

FACULTY OF ELECTRICAL
ENGINEERING**SUBJECT CARD**

Name in Polish: **Energoelektronika w automatyce przemysłowej**
 Name in English: **Power electronics in industry automation**
 Main field of study (if applicable): **Control Engineering and Robotics**
 Specialization (if applicable): **Automation of Machines, Vehicles and Apparatus**
 Level and form of studies: **2nd level, full-time**
 Kind of subject: **obligatory**
 Subject code: **ARR043224**
 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 EDUCATIONAL EFFECTS*relating to knowledge:*

- PEK_W01 Has knowledge of the use of power converters as power components in systems of automatic control of industrial equipment.
- PEK_W02 Has knowledge on how to control the output parameters of power converters.
- PEK_W03 Knows the basic conditions for co-operation of electrical machinery and electrical equipment with power electronic converters.

relating to skills:

- PEK_U01 Able to organize the study of industrial electronic systems.
- PEK_U02 It can determine the basic characteristics of the power converters working as part of the control system.
- PEK_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:

- PEK_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 | Research single- phase inverter with DC circuit with closed-loop control | 2 |
| Lab 8 | Crediting with grade. | 1 |
| Total hours: | | 15 |

TEACHING TOOLS USED

- 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 EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation <i>F - forming (during semester) P - concluding (at semester end)</i> | Educational effect number | Way of evaluating educational effect achievement |
|---|--|---|
| F1(w) | PEK_W01 PEK_W02 PEK_W03 | Written exam |
| F2(w) | PEK_W01 PEK_W02 PEK_W03 | Oral exam |
| P(w) | $p=0,4 \cdot F1 + 0,6 \cdot F2$ | |
| F1(L) | PEK_U01 PEK_U02 PEK_U03 PEK_K01 | Evaluation of preparation for laboratory |
| F2(L) | PEK_U01 PEK_U02 PEK_U03 PEK_K01 | Activity during laboratory classes. |
| F3(L) | PEK_U01 PEK_U02 PEK_U03 PEK_K01 | Evaluation reports for conducted laboratory measurements. |
| P(L) | $P=0,25 \cdot F1 + 0,25 \cdot F2 + 0,5 \cdot F3$ | |

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, Wiley 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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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT ARR043224 - Power electronics in industry automation AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY Control Engineering and Robotics AND SPECIALIZATION Automation of Machines, Vehicles and Apparatus

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable) | Subject objectives | Programme content | Teaching tool number |
|----------------------------|---|--------------------|--|--------------------------|
| PEK_W01 | S2AMPU_W10 | C.1 C.2 | Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 | N.1 N.3 N.4 |
| PEK_W02 | S2AMPU_W10 | C.1 C.2 | Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 | N.1 N.3 N.4 |
| PEK_W03 | S2AMPU_W10 | C.1 C.2 | Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14 Lec15 | N.1 N.3 N.4 |
| PEK_U01 | S2AMPU_U09 | C.2 C.3 | Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 | N.2 N.3 N.4 |
| PEK_U02 | S2AMPU_U09 | C.2 C.3 | Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 | N.2 N.3 N.4 |
| PEK_U03 | S2AMPU_U09 | C.1 C.2 | Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8 | N.2 N.3 N.4 |
| PEK_K01 | K2AiR_K06 | C.1 C.2 C.3 | Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8 | N.1 N.2 N.3 N.4 |