

FACULTY OF ELECTRICAL  
ENGINEERING**SUBJECT CARD**

Name in Polish: **Badanie i poprawa jakości energii elektrycznej**  
 Name in English: **Assessment and Improvement of Power Quality**  
 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: **ARR043309**  
 Group of courses: **NO**

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

**PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES**

1. He or she has basic knowledge in the field of linear circuits with sinusoidal waveforms. He knows the rules for creating circuit models and their mathematical description.
2. He or she has knowledge in the analysis of transients in linear electric circuits.
3. He has a basic knowledge of metrology and measurement units, knows basic metrological characteristics of measuring instruments, are knowledgeable about the design of measurement known calculation methods used in developing the measurement results, a knowledge of the latest measurement technology
4. He or she is able to do basic measurements of electrical devices using analog and digital oscilloscope. Can set on the basis of measurements of nonlinear characteristics of the elements. Able to present the results in the form of numerical tables and graphics to make their interpretations and draw conclusions

**SUBJECT OBJECTIVES**

- C1. Understanding the concepts of electromagnetic compatibility
- C2. Understanding the principles of interaction between the elements of the power system
- C3. Knowledge of voltage quality parameters, evaluation of the impact of power quality on loads and the impact on the quality of the loads
- C4. Knowing regulations and standardization of components which improve power quality
- C5. Getting the practical skills in the assessment of power quality and surge protection.
- C6. Acquisition and consolidation of social skills including emotional intelligence skills involving the cooperation of a group of students with a view to effective problem solving. Responsibility, honesty and fairness in the procedure observance force in academia and society.

## SUBJECT EDUCATIONAL EFFECTS

*relating to knowledge:*

- PEK\_W01 He or she knows the key concepts in the field of electromagnetic compatibility He has extensive knowledge in the field of power quality.
- PEK\_W02 He or she knows the power requirements of the law and regulations relating to electromagnetic compatibility standards - in particular the power quality
- PEK\_W03 He or she has knowledge of the location and control the interference sources and their affect on the device and knows the methods of overvoltage protection, methods to improve the power quality and ways to reduce disturbances

*relating to skills:*

- PEK\_U01 He can determine and evaluate the power quality parameters
- PEK\_U02 He knows the procedure for carrying out the immunity tests of the loads (equipment) on power system disturbances
- PEK\_U03 He or she has the skills to assess the disturbances emissions from loads

*relating to social competences:*

- PEK\_K01 He or she is aware of their own responsibility for their work and a willingness to comply with the principles of teamwork. He searches information and its critical analysis, properly identifies and resolves the dilemmas of working in the profession

## PROGRAMME CONTENT

Form of classes - lecture		Number of hours:
Lec 1	Electromagnetic Compatibility.Definitions of parameters determining the power quality - the conditions of measurement, presentation the impact of the distortion on electric loads	2
Lec 2	Power quality standards	2
Lec 3	Distortion interference with power supply system. Methods of reducing the voltage distortion - examples	2
Lec 4	Measurement methods of harmonics and interharmonics	2
Lec 5	Voltage dips,surge and voltage variation	2
Lec 6	Power in system with nonsinusoidal current and voltage	2
Lec 7	Electromagnetic Compatibility in radio frequency range. Electrostatic discharge (ESD) Fast transients (BURST) and high - energy surges (SURGE)	2
Lec 8	Test	1
Total hours:		<b>15</b>

Form of classes - laboratory		Number of hours:
Lab 1	Presentation of the safety rules and principles of assessment laboratory. Presentation of laboratory	2
Lab 2	Voltage quality - measurement of voltage variation, frequency, unbalance, dips, and short interruption, harmonics and interharmonics, mains signalling voltage	2
Lab 3	Current and voltage waveforms analysis - determining of harmonics and interharmonics contents	2
Lab 4	Testing of nonlinear loads influence on waveform distortion	2
Lab 5	Voltage variation, dips and short interruption immunity tests	2
Lab 6	Measurement of harmonics emission of electric equipments	2
Lab 7	Spectrum Analyzer	2
Lab 8	Pass, Summary	1
Total hours:		<b>15</b>

## TEACHING TOOLS USED

- N1. Traditional Lecture with audio-visual techniques
- N2. Laboratory run in the traditional manner of exercises + student groups, a report

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation <i>F – forming (during semester)</i> <i>P – concluding (at semester end)</i>	Educational effect number	Way of evaluating educational effect achievement
F1(W)	PEK_W01 PEK_W02 PEK_W03	test
P(W)	P=F1	
F1(L)	PEK_U01 PEK_U02 PEK_U03 PEK_K01	Assessment of implementation of tasks during laboratory classes
P(L)	P=F1 average mark	

PRIMARY AND SECONDARY LITERATURE	
<b>PRIMARY LITERATURE:</b>	
[1] Kowalski Z., Jakość energii elektrycznej, Wydawnictwo Politechniki Łódzkiej, Łódź 2007 [2] Bagginì A., Handbook of Power Quality, John Wiley&Sons, Ltd, 2008 [3] PN-EN 50160:2010, Voltage Characteristics in Public Distribution Systems [4] Rozporządzenie Ministra Gospodarki w sprawie szczegółowych warunków funkcjonowania systemu elektroenergetycznego. Dz. U. Nr 93 z dn. 04.05.2007r [5] Henry W. Ott, Electromagnetic Compatibility Engineering, John Wiley & Sons, Inc., Hoboken, New Jersey 2009 [6] Hanzelka Zb., Jakość dostaw energii elektrycznej. Zaburzenia wartości skutecznej napięcia . Wyd. AGH , Kraków 2013	
<b>SECONDARY LITERATURE:</b>	
[1] IEEE Std 1159-2009: IEEE Recommended Practice for Monitoring Electric Power Quality [2] Dugan R.C., Mc Gramaghan M.F., Beaty H. W., Santoso S: Electrical Power System Quality, Wyd 2. MC Graw-Hill 2002 [3] Machczyński W., Wprowadzenie do kompatybilności elektromagnetycznej. Wydawnictwo Politechniki Poznańskiej 2010	

SUBJECT SUPERVISOR
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**MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT  
ARR043309 - Assessment and Improvement of Power Quality  
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Control Engineering and Robotics**  
AND SPECIALIZATION **Automation of Machines, Vehicles and Apparatus****

<b>Subject educational effect</b>	<b>Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)</b>	<b>Subject objectives</b>	<b>Programme content</b>	<b>Teaching tool number</b>
PEK_W01	S2AMPU_W13	C.1 C.2 C.3	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7	N.1
PEK_W02	S2AMPU_W13	C.1 C.2 C.3	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7	N.1
PEK_W03	S2AMPU_W13	C.1 C.2 C.3 C.4	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7	N.1
PEK_U01	S2AMPU_U12	C.4 C.5 C.6	Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.2
PEK_U02	S2AMPU_U12	C.2 C.4 C.5 C.6	Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.2
PEK_U03	S2AMPU_U12	C.2 C.5 C.6	Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.2
PEK_K01	K2AiR_K07	C.6	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.1 N.2