UCLouvain	lelec2620 *2026*	Electronic Computing Systems for Artificial Intelligence

5.00 credits	30.0 h + 22.5 h	Q2

Teacher(s)	Andraud Martin ;Bol David ;
Language :	English > French-friendly
Place of the course	Louvain-la-Neuve
Prerequisites	A prior training in electronic circuits is mandatory#: ELEC1530 (or equivalent) . On top of the prerequistes, it can be good to have followed advanced electronic courses (for instance LELEC2650, LELEC2570) and/or machine-learning courses (for instance LELEC2870, LELEC2885, LINFO2262). *The prerequisite(s) for this Teaching Unit (Unité d'enseignement – UE) for the programmes/courses that offer this Teaching Unit are specified at the end of this sheet.*
Main themes	Artificial intelligence is gradually becoming ubiquitous in our daily lives. As such, designing hardware for AI tasks, known as AI accelerators, and using this hardware in the context of embedded systems is becoming a major topic in electronic systems. This is for instance related to edge AI and TinyML systems, able to compute AI with limited resources. However, the mainstream use of AI poses several significant challenges for electronic circuits and systems: (1) how to use existing hardware (microcontrollers, AI accelerators) to compute AI tasks efficiently? (2) what are the trends and challenges in custom digital and mixed-signal hardware dedicated to AI? And (3) what are the societal and environmental impacts of AI computation? In this course, you will study these three challenges, at the interface between AI models, processors and system-on-chips (SoCs). After an in-depth introduction to deep learning and hands-on efficient deep neural network strategies, you will study modern AI accelerator implementations both in digital and mixed signal. Finally, you will gain perspective on the larger impacts caused by AI computing, societally and environmentally. This course concludes with the ELEC formation in electronic circuits and systems.
Learning outcomes	**At the end of this learning unit, the student is able to :** a. Contribution to the program's learning outcomes: AA1#Basic knowledge : concepts of electronic circuits (AA1.1) simulation software and CAD (AA1.2) (architecture of digital and mixed signal AI acceleration systems, non-idealities in analog and mixed signal circuits, calibration of analog circuits, mixed-signal systems) AA2 Engineering skills#: analysis and modélisation of electronic systems and hardware/software integration (Use of various programming languages, training and inference with AI models, compilation of AI models on a given hardware) AA3 Research skills#: gather information about existing research solutions in the topic of the project (AA3.1) AA4 Project management b. Other learning outcomes : After follwing this course, engineering students in electronic circuits and systems will be able to#: • Understand how current AI algorithms (in particular deep learning models) are executed on generic processors and dedicated accelerators, thanks to various model and hardware optimization techniques (in digital or mixed-signal) • Critically compare different topologies of analog and digital circuits in the context of AI acceleration, regarding task accuracy, speed, power, cost, and necessary system flexibility. • Analyse and understand the propagation of non-idealities in a mixed-signal circuit chain, and how they can be calibrated. • Understand the societal implications and the environmental aspects of AI in our society.
Evaluation methods	In this course, students will be evaluated on: • A continuous evaluation based on group reports on the project work, to be submitted during the semester • A final oral evaluation in session

Teaching methods	The course will be organized as follows: • Lectures on various course topics (see contents) • A project will run for the entierty of the course, divided in three parts#: (1) optimize an AI task running on a resource-contrained TinyML system, (2) optimize the architecture of a dedicated AI accelerator for given AI tasks (3) design self-compensation techniques for analog AI accelerators • Perspective lectures on emerging technologies for AI, as well as enviromental and societal impacts of AI
Content	• Introducing AI models (in particular deep learning) and optimizing their hardware computation (quantization, pruning, etc.) • Digital AI accelerator topologies • In-memory computing and mixed signal AI accelerator topologies • Non-idealities of analog circuits and self-calibration techniques • Digitally-assisted calibration of analog circuits • Emerging technologies and neuromorphic circuits for IA acceleration • Societal and environmental impacts of IA
Inline resources	https://moodle.uclouvain.be/course/view.php?id=659
Bibliography	Chapitres de différents livres de références Liste de publications scientifiques récentes sur les différents sujets abordés Chapters of reference books Liste of scientific publications on the different course topics
Faculty or entity in charge	ELEC

Programmes containing this learning unit (UE)

Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Electrical Engineering	ELEC2M	5	LELEC2531 AND LELEC2532	
Master [120] in Electro-mechanical Engineering	ELME2M	5	LELEC2531 AND LELEC2532	