GHENT UNIVERSITY

Course Specifications

Valid in the academic year 2024-2025

Electricity, Magnetism and Sensors (I002429)

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 1)	Dutch	Gent	lecture
			seminar

Lecturers in academic year 2024-2025

Verstraelen, Toon	WE05	lecturer-in-charge

Offered in the following programmes in 2024-2025	**crdts**	**offering**
Bachelor of Science in Bioscience Engineering	5	A

Teaching languages

Dutch

Keywords

Basic physics, electricity, magnetism, electromagnetic waves, light, sensors

Position of the course

The objective of the course is for students to obtain a solid basic knowledge and basic insights in electricity, magnetism and physical optics, in which their use in sensors is explained. Basic aspects with respect to measuring with sensors (precision, accuracy, analog-digital conversion,...) is also taught.

Contents

1. Introduction to measuring with sensors (measurement range of a sensor, accuracy, precision, resolution, linearity, hysteresis, saturation, amplification of signals, causes and impact of noise on measurements, bandwidth, analog/digital conversion)
2. Electrostatics: electric charge (conservation law, conductor, isolator, induction), Coulomb's law, electric field, Gauss's law, electric potential, electric dipole.
3. Capacitors: capacitance, dielectrics, electric energy storage (application: capacitive sensors for measuring pressure, sound, air humidity, super capacitors, primary and secondary batteries)
4. Direct current circuits: electric current, resistance, Ohm's law, non-Ohmic resistors, diode, specific resistance, temperature dependence of resistors, series and parallel circuits, Kirchhoff's laws, RC circuit (application: measurement of forces using a strain gauge, measurement of fluid speed using a hot-wire anemometer, measurement of humidity of air/soil/material using resistive sensors, temperature measurement using temperature sensitive resistors)
5. Magnetism: magnetic field, force on a conducting wire and a moving charge, permanent magnets, fields generated by direct currents (laws of Ampère's law and Biot-Savart), magnetic dipole, solenoid, electromagnet, Hall effect (application: measurement of displacement/rotation using a Hall effect sensor)
6. Electromagnetic induction: laws of Faraday and Lenz, self induction and mutual induction, electromagnetic oscillations, introduction to alternating current circuits, transformer, impedance matching (application: measurement of displacement using a LVDT, Induction motor and generator, synchronous generator, rectifier)
7. Thermoelectric and piezoelectric effect (application: piezoelectric sensors for measuring accelerations, forces and pressures (including sound), measurement of temperature using a thermocouple)
8. Maxwell's equations: Ampère's circuital law, Gauss's law for magnetism,

electromagnetic waves, energy transport, the Poynting vector, electromagnetic spectrum, absorption of light (Lambert-Beer)

Initial competences

Electricity, magnetism and sensors builds on certain learning outcomes of course units 'Calculus, 'Linear algebra', and 'Mechanics, vibrations and waves'; or the learning outcomes have been achieved differently.

Final competences

1 Be able to describe and analyse electrical and magnetic phenomena

2 Be able to use and apply the various physical laws of electricity and magnetism
3 Understand the operation of sensors based on electrical, magnetic or electromagnetic principles

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

Extra information on the teaching methods

Plenary lectures for the theory part of the course. Exercise sessions consist of guided problem solving related to the theory and with a focus on applications of the theory. In addition, students will solve assignments independently and upload the answers to questions to Ufora for evaluation purposes.

Study material

Type: Handbook

Name: Elektriciteit, magnetisme en sensoren (a selection of chapters from Natuurkunde deel 2, only available in Dutch)
Indicative price: € 68
Optional: no
Language : Dutch
Author : Douglas G. Giancoli
ISBN : 0-123-45678-9
Number of Pages : 500
Oldest Usable Edition : 4
Online Available : No
Available through Student Association : Yes
Usability and Lifetime within the Course Unit : one-time
Usability and Lifetime within the Study Programme : one-time
Usability and Lifetime after the Study Programme : occasionally
Additional information: The textbook is custom-made incorporating only relevant chapters for the subject to reduce cost. It is only available in Dutch. ISBN and number of pages are not yet known before the deadline for the course specification. This information will be shared with the student body in order to purchase the book in bulk at a favorable price.

References

See learning materials.

Course content-related study coaching

Guided problem solving. Possibility to ask questions before and after the theory lectures and online.

Assessment moments

end-of-term and continuous assessment

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

Written assessment with multiple-choice questions, Written assessment with open-ended questions

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

Written assessment with multiple-choice questions, Written assessment with open-ended questions

Examination methods in case of permanent assessment

Written assessment with multiple-choice questions, Written assessment with open-ended questions

Possibilities of retake in case of permanent assessment

not applicable

Extra information on the examination methods

Periodical evaluation: written exam (closed book) consisting of multiple-choice questions and open questions (theory questions and exercises)
Permanent evaluation: evaluation via the electronic learning environment. Students submit answers to open questions and multiple-choice questions in exercises. The evaluations assess the outcome and aspects of the methodology. Retake not possible.

Calculation of the examination mark

Permanent evaluation: exercises via Ufora, 10% of the total mark.
Periodical evaluation: exam, 90% of the total mark.
Students who eschew periodical and/or permanent evaluations for this course unit may be failed by the examiner.

Facilities for Working Students

no extra facilities