FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Przekształtniki energoelektroniczne w układach zasilania i sterowania**
Name in English:	**Power converters in supply and control system**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Industrial Electrical Engineering**
Level and form of studies:	**2nd level, part-time**
Kind of subject:	**obligatory**
Subject code:	**ELR053269**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	22		22		
Number of hours of total student workload (CNPS):	120		60		
Form of crediting:	examination		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	4		2		
including number of ECTS points for practical (P) classes :			2		
including number of ECTS points for direct teacher-student contact (BK) classes:	2.80		1.40		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. It has a basic knowledge of the principles of semiconductor devices and power electronic systems.
2. He knows the basic methods of mathematical description of power converter systems and their control systems.
3. Understands and is able to describe the basic physical processes occurring during the conversion of electrical energy by means of static converters.
4. Is able be used to analyze the mathematical apparatus steady-state and transient in linear and nonlinear electric circuits which contain passive and active element.
5. He can effectively apply the knowledge in the field of automation for analysis of system operation control of power converters.
6. He understands the need for continuing education and professional skills developments.
7. It has a sense of responsibility for their own work.

SUBJECT OBJECTIVES

C1. Acquaint the student with the topology power converters used in electrical equipment.
C2. To acquaint the student with the basic mathematical models of static converters used in supply systems.
C3. To acquaint the student with the basic control systems for power electronic converters.
C4. To acquaint the student with elementary methods for the analysis of complex dynamical systems consisting of: power converters, input and output filters, and circuits of the inverter control.
C5. The acquisition by the student practical skills to connect systems and circuits of power electronic converters.
C6. Getting Acquainted students with the basic characteristics of the real power electronics systems.
C7. Acquiring basic skills to apply the measurement technique for determining the characteristics of power converters.
C8. Acquiring the ability to develop research results, their interpretation and critical evaluation.

SUBJECT LEARNING OUTCOMES	
relating to knowledge:	
PEU_W01	It has a knowledge of the principles of operation of power converter in power supply systems AC and DC.
PEU_W02	He understands the physical principles of electrical energy conversion in complex systems consisting of: the supply network, power converters and load of converters. Knows the basic mathematical models of power converters.
PEU_W03	It has an elementary knowledge of the principles of magnetic components used in static converters. Knows the principles of digital and analog control of power converters.
relating to skills:	
PEU_U01	He can connect basic measurement systems for power converters.
PEU_U02	He can connect basic measurement systems for power converters.
PEU_U03	He can verify the results of measurements with theoretical knowledge and execute critically evaluate the knowledge of mathematical models of static converters.
relating to social competences:	
PEU_K01	He can verify the results of measurements with theoretical knowledge and execute critically evaluate the knowledge of mathematical models of static converters.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours:**
Lec 1	An Introduction. Basic supply DC and AC. Power Supply DC. Linear voltage regulator. Continuous converter models.	2
Lec 2	Switching power supply DC - DC converters with pulse width modulation. Step-down and Step–up converters. Operation in continuous and discontinuous currents mode.	2
Lec 3	Switching regulators. Single-ended isolated flyback regulators. Single-ended isolated forward regulators. Comparison of power switching supplies.	2
Lec 4	AC supply converters. Basic topologies. AC converters with pulse width modulated.	2
Lec 5	Power supplies input circuits: rectifiers, filters the input. Basis of design and choice of components for converters. The magnetic elements switching power supplies. Filters and Reactors for inverters,transformers for pulse converters. Real magnetic components of switching power supplies. Chokes for filters and inverters, pulse transformer transformers.	2
Lec 6	Resonant converters and quasi-resonant used in power systems. Basic topologies.	2
Lec 7	Power factor correction circuits for rectifie.	2
Lec 8	Automatic control of output signals of converters. Basic method of synthesis of closed control systems output parameters of converters. Analog and digital control systems for power converters.	2
Lec 9	EMI effects of power converters. Basic methods of reducing interference.	2
Lec 10	The main fields of applications of power supplies.	2
Lec 11	Mathematical modeling of power converters consisting of ideal and real elements.	2
	Total hours:	**22**

Form of classes - laboratory		**Number of hours:**
Lab 1	Introduction. The organization of classes. Conditions for course credition.	2
Lab 2	Research of power semiconductor devices.	2
Lab 3	Research the characteristics of thyristor voltage regulators. Research the characteristics of three-phase voltage regulator.	2
Lab 4	Research the characteristics of thyristor phase-controlled rectifier with output filter. Examination of the characteristics of a thyristor rectifier six pulse for certain types of output filters	2
Lab 5	Research the characteristics of six-pulse rectifier, and its impact on the mains.	2
Lab 6	Research the characteristics of resonant converter DC / DC.	2
Lab 7	Test of forward converter. Test of pulsed DC power supply.	2
Lab 8	Research single-phase inverter with closed-loop control.	2
Lab 9	Study of transistor inverter with PWM with output filter.	2
Lab 10	Test of linear DC power supply.	2
Lab 11	Summary of the laboratory. Credit of the laboratory.	2
	Total hours:	**22**

TEACHING TOOLS USED
N1. Lecture using audio-visual presentation. N2. Individual work, self-study. N3. Consultation. N4. Laboratory exercises carried out for bench laboratory. N5. Self-prepare for laboratory classes.

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

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] L. Pawlaczyk, Z. Załoga Energoelektronika. Ćwiczenia laboratoryjne. Oficyna Wydawnicza Politechniki Wrocławskiej 2005. [2] Barlik R., Nowak M.: Technika tyrystorowa. Warszawa WNT 1994. [3] Januszewski S., Świątek H., Zymmer K.: Półprzewodnikowe przyrządy mocy. Warszawa WKŁ 1999. [4] Frąckowiak L., Januszewski S.,: Energoelektronika część 1. Wydawnictwo Politechniki Poznańskiej.2001. [5] Frąckowiak L.: Energoelektronika część 2. Wydawnictwo Politechniki Poznańskiej.1998 **SECONDARY LITERATURE:** Piróg S.: Energoelektronika. Kraków Wydawnictwo AGH 1998. [2] Tunia H., Winiarski B.: Podstawy energoelektroniki. Warszawa WNT 1987 [3] O. Ferenczi: Zasilanie układów elektronicznych, WNT, Warszawa 1989 [4] P. Horowitz, W. Hill: Sztuka elektroniki, WKŁ 2009

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