FACULTY OF ELECTRICAL ENGINEERING

# SUBJECT CARD

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|---|---|
| Name in Polish: | **Energoelektronika w automatyce przemysłowej** |
| Name in English: | **Power electronics in industry automation** |
| Main field of study (if applicable): | **Industrial Control Engineering** |
| Specialization (if applicable): | **Automation of Machines, Vehicles and Apparatus** |
| Level and form of studies: | **2nd level, full-time** |
| Kind of subject: | **obligatory** |
| Subject code: | **APR013224** |
| Group of courses: | **NO** |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU): | 30 | | 15 | | |
| Number of hours of total student workload (CNPS): | 90 | | 30 | | |
| Form of crediting: | examination | | crediting with grade | | |
| For group of courses mark (X) final course: | | | | | |
| Number of ECTS points: | 3 | | 1 | | |
| including number of ECTS points for practical (P) classes : | | | 1 | | |
| including number of ECTS points for direct teacher-student contact (BK) classes: | 2.10 | | 0.70 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. It has a basic knowledge of the principles of operation of electronic systems and power electronics.
2. It has a basic knowledge of automatic control systems.
3. It has a basic knowledge of machinery, equipment and electric drives.
4. It can effectively apply knowledge of electrical circuit theory to solve problems.
5. It can obtain information from the literature, catalogs, databases, and other sources of industrial electronic systems.

## SUBJECT OBJECTIVES

C1. To provide students with a basic knowledge of the specific work of electrical power converters in industrial automation system.

C2. To provide students with the basic characteristics of the converters working with machinery and electrical equipment.

C3. The acquisition of practical knowledge of construction measurement systems to determine the characteristics of the real converter systems.

## SUBJECT LEARNING OUTCOMES

*relating to knowledge:*

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| PEU_W01 | Has knowledge of the use of power converters as power components in systems of automatic control of industrial equipment. |
| PEU_W02 | Has knowledge on how to control the output parameters of power converters. |
| PEU_W03 | Knows the basic conditions for co-operation of electrical machinery and electrical equipment with power electronic converters. |

*relating to skills:*

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|---|---|
| PEU_U01 | Able to organize the study of industrial electronic systems. |
| PEU_U02 | It can determine the basic characteristics of the power converters working as part of the control system. |
| PEU_U03 | It can present the results in numerical and graphical form and to interpret them. He can draw conclusions from the measurements. |

*relating to social competences:*

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|---|---|
| PEU_K01 | He knows the rules of group work and managing a small team taking responsibility for the results of his work. |

| PROGRAMME CONTENT | | |
|---|---|---|
| **Form of classes - lecture** | | **Number of hours:** |
| Lec 1 | Mathematical models of controlled rectifiers and control systems for the rectifiers. | 2 |
| Lec 2 | Controls output parameters of rectifiers. Adaptive regulators. | 2 |
| Lec 3 | Controlled Rectifiers for DC electrical drive systems. | 2 |
| Lec 4 | Controlled rectifier for welding machines. Controlled Rectifiers in DC power transmission. | 2 |
| Lec 5 | AC thyristor controllers in systems for soft start induction motors. | 2 |
| Lec 6 | DC-DC switching power converters. Mathematical models. | 2 |
| Lec 7 | Controls of DC converters. Control of output parameters of converters. | 2 |
| Lec 8 | DC converters for drive systems of vehicles. | 2 |
| Lec 9 | Voltage source inverters. Mathematical models. | 2 |
| Lec 10 | PWM control of output voltage for voltage inverters. | 2 |
| Lec 11 | The use of voltage inverters for electrical drives. | 2 |
| Lec 12 | Resonant inverters. Basic mathematical models. Industrial applications of resonant inverters. | 2 |
| Lec 13 | The use of inverters for active filters and active rectifiers | 2 |
| Lec 14 | Control of current source inverters. Mathematical models. | 2 |
| Lec 15 | Simulation programs for analysis operation converters. | 2 |
| | Total hours: | **30** |

| **Form of classes - laboratory** | | **Number of hours:** |
|---|---|---|
| Lab 1 | Getting Acquainted with the positions of the laboratory. Principles of measurements. | 2 |
| Lab 2 | Research single phase cycloconverter. | 2 |
| Lab 3 | Research single phase AC controller with integration control. | 2 |
| Lab 4 | Test of forward converter. | 2 |
| Lab 5 | The testing of the STATCOM | 2 |
| Lab 6 | Research of DC converter. | 2 |
| Lab 7 | Examination of the AC-DC power supply converter with resonant inverter. | 2 |
| Lab 8 | Crediting with grade. | 1 |
| | Total hours: | **15** |

| **TEACHING TOOLS USED** |
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| N1. N1. Lectures using multimedia techniques. |
| N2. N2. Laboratory test performed on specialized research positions in groups. |
| N3. N3. Consultation. |
| N4. N4. Own work, individual preparation for classes. |

| **EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT** | | |
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| **Evaluation**<br>*F – forming (during semester)*<br>*P – concluding (at semester end)* | **Educational effect number** | **Way of evaluating educational effect achievement** |
| F1(W) | PEU_W01<br>PEU_W02<br>PEU_W03 | Written exam |
| F2(W) | PEU_W01<br>PEU_W02<br>PEU_W03 | Oral exam |
| P(W) | p=0,4*F1+0,6*F2 | |
| F1(L) | PEU_U01<br>PEU_U02<br>PEU_U03<br>PEU_K01 | Evaluation of preparation for laboratory |
| F2(L) | PEU_U01<br>PEU_U02<br>PEU_U03<br>PEU_K01 | Activity during laboratory classes. |
| F3(L) | PEU_U01<br>PEU_U02<br>PEU_U03<br>PEU_K01 | Evaluation reports for conducted laboratory measurements. |
| P(L) | P=0,25*F1+0,25*F2+0,5*F3 | |

## PRIMARY AND SECONDARY LITERATURE

**PRIMARY LITERATURE:**


[1] Tunia H., Winiarski B.: Energoelektronika. Warszawa WNT 1994.
[2] Januszewski S., Świątek H., Zymmer K.: Półprzewodnikowe przyrządy mocy. Warszawa WKŁ 1999.
[3] Kaźmierkowski M.P. ,Matysik J.T.: Wprowadzenie do elektroniki i energoelektroniki. WPW., Warszawa 2005.
[4] Piróg S.: Energoelektronika. Układy o komutacji sieciowej i twardej. Wydawnictwo AGH. Kraków 2006.
[5] Muhammad Raschid.: Power Electronics Handbook, Third Edition, Butterworth-Heinemann, 2011.
[6] Rozanov Y.,Ryvkin S., Chaplygin E.,Voronin P.,: Power Electronics Basics: Operating Principles, Design, Formulas, and Applications, CRC Press 2015.
[7] Ned Mohan: Power Electronics: A First Course, Wley 2011


**SECONDARY LITERATURE:**


[1] Barlik R., Nowak M.:Poradnik inżyniera energoelektronika. WNT, Warszawa 2013.
[2] Strzelecki R., Supronowicz H.: Współczynnik mocy w systemach zasilania prądu przemiennego i metody jego poprawy. Oficyna Wydawnicza Politechniki Warszawskiej. Warszawa 2000.
[3] Mikołajuk K.: Podstawy analizy obwodów energoelektronicznych. Warszawa, PWN 1998.
[4] Branko L. Dokic: Power Electronics: Converters and Regulators, Springer, 2015.
[5] Adrian Ioinovici: Power Electronics and Energy Conversion Systems: Fundamentals and Hard-switching Converters, Volume 1, Wiley 2013.


## SUBJECT SUPERVISOR


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