | TW06 | co-lecturer |

| Offered in the following programmes in 2023-2024 | crdts | offering |
|---|---|---|
| Bridging Programme Master of Science in Electrical Engineering (main subject Electronic Circuits and Systems ) | 6 | A |
| Bridging Programme Master of Science in Photonics Engineering | 6 | A |
| Master of Science in Electrical Engineering (main subject Communication and Information Technology ) | 6 | A |
| Master of Science in Electromechanical Engineering (main subject Control Engineering and Automation) | 6 | A |
| Master of Science in Electromechanical Engineering (main subject Electrical Power Engineering) | 6 | A |
| Master of Science in Electrical Engineering (main subject Electronic Circuits and Systems) | 6 | A |
| Master of Science in Electromechanical Engineering (main subject Maritime Engineering) | 6 | A |
| Master of Science in Electromechanical Engineering (main subject Mechanical Construction) | 6 | A |
| Master of Science in Electromechanical Engineering (main subject Mechanical Energy Engineering) | 6 | A |
| Master of Science in Biomedical Engineering | 6 | A |
| Master of Science in Biomedical Engineering | 6 | A |
| Master of Science in Photonics Engineering | 6 | B |
| Master of Science in Photonics Engineering | 6 | A, O |

**Teaching languages**

Dutch, English

**Keywords**

Sensors, actuators, classification, operating principles, static and dynamic characteristics, datasheets, accuracy, noise, calibration, system analogies, reliability, signal conditioning, linearization, bridge circuits, error suppression, basic electronic circuits, transconductance and transimpedance amplifier, photodiode interfacing, LED drivers, data acquisition and

instrumentation software, analog and digital data transmission, microcontroller, MEMS, microsystems, micro energy harvesting, microdisplays and image sensors

**Position of the course**

This course teaches the students the necessary skills for the electronic and opto-electronic interfacing of microsystems, sensors and actuators. This comprises transistor circuits, opamp circuits as well as microcontroller based solutions, and assumes a good initial knowledge of physics and a basic knowledge of electronics. Furthermore, the course aims at giving the students a good understanding of the possibilities and limitations of the different sensor and actuator types and the different ways they can be interfaced. Furthermore it provides hands-on experience of how to use them in practice.

**Contents**

- Primary sensors
- Sensor electronics and signal conditioning
- Sensor types
- Actuators
- Use of Microcontrollers in sensor based measurements
- Microsystems electronics & case studies

**Initial competences**

Good basic knowledge of analog electronics and device physics, for example acquired in the following manner: having successfully completed "Physics I", "Physics II", "Electrical circuits and networks" and "Analog electronics".

**Final competences**

1 Thoroughly understand and discuss the operation of electromotive, resistive, capacitive, 1 inductive and primary sensors and actuators.
2 Explain linearity, calibration, noise, precision, sensitivity, reliability and other sensor characteristics; explain and/or derive signal conditioning methods such as linearization, differential operation, amplitude and frequency modulation.
3 Recognizing and explaining basic electronic circuits useful for sensor interfacing, such as bridge circuits, modulation and demodulation circuits, transimpedance amplifiers.
4 Using sensors and actuators efficiently in practical applications, including the consulting of datasheets, the use of instrumentation software, the implementation of hardware (computer) interfacing and dealing with electromagnetic interferences and other limitations of data transmission in a mature way.
5 Deal with solid-state lights sources in an energy efficient way and take into account optical limitations and electronic driving efficiency.
6 Explain and discuss the operation and construction of the microsystems that were treated during the case studies.

**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, practical

**Extra information on the teaching methods**

On-campus lectures if this can be organised in a safe way; online lectures used as fall-back solution.
Practicals = predefined hands-on experiments with sensors and instrumentation software; in small groups
Group work = in small groups conceive and implement a solution for a realistic measurement problem

**Learning materials and price**

- Syllabus: English (about 300 pages). Distributed electronically for free via the electronic learning platform
- Viewfoils: English; free via the electronic learning platform
- Practicals and group work: English; assignment and data provided free via online learning system or downloaded from the internet; hardware material available free of charge in EA06

student lab.

**References**


1 J. Fraden, "Handbook of Modern Sensors" (AIP)
2 R. Pallàs-Areny / John Webster, "Sensors and signal conditioning" (Wiley and Sons)
3 Ilene J. Busch-Vishniac, "Electromechanical Sensors and Actuators"
4 Georges Asch, "Les Capteurs en Instrumentation Industrielle"
5 John P. Bentley, "Principles of Measurement Systems"
6 P. Rai-Choudhury, "Handbook of Microlithography, Micromachining and Microfabrication, Volume 2"
7 Aldert Van Der Ziel, "Noise", Prentice-Hall
8 D.V. Bugg, "Circuits, Amplifiers and Gates", Adam Hilger
9 James J. Allen, "Micro Electro Mechanical System Design", Taylor & Francis (available on "EngNetBase")


**Course content-related study coaching**

Interactive support via online learning platform.

**Evaluation methods**

end-of-term and continuous assessment

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

Oral assessment

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

Oral assessment

**Examination methods in case of permanent evaluation**

Assignment, skills test

**Possibilities of retake in case of permanent evaluation**

examination during the second examination period is possible in modified form

**Extra information on the examination methods**

- During examination period: oral closed-book exam (with written preparation if takes place on campus; without written preparation if has to be organized online).
- Permanent evaluation: graded practicals, graded group work reports.
- Frequency: 3 practicals + 2 assignment of group work.

**Calculation of the examination mark**

Special conditions: practicals + group work: 33%. Examination: 67%