

## Sustainable Computing (E034500)

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

<b>Credits</b> 3.0	<b>Study time</b> 90 h	<b>Contact hrs</b>	30.0h
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**Course offerings and teaching methods in academic year 2022-2023**

A (semester 2)	English	Gent	seminar	15.0h
			lecture	15.0h

**Lecturers in academic year 2022-2023**

Eeckhout, Lieven	TW06	lecturer-in-charge
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**Offered in the following programmes in 2022-2023**

	<b>crdts</b>	<b>offering</b>
<a href="#">Master of Science in Computer Science Engineering</a>	3	A
<a href="#">Master of Science in Computer Science Engineering</a>	3	A

**Teaching languages**

English

**Keywords**

Computer systems, sustainability, energy efficiency, power efficiency, thermal efficiency, modeling, measurement, hardware specialization, hardware re-configurability, QoS/SLA-aware computing, approximate computing, mobile devices, multicore processors, datacenters, fault tolerance, reliability

**Position of the course**

The aim of the course is to make computer science engineering students aware of the importance of sustainability in computing and to cover techniques to improve sustainability across the computer system stack. The course is intended to give an overview of the impact of computing on sustainability and various energy efficiency aspects of computer systems and computing, ranging from production to use and end-of-life, from electronic circuits up to the applications, and for systems ranging from small mobile devices to large data centers.

**Contents**

Topics to be covered in the course:

- Lifetime of a computer system (from production, to usage, to recycling, to waste) and its impact on sustainability
- Power, energy and thermal-aware management of computing systems
- Modeling and measurement
- Management at the hardware level: voltage and frequency management, re-configurability, dark silicon, heterogeneity, specialization
- Management at the runtime level: operating system, hypervisor, language runtime
- Management at the application level: QoS/SLA-aware computing, approximate computing
- Management at the system level: mobile devices, multicore processors, datacenters (cooling)
- Interplay of sustainable computing with performance, fault tolerance, reliability and security
- Optional topics: energy harvesting, intermittent computing, biodegradable computing, etc.

The course will have a strong emphasis on hot research topics in sustainable computing. The course will consist of theory lectures, seminar-type assignments and hands-on experiments through which the students will characterize and analyze the sustainability of modern-day computer systems.

**Initial competences**

The students should have taken systems courses on computer architecture, operating systems, and parallel computer systems.

**Final competences**

- 1 Understand the impact of computing on sustainability.
- 2 Be able to explain sustainable computing systems.
- 3 Be able to measure and model the power and energy efficiency of a computer system.
- 4 Be able to analyze and optimize computer systems for improved sustainability.

**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**

The course will consist of theory lectures, seminar-type assignments and hands-on experiments through which the students will characterize and analyze the sustainability of modern-day computer systems.

**Learning materials and price**

Slides, recommended reading list

**References**

A variety of sources including recently published articles (provided to the students as recommended reading) on various topics pertaining to sustainable computing, including the following synthesis lectures:

- The Datacenter as a Computer: Designing Warehouse-Scale Machines, Third Edition, Morgan & Claypool Publishers, Luiz André Barroso, Urs Hölzle, Parthasarathy Ranganathan, October 2018
- Power-Efficient Computer Architectures: Recent Advances, Morgan & Claypool Publishers, Magnus Själander, Margaret Martonosi, Stefanos Kaxiras, December 2014
- Fault Tolerant Computer Architecture, Morgan & Claypool Publishers, Daniel J. Sorin, 2009

**Course content-related study coaching****Assessment moments**

end-of-term and continuous assessment

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

Written examination

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

Written examination

**Examination methods in case of permanent assessment**

Report, Assignment

**Possibilities of retake in case of permanent assessment**

examination during the second examination period is not possible

**Extra information on the examination methods**

End-of-term evaluation and continuous assessment:

- End-of-term evaluation: written exam, open book
- The continuous assessment consists of (i) discussion and critical analysis of recent scientific articles during the coached exercise sessions, and (ii) executing and reporting practical computer exercises.

**Calculation of the examination mark**

End-of-term evaluation (75%) and continuous assessment (25%)