

FACULTY OF ELECTRICAL
ENGINEERING**SUBJECT CARD**

Name in Polish: **Sterowanie przekształtników statycznych**
 Name in English: **Control of static converters**
 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: **optional**
 Subject code: **ARR043228**
 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):	60		30		
Form of crediting:	examination		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	2		1		
including number of ECTS points for practical (P) classes :			1		
including number of ECTS points for direct teacher-student contact (BK) classes:	1.40		0.70		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. It has a knowledge of analysis and synthesis of linear and nonlinear circuits.
2. It has a knowledge of design and operation of of electronic devices and circuits, and basics power electronics.
3. It has a knowledge of electrical machines and electromechanical drive systems.
4. It has a knowledge of automatic control systems.
5. Can apply knowledge in the field of electrical circuit theory to analyze transients in linear and nonlinear circuits.
6. Can apply knowledge of control theory to the analysis and synthesis of control systems.
7. He understands the need for continuing education and professional skills development.

SUBJECT OBJECTIVES

- C1. To provide students with the principles of non-linear control, pulse, closed systems of automatic control.
 C2. To provide students with the mathematical models and the way of job analysis converters.
 C3. To provide students with the principle of operation of control systems and control of power converters.

SUBJECT EDUCATIONAL EFFECTS*relating to knowledge:*

- PEK_W01 It has a knowledge of the control of power semiconductor devices.
 PEK_W02 It has a knowledge in the field of power electronics systems.
 PEK_W03 He knows the methods of mathematical description of converter systems.

relating to skills:

- PEK_U01 Able to organize research on industrial power electronic converters.
 PEK_U02 It can determine the characteristics of the power converters operating as elements 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 can think and act in a creative and enterprising.

PROGRAMME CONTENT

Form of classes - lecture		Number of hours:
Lec 1	Power Semiconductor Devices. Basic gate control.	2
Lec 2	Multi-phase thyristor rectifier. Control of the output voltage.	2
Lec 3	Control the output current rectifiers. Adaptive regulators.	2
Lec 4	Control of DC - DC converters.	2
Lec 5	One, two and four quadrant switching converters.	2
Lec 6	Phase controlled three phase AC voltage controllers.	2
Lec 7	Control of voltage inverters	2
Lec 8	Multilevel inverters.	2
Lec 9	Pulse-width-modulated (PWM).	2
Lec 10	Vector control of inverters.	2
Lec 11	Closed loop operation of inverters.	2
Lec 12	Controls of current source inverters.	2
Lec 13	Control of three-phase active rectifier.	2
Lec 14	Control converters mains of variable frequency.	2
Lec 15	Mathematical modeling of power converters.	2
Total hours:		30

Form of classes - laboratory		Number of hours:
Lab 1	Introduction to the lab program.	2
Lab 2	The testing of the gate driver for thyristors.	2
Lab 3	Test of the control system for three-phase rectifier.	2
Lab 4	The test of the control of three-phase AC -AC voltage regulator.	2
Lab 5	Tests of the control system for three-phase inverter.	2
Lab 6	Tests of the control system for three-phase PWM inverter.	2
Lab 7	Tests of the control system for resonant inverter.	2
Lab 8	Crediting with grade.	1
Total hours:		15

TEACHING TOOLS USED

- N1. Informative lectures using presentation slides.
 N2. Measurement Laboratory.
 N3. Consultation.
 N4. Individual work, self-study.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation <small>F - forming (during semester) P - concluding (at semester end)</small>	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 PEK_K01	Oral exam.
P(W)	$P=0,4 \cdot F1 + 0,6 \cdot F2$	
F1(L)	PEK_U01 PEK_U02 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 conducted laboratory measurements.
P(L)	$P=0,25 \cdot F1 + 0,25 \cdot F2 + 0,5 \cdot F3$	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

- | |
|---|
| <ul style="list-style-type: none">[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:

- | |
|--|
| <ul style="list-style-type: none">[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

Leszek Pawlaczyk, leszek.pawlaczyk@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT ARR043228 - Control of static converters 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_W12	C.1 C.2	Lec1 Lec4	N.1 N.3 N.4
PEK_W02	S2AMPU_W12	C.2 C.3	Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14 Lec15	N.1 N.3 N.4
PEK_W03	S2AMPU_W12	C.1 C.2	Lec3 Lec4 Lec5 Lec6 Lec7 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14	N.1 N.3 N.4
PEK_U01	S2AMPU_U11	C.1 C.2 C.3	Lab2 Lab3 Lab4 Lab5 Lab6 Lab7	N.1 N.2 N.3 N.4
PEK_U02	S2AMPU_U11	C.3	Lab2 Lab3 Lab4 Lab5 Lab6 Lab7	N.1 N.2 N.3 N.4
PEK_U03	S2AMPU_U11	C.2 C.3	Lab2 Lab3 Lab4 Lab5 Lab6	N.1 N.2 N.3 N.4
PEK_K01	K2AiR_K06	C.1 C.2 C.3	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14 Lec15 Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.1 N.2 N.3 N.4