GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Power Electronics Systems, PG_00050045						
Field of study	Electrical Engineering						
Date of commencement of studies	October 2022		Academic year of realisation of subject	2022/2023			
Education level	second-cycle studies		Subject group				
Mode of study	Part-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	Zakład Przekształtników i Magazynowania Energii -> Department of Power Electronics and Electrical Machines -> Faculty of Electrical and Control Engineering						
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Wojciech Śleszyński					
	Teachers	dr inż. Wojciech Śleszyński					
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	20.0	0.0	20.0	0.0	0.0	40
	E-learning hours included: 0.0						
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	40		4.0	31.0	75	
Subject objectives	*Objectives of this course is a introduce to advanced power electronic systems, design principles and methods of their control in different application areas.*						

Learning outcomes

Course outcome	Subject outcome	Method of verification
K7_U06	Student is able to analyze, model and simulate electrical systems with power electronic converters, using standard cyber-physical simulation software packages	[SU1] Assessment of task fulfilment [SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools
K7_W10	Student knows the principles of operation, design and control of selected modern topologies of power electronic converters. Describes construction and operation of converters - differentiates system topology aspects and application control methods	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects
K7_W13	The student is able to conduct a qualitative analysis of power electronic converters in terms of power conversion quality, efficiency, electromagnetic compatibility and reliability	[SW2] Assessment of knowledge contained in presentation [SW1] Assessment of factual knowledge
K7_K02	Student is able to evaluate the possibilities and effects of using power electronic devices in environmental and social aspects	[SK4] Assessment of communication skills, including language correctness [SK5] Assessment of ability to solve problems that arise in practice
K7_K03	Student is able to cooperate and organize group activities in the realization of problematic tasks	[SK3] Assessment of ability to organize work [SK4] Assessment of communication skills, including language correctness [SK1] Assessment of group work skills [SK2] Assessment of progress of work
K7_U02	Student analyzes the results and selects, evaluates and presents the most important results of realized tasks in the area concerning power electronics systems	[SU1] Assessment of task fulfilment [SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject [SU5] Assessment of ability to present the results of task
K7_U07	Student is able to analyze, calculate, design, program and test power electronic systems and their control systems	[SU1] Assessment of task fulfilment [SU2] Assessment of ability to analyse information [SU4] Assessment of ability to use methods and tools
K7_W04	Student knows and understands the possibilities and characteristics of application of power electronic converters in various electromechanical devices	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects
K7_W13	The student is able to conduct a qualitative analysis of power electronic converters in terms of power conversion quality, efficiency, electromagnetic compatibility and reliability	[SW1] Assessment of factual knowledge [SW2] Assessment of knowledge contained in presentation

Subject contents	***LECTURE**: Analytical Basics of Power Electronics Systems: General Direct Converter Model, Coordinate Transformation, Spectral Analysis and Power Theory in Power Electronic Systems. Modern PE semiconductor devices (including SiC and GaN switches). Element Modulation Pulse Techniques: Scalar and vector control, Current regulation methods. Multilevel and other Special Converters: Multilevel Inverter Topologies, Multilevel Inverter Modulation Methods, Rectifiers for Multilevel Inverter, other Special Converters; PE Smart Transformers: DAB Topology, Control, Applications. Power Electronics Arrangements in EE Network: Power Conditioning Problems, Arrangements for Mitigation of Power Disturbances, Active PQ Controllers, Hybrid Arrangement of PQ Controllers. Predictive Control of the PE Systems: Hysteresis Based Predictive Control, Model Based Predictive Control. Soft Switching and Resonant Converter : Principle, Overview* ***LABORATORY:** Introduction to Matlab simulation tools: the S-function and Simscape Electrical software which operates in the Simulink environment. Implementation of the control system of PWM rectifier in simulation environment and converter operation analysis. Implementation and commissioning of the PWM rectifier control algorithm in a laboratory workbench consisting of a controller unit with the TMS320F28379D microcontroller and a three-phase voltage inverter based on GaN transistors. Simulation and laboratory tests of the system, comparison of results, final report with conclusions*
Prerequisites and co-requisites	*Basic knowledge in the field: Electrical engineering, electronics, circuit theory, automation, power electronics in accordance with the subject programs for the first degree studies. Additionally, it is desirable to complete the course Electrical Circuits conducted on the II degree studies.*

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Lecture	60.0%	60.0%
Laboratory practice	50.0%	40.0%

Recommended reading

Basic literature

1. Nowak M., Barlik R. Poradnik inżyniera energoelektronika. Tom1 Wydawnictwo WNT, Warszawa 2014, wyd. II , 400 pp.
2. Nowak M., Barlik R, Rąbkowski J. Poradnik inżyniera energo-elektronika. Tom 2, Wyd.WNT, Warszawa 2015, wyd.II 523 s
3. Akagi H., Watanabe E., H., Aredes M., Instantaneous Power Theory and Applications to Power Conditioning. J.Willy&Sons Inc Pub. - IEEE Press, New Jersey, 2007, 379 pp
4. Strzelecki R., Supronowicz H., Współczynnik mocy w systemach zasilania prądu przemiennego i metody jego poprawy: Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2000, 452 pp.
5. Rodriguez J. (Author), Cortes P., Predictive Control of Power Converters and Electrical Drives . Wiley IEEE Series 41, New Jersey, 246 pp.212

Supplementary literature

1. Ericson R.W., Maksimovic D., Fundamentals of Power Electronics: Springer; 3rd ed., London, 2020, 1075p.
2. Hartman M.: Wielopoziomowe falowniki napięcia, Akademia Morska w Gdyni, Gdynia,2006, 144 pp
3. Wu B., Narimani M., High-Power Converters and AC Drives (2nd Edition): Wiley-IEEE Press, New York, 2017, 480 pp
4. M. Kazmierkowski, R. Krishnan, and F. Blaabjerg, Control in Power Electronics Selected Problems. Academic Press, 2002
5. Du S., Dekka A., Wu B., Zargari N., Modular Multilevel Converters: Analysis, Control, and Applications: Wiley-IEEE Press, New York, 2018, 368 pp.
6. Piróg S., Energoelektronika. Układy o komutacji sieciowej i o komutacji twardej: Uczelniane Wydawnictwa Naukowo-Dydaktyczne, Kraków, 2006, 1011p
7. Strzelecki R., Supronowicz H.: Filtracja harmonicznych w sieciach zasilających prądu przemiennego. Wyd. Adam Marszałek, Toruń 1999.
8. R. Strzelecki, G. Benysek (Eds.) Power electronics in smart electrical energy networks. Springer-Verlag 2008.
9. Du S., Dekka A., Wu B., Zargari N., Modular Multilevel Converters: Analysis, Control, and Applications: Wiley-IEEE Press, New York, 2018, 368 pp.
10. 10.Geyer T., Model Predictive Control of High Power Converters and Industrial Drives , Wiley, 2016, 576 pp.
11. 11.Liu F., Abu-Rub H., Ge B., Blaabjerg B., Ellabban O., Loh P. Ch., Impedance Source Power Electronic Converters, Wiley-IEEE Press, New York, 424 p.
12. 12.D. G. Holmes and T. Lipo, Pulse Width Modulation for Power Converters, Principles and Practice. New York: IEEE Press, 2003.
13. Du S., Dekka A., Wu B., Zargari N., Modular Multilevel Converters: Analysis, Control, and Applications: Wiley-IEEE Press, New York, 2018, 368 pp

eResources addresses

Adresy na platformie eNauczanie:

UKŁADY ENERGOELEKTRONICZNE [Niestacjonarne][2022/23] - Moodle ID: 28632
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=28632

Example issues/ example questions/ tasks being completed	*1.Properties of modern commercial power electronic devices, including SiC and GaN.* *2. Basic topologies and features of multi-level converters and their typical applications in the power engineering and high power drive industry.* *3. Properties, construction and application of soft-switched converters.* *4. Start up the uP controller of the AFE rectifier based on a commercial 3-phase inverter module with GaN transistors*
Work placement	Not applicable