Co-funded by the European Union

P4ELECS
Platform for Electrification Skills & Competences

www.p4elecs.com

P4ELECS

Off grid systems case study - charging plaza for e-bikes

COURSE DESCRIPTION

BACKGROUND – RELEVANCE

Power electronics lies at the heart of modern energy conversion systems, enabling efficient control of electrical power in a wide range of applications. From renewable energy integration and electric vehicles to consumer electronics and industrial drives, power converters are key components that ensure optimal performance, reliability, and energy savings. This course equips students with the theoretical foundation and practical skills to design, analyse, and simulate power electronic circuits. Emphasis is placed on understanding semiconductor switching behaviour, converter topologies, capacitors, inductors, transformers, and thermal management. Real-world case studies provide insight into challenges faced by engineers in the field. The course bridges the gap between circuit-level design and system-level integration with real world applications. A strong focus on hands-on projects prepares students for industry or research careers. By the end, learners will be capable of developing robust, efficient, and application-specific power electronic systems.

ABSTRACT

This course on Power Electronics Design provides a comprehensive introduction to the essential components and techniques used in the development of modern power electronic systems. Students will gain a solid understanding of the main transistor and diode types, with an emphasis on calculating conduction and switching losses for reliable and efficient circuit operation. Capacitor selection criteria will be addressed in the context of voltage ripple, current handling, and lifetime. Learners will acquire the skills to perform basic inductor and transformer designs, considering core materials, magnetic flux, and winding parameters. Thermal management is also covered through practical methods for selecting appropriate heat sinks based on thermal resistance and power dissipation. The course explores the critical role of gate drivers, focusing on their timing, protection, and voltage requirements. Simulation plays a central role, and students will learn to model and analyse power converter circuits in PLECS, a leading tool in the field. Furthermore, during the physical part in EnergyVille, the design and development of a real converter is carried out. By combining theoretical foundations with practical tools, this course prepares participants to design, evaluate, and optimize key elements of power electronic systems. Emphasis is placed on real-world engineering constraints and design trade-offs, equipping students with industry-relevant skills.

KEYWORDS - HASTAGS

Power electronics, converters, component selection, hands-on, design and simulation

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FOCUS ON …	Knowledge	Application		Implementation	
CDIO		Conceive	Design	Implement	Operate
DIFFICULTY LEVEL	Basic	Intermediate		Advanced	
EQF LEVEL	6	CREDITS	4 (120h)	LANGUAGE	English

LEARNING OUTCOMES
The student can

1. calculate the losses of the main transistor and diode types and select an appropriate heat sink
2. make a basic inductor or transformer design
3. select the components (transistors, diodes, heat sink, capacitor) for a practical converter
4. make a PCB design for a (low power) power electronics converter based on the selected components
5. develop and test a lab prototype for the converter

PRIOR KNOWLEDGE REQUIRED

1. A strong knowledge of circuit theory and electromagnetism is required.
2. A basic knowledge on power electronics and the most utilized converter topologies (buck, boost, flyback, …) is desired

PRACTICAL ORGANISATION		
	Virtual part	**Physical part**
ORGANISER	KU Leuven	KU Leuven
ERASMUS CODE	xxx	
WHEN	Start AJ till 31/12/2025	1/12/2025 – 5/12/2025
WHERE	Online	EnergyVille (Thor Park – Genk – BE)
TEACHER(s) INSTRUCTOR(s)	• Wilmar Martinez (KU Leuven – Campus Diepenbeek) • Simon Ravyts (KU Leuven – Campus Gent) • Lars Haegemann (RWTH) • Julius Kleutgens (RWTH)	• Wilmar Martinez (KU Leuven – Campus Diepenbeek) • Simon Ravyts (KU Leuven – Campus Gent) • PhD Researchers and Postdoctoral Researchers
COURSE MATERIAL	BBs available in the Building Block Platform www.xdemia.com	BBs available in the Building Block Platform www.xdemia.com
SOFTWARE USED	PLECS, LTSpice, Altium	PLECS, LTSpice, Altium
OTHER MATERIAL		
MAX ATTENDEES	18 (6 teams of 3 studs)	18 (6 teams of 3 studs)
REGISTRATION		https://forms.office.com/e/B3Cuzwsj3b
CONTACT PERSON	Annick.dexters@kuleuven.be	
EVALUATION	Report of Design Assignment	Presentation + report on Development and Testing of the converter

Week	Date Exact timing	Location	TOPIC	Responsible
W1	21/9/26	1 x 2h online	Introduction - 1. ARCHITECTURES	KU Leuven Wilmar
W2	28/9/26	1 x 2h online	Q&A session - 2. DIODES + TRANSISTORS + Design Assignment	KU Leuven Simon
W3	5/10/26	1 x 2h online	Q&A session - 3. GATEDRIVERS + Design Assignment	KU Leuven Simon
W4	12/10/26	1 x 2h online	Q&A session - 4. CAPACITORS + Design Assignment	KU Leuven Simon
W5	19/10/26	1 x 2h online	Q&A session - 5. HEAT SINKS + Design Assignment	KU Leuven Wilmar
W6	26/10/26	1 x 2h online	Q&A session - 6. INDUCTORS + TRANSFORMERS + Design Assignment	KU Leuven Wilmar
W7	2/11/26	1 x 2h online	Q&A session - 7. CONTROL + Design Assignment Hand in PCB Design files Assignment (deadline 6/11/2026)	KU Leuven Wilmar
W7	9/11/25	1 x 2h online	FB session on PCB Design Assignment	KU Leuven Simon
W8	16/11/26	1 x 2h online	Q&A about MV converters – ACDC Topologies	RWTH Lars
W9	23/11/25	1 x 2h online	Q&A about MV converters – DCDC Topologies Report MV convertors Assignment (deadline 19/12/2025)	RWTH Julius

W10	WEEK 1 till 5/12/25	EnergyVille (BE)	Physical part – Development and testing of a real converter Presentation end of the week 5/12/2025 Survey first impressions course	Simon xxx Wilmar xxx