GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

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|---|---|---|---|
| Subject name and code | , PG_00053422 | | |
| Field of study | Automation, Robotics and Control Systems | | |
| Date of commencement of studies | October 2023 | Academic year of realisation of subject | 2026/2027 |
| 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 Electric Drives and Energy Conversion -> Faculty of Electrical and Control Engineering -> Faculties of Gdańsk University of Technology | | |
| Name and surname of lecturer (lecturers) | Subject supervisor | dr hab. inż. Marek Adamowicz | |
| | Teachers | | |

**Lesson types**

| 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 the student with knowledge on the design of drive systems and converter systems. The student will learn the principles of design, calculation methods and methods for selecting basic drive system components: motor, gear and inverter, as well as the principles of design, calculation methods and methods for selecting basic inverter components: transistor module and diode rectifier, radiator, DC link capacitor, motor filter and network filter. In addition, the student will learn the skills of presenting and discussing energy efficiency and energy quality issues in drive systems.

**Learning outcomes**

| Course outcome | Subject outcome | Method of verification |
|---|---|---|
| [K6_W10] has basic knowledge related to mechatronics and robotics systems | Student defines the electrical drive system as a set of electro-mechanical and electronic-informatic subsystems. Defines its tasks. | [SW3] Assessment of knowledge contained in written work and projects<br>[SW1] Assessment of factual knowledge |
| [K6_U01] can obtain information from literature, databases and other sources; integrate the information obtained, interpret it and draw conclusions, formulate and justify opinions | Student reads technical literature, reviews databases and updates knowledge of changing standards and emerging new technical solutions in the design and construction of converter systems and drive systems. | [SU2] Assessment of ability to analyse information |
| [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 | Student designs simple algorithms for the control and communication of converter systems and drive systems. | [SW3] Assessment of knowledge contained in written work and projects |
| [K6_U03] can prepare and present a presentation on the problems and results of an engineering task | The student has the ability to write a scientific text and publicly present research results using multimedia techniques. | [SU4] Assessment of ability to use methods and tools |

<table>
<tr><td>Subject contents</td><td>Course content – lecture<br>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.<br>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.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>Knowledge of the subjects of electric machines, basics of automatics, power electronics.</td></tr>
<tr><td>Assessment methods and criteria</td><td>
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<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Laboratory</td><td>60.0%</td><td>50.0%</td></tr>
<tr><td>Test</td><td>60.0%</td><td>50.0%</td></tr>
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<tr><td>Recommended reading</td><td>
<table>
<tr><td>Basic literature</td><td>[1] NOWAK M., BARLIK R., OLEKSIAK L., Poradnik inżyniera energoelektronika. Wydawnictwa Naukowo-Techniczne, Warszawa 2014.<br>[2] Allen Bradley Drives Engineering Handbook. Rockwell Automation. E-book PDF.<br>[3] Volke a., Hornkamp M., IGBT Modules. Technologies, Driver and Application. Infineon Technologies AG, Munich 2012. www.infineon.com<br>[4] TUNIA H., KAŹMIERKOWSKI M. P., Automatyka napędu przekształtnikowego. Panstwowe Wydawnictwo Naukowe, Warszawa 1987.<br>[5] Grunwald Z., Napęd Elektryczny, WNT, Warszawa1987.<br>[6] PIRÓG S., Energoelektronika: Układy o komutacji sieciowej i o komutacji twardej. AGH. Uczelniane Wydawnictwa Naukowo-Dydaktyczne, 2006.<br>[7] Sieklucki G., Bisztyga B., Zdrojewski A., Orzechowski T., Sykulski R., Modele i zasady sterowania napędami elektrycznymi. Wydawnictwa AGH, Kraków 2014.<br>[8] KRYKOWSKI K., Energoelektronika. Wydawnictwo Politechniki Śląskiej, 2007.</td></tr>
<tr><td>Supplementary literature</td><td>[1] AN2011-05 Industrial IGBT Modules. Explanation of Technical Information. Application Note PDF. Infineon 2015. www.infineon.com<br>[2] AND9140/D Thermal Calculations for[1]IGBTs. Application Note PDF. ON Semiconductor 2014. http://onsemi.com<br>[3] Output Filters Design Guide. E-book PDF. Danfoss 2011. www.danfoss.com/drives<br>[4] LC Sine Wave Filter for Motor Drives. Application Note PDF. Schaffner Group 2018. www.schaffner.com<br>[5] FUJI IGBT MODULES APPLICATION MANUAL. Ebook PDF. Fuji Electric Device Technology 2004. www.fujielectric.com<br>[6] Dimensioning program IPOSIM for loss and thermal calculation of Infineon IGBT modules. Application Note PDF. www.infineon.com</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
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<tr><td>Example issues/ example questions/ tasks being completed</td><td>1. Analysis of fan characteristics, selection of components and analysis of fan drive operation<br>2. Selection, thermal calculations and loss analysis of the IGBT power module<br>3. Selection, thermal calculations and loss analysis of the diode bridge and the IGBT chopper circuit<br>4. Design and analysis of the motor filter and mains filter operation<br>5. Analysis and simulation tests of the impact of the designed drive system on the power supply network</td></tr>
<tr><td>Practical activites within the subject</td><td>Not applicable</td></tr>
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