GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Power Electronics Systems, PG_00068317						
Field of study	Electrical Engineering						
Date of commencement of studies	February 2026		Academic year of realisation of subject	2026/2027			
Education level	second-cycle studies		Subject group				
Mode of study	Full-time studies		Mode of delivery	at the university			
Year of study	1		Language of instruction	Polish			
Semester of study	2		ECTS credits	3.0			
Learning profile	general academic profile		Assessment form	exam			
Conducting unit	Power Converters and Energy Storage Group -> Department of Power Electronics and Electrical Machines -> Faculty of Electrical and Control Engineering -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Paweł Szczepankowski				
	Teachers		dr hab. inż. Paweł Szczepankowski				
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	30.0	0.0	0.0	45
	E-learning hours included: 0.0						
	eNauczanie source address: https://enauczanie.pg.edu.pl/2025/course/view.php?id=885						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan		Participation in consultation hours	Self-study	SUM	
	Number of study hours	45		7.0	23.0	75	
Subject objectives	The aim of the course is for the student to acquire knowledge related to the design and control of power electronic systems. The student will learn the principles of designing such devices, the structure and functions of power components, as well as control and measurement techniques in voltage inverters and grid converters.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_U07] is able to analyse, calculate, design, program and test converters, drive systems, control systems and state observers	Is familiar with the PLECS software and is able to design a simulation circuit diagram for a given type of power electronics topology.	[SU3] Assessment of ability to use knowledge gained from the subject
[K7_W07] has an in-depth, theoretically grounded knowledge of electromechanical systems and their electromechanical systems and their design, electrotraction systems power supply and electrical energy storage devices	Selects and determines the limiting parameters of grid converters with energy storage systems.	[SW3] Assessment of knowledge contained in written work and projects
[K7_U06] is able to analyse, model, simulate and design electrical systems	Calculates and selects electrical parameters of power section components of the device using computer programs, particularly simulators.	[SU1] Assessment of task fulfilment
[K7_K04] correctly identifies and resolves dilemmas associated with the exercise of the profession, in particular relating to responsibility for his own safety and the safety of others	Identifies hazards and selects solutions used to enhance the safety and reliability of power electronic systems.	[SK5] Assessment of ability to solve problems that arise in practice
[K7_K03] can interact and work in a group assuming various roles and identify priorities for the achievement of a specific task	Identifies the needs of a power electronics application, selects components of the power electronic system, and performs its simulation and analysis. Additionally, defines priorities for design activities.	[SK1] Assessment of group work skills
[K7_W06] has an in-depth knowledge of industrial electronics, microprocessor control systems and in the field of power electronics and drive systems, their control and diagnostic methods	Designs a microprocessor system containing DSP TMS320F283XX processors, programmable logic devices, and analog-to-digital converters.	[SW3] Assessment of knowledge contained in written work and projects

Subject contents

Course content – lecture
Construction, operating principles, and control of three-phase DC/AC voltage inverters including two-level three-leg, two-level four-leg, and three-level NPC (Neutral Point Clamped) topologies. Construction, operation, and control of grid-connected converters. Digital signal processing algorithms used in power electronics: phase-locked loop (PLL), DSOGI filters, power calculations, harmonic analysis, and signal transformations. Control system of a grid converter using PI controllers and resonant controllers. Types and construction of DC voltage and current converters. Fault conditions and practical protections in control systems of power electronic circuits.

Course content – laboratory
Design, analysis, and simulation of a grid-connected converter using the PLECS software. Design and commissioning of a three-phase inverter using an evaluation board with the TMS320F28379D processor.

Prerequisites and co-requisites

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
exam	60.0%	50.0%
labs	60.0%	50.0%

Recommended reading

Basic literature	Power Electronics: Converters, Applications, and Design, Ned Mohan, Tore M. Undeland, William P. Robbins, John Wiley & Sons, 3rd Edition (2003), **ISBN:** 9780471226932
Supplementary literature	Digital Control of High-Frequency Switched-Mode Power Converters, Luca Corradini et al., IEEE Press / Wiley, **ISBN:** 9781119022800, . Digital Control of High-Frequency Switched-Mode Power Converters | IEEE eBooks | IEEE Xplore
eResources addresses	

Example issues/ example questions/ tasks being completed

Draw the schematic of the power section of a grid-connected converter with a two-level four-leg inverter. Draw the schematic of the power section of a three-level inverter with clamping diodes. Draw the schematic of the power section of a matrix converter with three inputs and five outputs. Draw and describe the block diagram of grid converter control in the dq reference frame using PI controllers. Provide the formula for the maximum amplitude of voltage generated by a 6-switch inverter with a DC-link voltage. Explain the concepts of power invariance and amplitude invariance. Describe the operating principle of any phase-locked loop (PLL) synchronization system. Describe the practical implementation of DFT and FFT algorithms in DSP processors and provide differences, advantages, and disadvantages. Provide algorithms for extracting quadrature signals from sinusoidal waveforms. Provide the formula for power transfer in a phase-shift controlled DC/DC converter.

Practical activites within the subject

Not applicable

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