GHENT UNIVERSITY

Course Specifications

Valid in the academic year 2017-2018

Bioelectromagnetism (E022250)

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

Credits 6.0	Study time 180 h	Contact hrs	45.0 h

Course offerings and teaching methods in academic year 2017-2018

A (semester 2)	English	lecture	22.5 h
		project	15.0 h
		practicum	7.5 h
B (semester 2)		practicum	7.5 h
		lecture	15.0 h
		project	7.5 h
C (semester 2)		practicum	2.5 h
		project	7.5 h
		lecture	12.5 h

Lecturers in academic year 2017-2018

Joseph, Wout	TW05	lecturer-in-charge
Stiens, Johan	VUB	co-lecturer
Tanghe, Emmeric	TW05	co-lecturer

Offered in the following programmes in 2017-2018	crdts	offering
Master of Science in Electrical Engineering (main subject Communication and Information Technology)	4	B
Master of Science in Electrical Engineering (main subject Electronic Circuits and Systems)	4	B
Master of Science in Biomedical Engineering	3	C
International Master of Science in Biomedical Engineering	3	C
Master of Science in Biomedical Engineering	3	C
Master of Science in Engineering Physics	6	A

Teaching languages

English

Keywords

Non-ionising radiation, electromagnetic fields, exposure, absorption, dosimetry, human body

Position of the course

This course involves the study the dosimetry or assessment of electromagnetic fields, interaction of radiation with humans, and absorption in the human body in the context of non-ionising field exposure. On the one hand, concepts about interaction with the human body are taught and on the other hand, state-of-the-art experimental and numerical dosimetry will be taught to the student. This will enable the student to acquire the skills and knowledge to judge current and future technologies and systems about their radiation exposure and to propose the required measures to reduce the exposure, and to design systems accounting minimal human exposure.

Contents

Content for course offering of 3 ECTS: points (11) to (18) see below
Content for course offering of 4 ECTS: points (1) to (13) see below
Content for course offering of 6 ECTS: points (1) tot (18) see below

1) Non-ionizing electromagnetic (EM) fields in real environments
2) Concepts of EM field interaction and the body: absorption of EM fields in the human body
3) Scientific basis and concepts for norms: basic quantities and basic restrictions and reference quantities and reference levels
4) Thermal and non-thermal effects of EM radiation
5) Whole-body absorption, organ specific absorption, and localized absorption in the body
6) Exposure to the general public and occupational exposure
7) EM description and modeling of electromagnetic fields
8) Experimental dosimetry of EM fields:
- measurement equipment and probes and calibration
- uncertainties
- broadband versus smallband measurements
- spatial dosimetry
- temporal dosimetry
- personal dosimetry: personal exposimeters
9) Experimental dosimetry of absorption:
- human phantoms
- measurement probes and robots
- liquids that simulate human tissues
- procedures for compliance testing
10) Practicum: Experimental dosimetry of EM fields and absorption
11) Numerical dosimetry+ project
- human models: homogeneous and heterogeneous 3D models
- numerical uncertainties (global)
- dielectric parameters (global)
- numerical simulations: Finite-Difference Time-Domain; Sim4Life software
- modeling techniques and statistical methods to characterize real environments
12) Therapeutic purposes of EM radiation:
- electromagnetic response of bio-molecular nlevel of tissue over entire spectrum: alfa, beta, gamma and delta dispersion
- repetitive transcranial neuro-stimulation: (r-TMS)
- anaesthesia and pain receptors, pain reduction using electromagnetic fields
- practicum
13) Use cases: application of theory on real EM sources:
- extreme low frequencies: high tension lines, substations, etc.
- intermediate frequencies: anti-theft gates, energy saving bulbs, etc.
- radio frequencies: GSM/UMTS/LTE base stations, mobile phones and smart phones
14) Medical applications
15) Dosimetry for Magnetic Resonance Imaging MRI:
- basic principles
- design of gradient and RF coils
- dosimetry for patients and workers
- numerical uncertainties
- dielectric parameters
16) Thermal therapy
- types of hyperthermia
- basic principles and dosimetry
17) Occupational exposure in medical environments: electrical churgery, MRI, hyperthermia,....
18) Small project: simulation of MRI and absorption in patient

Initial competences

Basic knowledge of math, physics and electronics, electromagnetism

Final competences

1 Insight in interaction between electromagnetic fields and the human body
2 Modeling of electromagnetic sources and fields in real environments
3 Calculation of fields and absorption in the body
4 Design networks with minimal human exposure
5 To report in writing and orally on the obtained results and to reflect on the papers that have been consulted

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

Lecture, practicum, project

Extra information on the teaching methods

Lectures: theoretical
Practicum: experimental dosimetry of EM fields and absorption in phantoms; bioelectromagnetism in the GHz-region
Project about numerical dosimetry and calculation of absorption in human models; simulation of MRI and absorption in patient
Presentation of articles and project results

Learning materials and price

Slides, articles (possibly an additional “EMF dosimetry handbook”)

References

See course material

Course content-related study coaching

The teacher and collaborators will be available during and in between lectures for further explanation + functionalities of Minerva

Evaluation methods

end-of-term evaluation and continuous assessment

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

Written examination, open book examination, oral examination

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

Written examination, open book examination, oral examination

Examination methods in case of permanent evaluation

Assignment, report

Possibilities of retake in case of permanent evaluation

not applicable

Extra information on the examination methods

Permanent evaluation:
practicum report, project report, presentation of articles and presentation of project
Periodic evaluation:
theory: periodic evaluation, aimed at understanding and being able to apply the course material, with special attention to practical problems - oral (open book) examination with written preparation
exercises: periodic evaluation, aimed at being able to apply models for calculation of absorption and fields in environments - written calculation exercise integrated in the examination (open book)

Calculation of the examination mark

Oral examination theory: 40%
Written examination exercises: 20%
Project and presentations: 30%
Practica: 10%