



## Subject card

Subject name and code	, PG_00053422						
Field of study	Automation, Robotics and Control Systems						
Date of commencement of studies	October 2020	Academic year of realisation of subject			2023/2024		
Education level	first-cycle studies	Subject group					
Mode of study	Full-time studies	Mode of delivery			at the university		
Year of study	4	Language of instruction			Polish		
Semester of study	7	ECTS credits			3.0		
Learning profile	general academic profile	Assessment form			assessment		
Conducting unit	Department of Controlled Electric Drives -> Faculty of Electrical and Control Engineering						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Marek Adamowicz				
	Teachers						
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	15.0	0.0	0.0	30
	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	30		5.0		40.0	75
Subject objectives	The aim of the course is to provide knowledge in the field of designing electric drive systems with adjustable speed electrical drives and power electronic voltage converters. Provide basic knowledge on calculations and methods of selecting the basic elements of drive systems: electric motor, gear and inverter, methods of selecting the basic components of the inverter: IGBT power module, diode rectifier, heat sink, DC link capacitor, motor filter and line filter. Presentation and discussion of life cycle issues, energy efficiency and energy quality in drive systems.						
Learning outcomes	Course outcome	Subject outcome			Method of verification		
	[K6_U03] can prepare and present a presentation on the problems and results of an engineering task	The student prepares and delivers a presentation regarding the issues and results of the completed engineering task.			[SU5] Assessment of ability to present the results of task		
	[K6_U01] can obtain information from literature, databases and other sources; integrate the information obtained, interpret it and draw conclusions, formulate and justify opinions	The student is able to use catalog data of power electronic components and understands the significance of basic parameters. They can utilize available simulation programs for confirming analyses and theoretical considerations.			[SU4] Assessment of ability to use methods and tools		
	[K6_W10] has basic knowledge related to mechatronics and robotics systems	The student possesses knowledge in the field of construction, design, and construction of mechatronics and robotics systems.			[SW3] Assessment of knowledge contained in written work and projects		
	[K6_W06] knows the structure of computers and microprocessors and the tasks of operating systems, has basic knowledge of the basics of computer software, drivers, microprocessor technology, design of simple algorithms and the operation of information networks	The student has knowledge in the field of designing and analyzing digital control systems for electric drives and power electronic converters			[SW3] Assessment of knowledge contained in written work and projects		

Subject contents	<p>Lecture: 1) Calculations of drive systems - introduction. 2) Selection of electric motors for industrial drives, incl. fans, conveyor belts, cranes, etc. 3) Designing special propulsion systems: electric cars and electric bicycles, electric boats and electric planes. 4) Selection of auxiliary elements: clutches, brakes, speed sensors, torque sensors. 5) Energy-saving hybrid construction crane driving system. 6) Electric-combustion drives for power backup generators. 7) Selection of a mechanical transmission. 8) Selection of regulator settings in electric drive automatics systems.</p> <p>Laboratory: 1) Selection and analysis of fan drive system components, incl. using the Motor System Tool and Drivesize environment. 2) Selection and thermal analysis as well as loss analysis of the IGBT transistor module, diode bridge and heat sink, incl. using the IPOSIM environment. 3) Selection and analysis of DC intermediate circuit components: capacitor, braking resistor and pre-charge circuit. 4) Designing inverter filters. Design and analysis of the line filter and engine filter using the FEMM environment. 6) Analysis of the designed drive system in terms of energy quality. Simulation tests of the designed drive system using the LTSpice environment.</p>											
Prerequisites and co-requisites	Knowledge of the subjects of electric machines, basics of automatics, power electronics.											
Assessment methods and criteria	<table border="1" data-bbox="448 456 1493 562"> <thead> <tr> <th data-bbox="448 456 794 490">Subject passing criteria</th> <th data-bbox="794 456 1141 490">Passing threshold</th> <th data-bbox="1141 456 1493 490">Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td data-bbox="448 490 794 524">Test</td> <td data-bbox="794 490 1141 524">60.0%</td> <td data-bbox="1141 490 1493 524">50.0%</td> </tr> <tr> <td data-bbox="448 524 794 562">Laboratory</td> <td data-bbox="794 524 1141 562">60.0%</td> <td data-bbox="1141 524 1493 562">50.0%</td> </tr> </tbody> </table>			Subject passing criteria	Passing threshold	Percentage of the final grade	Test	60.0%	50.0%	Laboratory	60.0%	50.0%
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Test	60.0%	50.0%										
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Recommended reading	<p>Basic literature</p>	<p>[1] NOWAK M., BARLIK R., OLEKSIK L., Poradnik inżyniera energoelektronika. Wydawnictwa Naukowo-Techniczne, Warszawa 2014.</p> <p>[2] Allen Bradley Drives Engineering Handbook. Rockwell Automation. E-book PDF.</p> <p>[3] Volke a., Hornkamp M., IGBT Modules. Technologies, Driver and Application. Infineon Technologies AG, Munich 2012. <a href="http://www.infineon.com">www.infineon.com</a></p> <p>[4] TUNIA H., KAŻMIERKOWSKI M. P., Automatyka napędu przekształtnikowego. Państwowe Wydawnictwo Naukowe, Warszawa 1987.</p> <p>[5] Grunwald Z., Napęd Elektryczny, WNT, Warszawa 1987.</p> <p>[6] PIRÓG S., Energoelektronika: Układy o komutacji sieciowej i o komutacji twardej. AGH. Uczelniane Wydawnictwa Naukowo-Dydaktyczne, 2006.</p> <p>[7] Sieklucki G., Bisztyga B., Zdrojewski A., Orzechowski T., Sykulski R., Modele i zasady sterowania napędami elektrycznymi. Wydawnictwa AGH, Kraków 2014.</p> <p>[8] KRYKOWSKI K., Energoelektronika. Wydawnictwo Politechniki Śląskiej, 2007.</p>										
	<p>Supplementary literature</p>	<p>[1] AN2011-05 Industrial IGBT Modules. Explanation of Technical Information. Application Note PDF. Infineon 2015. <a href="http://www.infineon.com">www.infineon.com</a></p> <p>[2] AND9140/D Thermal Calculations for IGBTs. Application Note PDF. ON Semiconductor 2014. <a href="http://onsemi.com">http://onsemi.com</a></p> <p>[3] Output Filters Design Guide. E-book PDF. Danfoss 2011. <a href="http://www.danfoss.com/drives">www.danfoss.com/drives</a></p> <p>[4] LC Sine Wave Filter for Motor Drives. Application Note PDF. Schaffner Group 2018. <a href="http://www.schaffner.com">www.schaffner.com</a></p> <p>[5] FUJI IGBT MODULES APPLICATION MANUAL. Ebook PDF. Fuji Electric Device Technology 2004. <a href="http://www.fujielectric.com">www.fujielectric.com</a></p> <p>[6] Dimensioning program IPOSIM for loss and thermal calculation of Infineon IGBT modules. Application Note PDF. <a href="http://www.infineon.com">www.infineon.com</a></p>										
	<p>eResources addresses</p>	<p>Adresy na platformie eNauczanie:</p>										
Example issues/ example questions/ tasks being completed	<ol style="list-style-type: none"> <li>1. Analysis of fan characteristics, selection of components and analysis of fan drive operation</li> <li>2. Selection, thermal calculations and loss analysis of the IGBT power module</li> <li>3. Selection, thermal calculations and loss analysis of the diode bridge and the IGBT chopper circuit</li> <li>4. Design and analysis of the motor filter and mains filter operation</li> <li>5. Analysis and simulation tests of the impact of the designed drive system on the power supply network</li> </ol>											
Work placement	Not applicable											