GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	DRIVES SUPPLIED BY POWER CONVERTERS II, PG_00022579		
Field of study	Electrical Engineering		
Date of commencement of studies	October 2022	Academic year of realisation of subject	2023/2024
Education level	second-cycle studies	Subject group	Optional subject group Subject group related to scientific research in the field of study
Mode of study	Part-time studies	Mode of delivery	at the university
Year of study	2	Language of instruction	Polish
Semester of study	3	ECTS credits	2.0
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	prof. dr hab. inż. Jarosław Guziński	
	Teachers	dr inż. Marcin Drzewiecki	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	10.0	0.0	10.0	0.0	0.0	20

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	20	4.0	26.0	50

Subject objectives

The aim of the course is to get knowledge on advanced topics in the field of electrical drives operating with power electronics converters.

Learning outcomes

Course outcome	Subject outcome	Method of verification
K7_W13	Has in-depth knowledge of modern electric drives	[SW1] Assessment of factual knowledge
K7_U07	Student can design a converter drive system of a squirrel-cage induction motor with the use of LC filter	[SU1] Assessment of task fulfilment

Subject contents

Lecture

Introduction to advanced topics of electrical drives with converter type supply. Simulation models of induction machines and permanent magnet synchronous (PMSM). Power electronic converters in electric drives systems: classification, pulse width modulation, three-phase voltage inverter, multilevel inverters, Z inverters, quasi-Z inverters, the dead time. Current source PWM inverters. Field oriented control (FOC) of induction motors. PMSM motor control. The direct torque control (DTC) of induction machines: base structure, modifications. DTC control of PMSM. Nonlinear control of induction machines. Electric drives with multi-phase machines (> 3 phase). Sensorless control. Selected topics on electric drives with voltage inverter output filters. Electric drives with medium voltage and high power machines. The use of new semiconductor materials in converter drive systems: silicon carbide SiC, gallium arsenide GaAs.

Laboratory

1. Circuit models of electrical machines.
2. Power electronics converters and control methods.
3. Electric drives with induction motor, inverter ond output filter (Control methods V/f and FOC).
4. Electric drive with induction motor, inverter ond output filter (Control method DTC-SVM).
5. Investigations of effects related to leakage currents and inverter output voltage filtering.
6. Investigations of matrix converter with output voltage and input power factor control.
7. Transistorized current source inverter with PWM.

Prerequisites and co-requisites

General knowledge on electrical machines, power converters and electric drives based on the field of Elekctrical Machines, Power Electronics and Electric Drives courses for I cycle engineering studies. Additionality is advisable to complete course Electric Drives with Power Electronics Supply I for II cycle of engineering studies.

<table>
<tr><td>Assessment methods and criteria</td><td colspan="2"><table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Project</td><td>60.0%</td><td>35.0%</td></tr>
<tr><td>Practical exercises at laboratory</td><td>60.0%</td><td>25.0%</td></tr>
<tr><td>Midterm exams</td><td>60.0%</td><td>40.0%</td></tr>
</table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>1. Lecturer teaching materials accesed on web page.
2. Abu-Rub H., Iqbal A., Guzinski J.: High Performance Control of AC Drives with MATLAB/Simulink Models. Wiley, United Kingdom 2012.</td></tr>
<tr><td>Supplementary literature</td><td>1. Zawirski K., Deskur J., Kaczmarek T.: Automatyka napędu elektrycznego. Wyd. Politechniki Poznańskiej, Poznań 2012.
2. Nowak M., Barlik R.: Poradnik inżyniera - energoelektronika. WNT, Warszawa 1998.
3. Guzinski J.: Układy napędowe z silnikami indukcyjnymi i filtrami wyjściowymi falowników napięcia - zagadnienia wybrane. Wydawnictwo Politechniki Gdańskiej, Gdańsk 2011.
4. Drury B.: Control Techniques Drives and Controls Handbook. The Institution of Electrical Engineering. London 2001.
5. Wu B.: High-Power Converters and AC Drives. John Wiley & Sons 2006.</td></tr>
<tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:
NAPĘDY O ZASILANIU PRZEKSZTAŁTNIKOWYM II [Niestacjonarne] [2023/24] - Moodle ID: 32284
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=32284</td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="2">1. Multilevel converters: structure, principle of operation, the output voltage waveform.
2. High power and medium voltage drives: problems, requirements, application, the topologies.
3. Semiconductor switches in medium voltage drive systems.
4. Commercial converter topologies for medium voltage.
5. Problems in the medium voltage drive systems.
6. Problems in the electric drives with converter power supply.
7. Bearing currents: the causes and mechanism of occurrence.
8. Elimination of bearing currents.
9. Wave reflections in the electric drives with inverters and long cable connection: the mechanism of the phenomenon, effects, elimination.
10. Common mode choke: structure, purpose and method of use.
11. Sinusoidal-wave filter: the purpose of the application, the topology, the method of elements selection.
12. Construction of electric machines for limiting the bearing currents.
13. Installation requirements for reduction of bearing currents.
14. Shaft grounding rings: structure, purpose and method of use.
15. Bearing currents reduction by changes in pulse width modulation algorithms.
16. Multi-phase drives: advantages, purpose of use, topologies.</td></tr>
<tr><td>Work placement</td><td colspan="2">Not applicable</td></tr>
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