GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2015-2016

Fluid Dynamics and Heat Transfer in Electronics (E028410)

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

Credits	**6.0**	**Study time**	**180 h**
Contact hrs	60.0 h		

Course offerings and teaching methods in academic year 2016-2017

A (semester 2)	lecture	30.0 h
	seminar	30.0 h

Lecturers in academic year 2016-2017

Beunis, Filip	TW06	lecturer-in-charge

Offered in the following programmes in 2016-2017	crdts	offering
Bachelor of Science in Electrical Engineering	6	A

Teaching languages

Dutch

Keywords

heat, conduction, convection, radiation, fluid flow

Position of the course

When designing an (integrated) electronic circuit it is important to take into account, during every stage of the design process, the heat dissipation and cooling of the circuit, and the influence of these aspects on the electric behavior. On the one hand there is a constant drive to make ever smaller and faster circuits, on the other hand heat transfer is a limiting factor.
Heat can be transferred in a number of ways, which means that knowledge of several scientific fields must be combined during electronic design. A thorough introduction to hydro- and aerodynamics is necessary to understand heat transfer by convection. Conductive heat transfer is related to fields and electromagnetism. Radiative heat transfer is based on principles from (quantum) physics. Both for the theoretical concepts and for practical techniques, there is a strong emphasis on analogies with and techniques from other disciplines.
In addition to a general description of the different mechanisms of heat transfer, there is special emphasis on phenomena that are relevant for micro- and nanoelectronics, such as heat transfer in the frequency domain. Not only the solution of thermal problems (by e.g. cooling fins and ventilators) is covered, but also electronic design techniques to avoid thermal problems in the first place.

Contents

- Introduction: History, need for thermal analyses, overview of the course, special aspects of heat transfer in electronics, one dimensional heat transfer.
- Conductive heat transfer: Fourier's law, stationary heat equation, examples, Green's function and applications.
- Cooling fins and substrates: Introduction, fundamental equations, one dimensional model for a cooling fin, two dimensional model for substrates.
- Time dependent heat transfer: Time dependent heat equation, Green's function in one dimension, Green's function in more dimensions, quasistationary theory.
- Thermal conduction in the frequency domain: Introduction, Heat equation in the frequency domain, Green's functions, thermal impedance, thermal coupling, influence of convection.
- Convective heat transfer: Introduction, fundamental equations, dimensionless forms, boundary conditions, cooling with ideal fluids, cooling with viscous fluids.
- Radiative heat transfer: fundamental equations, geometry coefficients, gray body radiation.
- Heat sources in electronics: Introduction, heat distribution in components, heat

distribution in circuits, adiabatic circuits.
- Electrothermal analysis of electronic circuits: Introduction, DC analysis, differential analysis.

Initial competences

Final competences

1 Estimating the influence of thermal phenomena on electronic circuits.
2 Simplifying thermal problems to a solvable form.
3 Analytically solving simple thermal conduction problems.
4 Mathematically modeling complex thermal conduction problems.
5 Mathematically modeling liquid and air flow.
6 Analytically calculating convection coefficients for simple structures.
7 Calculating radiative heat transfer between arbitrary structures.
8 Analyzing and solving simple problems that combine different forms of heat transfer.
9 Designing efficient cooling fins.

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, seminar

Learning materials and price

Syllabus

References

- Geen

Course content-related study coaching

Support through Minerva. The lecturer is available before and after classes. Additional guidance is by the lecturer or teaching assistants is possible by making an appointment.

Evaluation methods

end-of-term evaluation

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

Open book examination

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

Open book examination

Examination methods in case of permanent evaluation

Possibilities of retake in case of permanent evaluation

not applicable

Extra information on the examination methods

Written open-book exam

Calculation of the examination mark

Evaluation during examination period